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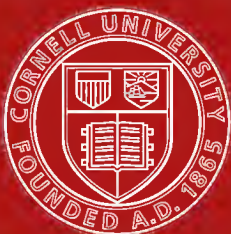
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THE
BOOK OF THE FARM
DIVISION IV.

Wherefore come on, O young husbandman !
Learn the culture proper to each kind.

VIRGIL.

THE
BOOK OF THE FARM

DETAILING THE LABOURS OF THE

FARMER, FARM-STEWARD, PLOUGHMAN, SHEPHERD, HEDGER,
FARM-LABOURER, FIELD-WORKER, AND CATTLE-MAN

BY

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FOURTH EDITION

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'POLLED CATTLE,' 'HEREFORD CATTLE,' ETC., ETC.

IN SIX DIVISIONS

DIVISION IV.

WILLIAM BLACKWOOD AND SONS
EDINBURGH AND LONDON
MDCCCXC

CONTENTS OF DIVISION IV.

PRACTICE—SPRING (*continued*).

PLANTING POTATOES.	PAGE		PAGE
Land for potatoes	261	Distributing dung from carts	268
Tillage for potatoes	261	Spreading dung	268
Manuring potatoes	261	Planting the seed	268
Mechanical influence of dung on		Planting-machines	268
potatoes	261	Conveying seed to the planters	269
Typical dressings	262	Sowing the artificial manure	269
Quickly acting manures for pota-		Covering in	269
toes	262	Complete planting as it proceeds	269
Dr Aitken on manuring potatoes	262	Danger of leaving dung and seed	
Form of manures for potatoes	262	uncovered	269
Nitrogen for potatoes	262	Width of potato-drills	269
Potash for potatoes	262	Width and depth of sets	270
Too much potash injurious	263	Experiments with late planting	270
Proportion of manurial elements	263	An Ayrshire practice	270
Rothamsted experiments with pota-		The lazy-bed system	270
toes	263	Culture after planting	271
Farmyard dung	263	Hand-hoeing	271
Dung and supersphosphate	263	Varieties of potatoes	271
Dung, superphosphate, and nitrate		The wild potato	272
of soda	263	Introduction into Europe	273
Artificial manures	263	Distribution of the potato	273
Conclusions	263	Selecting varieties for different	
Slow exhaustion of dung	264	soils	273
Residue of dung	264	Varieties in use	273
Dr Gilbert on dung for potatoes	264	Good potatoes	274
A practical lesson	265	The boxing system of preparing	
Potash for potatoes	265	potato sets	274
Application of manure for potatoes	265	Boxes	274
Details of planting	265	Tubers boxed	274
Potato-seed	265	Cut seed unsuitable	274
Preserving sets	266	Boxing the seed	275
Quantity of seed per acre	266	Storing boxes	275
Planting on the flat	266	Planting boxed seed	275
The drill system	266	Seed per acre	275
Autumn dunging	266	Advantages of the system	275
Spring tillage with autumn dung-		Raising new varieties of potatoes	276
ing	267	New varieties resisting disease	276
Spring dunging	267	Potato-seeds	276
Carting dung for potatoes	267	Seedless varieties	276
Details of planting	267	Cross-fertilisation	276
Single v. drill plough	267	Male and female organs	277
Filling dung	268	Process of cross-fertilising	277
		Marking fertilised plum	278

Ripe plums	278
Securing and storing seeds	278
Sowing the seed	279
The young seedlings	279
Lifting and selecting	279
Storing	279
Period of development	279
Second year	279
Third year	280
Retain only superior varieties	280
Need for new varieties	280

HORSES IN SPRING.

The foaling season	281
Insurance against foaling risks	281
Abortion in mares	281
Working mares in foal	281
Foaling-box	281
Watching mares at foaling	282
Symptoms of foaling	282
Assistance in foaling	282
Difficult foaling	282
Reviving an exhausted mare	282
Support to mare's belly	283
Mare's udder	283
After foaling	283
Cleansing	283
After-straining	283
Attention to the foal	283
Reviving weak foals	283
Rearing foals	283
Coaxing a backward mare	283
Intelligent treatment of mares	284
Extreme measures with obstinate mares	284
Beginning the foal to suck	284
Extra food for foals	284
Nursing motherless foals	285
Rearing foals by hand	285
Cow's milk for foals	285
Bean-milk and cow's milk for foals	285
Linseed, bean-meal, and milk for foals	285
Supplementing the mother's milk	285
Health of the foal	286
Housing mares and foals	286
Working nurse-mares	287
Feeding nursing-mares	287
Weaning foals	288
Feeding foals at weaning-time	288
Attention to the mare at weaning-time	288
The mating season	289
Feeding and treatment of stallions	289
Exercise for stallions	289
Number of mares to one stallion	289

SWINE IN SPRING.

Farrowing of sows	290
Preparation for farrowing	290
Period of gestation	290

Symptoms of farrowing	290
Litter for young pigs	290
Treatment of the sow and produce in farrowing	291
The after-birth	291
Assistance in farrowing	291
Pigs biting sow's udder	291
Weaning pigs	291
Housing brood-sows	292
Prolificacy in swine	292

POULTRY IN SPRING.

Hatching	292
Laying season	292
Selecting sitting hens	292
Selecting eggs for hatching	293
Sex of eggs	293
Number of eggs in a setting	293
Brood-nest	293
Hatching compartment	293
Training hens to sit	294
Time for setting	294
Feeding sitting hens	294
Testing fertility of eggs	294
Chicks appearing	294
Feeding chicks and hens	294
Care of the young brood	295
Open-air laying and hatching	295
Hatching and rearing turkeys	295
Care of turkey-poults	296
Food for turkey-poults	296
Turkeys as layers	297
Turkey hens as mothers	297
Hatching geese	297
Geese as layers	297
Produce in eggs	297
Setting a goose	297
Feeding a sitting goose	298
The gander	298
Period of incubation	298
Care of the goslings	298
Feeding goslings	298
Artificial hatching and rearing of geese	299
Hatching ducks	299
Hens as foster-mothers for ducks	299
Care of ducklings	299
Duck-rearing in Aylesbury	300
Hatching pea-fowls	300
Hatching pigeons	300
A plea for poultry	300
Fowls in town	301
Sand, dust, and water for fowls	301
Facts about eggs	301
Phenomena of incubation	301
Testing eggs for chicks	302
Embryo of the chicks	302
Formation of feathers	302
Artificial hatching	303
Caponing	303
Temperature for incubation	303
Poultry dung	303

PARING AND BURNING.

Object of paring and burning	304	Paring-plough	306
Advantages of paring and burning	304	Expeditions paring	307
Disadvantages of paring and burning	305	Time for the process	307
Useful on certain soils	305	Drying the sods	307
Lime essential	305	Process of burning	307
Paring and burning condemned	305	A good plan	307
Methods of paring and burning	305	Cooling the heaps	308
Flaughter-spade	305	The ashes	308
		Time to plough in ashes	308
		Changes involved in burning soil	308

PRACTICE—SUMMER.

The weather	309	HAY-STACK FOR HORSES.	
Atmospherical complications in summer	309	Taking in hay	316
Dew	309	Hay-knife	317
Cause of dew	309	Method of cutting a hay-stack	317
Beneficial influence of dew	309	Hay for young horses	317
Measuring dew	309		
Heavy dews foretelling rain	310	FLAX CULTURE.	
Thunderstorms	310	Soil for flax	318
Lightning	310	Rotation for flax	318
Motion of electricity	310	Tillage for flax	318
Lightning-conductors	310	Clod-crushers	318
Utility of thunderstorms	310	Seed	319
Hail in summer	311	Norwegian harrow	319
Sleet	311	Sowing flax	319
Summer rain	311	Grass seeds with flax	320
Rain without clouds	311	Top-dressing flax	320
Summer wind	311	Weeding flax	320
Evaporation	312	Pulling, steeping, and drying flax	321
Light	312	Pulling	321
Heat of the sun	313	Method of pulling	321
Summer weather prognostics	313	Rippling	321
Summer proverbs	313	The bolls	321
Rainbow prognostics	314	Steeping	321
Twilight	314	Drying	322
Daybreak	314	Lifting	322
		Scutching	323
SUMMARY OF SUMMER FARM-WORK.		Growing and saving seed	323
Calendar and agricultural seasons	314	Selecting seed	323
Root sowing	314	Old seed	323
Fat cattle	315	Manurial value of flax-pond water	323
Fat sheep	315	Flax-growing in Great Britain	323
Repairing fences	315	Formerly grown	323
Grazing stock	315	Recent trials	323
Horses	315	Outlet for flax straw	324
Haymaking	315	Uses of flax seed	324
Weaning lambs	315	Uses of flax straw	324
Forage crops	315	Flax straw for paper-making	324
Dairying	315	Experiments in flax-growing	324
Weeds	315	Advantages of flax over corn	325
Insect attacks	315	Disadvantages of flax over corn	325
Fallow land	315	Loss of the market for flax straw	325
Top-dressing	315	Will the market return ?	326
Hours of labour	315	Flax straw displaced	326
Rest	316	The flax plant	326
The farmer's duties	316		
The farmer's holiday	316	HEMP.	
		Method and objects of its culture	327

Preliminary cleaning	382
Thinning	382
After hoeing	382
Transplanting mangels	382
Injuring mangel plants	382
Varieties of mangels	382
Produce of mangels	382
Diseases and insect attacks	383

KOHL-RABI, CARROTS, AND PARSNIPS.

Kohl-rabi	383
Advantages of kohl-rabi	383
Uncertain crop	383
Soil for kohl-rabi	383
Tillage and manuring	383
Planting or sowing	383
Time for sowing	384
Thinning and hoeing	384
Produce	384
Varieties	384
Carrots	384
Carrot-tops as food for stock	384
Analysis	384
Storing	385
Soil for carrots	385
Tillage and manuring	385
Cleaning for carrots	385
Sowing carrots	385
Preparing carrot seed	385
Thinning carrots	385
Carrots and rye	386
Varieties	386
Produce	386
Parsnips	386
Forage crops	386

SUMMER CULTURE OF CORN CROPS.

Culture of beans	387
Beans in raised drills	387
Horse-hoeing	387
Hand-hoeing	387
Rows on the flat	387
No harbour to weeds	387
Broadcast	387
Cropping beans	387
Culture of peas	387
Culture of wheat	388
Autumn wheat	388
Over-luxuriance in autumn wheat	388
Cropping rank wheat	388
Soil and over-luxuriance	388
Weeding	388
Hoeing drilled wheat	389
Horse-hoeing	389
Top-dressing wheat	389
Flowering season	389
Culture of barley	390
Removing charlock	390
Top-dressing barley	390
Culture of oats	390
Culture of rye	390

CROSS-FERTILISATION OF GRAIN.

Degeneracy of grain	391
Mr Knight's efforts	391
Mr Raynbird's experiments	391
Mr P. Shirreff's experiments	391
Recent experiments	391
Process of cross-fertilisation	391
Organs of fructification	392
Male and female influence	392
Details of the process	392
Time of natural fecundation	393
Good weather essential	393
Period for crossing	393
First year usually unsatisfactory	393
Percentage of success	394
Protecting the ears	394
After culture	394
Details of Messrs Carter's experi- ments	394

INSECT PESTS.

Insect injury to crops	395
Services of entomologists	395
Bean aphid	395
Bean-seed weevils	396
Beet carrion beetle	396
Mangel-leaf maggot	396
Corn aphid	398
Daddy longlegs	398
Corn-fly	398
Corn saw-fly	399
Hessian fly	399
Wheat-midge	401
Wire-worm	402
Ear cockles	402
Hop-fly	403
Hop aphid	403
Wire-worm in hops	404
Slugs	404
Cone-fly	404
Hop-flea	405
Red spider	405
Thousand legs	405
Pea and bean weevils	406
Turnip-fly	408
Green fly, &c.	410
Dart moth maggot	410
Turnip saw-fly grub	411
Weevils, &c.	411
General observations	412

FUNGOID ATTACKS ON CROPS.

Corn mildew	414
Means of prevention	415
Bunt of wheat	416
Prevention	416
Disinfecting seed	416
Smut of corn	416
Propagation of smut	417
Prevention	417

Fungoid attacks on clover	417
Clover dodder	417
Potato disease	417
Cause	417
Weather and the disease	417
Recognising the fungus	418
The fungus in its active state	418
How the fungus passes the winter	421
Remedial measures	422
Cure	422
Preventive measures	422
Protective moulding	422
Merits of the system	423
Mr Speir's experiments	423
Other experiments	424
Bending the tops	424
The system little practised	424
The main difficulty	424
High moulding plough	424
Antiquity of the system	424
Cutting off the tops	424
Disease-resisting varieties	425
Conditions of culture	425
Humidity necessary for the fungus	425
Dry elevated land for potatoes	425
Sunshine and dry winds	425
Manure	425
Destroying potato refuse	426
Care of potato seed	426
Other potato diseases	426
Turnips	427
"Finger-and-toe" or sporting	427
Cause	427
Sporting	427
Remedies	427
Finger-and-toe distinct from an- bury	427
Anbury or club-root	427
Features and symptoms	427
Cause	427
M. Woronin's discoveries	428
Mr A. S. Wilson's experiments	428
Contributing influences	429
Manure and anbury	429
Varieties of turnips and the disease	429
Preventive measures	429
Mildew	429
Hops	430
Mildew	430
 LIVE STOCK IN SUMMER.	
Preparing pasture for stock	430
Removing surface stones	430
Rolling grass land	431
Repairing fences	431
Hedges	431
Stone fences	431
Repairing gates	431
Fixing gate-post	431
Water on pastures	432
Quantity of water for stock	432
Running water	432
Pump water	432
Rain-water ponds	432
Reliability of ponds	433
Care of ponds	433
Carting water	433
Rubbing post	433
Salt on pastures	433
Weeds on pastures	433
 SHEEP IN SUMMER.	
Pasturing sheep on arable farms	434
Ewes and lambs	434
Scarcity of grass	434
Attention to ewes and lambs	434
Summer treatment and disposal	435
Summer fattening	435
Store sheep in summer	435
Shifting sheep on pastures	435
Water for sheep	435
Salt for sheep	436
Maggot-fly	436
Unclipped sheep falling	436
Ravens injuring lambs	436
Pasturing sheep on hill-farms	436
Stocking on hill-farms	436
Ewes and lambs	436
Pasture plants on hilly ground	437
Heather-burning	437
Method in burning	437
Old method of burning	437
Modern method	437
Sheep-washing	438
Objects in washing	438
Opposition to washing	438
Study the market	438
Methods of washing	438
Force required	439
Process	439
Duty of the shepherd	439
Hours for washing	440
Effect on the sheep	440
Speed	440
After washing	440
Interval before clipping	440
Another method	440
Bath washing	440
Hungarian method	440
Australian methods	441
Lambs	441
Shearing of sheep	441
Time of shearing	441
Clipping-place	442
Clipping-floor	442
Force at clipping	442
Wool-shears	442
Sharpening wool-shears	442
Avoiding injury to the sheep	442
Shear-cuts	443
Method of clipping	443
Clipping with the left hand	443

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HORSES IN SUMMER.

Summer leisure	469
Pasturing work-horses	469
Soiling horses	469
Pasturing young horses	470
Peculiarities of the horse in grazing	470
Horses injured by green food	470

DAIRY WORK.

The dairy	471
Situation of the dairy	471
Milk-room in dwelling-house	471
A medley in the milk-room	471
Separate dairy	472
Compartments in the dairy	472
Verandah	472
Finishings of the dairy	472
Dampness to be avoided	472
Dairy-sink and wash-tank	472
Milk-shelves	472
Temperature of the dairy	472
Importance of temperature	473
Dairy utensils	473
Power for the dairy	473

Milk.

Composition	474
Butter-fat	474
Composition of milk from different breeds	474
Testing percentage of cream	474
Fat-globules	475
Casein	475
Milk-sugar	475
Albumen	475
Weight and specific gravity	475
Milk statistics	475
Weighing milk	476
Purifying and preserving milk	476
Heating and cooling milk	476
Milk in sealed bottles	477
Preserving milk	477
Boracic acid as a preservative	477
Saltpetre in milk	477
Condensed milk	477
Destination of the milk	478
Consumption and selling of whole-milk	479
Milk-selling trade	479
Cleaning dairy utensils	479
Milk for calves	479
Cream-raising	479
Principles of cream-raising	479
Methods of raising cream	479
Shallow-pan system	479
Airing cream	480
Disadvantages of the shallow-pan system	480
Temperature and shallow pans	480
Shallow pans	480

Zinc unsuitable	481
Milk-sieve	481
Skimmer	481
Cream-jar	481
Shelves	481
Movable milk-stand	482
Deep setting	482
The Swartz system	482
The Cooley system	482
Swartz and Cooley systems compared	482
Atmospheric influence on cream	483
Ice used in summer	483
Advantages of deep setting	483
Disadvantages of deep setting	483
Devonshire scalding system	483
Method of working	483
Merits of the scalding system	483
Jersey creamer	484
Method of working	484
Merits of the Jersey creamer	484
Speedwell cream-raiser	484
Method of working	484
Method of skimming	484
Merits of the "Speedwell" system	484
Similar other methods	485
Centrifugal separator	485
Method of working	485
Power for separators	485
The "Baby" separator	486
Advantages of the separator	486
Selling cream and skim-milk	486
Separated cream	486
"Speedwell" cream	486
Preserving cream	486
Devonshire clotted cream	487
Separated milk	487

Butter-making.

Ripening cream	487
Period of ripening	487
Uniform ripening of cream	488
Artificial ripening	488
Salt in cream	488
Sweet-cream butter	488
Keeping cream sweet	489
Times of churning	489
Temperature of cream for churning	489
Churning whole-milk	489
Advantages	489
Disadvantages	489
Method	490
Continental method	490
Churns	490
Types of churns	490
Barrel churns	491
Ordinary barrel with heaters	491
End-over-end churn	491
Dashers or no dashers	492
Diaphragm churn	492
Other forms	492
Box churn	492
Holstein churn	492

Streamlet churn	493	Cheddar cheese	505
"Speedwell" crystal churn	493	Character and composition of	
Swing churn	493	Cheddar cheese	505
Important features in a churn	493	Scale of points in judging cheese	505
Churning	494	Milk	506
Preparing the churn	494	Keeping and treatment of milk	506
Accelerating churning	494	Testing ripeness of milk	506
Straining cream	494	Cream	506
Speed of the churn	494	Colouring	506
Variation in speed	495	Adding the rennet	506
Ventilation	495	Quantity of rennet	507
Stop churning	495	The curd	507
Time churning	495	Cutting	507
Sleepy cream	495	Heating	507
Butter-working	495	Firmed or "cooked"	507
Objects of working	495	Testing acidity	507
Process of washing	496	Draining	507
Salting	496	Packing	508
Details of working	497	Milling	508
Centrifugal butter-drier	497	Salting	508
Butter rolls and pats	497	Pressing	508
Hand-working objectionable	498	Smooth skin	508
Packing into crocks	498	Hot bath	508
Prepared preservatives	498	Curing	508
Fresh butter	498	Curing-room	509
Colouring butter	499	Other methods	509
Butter extractor	499	Mr Gibbons's system	509
<i>Cheese-making.</i>			
Apartment for cheese-making	500	Stilton cheese	511
Utensils	500	Characteristics	511
Vat	500	Climate and soil	511
Circular cheese-tub	501	Method	511
Heating curd	501	Cheshire cheese	512
Curd-mill	501	Other English varieties	512
Presses	501	Cream cheese	513
Shelves	502	Skim-milk cheese	513
Rennet	502	Keeping milk for cheese-making	513
Testing rennet	502	Different makings of curd	513
Action of rennet	503	Foreign cheeses suitable for Britain	514
Acidity	503	Associated butter and cheese making	519
Acidity, ripening, and keeping	503	Creameries	519
Artificial souring of milk	503	Butter-blending house	519
Artificial souring curd	504	Dairy factory	520
Measuring acidity	504	Origin and development of dairy	
		factories	520
		Utility of the factory system	521

LIST OF ILLUSTRATIONS IN DIVISION IV.

ANIMAL PORTRAITS.

	PLATE
DRAUGHT MARE	7
CLEVELAND STALLION	8
SHORTHORN COWS	12
SUSSEX COW	16
AYRSHIRE COW	19
JERSEY COW	22
COTSWOLD RAM	25
SUFFOLK RAM	31

GENERAL ILLUSTRATIONS.

SPRING—continued.

FIG.	PAGE	FIG.	PAGE
320. Scotch drill-plough	267	340. Crosskill's clod-crusher	318
321. Potato hand-basket	269	341. Side view of one wheel of the clod-crusher	319
322. Triple drill-plough	270	342. Norwegian harrow	319
323. Section of a flower	277	343. Square mode of planting hops	329
324. Horizontal section	277	344. Quincunx mode of planting hops	329
325. Vertical section of a potato-blossom	277	345. Barclay and Sellar's patent digger or cultivator	342
326. Stamen discharging pollen	277	346. Digging and pulverising plough	343
327. Pistil with pollen-grains on top	277	347. Drill-plough	346
328. Pollen-grain magnified	278	348. Farm tip-cart	349
329. Vertical section of style and stigma magnified	278	349. Tip-cart going down hill	350
330. Potato-plum	278	350. Cart tipped	350
331. Plum cut, showing seeds inside	278	351. Dung-spreading machine	351
332. Potato-seed magnified	278	352. Turnip drill-sower	351
333. Sties for brood-sows under one roof	292	353. Seed and water drill	352
334. Common spade	305	354. Scotch drill-scurfler or horse-hoe	366
335. Flaughter-spade at work	306	355. English horse-hoe or turnip-scurfler	366
336. Paring-plough	306	356. Horse-hoe and harrow	366
337. Paring-sock	306	357. Turnip horse-hoe	367
338. Hay-knife	317	358. M'Kidd's drill-scarifier	367
339. Lightning hay-knife	317		

359. Dickson's turnip-cleaner	367	407. New-clipped sheep	446
360. Briggs's turnip-thinner	367	408. Rolling a fleece of wool	448
361. Wardlaw's turnip-thinner	368	409. Fleece of wool rolled up	449
362. Improved hand-hoe	368	410. White-shouldered wool-moth	449
363. Turnip hand-hoe	368	411. Weighing and packing wool	450
364. Weed-hook	388	412. Punching-nippers for sheep	455
365. Steeage horse-hoe	389	413. Buisting-iron for sheep	455
366. Organs of fructification in wheat	392	414. Branding-iron for sheep and cattle	455
367. Organs of fructification in wheat	393	415. Opened bull's ring	465
368. Bean aphid	395	416. Closed bull's ring	466
369. Beet-fly	397	417. Swivelled spring-hook	467
370. Large white cabbage butterfly	397	418. Sandringham dairy herd recorder	476
371. Small white cabbage butterfly	397	419. Temperature can	476
372. Grain aphid	398	420. Lawrence's refrigerator	477
373. Daddy longlegs	398	421. Scaldier and cooler	478
374. Ribbon-footed corn-fly	399	422. White Wedgewood-ware milk-dish	480
375. Corn saw-fly	399	423. Enamelled iron milk-pan	480
376. Hessian fly	399	424. Iron milk-pan	481
377. Hessian fly attack on barley	400	425. Milk-sieve	481
378. Chlorops	400	426. Cream-skimmer	481
379. Wheat-midge	401	427. Cream-jar	481
380. Wire-worms	402	428. Movable milk-stand	482
381. False wire-worms	402	429. Swartz system	482
382. Ear cockles	403	430. Cooley system	483
383. Tulip-rooted oat plant infested by eelworm	403	431. Devonshire cream stove	483
384. Hop aphid	404	432. Jersey creamer	484
385. Hop-jumper	405	433. Speedwell cream-raiser	484
386. Red spider	405	434. Speedwell method of skimming	485
387. Onion-fly	406	435. De Laval separator	485
388. Pea and bean weevils	406	436. "Baby" separator	486
389. Colorado beetle	407	437. Speedwell cream-cooler	486
390. Death's-head moth	407	438. The "ladies'" plunge-churn	491
391. Turnip-fly	408	439. Barrel churn	491
392. The Strawsoniser at work	409	440. End-over-end churn	491
393. Turnip aphid	410	441. The "Index Diaphragm" churn	492
394. Dart moth	411	442. Charlemont churn and butter- worker	493
395. Turnip saw-fly	411	443. Box churn	493
396. Turnip saw-fly grub at work	412	444. Speedwell crystal churn	494
397. Section through a fragment of a potato-leaf	419	445. Butter-worker	496
398. Section through a fragment of old potato-leaf	421	446. "Délaitouse" centrifugal butter- drier	497
399. Anbury or club-root—early stage	427	447. Butter-beaters or boards	497
400. Secure mode of fixing the hanging- post of a field-gate	432	448. Butter-boxes	498
401. Salt-roller	433	449. Milk-vat	500
402. Washing-pool and sheep-washing	439	450. Curd-mill	501
403. Wool-shears	442	451. Single cheese-press	501
404. First stage of clipping a sheep	443	452. Double cheese-press	502
405. Second stage of clipping a sheep	444	453. Curd-knives	507
406. Third stage of clipping a sheep	445	454. Metal chesset or cheese-mould	508
		455. Wooden chesset or cheese-mould	508
		456. Curd-breaker	509



DRAUGHT-MARE.
(1840)

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CLEVELAND STALLION, "SULTAN," 667.

THE PROPERTY OF MR BURDETT-COUTTS, M.P., OF HOLLY LODGE, HIGHGATE, LONDON.



John. Sharpe. A.R.S.A.

SHORT-HORN COWS. (1840)



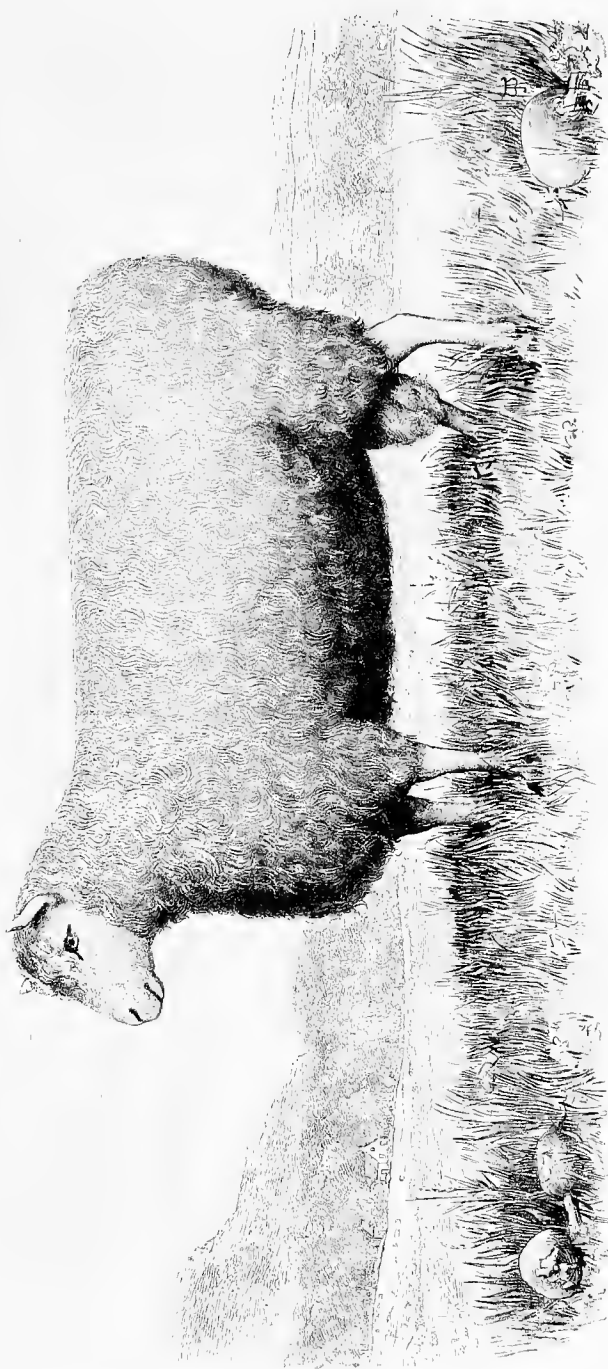
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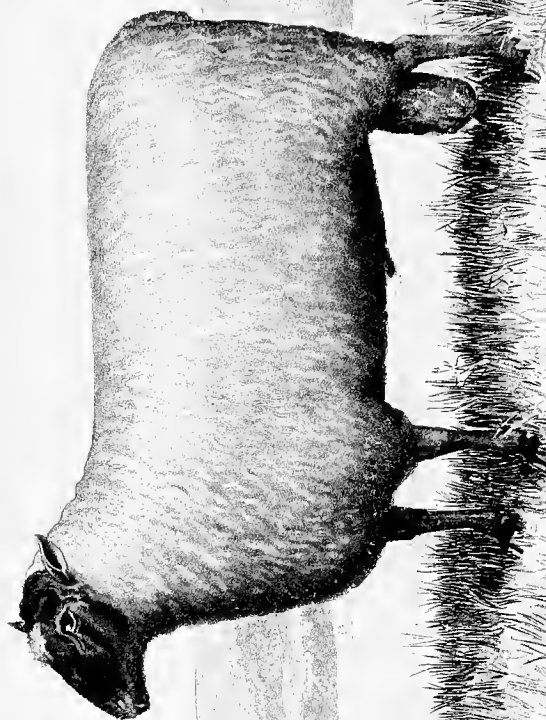




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THE PROPERTY OF RUSSELL SWANWICK, ESQ., ROYAL AGRICULTURAL COLLEGE FARM, CIRENCESTER.





SUFFOLK RAM.

THE PROPERTY OF THE MARQUIS OF BRISTOL.



PLANTING POTATOES.

As a rule the potato crop, cultivated on the fallow division of the farm, follows a crop of oats, which, in turn, had succeeded pasture. In some districts potatoes come after lea, and this many consider the best place in the rotation for the crop.

Land for Potatoes.—Potatoes thrive best on light dry, friable, or sandy loams. They also do well upon virgin soils and mossy or turfy land, but seldom give good results on strong, tenacious clays, with retentive subsoil.

Tillage for Potatoes.—The stubble land intended for potatoes is ploughed early in the autumn, so that it may have the full benefit of the ameliorating influences of winter. Potato land should be tilled early in spring, and cleaned as well as possible. The time for *cleaning* land is usually limited in spring, so that the cleanest portion of the fallow-break should be chosen for the potatoes to occupy.

The stubble land will either have been cast in autumn, or cloven down without a gore-furrow, according as the soil is strong or light. Having been abundantly provided with gaw-cuts, to keep it dry all winter, it may be in a state to be cross-ploughed or cultivated soon after the spring wheat and beans have been sown, where either is cultivated; and where not, preparing the potato land is the earliest work in spring after the ploughing of lea. After the cross-ploughing or grubbing, the land is thoroughly harrowed with a double tine along the line of the furrow, and a double tine across it, and any weeds brought to the surface and gathered off. If the land be clean, it is then ready for drilling; if not, it should receive a strip of the grubber in the opposite direction, and again be harrowed, and any weeds gathered off.

The cross-ploughing of potato land in spring is not so extensively practised now as formerly. With deep autumn or winter ploughing less spring stirring suffices, and if the land is clean, and the soil fine and friable, rank harrows may do all that is necessary. Most likely, however, a strip of the grubber will be

beneficial; and as grubbing is a speedy operation it need not long delay the planting.

The grubber indeed is a better implement for stirring the soil, under the circumstances, than the plough, as it will retain the dry surface still uppermost, and bring to the surface the weeds that have entangled themselves about the tines. The time occupied in doing all this, according to the character of the weather, may be about a month, from early in March to early in April, when the potatoes should be planted.

In cultivating land for potatoes, it is important to remember that the roots and tubers should have free scope to ramify in soil.

Manuring Potatoes.

Farmyard dung is the staple manure for potatoes. Without a certain amount of dung they are seldom grown; and heavier dressings of dung are employed for potatoes than for any of the other ordinary crops of the farm. From 15 to 20 tons per acre are common quantities, and often as much as 25 to 30 tons per acre is applied.

Mechanical influence of Dung on Potatoes.—It is obvious that the potato crop cannot make immediate use of more than a small portion of the plant-food contained in these heavy dressings of dung. Farmyard manure, however, would seem to be far more to the potatoes than a source of nutrition. Its mechanical influence upon the soil has evidently a peculiarly beneficial effect on this crop. It not only opens up the soil and renders it more friable, but by the decay of the organic matter the temperature of the soil is raised, thus surrounding the potato with more kindly conditions than would have existed in the absence of dung. These heating and pulverising influences of dung are undoubtedly of great importance; and we are inclined to think that a good deal more of the value of dung as a manure lies in these functions or influences than has usually been associated with them.

Typical Dressings.—In the Lothians of Scotland, where potato-growing is a prominent feature in the system of farming, the dressing of dung ranges from 20 to 30 tons per acre—even as much as 35 or 40 tons per acre being occasionally used for an early crop. In addition to these allowances of dung, from 5 to 10 cwt. of artificial manure is applied, the latter consisting of guano, dissolved bones, superphosphate, and perhaps a little potash, or instead of guano, nitrate of soda or salts of ammonia. A dressing of 6 cwt. of artificial manure sometimes used with about 20 tons of dung, consists of 2 cwt. bone-meal, 1 cwt. vitriolised bones, $1\frac{1}{2}$ cwt. of mineral superphosphate, 1 cwt. sulphate of potash, and $\frac{1}{2}$ cwt. sulphate of ammonia. On light lands in Ayrshire, where potatoes are successfully grown for early consumption, very heavy manuring is practised. In some cases here as much as 30 tons of dung, and 12 to 15 cwt. of artificial manure, is applied per acre—the artificials consisting of 4 or 5 cwt. of kainit, and 8 or 10 cwt. of a mixture containing from 8 to 10 per cent of ammonia and 20 to 30 per cent of phosphate.

Quickly acting Manures for Potatoes.—For potatoes, manure should be supplied in a readily available form near at hand, as it is a moderately or rapid growing, feebly rooted plant. It is thus desirable that, however much dung may be applied, a certain quantity of more quickly acting manure should also be given. It may be that the dressing of dung will contain far more nitrogen, phosphoric acid and potash, than the crop of potatoes will require. Experience, however, has clearly shown, notably in the case of the Rothamsted experiments (p. 264), that only a very small portion of the plant food in the dung can be utilised by the first crop of potatoes. Thus, while the heavy dressing of dung is beneficial, partly as a source of manure and partly on account of its mechanical influence on the soil, it is necessary to apply phosphates, nitrogen, and potash, in forms in which they will be immediately available to the crop. For this purpose, bone-meal or mineral superphosphate, or both, guano, sulphate of ammonia or nitrate of soda, and kainit, are most largely used.

Dr Aitken on Manuring Potatoes.

With special reference to the experiments conducted under the auspices of the Highland and Agricultural Society, Dr A. P. Aitken writes as follows as to the manuring of potatoes:—

“The potato is a feeble rooter, and requires its manurial food to be closely within reach. In order that the tubers may be able to expand, the soil about them must be loose. Manures which keep the roots free are therefore very appropriate. There is nothing so suitable as dung for that purpose, but any very bulky manure is also good, and especially if it has a large proportion of organic matter to keep the soil warm and make a soft compressible seed-bed.

Form of Manures for Potatoes.—“The potato is not well adapted for utilising insoluble materials, and therefore any artificial manures applied with the dung should be of a soluble, or, at least, not very insoluble kind. Superphosphate is better than ground mineral phosphates or bone-meal; and even dissolved bones is rather a slow manure for this crop.

Nitrogen for Potatoes.—“The most important ingredient of a potato manure is nitrogen, and the most of it should, as has been said, be of a soluble quick-acting kind. Insoluble nitrogenous matters do not come into activity quickly enough for the wants of the crop. When dung is used, there is no better way of increasing the nitrogenous manure than by giving some *nitrate of soda* along with the dung.

“*Sulphate of ammonia* along with dung is to be avoided. It not only produces a smaller crop than the nitrate of soda, but it causes the production of an undue proportion of small tubers.

“On the other hand, if no dung is being applied to the potatoes, sulphate of ammonia is an excellent nitrogenous manure, especially in a wet season.

Potash for Potatoes.—“As regards *potash* the wants of the potato crop are peculiar. The potato plant takes away a great deal of potash; and fields on which potatoes are frequently grown very soon become exhausted of potash. This must be made good, for the potato is very dependent on potash manures. Where

much dung is used there is little need of applying extra potash manure, seeing that dung is so rich in potash; but where dung is used for the green crop, only an addition of potash salts is to be recommended, for much of the potash in dung is not very readily available.

Too much Potash Injurious.—“Where no dung is used, potash forms an exceedingly important ingredient. The limit of potash manure required for potatoes is nevertheless very soon reached; and no good but rather harm is done by overdoing the application of potash.

“It is a common practice to apply very large doses of light manures to the potato crop. Much extravagance may occur in that way, and sometimes more harm than good result. It is important in such cases that the manure should not be placed in direct contact with the sets. It should rather be applied some time before planting, and should be well incorporated with the upper layer of the soil as a general fertilising application.

Proportion of Manurial Elements.—“When no dung is used, the proportion of the manurial ingredients in a well-balanced potato manure, will be just about equal parts potash, ammonia, and phosphoric acid. When applied along with dung the potash may be diminished by half, and the nitrogen slightly increased.”

Rothamsted Experiments with Potatoes.

An interesting series of experiments upon the manuring of potatoes has been conducted at Rothamsted. The results have been fully explained by Dr Gilbert in his lectures at Oxford and Cirencester, and several of them are of considerable practical value to farmers.

Farmyard manure was tried by itself and in conjunction with nitrogenous, phosphatic, and potassic manures. The potatoes were grown on the same land every year, and on this account the results cannot be unreservedly applied to potato culture under ordinary rotation farming. Still some lessons of importance may be learned.

Farmyard Dung.—This was applied at the rate of 14 tons per acre every year, and the average yield for six years was $5\frac{1}{4}$ tons per acre—just over 3 tons more

than the plot which had no manure of any kind in those six years.

Dung and Superphosphate.—The addition of $3\frac{1}{2}$ cwt. superphosphate of lime to the dung had very little influence on the crop. The yield rose to 5 tons 12 cwt., or an increase of 7 cwt. over the dung alone.

Dung, Superphosphate, and Nitrate of Soda.—But when the dung and superphosphate were supplemented by some nitrate of soda, supplying 86 lb. of nitrogen per acre, a marked difference upon the crop became apparent. The produce rose to 7 tons 2 cwt.—an increase of $1\frac{1}{2}$ ton, due to the 86 lb. of rapidly acting nitrogen.

Artificial Manures.—Artificial manures were also tried by themselves, separately, and in different combinations.

Superphosphate of lime ($3\frac{1}{2}$ cwt. per acre) applied alone gave an average of 3 tons $13\frac{3}{4}$ cwt. for twelve years—nearly 3 tons 6 cwt. more than the no-manure plot.

Mixed mineral manure (consisting of $3\frac{1}{2}$ cwt. per acre of superphosphate, 300 lb. sulphate of potash, 100 lb. sulphate of soda, and 100 lb. sulphate of magnesia) gave only 2 cwt. per acre more than the superphosphate alone.

Salts of ammonia (450 lb.) alone gave a poor result—only 2 tons $5\frac{3}{4}$ cwt. per acre, or 6 cwt. more than the unmanured plot.

Nitrate of soda (550 lb.) alone did little better. It exceeded the salts of ammonia by 7 cwt. per acre.

Nitrogenous and mineral manures mixed produced very different results. Applied together to the same plot they raised the produce to an average of over $6\frac{1}{2}$ tons—6 tons $14\frac{1}{2}$ cwt. for salts of ammonia and mixed mineral manure, and 6 tons 13 cwt. for nitrate of soda and mixed mineral manure.

Conclusions.—In contrasting these experiments with various kinds and dressings of manure, some noteworthy results are observed. As to *artificial manures* it is shown (1) that the exhaustion of phosphoric acid by the potatoes was greater than that of potash; (2) that in the continuous growth of potatoes here it was the available supply of mineral constituents within the root-range of the plant, more than that of nitrogen, which became deficient—hence the greater pro-

duce from mineral manures alone than from nitrogenous manures alone; (3) that it is only when all the essential elements of manure are present in sufficient quantity that the full benefit of any kind of dressing can be derived; and (4), that when thus applied together in a well-balanced dressing, artificial (nitrogenous and mineral) manures produced a crop which for twelve successive years exceeded the average yield of the United Kingdom—decidedly greater indeed than the yield from farmyard manure alone, and only about 8 cwt. per acre behind the produce from a combined dressing of dung, superphosphate, and nitrate of soda.

The efficacy of well-proportioned artificial manures for potatoes thus demonstrated at Rothamsted is a consideration of great importance to farmers. Equally valuable to the practical farmer is the unquestionable conclusion that, in efficient and profitable manuring, an essential condition is that the dressing shall be properly balanced—that is, contain all the necessary elements of plant-food in due proportion.

Slow Exhaustion of Dung.—In the Rothamsted experiments with potatoes some interesting information has been brought out as to the behaviour of farmyard manure in the soil. The most striking point in these results is the slow action of the dung, particularly of the nitrogen it contained. The dressing of dung applied annually to the potato crop contained, per acre, about 200 lb. of nitrogen—besides, of course, an abundance of mineral matters, &c.; yet from 86 lb. of nitrogen, supplied in the form of nitrate of soda or salts of ammonia, along with an artificial mixture of mineral manures, the average produce was considerably greater than from the dung. Thus it is observed that, while the dung supplied far more nitrogen than the crop required, it did not contain enough in such a readily available condition as that it could be at once seized by the crop.

Further striking evidence of the slow action of nitrogen in dung was furnished by the fact that by supplementing the dung with some quickly acting nitrogen—86 lb. of nitrogen per acre in nitrate of soda—the produce of the tubers was increased by over $1\frac{1}{2}$ ton per acre.

Residue of Dung.—Then as to the residue of dung, the results showed that it acted very slowly. Of the nitrogen supplied in the annual dressing of dung only about 6.4 per cent had been recovered in the crop of potatoes in the first six years. In the succeeding six years potatoes were grown every year on the same plot without any further application of dung or other manure, and in that time only 5.2 per cent of the unrecovered nitrogen was taken up in the crop. Thus in twelve years only 11.6 per cent of the nitrogen supplied in the dung during the first six years had been recovered in the crop.

Dr Gilbert on Dung for Potatoes.—Referring to this point in his Cirencester lectures, Dr Gilbert says: "In the case of other crops it has been found that only a small proportion of the nitrogen of farmyard manure was taken up in the year of application. But these results seem to indicate that the potato is able to avail itself of a less proportion of the nitrogen of the manure than any other farm crop. Yet in ordinary practice farmyard manure is not only largely relied on for potatoes, but is often applied in larger quantity for them than for any other crop. It is probable that, independently of its liberal supply of all necessary constituents, its beneficial effects are in a considerable degree due to its influence on the mechanical condition of the soil, rendering it more porous and easily permeable to the surface-roots, upon the development of which the success of the crop so much depends. Then, again, something may be due to an increased temperature of the surface soil, engendered by the decomposition of so large an amount of organic matter within it; whilst the carbonic acid evolved in the decomposition will, with the aid of moisture, serve to render the mineral resources of the soil more soluble."

In considering these results obtained at Rothamsted it should, of course, be borne in mind that the system of cropping pursued on the experimental plots there—the same crop on the same plot every year—differs greatly from that followed in ordinary farming. In all probability, with the more thorough and varied tillage, and the cropping with plants of different depth of roots and dif-

ferent powers of assimilating food which obtain in ordinary rotation farming, the residue of dung would be more speedily recovered by crops than was the case at Rothamsted. Still it can hardly be gained, that the Rothamsted experiments have proved that the beneficial influence of dung upon potatoes is due in a larger measure to its mechanical effect, and in a less degree to it as a source of plant-food, than was before generally believed.

A Practical Lesson.—The chief lesson which the practical farmer is to draw from these conclusions, as to the action of dung, is that, while a large dressing of dung may with advantage be applied for potatoes, it must not be relied upon as the sole source of plant-food for the crop—that the dung must be supplemented with a substantial allowance of quick-acting nitrogenous manure, such as nitrate of soda, and with a smaller application of phosphates and potash.

Potash for Potatoes.—The undoubted value of potash for potatoes is not very clearly shown in the Rothamsted experiments. In soils deficient in available potash the application of about 2 or 3 cwt. of kainit per acre will be found to have quite a wonderful effect on the produce. Good results have been obtained from kainit when sown as a top-dressing just before the drills of potatoes are earthed up for the first time, especially when rain happened to fall soon after, thus carrying down the potash to the roots of the crop, which is then ready to absorb it. Mr John Speir says he prefers to sow the kainit on the ploughed land in autumn or early winter, which indeed is generally believed to be the best plan.

Application of Manure for Potatoes.—Occasionally, chiefly in stiff soil, the dung for potatoes is spread upon the land and ploughed in late in the autumn or in winter. In that case the land is again ploughed in spring or perhaps first grubbed, and then ploughed and the seed planted on the flat in every third furrow, the artificial manure being sown just before the last ploughing, or deferred till the plants are hoed or earthed up the first time. But the most general system is to spread the dung in the drills, sow the artificial manure on the top of this, and then plant the seed, and cover all in

together by splitting each drill with the drill plough.

Details of Planting.

The planting of potatoes demands attention early in spring.

Potato-seed.—While the land is being prepared for the potatoes—and it will not be possible to prepare it continuously, as the sowing of grain has to be attended to—the *potato-seed* should be prepared by the field-workers. When preparing potato-seed a great saving of time will be effected if the seconds (*i.e.*, after the ware has been taken out) are dressed over $1\frac{1}{4}$ inch riddle, and then over $1\frac{3}{4}$ inch riddle. The tubers above the $1\frac{3}{4}$ inch should be taken to an outhouse and cut, while the smaller ones can be covered up again and planted whole. In selecting tubers to cut into sets, the middle-sized, that have not sprouted at all, or have merely sprouted buds, will be found the soundest; and wherever the least softness is felt, or rottenness seen, or any suspicion as regards colour or other peculiarity is indicated, the tuber should be entirely rejected, and not even its firm portion be used for seed. The very small potatoes should be picked out and put aside to boil for poultry and pigs.

Potatoes intended for seed should always be turned in the pits between February and March, in order to prevent sprouting. This checks the growth, and plumps up the buds wonderfully.

Potatoes are planted whole or cut into parts or *sets*. Large whole potatoes should not, as a rule, be planted, as it is a waste of seed. Some kinds of potatoes, however, such as Magnum Bonum, are best planted whole. With the Magnum Bonum, growth begins so late in the season, that at cutting time it is impossible to say whether or not any eye will grow. They have few "eyes," which are nearly all at one end, and when cut the part containing the eye is thin. Very small sets, or very small whole potatoes should not be used as seed, as they are liable to produce a light crop of puny tubers. Moderately small tubers, if they have not too many eyes, make good seed.

The usual practice is to cut a middle-sized potato into two or three sets, according to the number of eyes it contains. It is well to leave two eyes in each set,

lest one of them may have lost its vitality. The sets should be cut with a sharp knife, be rather large in size, and taken principally from the rose or crown end of the tubers. The other heel or root end may be kept for pigs or poultry. When fresh the tubers cut crisp, and exude a good deal of moisture, which soon evaporates, and leaves the incised parts dry.

A common practice was to heap the cut sets in a corner of the barn until they were planted. Had they been exposed previously to drouth they might remain uninjured, but if heaped immediately on being cut, in a moist state, they will probably *heat*, and heated potatoes, whether whole or cut, rarely vegetate. Much of the injudicious treatment which sets of potatoes receive arises from want of room to spread them out thin. The straw-barn is most generally used, but in many cases it cannot be spared, as the cattle-man and ploughman must have daily access to it. The corn-barn may be occupied with grain. The implement-house has too little room—besides the many small articles which it contains. The only alternative is an outhouse; a large one should be in every steading.

A considerable quantity of seed should be prepared before planting is begun, and the rest can be made ready when the horses are engaged with the barley or oat seed, or during any broken weather. A considerable quantity of seed can usually be stored about the steading for cutting in wet or stormy weather; while the rest can generally be prepared at the pit-side.

Preserving Sets.—When cut indoors the sets should be spread out thin and dusted with lime. This forms a crust on the incised surface,¹ and prevents the sap from exuding. Potatoes are best cut a day or two before planting, as they keep longer fresh in the ground when there is a crust on the incised surface of the set.

Quantity of Seed per Acre.—The sets required to plant an acre of land vary very much according to size of sets and kinds of potatoes. From 8 to 10 cwt. of cut Regents will plant an acre, while from 10 cwt. to 14 cwt. of whole Magnums will be required.

Since the prevalence of disease among potatoes in all soils and situations, numer-

ous expedients have been devised to prepare the seed, with the view of warding off disease, but without much practical effect.

Potatoes not required for seed, firm and of good size, whether intended for sale or for use in the farmhouse, should remain in the outhouse until disposed of or used, kept in the dark, with access to air, and examined as to soundness when the sprouts, if any, are taken off.

Planting on the Flat.—In many parts of England, where the climate is dry, potatoes are grown extensively on the flat. There autumn or winter dunging is often practised, and by grubbing, harrowing, and ploughing, the land is prepared for the seed in spring. As already stated, the seed in this case is dropped into every third furrow, the seeds being from 9 to 14 inches apart in the furrow. The spaces between the rows of potatoes are hoed by horse and hand hoes just as in the case of drills, and when the plants are well grown they are earthed up by passing a double mould plough between the rows, thus forming ordinary drills.

The Drill System.—But the growing of potatoes in drills is far better than planting on the flat. The drill system is all-prevailing in Scotland (except in some parts of the Highlands and Western Islands) and the northern counties of England, while it greatly predominates in Ireland, except on small holdings where the “lazy-bed” method is still pursued extensively.

Autumn Dunging.—If the land is strong and a supply of dung happen to be then on hand (which, however, is not often the case), it is considered a good plan to spread the dung for potatoes on the stubble just before ploughing in the end of autumn or early in winter. This, no doubt, tends to the better preparation of strong land for potatoes; and the carting and spreading of the dung in autumn or winter lightens the pressure of work in spring. One great hindrance to this system is the fact that a sufficient supply of dung is not usually available in the autumn or beginning of winter. Where summer-house feeding is practised, there is generally an ample supply of dung in good time for this purpose; and these two systems, which, in suitable circumstances, are both to be commended, fit well into

¹ *Trans. High. Agric. Soc.*, xiv. 144.

each other. On dry soils and in dry seasons dunging before ploughing usually gives the best results. In the opposite conditions spring dunging will be found to excel.

Spring Tillage with Autumn Dunging.—When the potato land has been dunged and deeply ploughed in autumn or winter, the spring tillage is simple and soon finished. If the land is clean no

further ploughing may be necessary. A single or double stripe with the grubber and moderate harrowing will most likely suffice, and then shallow drills are opened from 28 to 30 inches wide. The seed is planted in these drills with from 10 to 14 inches between the sets, and an allowance of artificial manure is sown, and the drills are closed by splitting each ridgelet in two with the drill-plough, of which an

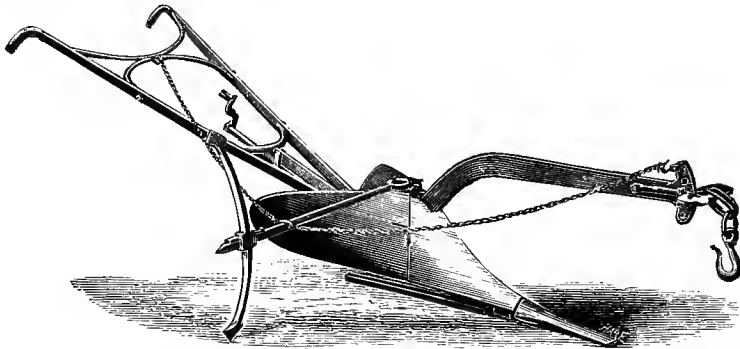


Fig. 320.—*Scotch drill-plough.*

improved Scotch pattern, made by A. Newlands & Son, Linlithgow, is represented in fig. 320.

Spring Dunging.—The more general practice is to apply both the dung and the artificial manure in the drills at the time of planting in spring. If the land is clean and not too rough, a small amount of spring tillage will suffice. When they have to hold dung, as well as the seed and artificial manure, the drills have to be a little deeper than is necessary with previous dunging on the surface.

Carting Dung for Potatoes.—The more expeditious plan is to have the dung carted in a heap on the field before the rush of spring work sets in. In this case the carting of the dung into the drills is speedy work. But it is very often found that better crops of potatoes are obtained from dung carted right from the cattle-court to the drills than from exactly similar dung which had some time before been carted into a heap on the field. Where the lessening of spring work is of special importance, as in late districts, with their long winter and short growing season, it will perhaps still be best to pursue the practice of carting the dung

to heaps on the field in winter. In cases, however, where there is no such excessive rush of spring work, and where the potato field is within easy distance of the homestead, the dung had better be left in the courts till required for the drills in spring, or until it is to be spread upon the land in one form or other.

Details of Planting.—In the afternoon before the day on which the planting of potatoes is to be commenced, the drill-plough should be set to work to open a few drills, so that on the following morning the full force of men, women, boys, and horses, may at once get into action. As soon as the carts with the dung get into drills they are followed by men, women, and boys spreading the dung. These again are closely succeeded by women and boys planting the seed, and by a man sowing the artificial manure. One or two drill-ploughs are opening drills, and one or two closing in, according to the size of the farm and the extent to which potatoes are cultivated. In some cases the ploughs open one way and cover the other.

Single v. Drill Plough.—Mr Speir, Newton Farm, Glasgow, says: "On any

land, fine or firm, where one or more ploughs can be kept in constant work, a single mould-board plough with a specially narrow mould-board on, makes *much* better work and is easier held than the double one. With it the soil is lifted and turned right over on the dung and sets—not *shoved* over as with the other. Here no double mould-boards are used at planting time.” It is very important that the double mould plough should be formed so as to turn over rather than press the soil outwards.

Upon a large farm, where a considerable area is devoted to potatoes, the operations of opening drills, carting dung, spreading dung, planting seed, sowing artificial manure, and closing in drills, are all proceeding simultaneously. There is no more active scene upon a farm in the course of the whole year than this; and few operations afford greater opportunities for the exercise of skill and forethought in arranging and controlling farm labour.

Filling Dung.—To avoid delay in the field, and keep the horses as active as possible, one or two men may be employed at the dung-heap in assisting the drivers of the carts in throwing the dung into the carts, which is done with ordinary four-pronged steel graips. The movements of the carts are so arranged that only one, or at most two carts are at the dung-heap getting filled at one time.

Distributing Dung from Carts.—The dung is thrown from the cart into the drill in graipfuls as the horses move on at a moderate pace. The quantity of dung intended to be given to the land is evenly apportioned by the farmer or overseer, fixing the length of drill which loads of certain size should cover, and seeing that the man throws out the dung in uniform graipfuls at regular distances. Intelligent horsemen very quickly become expert at this practice, which is far more expeditious and satisfactory than the antiquated method of dragging the dung out of the cart into heaps in the drills.

Three ordinary drills are just about the width of a farm-cart. The dung is often thrown into the drill in which the horse is walking, and one wheel of the second cart thus runs over the dung thrown out from the first cart. This packing of the dung by the cart-wheel

should be avoided by throwing the dung, not into the centre drill, but into the drill on the side of the cart next to where the dunging was begun.

Spreading Dung.—The spreading of the graipfuls of dung in the drills is done by men, lads, and women.

In England women are rarely seen at this work, and in Scotland also the custom of employing them at it is by some strongly condemned as unbecoming modern civilisation. We shall not enter upon a discussion of the question here. Our object is rather to describe practices as they exist. Certainly much less female labour is now engaged in outdoor farm-work than in former times, and the tendency is still towards diminution.

In many parts of Scotland women are still extensively employed in spreading dung. It is undeniable that they do it almost as well and as expeditiously as average men; and they are usually far superior to lads and boys. A long-shafted steel fork or graip, with three or four prongs, is best suited for spreading dung. It is very important that the dung should be finely broken and evenly spread in the drill. Lumps of dung should be thoroughly broken, and rolls of straw or other litter undone, so that the dung may not only be evenly distributed over the land, but be so exposed to the surrounding soil as that it may speedily and regularly decompose.

Four or five workers will, in average circumstances, spread as fast as one drill-plough can cover in.

Planting the Seed.—The spreaders of dung are followed immediately by a similar force planting the seed. Women make the best planters. Five or six planters with the seed regularly supplied to them will plant as fast as the four or five workers will spread the dung; and this force of spreaders and planters, with one man to sow the artificial manure, will keep one drill-plough at full work in covering in. It is perhaps better that each planter carry her own sets, as a relief to the stooping posture is thus obtained, and each planter should have a separate drill, otherwise parts may be missed. The sets are dropped into the drill upon the top of the dung, at from 9 to 14 inches apart.

Planting-machines.—Machines have

been invented for planting potatoes, but have not come into use to any considerable extent. They plant only whole sets.

Conveying Seed to the Planters.—

The sets are shovelled either into sacks like corn, or into the body of close carts, and placed, in most cases, on one or both head-ridges or middle of the field, according to the length of the ridges. When the drills are short, the most convenient way to get at the sets is from a cart; but when drills are long, sacks are best placed along the centre of the field. A still better plan, if a horse can be spared, is for a boy to drive the potatoes alongside the planters. The cart can go in the drills that are covered, and the boy will carry the sets to the workers.

In some cases a small round willow basket, with a bow-handle, fig. 321, is provided for each person who plants the

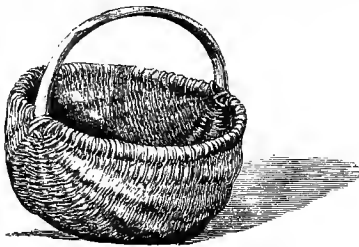


Fig. 321.—Potato hand-basket.

sets. Others prefer aprons of stout sacking. As a considerable number of hands are required, boys and girls may be employed beyond the ordinary field-workers. The frying-pan shovel, fig. 252 (vol. ii.), with its sharp point, is a convenient instrument for taking the sets out of the cart into the baskets.

Sowing the Artificial Manure.—

Whatever artificial is to be given at the time of planting is sown broadcast by hand along the drills, after the dung is spread, and either before or after the seed is planted. A man sowing with two hands will sow as fast as three drill-ploughs can cover in.

Covering in.—The drill-plough should at once follow the planters, as both dung and potatoes suffer by being exposed to the sun. The drills are split in the same way as they are set up—that is, the plough splits the drill, throwing one-

half of the land on one row of sets and the other half on the other, both of the drills being completely covered in two rounds of the plough. The whole of the drills dunged and planted should be covered every day—the man who has been opening helping the one who is covering, after he has opened enough to serve for the day, with a few for a start next morning.

Where there is only one drill-plough, it is employed alternatively in opening and covering in, or opens one way and covers the other. Or the single board plough is used as described on page 267.

Complete Planting as it proceeds.

—It is undesirable to open many more drills than can be planted and covered in before nightfall, lest inclement weather should set in, and so render the opened drills too stale before the planting can be resumed. The work of planting is done most satisfactorily where, as far as it goes, it is begun and completed in the same day.

Danger of leaving Dung and Seed uncovered.—

Most farmers are specially careful as to the completion of the work of potato-planting as it goes on. In many cases it is insisted that, even at loosing from the forenoon yoking, every drill should be covered in, although the ploughman should work a little longer than the rest of the work-people; for which detention he would delay as long in yoking in the afternoon. In dry hot weather he should make it a point to cover in the drills at the end of the forenoon yoking in a complete manner, as dung soon becomes scorched by the mid-day sun, and in that state is not in good condition; not on account of evaporation of valuable materials, as what would thus be lost would be chiefly water, but because dry dung does not incorporate with the soil for a long time, and still longer when the soil is also rendered dry. If all the ploughs cannot cover in the drills at the hour of stopping at night, give up dunging the land and planting the sets a little sooner, rather than run the risk of leaving any dung and sets uncovered.

Width of Potato-drills.—Drills for potatoes should be made 28 inches to 30 wide, according to kind of potato. Abundance of air is of great importance to the potato plant. Near large towns

the drills are made narrower, from 24 inches to 27 inches, the early varieties of potatoes chiefly cultivated there having comparatively small stems.

Width and Depth of Sets.—The distance between the sets in the drill varies from 9 to 14 inches, according to the width of the drill, the variety of potato, whether the stems are tall, medium, or short, and the character and condition of the soil and climate, whether likely to favour a heavy or light yield, and the size of the sets. Sets placed 6 inches under the surface yield the greatest crop; at 3 inches the plants are weak; and at 9 inches many never come up at all.

Experiments with Late Planting.

—The main bulk of the potato crop is usually planted in spring, except in the later districts, where it is generally done early in May.

It has been suggested that in certain circumstances potato-planting might be more remunerative if the tubers were not planted until June. Mr John Speir, Newton Farm, Glasgow, conducted experiments with plantings on different dates in June and July in the years 1888 and 1889. Early varieties were planted—whole seed which had been strongly sprouted before being set. Farmyard dung alone was used. In 1888, the planting on June 30 gave about one-third more produce than the planting ten days later. The July plantings were still more unsuccessful in 1889, but in both years the June plantings gave satisfactory results. In June 1889 three plantings gave the following results:—

Planted.				Produce.
June 10	.	.	.	7 tons per acre.
" 20	.	.	.	5½ "
" 29	.	.	.	4 "

Mr Speir is quite convinced that the system is capable of great expansion, more particularly on market-garden farms or in late districts. But he adds, that to be attended with any measure of success at all, *the seed must be sprouted, and the sprouts must never have been broken off, but be the first ones which come.*

An Ayrshire Practice.—On the earliest farms along the coast of Ayrshire, principally around Girvan, Maybole, and Ayr, where the area of potatoes grown is excessively large in proportion

to the size of the farms, a different class of plough is used from that which is commonly met with throughout the country. There the area planted is so great in proportion to the power at the command of the farmer, that a speedier method must be adopted than that in general use. The plough (one of which, made by T. Hunter, Maybole, is shown in fig. 322) has very much the appear-

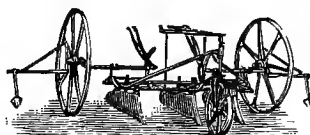


Fig. 322.—Triple drill-plough.

ance of an ordinary 3-horse grubber, at least so far as the frame is concerned, while it has also two similar side-wheels, a fore-wheel, and lifting lever. Instead, however, of from five to seven times, it has only three, all set abreast, each tine being in fact a double mould-board plough hung from the frame. The mould-boards are a little less in size than those in use in the ordinary mould-board plough, but otherwise they are the same. By this plough, with three horses, three drills are opened or covered at one passage of the plough. To work it properly the land must of necessity be well prepared beforehand, and any farmyard manure which is to be used has generally been ploughed in some time previously.

In this district, where much of the best potato-land is very sandy, a peculiar class of double mould-board plough is also used to earth up the potatoes. In it the mould-boards are solid and continuous from the sole of the plough to the top of the drill, so that in working in dry weather the whole weight of the plough is exerted in pressing the sandy earth on the side of the drill, and in the driest weather slipping down rarely happens. The same class of plough is in use on the early potato-lands of Cheshire, from which district the Ayrshire men adopted it.

The Lazy-bed System.—Another mode of field-culture for potatoes is in *lazy-beds*, very common in Ireland. This system is becoming less general on arable land, though on lea-ground it gives very good results, and seems indeed to be

best suited to certain circumstances. In the island of Lewis drill-sowing was at one time adopted, but found unsuitable for the soil and climate, and the lazy-bed system had again to be resorted to. The usual method is to remove a line of turf along the margin of the proposed lazy-bed, after which a slight covering of dung is given, and the next line of turf turned over green side under upon the top of the sets. The next line is turned over without sets, then dung, &c.; this proceeding being adopted along the whole bed, until finished, after which a trench is cut or formed round the edges to carry off any surplus moisture.

In reference to Ireland, Martin Doyle says: "In bogs and mountains, where the plough cannot penetrate through strong soil, beds are the most convenient for the petty farmer, who digs the sod with his long narrow spade, and either lays the sets on the inverted sod—the manure being previously spread—covering them from the furrows by the shovel; or, as in parts of Connaught and Munster, he stabs the ground with his *loy*—a long narrow spade peculiar to the labourers of Connaught—jerks a cut set into the fissure when he draws out the tool, and afterwards closes the set with the back of the same instrument, covering the surface, as in the case of lazy-beds, from the furrows.

"The general Irish mode of culture on old rich arable lea is to plough the fields in ridges, to level them perfectly with the spade, then to lay the potato-sets upon the surface, and to cover them with or without manure by the inverted sods from the furrows. The potatoes are afterwards earthed once or twice with whatever mould can be obtained from the furrows by means of spade and shovel. And after these earthings, the furrows, becoming deep trenches, form easy means for water to flow away, and leave the planted ground on each side of them comparatively dry.

"The practice in the south of Ireland is to grow potatoes on grass land from one to three years old, and turnips afterwards, manuring each time moderately, as the best preparation for corn, and as a prevention of the disease called fingers-and-toes in turnips. In wet bog-land, ridges and furrows are the safest, as the fur-

row acts as a complete drain for surface-water; but wherever drilling is practicable, it is decidedly preferable, the produce being greater in drills than in what may be termed, comparatively, a broadcast method."¹

Culture after Planting.—Potatoes require a considerable amount of horse-work both before and after brairding. As soon as convenient after planting, the drills should be harrowed down either with a set of light zigzag harrows or chain-harrows, or, better still, with a saddle-drill harrow, such as is illustrated in fig. 273, p. 205. Immediately after, the drills are again set up with the double-moulded plough. When the plants are well sprung, but before they are too far advanced, the drills should be again harrowed down. This makes a fine surface for the young plants, and helps to keep down weeds. A very suitable implement to crush clods on strong land is a fluted roller to embrace two drills. This crushes the clods, and rolls them into the hollow of the drills.

Hand-hoeing.—The drills are then hand-hoed, loosening the soil around the young plants and removing weeds. The hollows of the drills are stirred with the drill-harrow or horse-hoe, and then the drills are set up with the double mould plough. Unless weeds are so abundant and strong as to necessitate another hoeing, no further tillage may be required.

Varieties of Potatoes.

The potato belongs to the class and order *Pentandria Monogynia* of Linnaeus; the family *Solanaceae* of Jussieu; and to class iii. *Perigynous exogens*; alliance 46, *Solanales*; order 238, *Solanaceae*; tribe 2, *Curvemyræ*; genus *Solanum* of the natural system of Lindley. — On this remarkable family of plants, Lindley observes that they are "natives of most parts of the world without the arctic and antarctic circles, especially within the tropics, in which the mass of the order exists in the form of the genera *Solanum* and *Physalis*. The number of species of the former genus is very great in tropical America. At first sight this order seems to offer an excep-

¹ Doyle's *Cy. Prac. Husb.*—art. "Potato."

tion to that general correspondence in structure and sensible qualities which is so characteristic of well-defined natural orders, containing as it does the deadly nightshade and henbane, and the wholesome potato and tomato; but a little inquiry will explain this apparent anomaly. The leaves and berries of the potato are narcotic; it is only its tubers that are wholesome when cooked. This is the case with other succulent underground stems in equally dangerous families, as the cassava among spurge-worts; besides which, as De Candolle justly observes, 'Il ne faut pas perdre de vue que tous nos aliments renferment une petite dose d'un principe excitant, qui, s'il y était en grande plus quantité pourrait être nuisible, mais qui y est nécessaire pour leur servir de condiment naturel.' The leaves of all are, in fact, narcotic and exciting, but in different degrees, from *Atropa belladonna*, which causes vertigo, convulsions, and vomiting, to tobacco, which will frequently produce the first and last of these symptoms; henbane and stramonium, down to some *Solanums*, the leaves of which are used as kitchen herbs. . . . An extract of the leaves of the common potato, *Solanum tuberosum*, is a powerful narcotic, ranking between belladonna and conium; according to Mr Dyer, it is particularly serviceable in chronic rheumatism, and painful affections of the stomach and uterus. . . . The common potato in a state of putrefaction is said to give out a most vivid light, sufficient to read by. This was particularly remarked by an officer on guard at Strasburg, who thought the barracks were on fire, in consequence of the light thus emitted from a cellar full of potatoes."¹

The *Solanaceae*, or Nightshades, comprise 900 species, of which we have only five in Britain. The genus *Solanum* has only two British representatives—*Solanum dulcamara*, a pretty climbing shrub, found occasionally in hedges; and *Solanum nigrum*, with an herbaceous stem. Both these plants, like the rest of the tribe, are strongly narcotic. The *Solanum dulcamara*, bitter-sweet, or woody nightshade, has a purple flower and bears red berries; the *Solanum nigrum*, or garden nightshade, bears white flowers and

black berries. These plants can be identified botanically only by an examination of the leaves and berries. The active principle in both is an alkaloid, *Solanina*, which is itself a poison, although not very energetic: two grains of the sulphate killed a rabbit in a few hours. According to Liebig, this poisonous alkaloid is formed in and around the shoot of the common potato when it germinates in darkness; but there is no evidence that the potatoes are thereby rendered injurious. Their noxious qualities are probably due to other causes.

The Wild Potato.—Having been so long familiar with the potato in a cultivated state, it is interesting to become acquainted with its appearance in its native localities and unaltered condition. "The wild potato," says Darwin, "grows on these islands, the Chonos Archipelago, in great abundance in the sandy, shelly soil near the sea-beach. The tallest plant was 4 feet in height. The tubers were generally small, but I found one of an oval shape, 2 inches in diameter; they resembled in every respect, and had the same smell, as English potatoes; but when boiled they shrank much, and were watery and insipid, without any bitter taste. They are undoubtedly here indigenous; they grow as far south, according to Mr Low, as lat. 50°, and are called Aquinas by the wild Indians of that part: the Chilotan Indians have a different name for them.

"Professor Henslow, who has examined the dried specimens which I brought home, says that they are the same as those described by Mr Sabine from Valparaiso, but that they form a variety which by some botanists has been considered as specifically distinct. It is remarkable that the same plant should be found on the sterile mountains of Central Chili, where a drop of rain does not fall for more than six months, and within the damp forests of these southern islands."²

"The potato (*Solanum tuberosum*) was generally cultivated in America at the time of its discovery; but it is only a few years since its native country has been ascertained with certainty. Humboldt sought for it in vain in the mountains of Peru and New Granada, where it is cul-

¹ Lindley's *Veg. King.*, 619-21.

² *Voy. H.M.S. Beagle round the World*, 285.

tivated in common with *Chenopodium quinoa*. Before his time the Spanish botanists Ruiz and Pason were said to have discovered it in a wild state at Chancay on the coast of Peru. This fact was doubted after the journey of Humboldt and Bonpland, but it was reasserted by Caldcleugh, who sent spontaneous plants from Chili to the Horticultural Society of London; and latterly Mr Cruikshanks confirmed it in a letter to Sir William Hooker, in which he says,—"This wild potato is very common at Valparaiso; it grows chiefly on the hills near the sea. It is often found in mountainous districts far from habitations, and never in the immediate vicinity of fields and gardens." There is little doubt, therefore, that Chili is the native country of the potato; but Meyer affirms that he found it in a wild state, not only in the mountains of Chili, but also in the Cordillera of Peru."

Introduction into Europe.—It is asserted that Sir Francis Drake introduced the potato into Europe in 1573; but this is very doubtful, since it has also been ascribed to Sir John Hawkins in 1563; it is, however, certain that Raleigh brought it from Virginia to England in 1586; and it appears probable, from the learned researches of M. Dunal, that the Spaniards had established its cultivation in Europe before this time. It was first cultivated extensively in Belgium in 1590, in Ireland in 1610, and in Lancashire in 1684. Between 1714 and 1724 it was introduced into Swabia, Alsace, and the Palatinate; in 1717 it was brought to Saxony; it was first cultivated in Scotland in 1728; in Switzerland, in the canton of Berne, in 1730; it reached Prussia in 1738, and Tuscany in 1767. It spread slowly in France till Parmentier, in the middle of the eighteenth century, gave it so great an impulse that it was contemplated to give his name to the plant; the famine in 1793 did still more to extend its cultivation.

Distribution of the Potato.—According to Humboldt, the potato is generally cultivated in the Andes, at an elevation from 9800 to 13,000 feet; which is nearly the same elevation to which barley attains, and about 9800 feet higher than wheat. In the Swiss Alps of the canton of Berne, the potato reaches,

according to Katsoffer, an elevation of 4800 feet.

"Towards the north of Europe, the potato extends beyond the limits of barley, and consequently that of all the cereals; thus an early variety has been introduced into Iceland, where barley will not grow. The potato degenerates rapidly in warm countries, yet the English have succeeded in cultivating it in the mountainous regions of India; but it is doubtful if it will ever succeed in the intertropical plains of Africa and America, where the temperature varies less than in Bengal. An elevation of at least 4000 feet seems to be necessary for the growth of the potato in tropical regions."¹

Selecting Varieties for different Soils.—A remark of Mäers, that "some potatoes put out long filaments into the soil, others press their tubers so closely together that they show themselves above ground," suggests considerations in the selection of potatoes, which do not receive sufficient attention from farmers in search of seed-potatoes. On choosing seed, it is too often the case that the tuber alone is regarded, without reference to the habit of growth of the plant under ground; and many of those who profess to study the habits of the plant, confine their attention to the stem, foliage, and flowers, while the habits under ground of roots and tubers are entirely neglected. Now, when it has been ascertained that one variety "puts out long filaments into the soil," surely it is improper to plant that variety in strong soils, which necessarily oppose the penetration of tender filaments through them, when a light soil is just suited to that peculiarity of growth. Mr John Speir writes that on his farm, where all potatoes are grown for seed purposes, coarse, degenerate, or foreign varieties are regularly dug out every season *before the crop is matured*.

Cultivators should take the trouble of investigating experimentally the peculiar growth under ground of different varieties of the potato-plant, so that it may be cultivated in soil suited to its nature, and thereby return the largest yield of sound, wholesome, and palatable tubers.

Varieties in Use.—The varieties of

¹ Johnston's *Phys. Atl.*,—"Phyto," Map No. 2.

potatoes now in use are very numerous. Several hundreds indeed there are, and every year adds to the number.

The principal kinds planted now are the various sorts of Regents for early sale, while Magnum Bonums and Champions form the main crop. More interest is taken in rearing new potatoes by hybridisation, and new varieties of considerable promise are offered to farmers every season.

The influences of soil and climate introduce variations in the different sorts, but the multiplicity of varieties is due mainly to the raising of new sorts from the seed. It has been found that an occasional new variety successfully resists disease for a few years, and this, of course, has given a great stimulus to propagation from seed.

Good Potatoes.—A good potato is neither large nor small, but of medium size; of round shape, or elongated spheroid; the skin of rough and netted appearance, and homogeneous; and the eyes neither numerous nor deep-seated. Smooth potatoes are almost always watery and deficient in starch.

Some kinds of potatoes, as Kidneys and Regents, are fit to use when lifted, but other kinds improve with keeping, and are best in spring.

The *intrinsic* value of a potato, as an article of commerce, is estimated by the quantity of starch it yields on analysis; but, as an article of domestic consumption, the *flavour* of the starchy matter is of as great importance as its quantity. Almost every person prefers a mealy potato to a waxy one, and the more mealy it is usually the better flavoured. The mealiness consists of a layer of mucilage immediately under the skin, covering the starch or farina, which is held together by fibres.

Light soil yields a potato more mealy than a strong soil; and a light soil produces a potato of the same variety of better flavour than a clay soil. Thus soil has an influence on the flavour, as well as on culture; and the culture which raises potatoes from soil which has been dunged for some time, imparts to them a higher flavour than when grown in immediate contact with dung.

The destructive fungoid disease known as *Peronospora infestans* is dealt with

in connection with other "Fungoid Diseases" of crops.

The Boxing System of preparing Potato-sets.

Mr John Speir, Newton Farm, Glasgow, thus describes the system of preparing the potato-sets in boxes:—

This system was introduced for the purpose of maturing the potato crop sooner than could be done by the ordinary manner of planting. It is said to have been first introduced in Jersey, where it is extensively practised. Along the whole of the Firth of Clyde it is more or less in use on all the earlier farms, and more particularly in the neighbourhood of Girvan it has been carried to such an extent that several farmers there have upwards of a hundred acres of potatoes all planted from boxes.

Boxes.—The boxes may be of any convenient size or shape, provided they are not too deep, the size in most common use being about 2 feet long, 18 inches broad, and from 3 to 4 inches deep. Each box generally holds from 3 to 4 stones of potatoes, the former being about the average. The boxes are made of $\frac{1}{2}$ -inch deal, and have pins 1 inch square and 6 inches high nailed in each corner. The top of these pins therefore projects from 2 to 3 inches above the edge of the box. These pins are strengthened in their position by having another bar, 1 inch square, nailed across the ends, and reaching from the top of the one corner pin to the top of the other. These cross-bars also serve as handles for carrying the boxes, besides being in other ways useful.

Tubers Boxed.—The potatoes used may be of any variety, but where early maturity is the main object, only the earliest varieties are used. Those most in demand at present are Don, Sutton's Early Regent, Beauty of Hebron, Goodrich, Dalmahoy, and Red Bogg, in the order here enumerated. Only small or medium-sized potatoes are used, all over $1\frac{1}{4}$ inch and under $1\frac{3}{4}$ inch in diameter being considered suitable.

Cut Seed Unsuitable.—Cut seed cannot so satisfactorily be used, because the sets remain so long in the boxes, and such a quantity of the moisture evapo-

rates from the sets that they ultimately shrivel up, and become so dry that the bud never starts into life.

Boxing the Seed.—The seed may be placed in the boxes any time between the end of July and the New Year, the most suitable time being probably September or October. At the latter end of July, all potatoes which are at that time dug and of too small size for table use, may at once be put into boxes, and thus preserved for seed to the following spring. In the boxes they keep with very little loss, even although quite soft and green when put in, whereas if stored in the ordinary manner all would be lost.

Storing Boxes.—During autumn the boxes may be stored in any unused barn, byre, shed, or other house which is rain-proof. The boxes are placed in tiers one above the other to any convenient height, the corner pins and cross-bars of the one box supporting the weight of those above, the extra height of the pins over the depth of the box giving sufficient room for the ventilation of the tubers and growth of the sprouts.

When cold weather sets in, the boxes should be removed to some position where they will be free from the effects of frost. Very many are stored on the joists of byres, bullock-houses, &c., where the heat from the animals is always sufficient to start germination, and keep out most frosts. Others, again, are stored in empty cheese-rooms and other houses specially built for the purpose, which are provided with artificial heat in the shape of a stove or other heating apparatus. It is not often that the heating apparatus requires to be called into use, but it is almost a necessity against occasional extreme frosts, and it comes in handy for pushing on late boxed or tardy germinating tubers.

Planting Boxed Seed.—Planting is generally begun about the first of March, and in the most favoured localities a little earlier. Before this system was adopted, the localities which now use it generally began to plant in January or February, but now there is nothing to be gained by beginning so early, and much may be lost by frost cutting off the haulms of the plants after they have come through the ground. Previous to planting, the boxes

with the potatoes in them are removed to the field in carts, and distributed along the side of the land, being placed in much the same way as sacks of cut potato-sets are put down before planting begins.

The *sprouts* at this time may be from 2 to 4 or more inches long, but instead of being white and brittle like those seen on potatoes in an ordinary pit, they are blue and tough, and not at all readily broken off. The tubers are generally removed from the boxes by light trowels, and carefully deposited in hand-scoops of such a size that a woman or boy can easily carry them full in one hand, while the potatoes are picked from them and planted with the other. The removal of the potatoes from the boxes to the scoops is generally the work of one or more careful persons, as they will not bear rough handling, while others carry them when filled to the planters. If the sprouts are comparatively short, the sets may be transferred from the boxes to the planters' aprons in the usual way of carrying cut potato-sets; but by doing so the plants get much rougher handling, and a few are always more or less damaged.

Seed per Acre.—The seed required to plant an acre on this system varies very considerably according to the size of the potatoes used. Where the smallest size of potatoes are planted, 30 boxes containing from 3 to 3½ stones will be found amply sufficient, even where two-foot drills are made, and close planting in the drill is followed. If, however, the potatoes are larger, say about 1¾ inch in diameter, 50 boxes of the same capacity may not be more than sufficient. In the former case, therefore, 12 cwt. or so will be sufficient for an acre of land, while a ton may be required in the latter.

Advantages of the System.—The reasons of the success of this system appear to be,—1st, the gain in time by the sets being sprouted before being planted; and 2d, the long period of drying to which the seed is subjected to in the boxes so ripens the potatoes and alters the constitution of the plant, that it matures its tubers the following season much quicker than if it had been preserved and planted in the usual way.

A crop from seed which has been boxed is usually ready to lift *three weeks* earlier than one grown from similar seed which has not been boxed. The produce is, however, generally believed to be a little less than that grown in the ordinary way, but the higher price at that time more than makes up for the lessened crop and extra expense incurred.

In the forcing of rhubarb, hyacinths, narcissi, spiræa, &c., the plants or bulbs must all be rested a certain time before growth will begin, no matter what heat and moisture are used; and in the case of the potato, the dry-keeping in the boxes instead of the damp-keeping in pits, appears to have a somewhat similar effect, as more time is gained than is accounted for simply by sprouting. An unsprouted crop may indeed look as far forward as a sprouted one, and yet not exhibit half the weight of tubers.

Raising New Varieties of Potatoes.

New Varieties Resisting Disease.—Ever since the well-known potato disease (*Peronospora infestans*) manifested its effects with such baneful influence, the raising of new varieties has been incessantly pursued, because it was found that new varieties withstood the disease better than most old ones. It has, however, been found that potatoes which were almost absolutely proof against disease when first introduced, have in course of time gradually fallen a prey to it, until in the end they had to be discarded altogether. Since the introduction of the Champion and Magnum Bonum, this search after new disease-resisting varieties has received a marked impetus, and as these varieties likewise began to show evident signs of decay, the desire for new varieties continued to increase. In order, therefore, to stimulate private energy in the direction of introducing new and improved varieties, we produce here the following description of the process, prepared for us by Mr John Speir, Newton Farm, Glasgow. The illustrations used in describing this process are taken (by the kind permission of the publishers, Messrs A. & C. Black) from Balfour's 'Elements of Botany.'

Potato-seeds.—As most people

know, new varieties of potatoes are raised from the plum, as it is popularly called. The plum holds the same relation to the potato-plant as the apple does to the apple-tree. It is the fruit, and, within, the fruit contains the seeds. The seeds of the apple or orange, I presume, every one is familiar with. The potato also, like them, has its seeds contained in a mass of pulp, which, however, unlike the apple or orange, is not of such a pleasant taste. Hence the seed of the potato is not so well known.

Seedless Varieties.—Some varieties of potatoes do not throw up flowers, and therefore cannot have plums. Seed must thus be looked for only on those varieties which have flowers. Again, all varieties which have blossoms do not have plums, as some appear unable to set a single bloom, unless on very rare occasions. With plants as with animals, in-breeding, if I may so express it, although not at first very hurtful in its effects, is very liable if persisted in to have a deleterious influence on either plant or animal; the stamina of both evidently becoming so reduced, that they fall a ready prey to disease.

Cross-fertilisation.—The methods which nature has adopted in plants, not exactly to prevent self-fertilisation, but to favour cross-fertilisation, are numerous, curious, and very interesting. Darwin proved beyond doubt that certain plants if self-fertilised would attain a moderate size; if cross-fertilised from plants growing alongside of them, they would attain a much greater size, and if fertilised from plants of the same variety grown on different soil, some miles away, their size would be still further increased.

These facts are of very great importance to the raiser of new varieties of potatoes. In fact, it is principally on cross-fertilisation that he relies for success. A new and quite good enough potato may be raised from seed where no intentional cross-fertilisation has been done, but the chances are that such a plant has been self-fertilised, or cross-fertilised by a plant of its own variety. The consequence will be that a much smaller proportion of the seeds sown will produce plants having vigorous constitutions, than if a different and improved

variety from a dissimilar class of soil had been used in fertilisation.

Male and Female Organs.—Among plants, as among animals, there are male and female organs, which in most plants are situated in the same flower. On some, however, the male blossoms are on one part of the plant and the female ones on another, while in others the males and females are on separate plants.

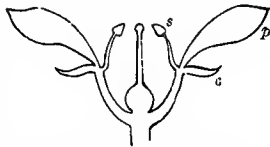


Fig. 323.—Section of a flower.
c, Calyx. p, Petal. s, Stamen.

In fig. 323 is shown a section of a flower, in which *c* represents the calyx or short green hard leaves at the base of most flowers, *p* is the petal or flower proper, *s* is a stamen, of which there are two shown on either side of the central figure: these are the male parts of the flower, while the centre part is the pistil or female part.

Fig. 324 is a horizontal section showing the organs of fructification of the potato, where the calyx or outer scales are five in number, and the blossom proper contains five petals, the one overlapping the other. Inside the circle of petals are shown five stamens, and inside that again the pistil, with seed-pod at its base.

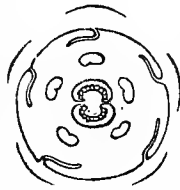


Fig. 324.—Horizontal section.

In fig. 325 is shown a vertical section of a potato-blossom, in which *c* represents the calyx; *p*, the petals, or bloom proper; *e*, the stamens; *s*, the pistil; and *o*, the ovary or seed-vessel. At a certain age the stamens throw off from their top a very fine powder, which is called pollen.

Fig. 326 represents a stamen in the act of discharging its pollen, which in some cases is thrown out through slits in the anther, *a*, or top part, while in others, like the potato, it comes out through holes or tubes.

Fig. 327 is a pistil with pollen-grains on the top. The uppermost part, *stg*, is

called the stigma, with pollen-grains, *p*, adherent to it, sending tubes, *tp*, down

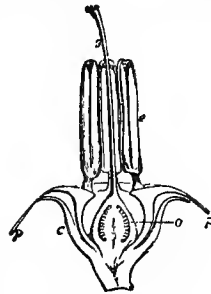


Fig. 325.—Vertical section of a potato-blossom.
c, Calyx. p, Petals.
e, Stamens. s, Pistil.
o, Ovary.



Fig. 326.—Stamen discharging pollen.
a, Slits in the anther.
p, Pollen.

the conducting tissues of the style, *styl*; the ovule is *o*; while in (2), *p* is a pollen-grain separated, and *tp* its tube.

Fig. 328 represents a pollen-grain very much magnified, showing three points where the tubes come out, one of which is considerably elongated.

Fig. 329 is a very much magnified vertical section of the style and stigma of the pistil, showing two pollen-grains on the top, throwing out their protruding tubes which descend to the ovules.

Process of Cross-fertilising.

—When it is wished to cross-fertilise a potato-blossom, the flower is held steadily in the left hand, while with the right the stamens, or male parts of the flower, are cut away with a pair of fine-pointed scissors, or a sharp and fine-pointed knife. These are the parts marked *s* in fig. 323, and *e* in figure 325, all of which must be destroyed soon after the bloom has expanded. Three or four days afterwards, on a bright clear day, the bloom of some plant which it is intended to

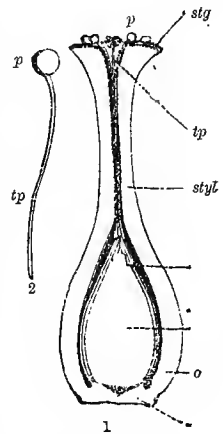


Fig. 327.—Pistil with pollen-grains on top.
(1) *stg*, Stigma; *p*, pollen-grains; *tp*, tubes; *styl*, style; *o*, ovule. (2) *p*, pollen-grain; *tp*, its tube.

cross with the one on which we have operated, is taken, and the pollen scattered on the stigma of the mutilated plant. If the anthers are ripe, this can be very readily done by bending the stamens back with the tip of one of the fingers, then letting it spring forward again, when the pollen will be thrown off. Another way is to brush them with

showing the seeds inside. According to variety the size of the plum may vary from that of a cherry to the size of a

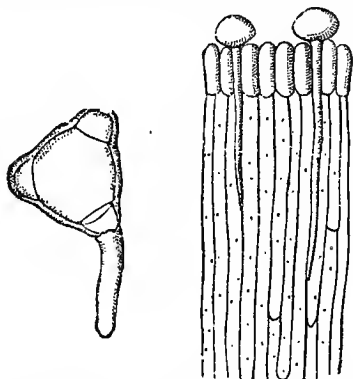


Fig. 328.—Pollen-grain magnified.

Fig. 329.—Vertical section of style and stigma magnified.

a dry feather or small camel-hair brush, which takes on a certain amount of the pollen-grains, which by drawing across the stigma are in part conveyed to it. The top of the stigma always contains more or less glutinous matter, on which the pollen-grains readily stick.

If it is desired to make the cross-fertilisation very accurate, and to be certain that no other pollen-grains are conveyed to the stigma by insects or the wind, the bloom may be tied to a stake and covered with a small fine canvas bag, or a glass globe.

For the purpose of raising seedling potatoes these precautions are, however, unnecessary. It may be here mentioned that when a potato-bloom has been only a day or so opened, the organs of fructification then have a more or less greenish tint, the colour of the stamens and pistil being as yet only partially developed;—that is the time to cut away the stamens. At first the stamens are much shorter than the pistil, but as they approach maturity they become more or one length.

Fig. 330 represents the ripened plum, while fig. 331 is one cut across the centre,



Fig. 330.—Potato-plum.



Fig. 331.—Plum cut, showing seeds inside.

damson plum. Fig. 332 represents a magnified seed.

Marking Fertilised Plum.—In order that the plum of the flower on which cross-fertilisation has been practised may not be mistaken for some self-fertilised one, each bloom as operated on should be tied to a stake, to which a label is affixed, giving the name of parent, date of cutting the stamens away, date of fertilisation, and name of the variety used for crossing. Flowers thus labelled are easily found, as the white stakes and labels are good guides, and worth all the labour for that alone.



Fig. 332.—Potato-seed magnified.

Ripe Plums.—When the plums are thoroughly ripened, they should be gathered and the seeds separated from the pulp. The ripening stage is easily known, because as maturity is approached the stalk bearing the plum first withers, then gradually shrivels up, ultimately becoming so dry that it breaks, when the plum drops on the ground. If left to themselves the plums soon rot, the hard seeds alone remaining fresh, and if these are kept moderately dry and out of the reach of birds they remain dormant till spring, when they begin life anew.

Securing and Storing Seeds.—For experimental purposes, however, the plums should be cut up when ripe, and the seeds picked out and dried under cover, preferably on a window-sill, or in a dry greenhouse; and when dried sufficiently to keep during the winter, they may be stored away in any dry situation. Instead of thoroughly drying the seeds, they may be mixed with dry earth or

sand, and thus stored during the winter, the whole (the earth or sand and seeds) being sown in a seed-bed in spring.

The plums may even be treated in this way, by surrounding them with dry earth and letting them so remain till spring, by which time the pulp will have rotted or dried up, leaving the seeds more or less mixed up with the soil. Either plan may be adopted successfully enough, but personally I prefer the first.

Sowing the Seed.—In spring the seeds may be sown under glass any time during February, March, or April, the young plants being kept under glass, particularly at nights, until all risk of frost is gone. If no glass is at hand, the sowing of the seed should be deferred till April or May, when it may be sown thinly on any garden soil in a small bed by itself.

The Young Seedlings.—In the month of May the young seedlings should be planted out, in rows not less than 20 inches apart, with 1 foot between the plants. If the seeds have been raised from strong-growing varieties such as *Champion* or *Magnum Bonum*, the seedlings will be all the better of more space; while if they are from smaller-stemmed varieties, such as *Myat's Kidney*, &c., they can do with less space. If the ground is dry-bottomed, they should be planted in the bottom of the drills, so as to give a suitable opportunity for thoroughly earthing them up. But if the young plants are likely to run any risk of being soured at the root by heavy rain they will be better planted on the flat, the earthing up in either case being done as the plant grows. If moderately manured, and kept in good clean order, the plants will soon cover the ground, the time they will take to do so being not very much longer than if ordinary potato sets had been used.

Lifting and Selecting.—At the end of October, or beginning of November, storing should commence, when the experimenter's real difficulties begin. When storing, all varieties of a very bad shape, coloured, or partly coloured skins, or bad colour of the flesh, should at once be rejected, as their preservation will likely only lead to trouble and expense, with very little chance of any corresponding gain.

The first year all plants not positively bad should be preserved, and a note kept of any peculiarities of growth, shape, colour, size, or productiveness of each.

Storing.—With many experimenters, the separation and preservation of, it may be, several hundred varieties, has been a serious drawback to their continuing the search for improved kinds. This, however, may be easily overcome in the following manner: A number of ordinary drain-pipes should be procured, and, for the first year's crop, the smaller the bore the better. One end of the pipe having been closed by a small wisp of hay or straw, the tubers of each variety are put in along with their number, when another small portion of straw, or piece of turf from an old pasture, is put on the top, then another variety, and so on till the tiles are all filled. The first year each tile may hold several varieties, whereas the second year one variety may be more than enough for one narrow-bored tile, in which case two may be used, or larger-sized ones procured. Small strips of wood, coated with white lead, and marked with an ordinary lead pencil, serve for numbering each lot; or pieces of tin, with the figures stamped on, may be used, if a set of figure stamps can be procured. After packing, the tiles may be built up in a heap, and covered as if it were an ordinary potato-pit, when they will require no further attention until planting-time in the following spring.

Period of Development.—It is a common belief that seedling potatoes require several years to form ordinary-sized tubers. Such, however, is not the case, as even the very first year many of the varieties may yield potatoes of a medium size and upwards, while the second year all worth preserving should have one or more full-sized potatoes.

Second Year.—When the potatoes are taken out of the pit or clamp the following spring, they may be planted in the usual way, and at the usual time, no particular advantages of soil, situation, or manure being given, in order to facilitate the elimination of the worthless varieties as soon as possible.

At the end of the second year, they should again be stored in tiles as for-

merly. This time each variety will require one or more tiles for itself.

The selection must this year be much more searching than the former one, and instead of rejecting only what appeared to be positively bad varieties, those only should be kept which show some good points, or other noted peculiarity.

If notes have been taken during both the growing seasons of the robustness, earliness, lateness, liability to disease, or other peculiarity of the plants, the grower will be greatly aided in his selection.

Third Year.—The third year, only tubers should be kept which show positively some good points, all others being laid aside for consumption. In this way the list will be gradually reduced each autumn and spring, as many good cropping varieties will be found to be bad keepers. A large portion of the plants will thus be rejected every autumn, with a smaller portion in winter and spring, as some which have stood the test of several years may be found not to keep well, or to cook badly.

Retain only Superior Varieties.—After the fourth year, no variety should be kept which the grower does not consider better than those already in cultivation, because to propagate any that are not superior to those already in use, undoubtedly in the end will be sure to bring pecuniary loss on the grower. It is on this rock that most raisers of new varieties wreck themselves. They

find it so difficult to cast away seedlings on which they have expended so much time and care, and to do so appears to them like sacrificing their own children. For want of courage to apply the pruning-knife severely enough, they continue, in the hope that they will yet improve, to propagate and keep in existence a large number of varieties which no one but themselves thinks worth devoting attention to. The consequence is, that in the end they become overwhelmed with varieties which are of no commercial value, and they throw up the whole thing in disgust.

Need for New Varieties.—At present there are more than enough varieties of potatoes in commerce or cultivation. Unfortunately, however, there are only a few good ones, so that the field for research is not only a wide, but a very varied one. The qualities requisite to make a first-class early, medium, or late potato are so many, and even good varieties retain these for such a short time, that there is likely always to be a demand for really first-class varieties. Although the personal attention requisite may be too heavy a drag on the ordinary farmer, who already has as much to do as he can well accomplish, the raising of new varieties of potatoes might well form a very suitable and interesting pastime for a proportion of our farmers' sons and daughters, as well as older farmers and gardeners, who have the time to spare.

HORSES IN SPRING.

The feeding and general treatment of farm-horses in spring is, in the main, a continuation of the methods pursued in winter. The various systems of feeding and management are so fully discussed in Divisional vol. ii. pp. 392-420, that little need be said here.

As the spring advances and the days lengthen, more work has to be accomplished by the horses than fell to their lot throughout the winter. The allowances of food must therefore be a little more liberal. In particular the propor-

tion of the more strength-giving and staying foods, such as oats, should be increased, the object being to make the horses strong and active rather than high in condition, and soft and liable to excessive perspiration.

Great attention should be given to the grooming as well as to the feeding of horses that are hard worked in the spring months. When they return to the stable, most likely wet and "steaming" with perspiration or rain, or both, they should at once be well rubbed down with

a handful of straw. Then when dry they should be combed and well brushed. At night their legs and feet should be cleaned of any clay or earth adhering to them, and a comfortable bed, as well as a plentiful and wholesome supper, provided for them.

A nightly or occasional feed of raw swedes will be relished by work-horses in spring; and many give a warm mash, consisting perhaps of boiled barley and oats and turnips, at least once a-week.

Good hay is preferable to oat-straw for hard-worked horses in spring. The mid-day meal in the height of spring work, when the horses are hard driven, and need rest as well as food, should consist largely of such concentrated sustaining material as oats. The horses speedily consume a feed of bruised oats, and thus have time for rest. Hard-worked horses should be disturbed as little as possible during the hours allotted for rest and feeding, so that they may return to their work fresh and vigorous.

THE FOALING SEASON.

In connection with the management of horses in spring, *foaling* is of course the chief subject of consideration. The foaling season is an anxious time for the owners of brood mares. The risks in foaling are greater than the calving risks, for the bovine race is hardier than the equine. With moderate skill and timely attention, however, serious losses in foaling are not likely to be of frequent occurrence.

Insurance against Foaling Risks.

—Several insurance companies provide special facilities for insurance against losses in foaling, and farmers are very prudently taking advantage of this provision of safety. The cost of insurance is comparatively small, and the sense of security it affords to the farmer is very comforting.

Abortion in Mares.—Abortion in mares, as in other animals, is often difficult to account for. Some mares are predisposed to it by disease, or by malformation of the parts specially involved in generation. In the large majority of cases, however, abortion in the mare may be attributed to injury inflicted in one

form or other. A fright, chasing, hurried driving, a kick from another horse, over-exertion at work, a shake between the shafts of a heavily loaded cart or waggon, are amongst the more violent actions liable to cause abortion. But it may also be induced by serious illness, improper feeding, especially with forcing food, exposure to wet stormy weather, eating poisonous plants, consuming frosted food, drinking an excess of cold water, &c.

The greatest possible care should be exercised all through the period of pregnancy, alike in feeding and working the mare. She should be fed liberally but not excessively, for overfeeding may itself cause abortion. It is a well-known fact that overfed mares are liable to produce small foals, and the tendency to this is still greater when the overfed mare is an idle animal, kept perhaps solely for showing and breeding purposes.

When abortion does occur, the mare should be kept apart from other mares in foal until they have produced their young. And these other mares should not be allowed access to the spot where the unfortunate mare aborted.

Working Mares in Foal.—There is considerable difference of opinion and practice amongst farmers as to the working of mares up to foaling-time. Mares accustomed to steady farm-work may safely enough be kept at the lighter kinds of work up to within a few days, or at most a week, of the expected date of foaling. Indeed, if the work is not too heavy, and she is not overdriven, the mare will be all the better of the exercise. Harrowing is very suitable farm-work for mares near foaling; and they also may be employed safely in ploughing if driven at an easy pace, and not yoked with a restless ill-natured animal, or in the care of a reckless ill-tempered man. Carting is unsafe work for mares heavy in foal, and should be avoided if at all possible. The shafts may inflict serious injury, and backing a loaded cart often brings on dangerous abortion.

Foaling-box.—About ten days before the date upon which the foal is expected, the foaling quarters should be prepared. A large loose-box or shed, apart from the other horses, is best adapted for the purpose; and the compartment should be comfortably littered, free from unpleasant

smells, perfectly free from draughts which could play either upon the mother or youngster, yet be so ventilated as to maintain the atmosphere in pure, equable, and wholesome condition. The means of ventilation should thus be placed some little distance above the head of the mare when she is standing, perhaps in the roof of the house. Where a special compartment such as this does not exist, or cannot be provided, a fairly comfortable foaling-box may be improvised by removing a travis and turning two stalls at one end of the stable into one loose-box. The foaling compartment should always be large enough to allow the mare to turn herself with ease at any part of it without incurring the risk of crushing the foal in so doing.

Watching Mares at Foaling.—It is very desirable that an eye should be kept on the mare night and day at foaling-time. Mares carry their foals from 330 to 360 days, eleven months being the time most generally "reckoned." They are by no means punctual however, and very often a mare has to be watched for a week or ten days, occasionally even longer. This duty may be irksome, but it is better to endure it than run the risk of losing a valuable foal, and perhaps also a still more valuable mare.

Symptoms of Foaling.—One of the surest signs of the approach of foaling is afforded by the udder. It of course becomes large, and a fluid begins to ooze out of the teats. At first the fluid is thick, dark-coloured, and sticky, but it gradually becomes white and milk-like. When this change has set in the foal may be expected within twenty-four hours, and the mare should not be left for a moment till the event has taken place.

Less definite indications of the completion of the period of pregnancy are the drooping of the belly, the swelling of the external organs of generation, and the flanks sinking inwards. The mare becomes dull and disinclined for exercise, while the movements of the foal will be seen to grow more distinct and active.

Assistance in Foaling.—Mares seldom need assistance in foaling. When aid is required, great skill and care must be exercised in rendering it. In cases which threaten to be protracted, or show any unusual and dangerous symptoms,

the veterinary surgeon should at once be called in. Rarely, indeed, is a case of difficult foaling carried through successfully by any except an experienced and specially trained man in obstetrical work amongst farm animals.

Difficult Foaling.—If the mare has gone the full time of pregnancy, any exceptional difficulty in foaling is more than likely to arise from the foal lying in an abnormal position. The head and forefeet should come first, the head resting upon the two fore-legs, just as in the case of a calf. If the labour pains are protracted without any apparent or sufficient progress, the hand should be smeared with oil or lard, and gently inserted to discover the position of the foal. If it is in its natural position as indicated, a little time will likely complete the process. If the foal is not yet in the passage, give the mare more time, and if necessary make another examination. If the foal is not presenting itself in the usual position mentioned, it may be necessary to adjust it, or at any rate to make some alteration in its position before birth can take place.

But this delicate work requires so much skill that, as already stated, it cannot be safely intrusted to any but a well-trained veterinary surgeon. If at all possible, have the veterinary surgeon at hand in such cases. If this is impossible, obtain the advice and assistance of the most experienced person within reach. Do not be too hurried in assisting the mare. Watch carefully, and assist nature when assistance seems likely to be useful. The mare needs more skilful and more careful operating than the cow in difficult parturition.

Such a case as this, however, is quite exceptional. As a rule, all that need be provided for the mare is a comfortable and cleanly compartment, with just a little less than the usual amount of food given to her when at work. The rest will, in most cases, be accomplished by nature.

Reviving an Exhausted Mare.—If the mare should seem to be weak or exhausted she will be revived by a drink of milk-warm oatmeal gruel, with the addition of a little brandy, perhaps about three ounces. In protracted cases this may have to be repeated at intervals.

Support to Mare's Belly.—Brood mares which have produced several foals are liable, when well up in years, to show a large extension of belly. For the sake of appearance as well as comfort to the mare, it would be well in extreme cases to support the belly for a time after foaling with wide soft bandages, wrapped several times round the body.

Mare's Udder.—Inflammation sometimes occurs in the udder of a mare being sucked. The udder is found to be hard and hot to the touch, and evidently painful to the mare. Foment the udder with warm bran-water, rub gently, and draw away a little milk at frequent intervals. It may be necessary to remove the foal for a few days and give the mare a dose of physic. Do not give medicine unless the foal is taken away from the mare for the time. A change of diet and low feeding for a few days may give relief. In a bad case, lose no time in calling in the veterinary surgeon.

After Foaling.—When it is seen that the foaling has been completed successfully, and the mare and foal on their feet, a drink of warm gruel, made of oatmeal and water, or oatmeal, bran, and water, should be given to the mare, some sweet hay being placed in the rack. The two should then be left in solitude for a little time. As a rule they speedily become accustomed to each other's society, and only in exceptional cases is any further interference required, either on behalf of the foal or the mare.

Cleansing.—In ordinary circumstances the "after-birth" will come away of its own accord very shortly after delivery. If it has not done so within at most a couple of days, it will most likely have to be removed by the hand. This must be done gently and carefully; and if the after-birth has begun to putrefy, the passage and uterus should be cleansed and disinfected by alternate injections of warm water and diluted Condy's fluid.

After-straining.—If the mare should continue to strain heavily for some time after birth, it may be assumed that all is not well with her, and that the advice of the veterinary surgeon would be useful.

Attention to the Foal.—The foal needs attention the moment it is born. First see that it has broken through and

freed itself from the enveloping membranes, so that respiration may set in. Then examine the umbilical cord, or navel-string, and see that it has been severed, and that there is no serious bleeding. The navel-string is usually snapped in the act of foaling, but occasionally, particularly if the mare is lying and unable to rise, it may not be broken. In that case, the attendant should at once tie a piece of twine around the navel-string at two places, about two inches apart, and then sever it between the tyings.

Reviving Weak Foals.—It occasionally happens that a foal, although still living, is to all appearance dead when born. In this case, efforts should at once be made to induce respiration. A moment's delay may result in the extinction of the vital spark, which, with prompt action, might be fanned into active life. Sponge the mouth, face, and nostrils with cold water, blow hard upon the nostrils, smack the sides of the chest smartly with a cloth, rub the body well—all this as quickly and deftly as possible, but without violence. In all probability respiration and breathing will begin immediately, and no further trouble will be encountered. Cold water dashed sharply against the chest is sometimes successful in reviving foals.

Weakly foals will be all the better of a little extra attention at the outset, in the way of rubbing and drying with a woollen cloth. The limbs as well as the body should be well rubbed. It helps to promote circulation and give strength to the young creature.

Rearing Foals.

Foal-rearing demands the most careful attention from the breeder. Foals are not so robust as calves, and are more subject to injury from cold and wet. In the great majority of cases, the foal is reared almost entirely on its mother's milk for a period ranging from four to six months. Unless exceptional circumstances have arisen—unless from some cause or other the mare becomes an inefficient or unkindly nurse—it will rarely happen that the mother and offspring require any special aid or interference until weaning-time arrives.

Coaxing a backward Mare.—Occa-

sionally it does happen that a mare, most likely in cases of the first foal, will not admit the youngster to the udder. The cause of this may be nervousness or ill-temper, and, as a rule, a little kindly coaxing will do all that is required. Let the mare see that you mean no harm to her or her foal, speak gently to her, give her a drink of milk-warm gruel, and a mouthful of sweet hay. Leave the two together for a quarter of an hour, and if she should once begin to lick the foal there will be little fear of her objecting to its sucking. If you find still that she is not licking the foal, sprinkle a little flour over its back, and contrive gently to bring the presence of the flour under her notice.

Try hard with coaxing before resorting to other measures. A mare in such circumstances is inclined to be suspicious, and will watch your conduct very closely, and with wonderful intelligence. Kindliness and patience are valuable attributes in the attendant upon brood-mares. In cases such as have been indicated, there is ample scope for the exercise of both virtues. In nine cases out of ten they will accomplish the object.

Intelligent Treatment of Mares.—But if it should unfortunately happen that by gentle coaxing the mother cannot be induced to admit the foal to the teat, other measures of a firmer kind must be resorted to, still taking care that in all measures, however drastic, calmness and good temper are displayed. Fussiness and irritability should never be witnessed in the foaling-box. The mare would quickly detect such behaviour, and would become the less tractable in consequence. Be kind but firm with the mare, giving her clearly to understand that, while you are not to abuse her, you mean to make her submit to your will. Depend upon it she will not be slow to read your meaning. The intelligence of horses is wonderful. We would often be more successful than we are in the management of contrary animals if we treated them more rationally than we do, and paid more respect to their intelligence and sensibility. In a very special sense these remarks apply in the foaling-box.

The attendant at foaling-time should be a man with whom the mare is familiar,

and upon friendly terms. The presence of strangers is liable to make the mare suspicious, and therefore restless.

Extreme Measures with Obstinate Mares.—Sometimes, when coaxing has failed, confinement of the two in a dark loose-box will be sufficient to bring mother and foal into friendly relationship. If this again should fail, hold the mare and allow the foal to suck. If the mare is vicious, she may attempt to kick the foal. In that case, hold up her near fore-foot, and if she is persistently obstinate and mischievous, it may be necessary to put the twitch on her nose, and perhaps administer a little sharp chastisement with the whip, taking care that no harm comes to the foal in the excitement. These extreme measures will very seldom be necessary, and should never be resorted to until all the more gentle efforts have been tried in vain.

Admit the foal to the udder five or six times a-day, and each time, before resorting to harsh measures, do your very best to induce her to let it suck willingly. Most likely two days of such treatment will bring the mare to a sense of her duty. In rare cases of obstinacy, the interference may have to be continued for a whole week.

Beginning the Foal to Suck.—The foal will often be very awkward in its first efforts to suck. Do not attempt to assist or direct it. Keep the mare quiet, and let the youngster feel its way itself. The instincts of nature will be its best teacher, and it will soon learn how to proceed. The mare's udder may be hard, and the teats dry. If so, rub the udder with the hand, and draw away a little milk, leaving the teats moist, so as to lead on the foal in its first attempt to suck.

Extra Food for Foals.—Many experienced breeders begin very early to give extra food to foals, even where there is no very obvious deficiency of milk on the part of the mother. In some cases mashies, consisting of scalded oats, bran, and water, with perhaps a little boiled beans or peas, and a sprinkling of salt, are given to the foal before it is quite two months old. To induce the foal to eat this extra food, it may be taken away from its mother for an hour or two each day, and the food then given to it. In

its first few months the growth of a foal may be easily and effectually stimulated; and this should certainly be done, with due care, of course, not to overdo the young animal in any way. It is a common experience amongst breeders that a pint or two of beans, or other similar food, given to a foal, will do more to promote the growth of the animal at that stage than double the quantity consumed two years afterwards.

Nursing Motherless Foals.—When a mare dies and leaves a living foal, or when a mare is unable to rear twin foals, or even to rear one, the best course for the sake of the foal is undoubtedly to procure a nurse-mother. No system of hand-rearing is quite equal to the mare's udder; and especially in the case of an exceptionally valuable foal an effort should certainly be made to procure a nurse-mother. This, however, is usually difficult to obtain, and, as a rule, foals that cannot be suckled by their own mothers have to be reared by the hand.

Rearing Foals by Hand.—For the young foals cow's milk is the next best food to the mare's milk. If the foal is newly born, the milk must at the outset be poured gently into its mouth. A feeder may be improvised by taking a teapot or kettle with small spout, and wrapping two or three folds of a cloth around the spout to make it soft and comfortable for the foal's mouth. The foal will suck away at this, but take care not to let the milk run into the foal's mouth too rapidly at first. As a protection against this the aperture in the spout of the feeding vessel should be very small, perhaps not more than an eighth of an inch.

By the time the foal is a week or ten days old it may be taught to drink the milk out of a pail, just as the hand-fed calf drinks its milk. And the method of teaching a foal to drink in this way is very similar to that pursued in learning the calf. Give the foal your fingers to suck, and gently lead its head into the pail until it draws up milk between the fingers. By introducing the foal to the milk a few times in this manner it will readily learn to drink of its own accord when the pail is placed before it.

Cow's Milk for Foals.—Cow's milk, as we have said, is the best food on which

to rear a foal for which mare's milk cannot be obtained. For some time at the outset at any rate, the milk should be new and warm as it comes from the cow. Many experienced breeders think it desirable to dilute the milk with warm water and a little sugar. The foal should get little at a time, and be fed four or five times a-day. It may not be convenient to milk a cow so often as five times a-day, and therefore, at least for two of the meals to the foal, the cow's milk may have to be kept for two or three hours. In this case the milk should be heated to about the temperature of new milk by the admixture of a little hot water in which a very little sugar has been dissolved. When it is desired to give the milk undiluted, the best way of heating it is to insert the tin vessel holding it into another vessel containing hot water.

Bean-milk and Cow's Milk for Foals.—It sometimes happens that foals do not thrive satisfactorily on cow's milk alone. In this case the substitution of bean-milk for perhaps about one-half of the cow's milk may be tried. The bean-milk is prepared by boiling the beans almost to a pulp, removing the shells and pressing the pulp through a fine hair-sieve. The result is a thick creamy fluid or paste. Sprinkle a pinch of salt over it, add the entire or diluted cow's milk, and the compound is ready for the foal. This system of feeding is highly spoken of by breeders of great experience.

Linseed, Bean-meal, and Milk for Foals.—Another liquid mixture used successfully in rearing foals consists of skimmed milk, linseed, and bean-meal. One formula for preparing the daily food of a foal from these substances is as follows: 12 pints sweet skimmed milk, 1 quart of linseed, which has been previously boiled for three or four hours, and 3 lb. of fine bean-meal added in a dry state. In some cases where the mares are hard-worked on the farm, the foals are weaned when only a few weeks old, and reared by the hand in some way similar to the above.

Supplementing the Mother's Milk.—In some cases the mother's milk is not sufficient to rear the foal successfully. Supplementary food should then be given,

and there should be no delay in providing the extra food, for it is desirable that the progress of the foal should be continuous. For very young foals this supplemental food should consist of diluted cow's milk, or some of the other liquid mixtures described above. The quantity given will of course depend on the supply of milk furnished by the mother and on the wants of the foal.

While it is quite true that by a liberal and judicious feeding the progress of a foal may be greatly promoted, it is equally certain that by insufficient feeding in its youth the animal may be spoiled for life. To stint or starve a foal is a most ruinous policy. Good feeding may not be able to convert a weedy foal into a first-class horse. Bad or insufficient feeding, however, may very easily transform a first-class foal into a weedy horse. The foal should be bountifully fed from the very outset and all through its career,—fed so as to maintain its health and keep it growing in size and strength. If the mother is unable to do this herself, do not delay in providing additional food to the youngster.

Health of the Foal.—During the nursing period the health of the foal must be watched carefully, so that its progress must not be interrupted by any derangement of the system that might be avoided or remedied. Young foals are liable to suffer from constipation, especially if they have not been able to suck the *first milk* from the mare's udder. The first milk is by nature provided with a moderate purgative tendency which is very beneficial to the offspring; but if the slightest symptoms of constipation appear in the foal it should at once receive a light dose of castor-oil.

Diarrhoea must also be carefully guarded against. Fresh air, exercise, protection from inclement weather, and good sound food to the mare, are the surest preventives.

Referring to this ailment in foals, Dr Fleming says: "When it appears it must be checked immediately by giving a dose of castor-oil in a little milk or gruel, and afterwards small doses of alkaline medicine—such as bicarbonate or baborate of soda, with a few drops of tincture of iron, and if there is straining or evidence of pain, a simi-

lar quantity of laudanum. Boiled rice or starch-gruel should be used as the vehicle of these medicines, as well as food in small doses at intervals. The body should be enveloped in a soft warm blanket, and the dwelling kept clean and comfortable. As the mare's milk may be the cause, the foal should be kept from her except at short intervals, and her diet ought to be changed, while tonics—as iron—and alkaline medicines, may be beneficially given to her."¹

Housing Mares and Foals.—The mare and foal should be kept in the foaling-box for about a week or ten days. Both should then have a little exercise daily—a run for an hour or two on a pasture-field if the weather be dry and moderately warm, or merely a walk out and back again if the weather is unfavourable. Unless the weather is dry and genial, it will be prudent to keep the mare and foal under cover for three or four weeks. At the end of that time they will both be able to stand exposure to a good deal of inclement weather, if they are by degrees accustomed to the exposure, and are all the time well fed, and comfortably but not too cosily accommodated over night.

Serious losses are sometimes incurred by want of care in turning mares and foals out to pasture soon after foaling. The sudden removal from a warm foaling-box to an exposed field in cold wet weather is in itself very dangerous; while the risk is increased by the change from dry food to green succulent pasture—the result being, perhaps, serious attacks of cold, inflammation, or diarrhoea.

Great care should be exercised in the exposing of mares and foals after parturition. Let every change be introduced gradually, whether it be a change in food, from a cosy box to an open field, or from idleness to work.

It will be a good plan, if the season is favourable and sufficiently far advanced, to accustom the mare to living on a pasture-field for two or three weeks before foaling. A month or six weeks after foaling, if the weather be dry and warm and the field well sheltered, the mare and foal may be left out over night. This is the best plan for southern counties; but

¹ *Prac. Horse-Keeper*, 163.

in the north, where the spring nights are cold, it is thought advisable to take mares and foals under cover over night until well into summer.

Working Nurse-mares.—Draught mares are often returned to work two or three weeks after foaling. If circumstances permit, it would be better to delay till the beginning of the fifth week—better for the mare and the foal too. In any case, the work for a time should be light, and for several weeks the mare should not be kept longer from the foal than two or three hours on end. With good feeding the mare will be able for two yokings, of three hours' duration each, at light work, in six or eight weeks after foaling. As long as the foal is depending mainly upon the mare for its sustenance, it will be better, in a pressure of work, to take three yokings of three hours each daily from the mare, with intervals of not less than an hour, than to keep her longer in work at one time. Two short yokings daily, however, are as much as any nursing-mare should have to accomplish.

Some recommend that the foal should accompany the mare to the work, and be allowed to suck her at frequent intervals. This plan has its advantages and its disadvantages. It no doubt familiarises the foal with the society of men and of other horses, and prevents the evils that sometimes occur to both mare and foal from long fasts. But it may be dangerous to the foal to have it moving about amongst other horses, and where it may be liable to injure itself by running against field implements; while it may also sustain harm by exposure to sudden storms or chills.

It is upon the whole safer to keep the foal in more comfortable quarters, and bring the mare to it at intervals of from two and a half to three or three and a half hours, according to the stage in the nursing period.

It is most injudicious, dangerous indeed to both mare and foal, to keep the mare away from the foal until her udder is very much engorged and distended. Inflammation may arise in the udder, and unless it is at once checked, the life of the mare be endangered. Then it will be risky for the foal to allow it to suck the milk from the inflamed udder. If

there is any reason to suspect that inflammation has begun, a portion of the milk should be drawn away by the hand and the udder bathed with cold water before the foal is admitted.

It is believed by some farmers that, when a nursing-mare gets overheated at work, and returns to her foal with a full udder, the milk, because of the overheating of the mare, is liable to injure the foal. They therefore draw away a little of the milk and bathe the udder with cold water. This idea, however, is not well founded. The mere heating of the mare will not spoil her milk so as to endanger the foal, and unless there is reason to fear that inflammation has begun in the udder, the foal may be admitted at once without any previous stripping or bathing.

But the overheating of nursing-mares at work is very reprehensible, and should never on any account take place.

Feeding Nursing-mares.—Brood-mares while nursing their young should be liberally fed. For the first few weeks, while the mare is kept in the house, the mare may be fed on sweet hay, given in small quantities, three or four times a day, with bruised oats and bran, in one or two moderate feeds, and at least one mash daily, made perhaps of barley, oats, and bran and water, with a sprinkling of salt. The mash will be all the better for milk production, as well as more palatable to the mare, if a little treacle is dissolved in it. For a few days at the very outset, if the flow of milk is not sufficient, it will be well to give frequent drinks of oatmeal or flour gruel.

When nursing-mares are being worked they must be exceptionally well fed. Let them have plenty of sweet hay or fresh grass—the latter introduced gradually,—and a liberal allowance in three or four feeds per day of bruised oats, bran, and some such mash as has been described.

If the mare has not to be worked, and if grass is plentiful, and the flow of milk sufficient, nothing more will be required than what she picks up on the pasture—that is, when the grazing season has fully set in. When first turned out to grass it may be necessary to give a feed of bruised oats morning and evening for a week or two. In arranging the feeding, in all circumstances the condition of the

mare and the supply of milk for the foal must be carefully considered.

Weaning Foals.

In ordinary circumstances foals are not weaned until they are from four to six months old. The weaning of foals, therefore, does not properly come into spring work; yet, in some cases, the separation of mother and offspring takes place earlier, and it may, on the whole, be convenient to deal with the subject of weaning here.

The weaning-time is a critical period in the existence of a young horse. It is usually the first great trial of its life, and if not properly cared for at the time, the progress of the young animal may be seriously impaired. The separation of mare and foal should be effected gradually, so that to both the influence of the change may be as light as possible.

As already indicated, the foal will be trained to eat other food some time before weaning. As the time for weaning approaches, the intervals during which the foal is withdrawn from the mare will be lengthened, and the extra food increased. When the weaning begins in earnest, the foal should have admission to the mare twice daily, morning and evening, for a few days, taking care not to let it quite empty the udder at either time; then break off to once daily. And if the foal takes kindly to its other food this process need not be long continued.

Whether the weaning process is to be short or protracted will depend mainly upon (1) the manner in which the foal takes to and thrives upon the other food; (2) the condition of the mare's udder; and (3) the necessities of the time as to the working of the mare. If the foal is weakly, and does not seem to thrive satisfactorily upon the other food, it may be well to continue a little of its mother's milk for some time: better submit to some inconvenience in this way than spoil a good foal. Then the mare may have such an abundant flow of milk that the sudden withdrawal of the food would be undesirable for her sake. On the other hand, the pressure of work may require that the weaning shall be completed as quickly as possible. Thus, in weaning, there is need for experience and careful consideration.

When the foal is being weaned it should be kept out of sight and beyond the hearing of the mare, otherwise both will be restless, and may become injuriously excited. For a few days it may be well to keep the foal in a yard or loose-box, but if there is a safely fenced pasture-field some considerable distance from the mare, the youngster will thrive better there than in a house.

Feeding Foals at Weaning-time.—As to feeding, the foal should be well attended to at weaning-time. Feed it liberally but not to excess, taking care to keep its bowels and general health in as good order as possible. Bruised oats, bran, and beans, make a capital mash for foals; and some add boiled linseed. With moderate feeds of such food as this—giving the foal just what it will readily consume, but never gorging it—and a run on a pasture-field, a strong healthy foal will not be long in forgetting its mother. The youngster will soon be able to maintain itself mainly on pasture, but a little artificial food as well will be well bestowed; for the ultimate development and value of the horse may be much increased by liberal treatment in its youth. The object is to promote the growth of bone and muscle, and oats, beans, and bran, are well suited for this. Oats stand pre-eminent, and should bulk most largely.

Attention to the Mare at Weaning-time.—At weaning-time the feeding of the mare also needs careful attention, so that the flow of milk may be stopped. Hard work and spare feeding will diminish the secretion of milk. Let the food be dry and lessened somewhat in quantity. Even the allowance of water may be slightly restricted. Draw some milk from the udder once or twice a-day, or oftener if it becomes very full, but do not empty it at any time. If the secretion of milk is not diminishing satisfactorily, it may be well to give a light dose of physic. This is sometimes necessary with mares maintained solely for breeding, but rarely with mares kept hard at work.

In the event of a mare having to be dried soon after foaling, by the death of the foal or other cause, the flow of milk will usually be stopped by drawing away a little milk by the hand once or twice daily for a few days, and by giving the

mare some purgative medicine, a short allowance of dry food and little water, and plenty of work or other exercise.

The Mating Season.

The latter end of spring and early summer is the *mating season* for horses. Both mares and stallions are in the best form for breeding when in robust health, in good natural condition—just such condition as should be shown by hard-worked well-cared-for horses. Over-feeding should be avoided; it is as injurious as insufficient feeding.

A mare will usually come into *season* about nine or ten days after foaling, but occasionally not in less than twice that period. It is generally quite apparent when a mare desires to receive a stallion; but if there is any doubt, the point may easily be settled by *trying* the stallion with her.

It is advisable to serve the mare in the first heat of the season. As a rule, with healthy animals one service will be sufficient. About twenty days after the first service the mare should again be shown to the stallion, and if the usual symptoms of desire are not then exhibited by her, it may be assumed that she is pregnant. Still she may “come round” again in about three weeks, and the attendant should watch carefully for the symptoms. Some breeders think it desirable to have the mare served twice at one time, with an interval of ten to twenty-four hours; but this is not the rule.

Feeding and Treatment of Stallions.—The management of stallions during the service season requires considerable care and experience. He should be in full, natural, lean flesh, but on no account highly fattened. The food given to him at this time should be strengthening rather than fattening. Nothing excels bruised oats and sweet hay, and of this food the stallion should

have enough to well maintain his condition and vigour. With the evening allowance of hay some green food, such as tares or grass and clover may be mixed, but when the horse has much walking to accomplish, as is often the case with stallions on their rounds, a big stomachful of green food is undesirable. A little split beans added to the bruised oats will be beneficial to old stallions.

It is all the more necessary that careful attention be given to the feeding and general treatment of stallions during the service season, seeing that derangement of his system and physicking may impair his usefulness just when it is most required. Physic or drugs, if any, should never be resorted to except in cases of absolute necessity. We have no belief in the so-called prescriptions for stimulating the procreative powers of a stallion. If plenty of good sound food, such as has been indicated, with pure water and abundance of exercise, do not maintain the fertility of a horse, nothing else will.

Exercise for Stallions.—Exercise is very beneficial for stallions in the active season. It is customary for horses to make a circuit of the districts in which they are to serve, going the round three or four times in the season. In these cases the necessary walking affords ample exercise. When the stallion is stationed at a certain place and the mares brought to him, it is very desirable that he should have walking exercise every day.

Number of Mares to one Stallion.—The number of mares allotted to one stallion in a season varies considerably with circumstances, such as the age, condition, and value of the horse. An adult horse in robust active condition may have from 60 to 70 mares. The number often exceeds 80, but it is highly imprudent to overdo a stallion, and it may incur the risk of many *blanks* amongst his mares.

SWINE IN SPRING.

As with other varieties of farm live-stock the bringing forth of the young is the main feature of the spring work in the management of swine.

As pointed out in page 421, Divisional vol. ii., it is desirable that, as a rule, the fattening of pigs should be done during the warmer months, say between March and October. The times for farrowing will therefore be in the main regulated to suit this system.

FARROWING OF SOWS.

There is as much diversity of opinion as to the best system to adopt with a sow at the time of farrowing as there appears to be on most other points connected with the management of pigs. Some persons will advise that the sow should be left entirely to herself whilst she is farrowing, and others will just as strongly urge that the sow ought to have some one in attendance on her.

As with many other apparently contrary views relating to stock management, there is much to be said in favour of both systems; everything depending on the temperament of the sow, and the manner in which she has been previously treated.

Many of the common "anyway-bred" country sows, whose time is spent in a struggle or search for the bare necessities of life, and whose aim is to give as wide a berth as possible to every human being lest they should meet with the punishment they have already deserved (or most likely will, at some future time, deserve) for their predatory habits, resent the presence of an attendant when they are farrowing. At such a time sows of this class are naturally in a somewhat excited condition.

On the other hand, the well-bred, carefully tended sow, whose experience of man is of an exactly opposite nature, appears to like rather than dislike the attendance of the person who is in the habit of feeding and looking after her. It would, of course, be most unwise to

have a stranger to attend to the sow at such a time.

It has been the custom at Holywell Manor for a great number of years to have the pigman with the sow when she is farrowing; and of the many hundred of sows which have been kept there, only one was much trouble. In this case the cause of the sow being savage (no other word so well expresses her state) was afterwards discovered. Some workmen who were making alterations in the farm premises stupidly amused themselves by teasing the sow a short time before she was due to farrow. This appeared to render her almost mad for two days after the arrival of the little pigs. So excited was she that she would not allow the soiled litter (straw) to be removed, nor the pigman to enter the sty to feed her. The sow gradually tamed down, and within a fortnight was as quiet as usual.

Preparation for Farrowing.—It is a good plan to have the sow placed in the sty or house where it is intended that she should farrow, at least a fortnight before her time is up.

Period of Gestation.—The period of gestation with sows is as nearly as possible sixteen weeks. Some aged sows, and yelts with their first litters, will often farrow a day or two before the four months have elapsed; whilst the more robust sows will as frequently carry their pigs one hundred and fifteen or eighteen days, and in a few cases even a little longer.

Symptoms of Farrowing.—The pigman will easily foretell the arrival of the litter. The sow will be restless, her udder will become swollen and heated, and on the teats being drawn, moisture of a sticky glutinous nature, and sometimes milk, will be found at least twelve hours before the little pigs arrive on the scene; the vulva will become enlarged, and the muscles on either side of the tail will give way.

Litter for Young Pigs.—It is not advisable to allow the sow to have much long straw for bedding during the first few days after she has pigged, or the

little pigs may become entangled in it, and get lain upon by the sow. Some persons give their sows at this time long cut chaff for bedding, but the best material for the purpose is the wheat screenings or "cavings" from the riddles of the threshing-machine. This is both short and soft, and has no sharp ends such as are found in cut chaff.

Treatment of the Sow and Produce in Farrowing.—When the sow commences to farrow, the attendant should have ready a three-dozen size hamper, three-parts filled with wheat-straw, and as the little pigs come into the world they should be wiped with a cloth and put into the hamper, where they will rest contented and warm until the sow has finished farrowing—unless it be a very prolonged case. In the latter event the piglings should be taken out of the hamper and placed near the udder of the sow, when they will soon begin to forage about for that which nature almost invariably provides for them.

After the sow has suckled the pigs it will be advisable to again place them in the hamper and to give the sow a little slop composed of bran and sharps stirred with tepid water or skim-milk. The sow will then soon lie down again, when the pigs may be placed with her and the family party will generally rest comfortably until the return of feeding-time. In cold weather it is better to cover the hamper with a sack or cloth, as the little pigs are easily chilled before they have become dry.

The After-birth.—In some cases the sow is allowed to eat the placenta or after-birth. This should be carefully avoided. The placenta should be removed from the sty as soon as it is clear of the sow.

It will be found advisable to walk the sow out of the sty the day after she has farrowed. The little exercise will generally cause her to relieve the bowels and the bladder.

Assistance in Farrowing.—It is not often that the sow requires any assistance in getting rid of the pigs, but it will occasionally be necessary to give her help. Sometimes the little pig will present itself crosswise. At other times there may be a double presentation, or the foetus be abnormally large. There is

seldom any great difficulty in relieving the sow. The two great essentials are care and a plentiful supply of lard. The hand and arm of the operator should be small and well smeared with grease. If the sow appears to be slightly amiss a day or two after farrowing, 2 oz. of sulphur and $\frac{1}{2}$ oz. of nitre should be given to her in a pint of skim-milk. She will soon drink this up, and generally it will be all the medicine needed.

Pigs Biting Sow's Udder.—It will sometimes be found that when the newly born pigs are placed with the sow, they will fight for the teats to such an extent as to bite the udder of the sow, which at the time is especially sensitive. The sow will jump up in a hurry, and should no steps be taken to prevent the youngsters injuring her, she will often lie flat on her body and refuse to suckle the little pigs. This occurs more frequently when the sow carries her pigs beyond the usual period of sixteen weeks. The eight tusk-like teeth of the piglings will be found abnormally long, and generally of a dark colour at the root. Old-fashioned pigmen were wont to say that "these black-teethed pigs are never any good, and are sure to pine away and die." In this they were doubtless correct, unless the simple remedy of breaking off these offending teeth was applied. If this were not done the pigs would naturally become more hungry, and consequently more combative, whilst the sow's udder would become more sensitive and inflamed owing to the milk not being extracted. The usual result would be that the pigs would be starved to death from want of their natural food, and the sow would suffer from inflammation of the udder.

The remedy, a most simple and efficacious one, is to remove the pigs out of hearing of the sow, and to break off the teeth of the piglings with a small pair of pincers. If the pigs are then placed with the sow no further trouble will be experienced. Each pig will soon settle down to its selected teat, which it will make its headquarters for obtaining lacteal nutriment until it is weaned.

Weaning Pigs.—This should take place when the pigs are about six weeks old, if in summer, and about eight weeks old in the colder months. The

weaning should be done gradually, by extending the time during the last three or four days, of keeping the sow from the pigs.

Housing Brood-sows.—Fig. 333 represents an arrangement of four sties or compartments for brood-sows, all under one roof, and communicating with a

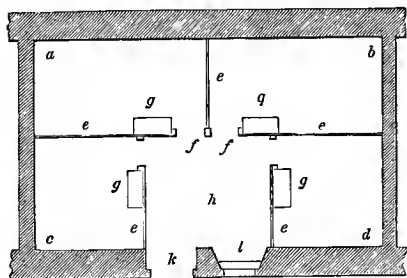


Fig. 333.—Sties for brood-sows under one roof.

a b Two sties, $7\frac{1}{2}$ by 12 feet.

c d Two sties, $7\frac{1}{2}$ by 8 feet.

e e e Wooden partitions.

f f f Four doors of sties.

g g g A feeding-trough in each sty.

h Area from which to overlook the sties and to fill the troughs.

k Outer door of sties.

l Window for the sties.

compartment in which the attendant may provide a bed for himself.

Drains proceed from all the sties to the nearest liquid-manure drain; and the apartment is rendered comfortable by having the ceiling and walls plastered, a ventilator placed on the roof in connection with the ceiling, and the floor

of brick. When two sows only are kept, the other two sties may be occupied by the weaned pigs.

Prolificacy in Swine.—In the different varieties, and even in the different strains or families of each breed of pigs, there is a marked difference in the prolific powers. This is most noticeable in those strains which have been bred for a number of years for showyard points alone, without due regard to those more useful and general-purpose qualities which are the only really valuable ones for the pig-breeder to study and cultivate. We would not for one moment wish to be understood as expressing the opinion that prolificacy, utility, and ability to win prizes are not to be found combined in several families or tribes of the different kinds of pigs. There are, indeed, numerous instances of such a happy blending, but it is undeniable that the rule is "the other way about."

Sows are capable of breeding—that is, of conceiving—when about seven months old; but it is imprudent to begin at such an early age. About the tenth month is soon enough to mate a sow with the boar.

A good breeding-sow will produce and nurse two litters in a year.

What is said in Divisional vol. ii, pp. 421-425, as to the feeding and management of pigs, should be consulted at this time.

POULTRY IN SPRING.

HATCHING.

Spring is the busy and happy season of the feathered inhabitants of the farm.

Laying Season.—As soon as the grass begins to grow in spring, so early will well-cared-for hens delight to wander into sheltered portions of pasture, in the sunshine, in the warm side of a fence, pluck the tender blades of grass, and pick up the insects which the genial air may have warmed into life and activity. With such morsels of spring food, and in agreeable temperature, their combs redden, and their feathers assume a

glossy hue; and even by February they will chant—which pleasant sound is a sure harbinger of the laying season.

Selecting Sitting Hens.—By March, a disposition to sit will be evinced by early-laying hens—but every hen should not be allowed to sit; nor can any hen sit at her own discretion, where the practice is, as should be, to gather the eggs every day as they are laid.

It is expedient, then, to select the hens to bring out chickens. Those selected should have quiet dispositions, not easily affrightened, nor disposed to wander afar; should be large and full-

feathered, to cover their eggs well, and brood their young amply. Those which have proved themselves good sitters and brooders, careful and solicitous of their broods, should be chosen in preference to birds which do not exhibit these characteristics. But it is proper to make some young hens every season sit for the first time.

Selecting Eggs for Hatching.—The eggs to be set should be carefully selected. Every one proposed to be hatched should have the date of its being laid written upon it. Those of a particular hen desired to be hatched should be kept by themselves, well preserved, and set after her laying-time is finished.

In selecting eggs for hatching, they should be quite *fresh*—laid within a few days—large, of truly ovoidal shape, single, not seeming double-yolked; neither too thin nor too thick, but smooth in the shell. Their substance should almost entirely fill the shell, and be uniform and translucent when looked through at a light, which is the best test for their examination.

Sex of Eggs.—It has been said that the *position* of the cell that contains the air in an egg determines the sex of the chick—if the cell occupies the exact apex of the end, which is always the large end, the chick will be a male; and if on one side of the apex, it will be a female. But this cannot be accepted as being reliable, nor can any of the other numerous supposed methods for predetermining the sex of eggs.

Hens are required to lay eggs for the dealers of eggs, and young cocks are required for the dealers of fowls, and for converting into capons. Both businesses are carried on by different persons, and hence the utility of determining the sex of eggs. M. Génin says, that as the female skeleton of a fowl contains smooth bone, and that of the male rough, so the male egg is wrinkled at the small end, and the female is smooth at both ends. This is the result after three years' experience.

But all the indulged notions as to determining the sex of eggs, and regulating sex in breeding, have, in the case of poultry as of other animals, been proved over and over again to be fallacious. We take it that this is a law

wisely kept beyond the knowledge and control of man.

The matter of sex of the egg is of no importance on a farm, as good chickens of both sexes are valuable as an article of food.

Number of Eggs in a Setting.—Either eleven or thirteen eggs are placed under a hen; eleven are more likely to be entirely hatched than thirteen, as few hens can cover thirteen large eggs sufficiently. The custom prevails even at the present day, of setting an *odd* number of eggs under a hen. This may have arisen from the idea that, allowing one egg to be a nest-egg, an *even* number of *couples* of chickens will be obtained in the hatching; and hence it is a good hatching if ten chickens are brought out from a setting of eleven eggs, or twelve from thirteen eggs.

Brood-nest.—A brood-nest for the sitting hen may consist of a circular hassock of soft straw-ropes, for a foundation on the ground, or in a box or basket. The object of this foundation is to raise the nest sufficiently above the ground to keep it dry, and to give it such a hollow as none of the eggs shall roll out by any mischance. A box or basket is a convenient receptacle for a nest, but in using either, it will be requisite to stuff the corners firmly with straw, that neither the eggs nor the young chicks may fall into them. The nest itself should be of soft short oat-straw. It should be made as large as to afford the hen ample room, not only for her body, but her tail. If the tail is bent awry while sitting, the hen will feel uncomfortable. Nests are commonly made too small. The hollow occupied by the body of the bird should not be larger than she can fill; but the sides and base of the nest should spread out to give room around the hen, and elevation above the floor.

Hatching Compartment.—Places may be chosen for the sitting hens in the regular hen-house. Hatching-places should be made to contain one hen at a time, but partitioned to separate the hens completely, as hens are jealous of each other when sitting, and will sometimes endeavour to take possession of the nest and eggs of others, or drive them away from their eggs. Other places may be selected for sitting in—

an outhouse, a loft, a spare room in the farmhouse, or even the back-kitchen, when warmth is required for early broods. Where a large number of hens are set, it is especially desirable to set apart a room, loft, or house for their accommodation. In that case, they should be set in hatching-boxes, 21 inches high, and 15 inches square, solid (except for ventilation holes) on top and sides, the front forming a door, and no bottom. The nest should be made in this on fine earth, and the hens let out for feeding once a-day.

Training Hens to Sit.—Should the hen selected for sitting have been accustomed to lay in the hen-house or elsewhere, she would feel annoyed on being transferred to new quarters; she will have to be coaxed to it, and even after all may prove obstreperous, though exhibiting strong symptoms of clucking, in which case she must be dismissed and another chosen, rather than run the risk of spoiling the entire hatching by her caprice.

Having got a quiet subject, a couple or so of old eggs should first be put into the nest, upon which she should be induced, by meat and water beside her, to sit for two or three days, to warm the nest thoroughly before the eggs she is to hatch are placed under her. After she shows a disposition to sit, and the nest warm, the old nest-eggs are taken away, and the selected eggs are put in the nest—eleven being enough—and the hen allowed to go upon them in her own way, and to manage the eggs as she pleases, which she will do with her bill and body and feet, spreading herself out fully to cover all the eggs.

Time for Setting.—The time chosen for setting the hen should be towards the evening, when the natural desire for roosting and rest arrives, and by next morning she has taken to the nest contentedly. It is usual to set a hen at any time of the day, even in broad daylight, when she is almost certain to come off and desire to wander; and to curb the disposition, a tub is placed over her to keep her in the dark. The consequent fright not only prevents her attending to the eggs, but some may be broken in her attempts to get out of confinement.

In the desire to keep the creature in

the dark, it might suggest itself to any considerate person, one should suppose, that darkness is more easily found at night, and that natural darkness is better than artificial.

Feeding Sitting Hens.—While sitting upon her nest, the hen should be looked at regularly every day, and supplied with fresh food, corn, and clean water. She will not consume much food during the time of incubation, which is three weeks. Every two or three days the dung, feathers, &c., about the nest and on the floor should be swept and carried away, and the place kept clean and dry.

Testing Fertility of Eggs.—It is advisable to test the eggs when they have been sat on for a week, as in this way infertile eggs can be removed, and the work of hens economised. Many breeders set two or three hens at the same time, and if there are several eggs infertile they give all the fertile eggs to one or two hens, and place fresh eggs under those thus liberated.

The method of testing is to take the eggs into a dark place and hold them in the left hand between the forefinger and thumb, midway betwixt a candle and the eye, shading the light with the right hand also. Or an egg-tester may be used. Fertile eggs will be dark and quite opaque, whilst those which are infertile will be perfectly clear.

During very dry weather the ground under and around the nest should be moistened by a moderate quantity of warm water every other day, but the eggs must not be damped.

Chicks Appearing.—In three weeks a commotion among the eggs may be expected; and should the hen have proved a close sitter, and the weather mild, it is not unlikely that the heads of two or three chicks will be seen peeping out below her feathers before that period. The hen should not be disturbed during the time the chickens are leaving the eggs, or until they are all fairly out and dry. Any attempt to chip an egg, if not carefully done, generally kills the chick.

Feeding Chicks and Hens.—For the first twenty-four hours, or until the yolk is absorbed and digested, being the first food of the chicks, they should receive neither food nor water. After that

give water. Food is then set down to them on a flat plate, the food consisting of crumbled bread and oatmeal, or some of the well-known prepared foods, with a flat dish or small fountain of clean water. The hen's food consists of corn, or soft food, boiled potatoes, and water.

The chickens should be visited every three hours, and a variety of fresh food presented, so as to induce them to eat it the more frequently and heartily—such as picks of hard oatmeal porridge, crumbled boiled potatoes, rice, groats, or some of the well-known prepared foods,—taking care to have the food fresh and the water clean, however small the quantity that may be consumed.

Care of the Young Brood.—The hassock, or box, or basket, should now be removed, and the true nest set upon the floor, with a slope of straw from it, that the chickens may walk up to the nest to be brooded at night.

In the course of twenty-four hours, after all the chickens are on foot, the hen will express a desire to go out, which she should be indulged in if the weather is dry, and especially when the sun is out; but if it rain she had better be kept within doors, unless a convenient shed is near, in which she may remain with her brood for a short time.

Visited every three hours during the day, and supplied with a change of food and water until the feathers of the tails and wings begin to sprout, chickens may be considered out of danger, and become less of a charge.

It is not always expedient to set a number of hens at one time, but in succession every three weeks or a month; for a few chickens, ready for the table in succession, are of greater value than a large number of the same age.

Chickens should receive food four times a-day, consisting of barley and oatmeal, made crumbly and moist with hot water, or boiled potatoes, as long as they last, and the other foods already named.

Open-air Laying and Hatching.—

As the season advances into summer, hens, as they become fat by picking up food in the fields, have a predilection to select places there for nests to lay eggs, and bring out chickens. It must be owned this is a most natural predilection,

but no dependence can be placed in it for a regular supply of young fowls. The weather may not suit hens sitting in the open air; and hens have not the disposition to sit in the most desirable periods of the year—early and late. It is impossible to obtain a regular supply of eggs or chickens, unless provision is made for collecting the eggs and hatching the chickens in a systematic manner.

Chickens go six to eight weeks with their mother. A good hen that has brought out an early brood will become so fat while rearing them, that she will soon begin again to drop eggs, and of course again become a clucker, and may then be employed to bring out a late brood.

Hatching and Rearing Turkeys.

The hatching and rearing of turkeys are usually regarded as difficult matters. Many, however, maintain that turkeys are almost as easily reared as chickens.

When a turkey-hen is seen disposed to lay, a nest should be made for her in her hatching-house. It consists of the same materials as the hen's nest, but of larger size to suit the bird. A box or basket is an excellent thing, with the corners filled up. When once the turkey-hen lays an egg, and a nest-egg is placed in the nest, she will use it regularly every time she requires it, which will be once in about thirty hours. As the eggs are laid, they should be removed, and placed gently in a basket in the house, in a *dry* place, and turned with caution every day.

When she has done laying, which may not be till she has laid twelve or thirteen or even fifteen eggs, she will be disposed to sit, when the eggs should be placed under her, towards evening, to the number of eleven or thirteen, the eleven being the most certain of success, as a turkey cannot cover more of her own eggs than a hen can of hers; and a brood of ten poults is an excellent hatching.

A turkey need not be confined within the apartment she occupies, as she is not disposed to wander, nor is she jealous, like a hen, of another one sitting in the same apartment with her. A turkey sits four weeks, and is proverbially a close sitter.

During the incubation, corn and water should be supplied to her fresh and clean daily, and the dung and feathers removed from the nest every two or three days.

Care of Turkey-poults.—When the poults are expected, the turkey should be frequently looked at, but not disturbed, until all the poults are fairly hatched. All turkey-poults require at first is a drink of water, and they should be immediately returned to the warm nest, where the mother will receive them with characteristic fondness.

But before leaving the turkey for that night, the box or basket in which the nest is formed should be taken away, and the nest formed with a sloping face towards the floor, to enable the young poults to gain it.

For twenty-four hours the poults will eat nothing, though the turkey herself should be provided with corn, boiled oatmeal, or boiled potatoes, and water.

Food for Turkey-poults.—Next morning the young creatures will be quite astir, and ready to eat food, which should now be given them. It should consist *solely of hard-boiled eggs, yolks and white shredded down very small*, and put on a flat plate or small board.

In one respect turkey-poults apparently differ in their nature from chickens, inasmuch as they evince a tendency to purge for the first two weeks of their existence; and when purging overtakes them, it is difficult of cure, and generally proves fatal. The prevalence of this complaint among turkey-poults, it is believed, arises from the laxative condition of the food they then receive. Hard-boiled eggs being astringent and nourishing, no tendency to purging is observed with them. On the contrary, the little things are as lively and healthy as ordinary chickens, and, after their wing and tail feathers have sprouted, can bear inclement weather.

For the sake of experiment, firm oatmeal porridge was given instead of hard-boiled eggs, and in a few days two poults took the flux and died, the rest having been saved by a return to the egg. With egg for two weeks not a single death occurred among two hatchings every year for upwards of fifteen years; and this surely is sufficient experience to justify the recommendation of any practice.

Let the poults be visited every three or four hours, and supplied with hard-boiled egg and clean water. Let this food be removed after the poults are served, otherwise the turkey will devour it; for she is a keen feeder, and not so disinterested a bird in regard to food as a hen.

Let them remain two nights and one day in the house, and afterwards let them go into the open air and enjoy the sun and warmth, of which, it is hoped, there will be plenty by May. In wet weather they should be confined to the house, or go into a shed. When the birds become strong and active in the course of a few days, let the turkey be placed in a coop on the green to curb her wandering propensity, until the poults can follow her, which they will be able to do after they have been supported on hard-boiled eggs for two weeks—for three all the better. The hard-boiled eggs should be put upon a plate on the green beyond the reach of the coop, and where the poults can help themselves; whilst the food of the turkey is placed within reach of the coop.

After the feathers in the tails and wings of the poults have fairly sprouted, the egg may be *gradually* withdrawn, and hard-boiled picks of porridge, with a little sweet-milk in the dish, to facilitate the swallowing of the porridge, should be given them at least four or five times a-day at stated hours—which wholesome food will support them until the mother can provide insects and other natural food as a variety. They will now thrive apace, and grow fast as the weather becomes warm. Excellent food, specially prepared for rearing turkeys, is largely advertised.

Should the grass be damp, let the coop be placed on the gravelled walk or some other dry spot, as dampness is injurious to all young birds of the gallinaceous tribe.

After the egg is withdrawn, the poults are fond of shredded dandelion, cress and mustard leaves, and, when at liberty, pick the tender leaves of nettles with avidity. The predilections for ants and nettles show that turkeys enjoy stimulating condiments with their food. In eight or ten weeks they are well feathered. They eat rice, pot-barley, fresh curds, acorns, beechmasts, sunflower-seed.

Turkeys as Layers.—Turkeys are sometimes extraordinary layers. One season a hen-turkey, after bringing up eleven poults till they were eight weeks old, made a nest in the middle of a large bush of nettles at the edge of a young plantation, which she visited by contriving to slip away unnoticed from her brood to lay an egg *every day*. The nest was soon discovered, the egg taken away as it was laid, and a nest-egg left; and she continued to visit the nest *daily* till she had laid the extraordinary number of ninety eggs.

The consequence of this oviparous fecundity was, that she did not moult till the depth of winter, and the moulting was so very bare that she had to be confined to a warm house; and whether the misfortune which befell her before spring was owing to the late moulting, acting on an exhausted constitution, superinduced by the inordinate production of eggs, we do not know, but inflammation seized one of her eyes, and deprived her of sight. By spring she recovered from the moulting, had a new plumage, the blind eye healed, but she never recovered her condition on the best of food, and died a short time after.

Turkey-hens as Mothers.—Turkey-hens are most watchful protectors of their young, and are particularly wary of birds of prey, which, whenever observed, even at the greatest height in the air, they will utter a peculiar cry, which the poults understand, and will hide themselves instantly amongst long grass and other plants within reach.

Another peculiarity affects the turkey-hen: one impregnation from the cock fecundates all the eggs of the ovarium; and on account of this property, it is not uncommon in spring, in Ireland, for people to carry about turkey-cocks and offer their services at farmsteads. It is, perhaps, this peculiar constitutional property of the turkey-cock that makes him regardless of his own progeny, and which leads the hen to shun him as long as she has charge of a brood.

The brood goes with the turkey-hen for an indefinite length of time. Roosted on a high straw-rack, a turkey-hen has been seen to spread her wings over one of her young on each side of her, when they were nearly equal to herself in size.

Hatching Geese.

Geese make early preparation for incubation. They, however, seldom lay eggs in Scotland till the end of February. The goose and gander cannot copulate except in water; and if the pond which they frequent be covered with ice, it should be broken to allow them to get to the water, and every egg requires a separate impregnation.

Geese as Layers.—An attentive observer knows when a goose is desirous of laying, by her sitting down amongst straw and picking up and placing one on this side and one on that side of her, as if making a nest. Whenever this, or an embrace on the water with the gander, is noticed, a nest should be made for her to lay in, in the hatching-house, in a box or basket to suit the size of the bird, to which she should have easy access by the door. It is improper to confine a goose a long time before laying her first egg; but when symptoms of laying are observed, she should, in the morning, before being let out, be examined in the lower part of the abdomen; and if the egg is felt, she should be put in her nest and confined until she lays it in the course of the day, when she is let out, the egg taken away, kept dry in a basket, and turned every day until the entire number is completed—a nest-egg being left in the nest.

Produce in Eggs.—Every second day after the first, the goose will visit the nest made for her, and lay an egg, and the number will seldom exceed twelve, though eighteen have been laid. By the time she is done laying, it will thus be about the end of March.

Considerable difference in this respect exists amongst geese. They lay on some farms earlier than on others. This may arise from the nature of the soil, as probably a dry, sharp, early soil for grass and grain promotes the functions of animals to an earlier development.

Setting a Goose.—After the goose has finished laying, she will incline to sit. She should receive her eggs towards evening, so that by the morning the nest will be so warmed as to induce her to keep possession. The number of eggs to be hatched should be eleven, which is as many as a goose can easily cover. The

goose plucks the down off her breast and furnishes a lining to her nest to increase its heat; while the down also forms a covering for the eggs when she leaves her nest for a time, thus preventing their cooling.

Feeding a Sitting Goose.—A little clean water and a few oats are put beside her while she is sitting; but she will eat very little food all the time she sits. A feed of good oats, such as is given to a horse, will serve a sitting goose for a month; yet this handful is often grudged the poor patient goose. The lightest corn is only allowed by many who consider themselves good rearers of stock. In neglecting her food, the chance is that she will forsake her nest in order to search for the necessary sustenance. At any rate, it is proper to attend to her every day while she is sitting.

Some do not allow a goose to go out while she is sitting, in case she should forsake her nest; but this is an unnecessary constraint. Let her have food and water beside her, and let her go off whenever *she pleases*, and she will return to her nest in time to maintain the heat preserved by the down. Many will not allow her to go to the water at all, alleging that when she returns wet upon the eggs they will become added; but this is a mistake. Let her go to the pond if she wishes to wash herself, and she knows better what to do for herself than her teachers; she will not continue longer than to refresh herself. Her feathers cannot become *wet*, for it is opposed to their nature; and after the relaxation she evidently so much enjoys, she will sit the closer.

Geese are liable to become costive while sitting and eating nothing but corn. To counteract this tendency, they should now and then have boiled potatoes in a crumbled state; in fact, every fowl, while sitting, should have this useful ingredient.

The Gander.—The *gander* usually takes up with one mate, but if there are only two geese, he will pay attention to both. Regard for his mate is so strong in the gander that he will remain at the door of the hatching-house like a watchdog, guarding her from every danger, and ready to attack all and sundry that approach her sanctuary.

Period of Incubation.—At the end of a calendar month the eggs will be hatched. During the hatching the goose should be left undisturbed, but not unobserved.

Care of the Goslings.—After the goslings are fairly out of the shell, and before they are even dry, they may be taken in a basket with straw to a dry sheltered spot in a grass-field hard by, the goose carried by the wings, the gander following uttering a soft whistling sound. Here they may remain for an hour or two, provided the sun shines, and in sunshine goslings pick up more strength in one hour than from any brooding they receive from their mother for a day. The goslings endeavour to balance themselves on their feet and pluck the grass; the goose rests beside them; and the gander proudly protects them all. Water should be placed beside them to drink.

Should the sky become overcast, and rain appear likely to fall, the goslings should be carried with the goose to the nest: for if they get their backs wetted in the first two or three days of their life, they will lose the use of their legs, and die. Should the weather be wet, a sod of good short grass should be cut and placed within their house, beside a shallow plate of water. In setting down a common plate to goslings, it should be prevented upsetting, as some will put their feet upon its edge and spill the water.

After two days' acquirement of strength, in sunny weather, the goslings may venture to a pond to swim; but the horse-pond, being frequented by so many kinds of animals, is too dangerous a place for them as yet. A piece of water in a grass-field is the best place for them.

For the first few days after goslings go about, they should be particularly observed; for should one fall upon its back on the grass, or into a wheel-rut in the ground, it cannot recover its legs, will be left by the others, and perish. After three or four days in dry sunny weather, and on good grass, they will become so strong, and grow so fast, as to be past all danger. It is surprising how rapidly a young gosling grows in the first month of its life.

Feeding Goslings.—After that time they begin to tire of grass, and go in search of other food; and this is the time

to supply them daily with good oats, if fine birds by Michaelmas are desired; any other grain will answer the purpose—rice, Indian corn, let it be but corn, though oats are their favourite food. Light corn will be better than none; and if they get corn till harvest, they will have passed their fastest-growing period, and will then be able to shift for themselves, first in the stack-yard, and afterwards on the stubbles.

The sex of the gosling may be easily ascertained after the feathers begin to sprout—the ganders being white, and strong in the leg, head, and neck; the geese grey, with a gentler aspect. Goslings go with their parents for an indefinite length of time.

Artificial Hatching and Rearing of Geese.—Geese are in general close sitters; but sometimes they forsake the remaining eggs after a few of the goslings are hatched. One instance of this sort of desertion is worthy of mention. A goose after hatching five goslings left her nest, would no longer sit on the other six eggs, and would be away with the goslings she had. She was not allowed to do that; but fearing that the deserted eggs would perish, my housekeeper brought the eggs into the house, put them in a basket amongst warm flannel and wool, heated the oven gently, placed the basket with the eggs in the oven, and continued the heat in it until the goslings were hatched one by one, excepting one which had died. They occupied some days in leaving their eggs, and longer than they would have done under the goose. They were carefully attended to, taken out to the grass in the best part of the day, kept warm in the house at night, and, when the weather was bad, a grass sod was brought to them.

The goose refused to take this part of her own brood when offered her, after they had gained sufficient strength to go about: they were brought up without her aid, and became as strong birds as the rest.

This was a remarkable instance of disregard of personal trouble; and is an encouraging example of successful perseverance in the preservation of the lives of useful animals under unfavourable and even provoking circumstances.

Hatching Ducks.

Ducks will begin to lay eggs as early as November, if early hatched young ducks are selected. It is therefore possible to obtain an early hatching of ducklings. But early ducklings are rarely desirable, as, even with the utmost care, they do not acquire much flesh, their bills and bones growing disproportionately large. They indeed never become fine birds.

It is early enough to set duck-eggs in Scotland by May, and by April in England, unless, as in the Aylesbury district, a point is made of supplying the spring market.

Hens as Foster-mothers for Ducks.

—It is customary to place duck-eggs under hens, owing to the difficulty of making a duck take to a nest she has not herself made. Hens make tolerable foster-mothers to ducklings, though the task imposed upon them of a week's longer sitting is not in conformity with their nature, and their tempers are frequently sorely tried when the young fleet of ducklings launch themselves upon the water and leave them, where they cannot follow.

Ducks should bring out their own kind; and it is thought that, when a duck does choose a nest for herself, lines it with her own down, and brings out a brood, that the ducklings are better than any reared under a hen; her instinct leading them to places in search of food suitable for them upon land as upon water. Still the entire production of ducklings on a farm should not be left to the chance of ducks setting themselves on eggs, for they are proverbially careless of where they drop their eggs, so that hens must be employed to hatch a few broods of ducks. A hen can cover only eleven duck eggs with ease; a lunar month is required to bring them out; and during the hatching, the hen should be left undisturbed until all the brood comes out.

Care of Ducklings.—Ducklings should be kept from water for two or three days. The food which they receive should be soft, as oatmeal porridge, boiled potatoes, bread steeped in water or milk, barley-meal brose, and clean water to drink, in a flat dish in which they can-

not swim. With this treatment, three or four times a-day, they will thrive apace, and become soon fledged over the body, when they are fit for use; but the quill-feathers do not appear for some time after. Ducklings can be made very fleshy by feeding on boiled rice in which some greaves have been mixed.

Duck-rearing in Aylesbury.—A large number of ducks are bred and reared every year, in the Vale of Aylesbury in Buckinghamshire, for the London market. The eggs are hatched by hens, and three or four broods are put together into one division; whilst other divisions contain them in a more forward state of growth, some half-grown, others full-fledged, and all are fed alike. In this way one person may have 300 or 400 ducklings feeding about the house, perhaps some of them in some cases under the same roof with the family. A great many are housed in little space, and never allowed to go at large, but permitted to wash themselves every day in a pond made on purpose near the house.

They are fed three times a-day, on potatoes, barley-meal, bran, greaves, &c., and receive as much as they can eat; and it is stated that they eat an incredible quantity of food while thus forcing for the market. When full-feathered they are sent to London, where they find a ready sale at from 10s. to 12s. a pair. As the season advances, prices fall, till they reach 4s. a pair, when the breeding is given up for the season.

Hatching Pea-fowls.

Pea-hens, in their hatching, will not be subjected to control. The hen selects a secluded spot for her nest, in which she lays about five eggs—not unlikely in a garden, where she feels herself secure from the attentions of the cock, whom she avoids at this season with marked assiduity. She takes care that he shall not know, not only where her nest is, but where the pea-fowls are when they come out, because the cock would destroy them. A pea-hen in this country seldom brings out more than three or four birds, which she tends with great care, taking them to places where wild food, insects, can be found in greatest abundance; and besides, they are fed as young turkeys, their habits being very similar. She

continues to care for her young through the greater part of the year.

Hatching Pigeons.

Pigeons, when their dovecot is favourably situated for heat, begin to lay in February, and will continue until December. They make their own nests, which are of the simplest materials and rudest construction, sticks and straw laid down indiscriminately; and the same nest will be used by the same pair season after season, even after it is much elevated by the dung of the young pigeons. On this account pigeons' nests should be cleared away at the end of every brooding season. They lay only two eggs at a time, which the hen can cover effectually by pushing them below her, with her bill, amongst the feathers.

A Plea for Poultry.

What has been said on the mode of hatching the different sorts of fowls usually reared, is suitable to every sort of farm, and may be acquired by any domestic of the farmhouse; and that it is practicable and certain, our own experience for years has proved. Great schemes are recommended in books, and large establishments, consisting of buildings and ponds and spare ground, are erected and laid out in the parks and farm-courts of country gentlemen; but let any other plan be what it may, and its erections and appliances of whatever magnitude, none will afford poultry at all times in a higher degree of perfection and health than the simple methods here described.

It may not be a cheap plan, that will supply good poultry at little or no cost—such an idea of cheapness, at least, as is entertained by farmers when they condescend to cast a thought on the poultry of their farms. Fowls cannot be reared upon the refuse of the products of a farm more than any other sort of stock; and when one sees that the best oats, the best turnips, and the best grass that a farm can raise, are required to rear such horses, cattle, and sheep as purchasers desire to have, one must also believe that poultry require the best food to make them as acceptable to purchasers. For the plan here recommended for an ordinary farm, it can at least be said that it requires no costly buildings, and will assuredly yield

poultry in good condition at all seasons, in return for the food and trouble bestowed upon them—and what more can a reasonable farmer desire?

Fowls in Towns.—Fowls are kept, in towns, in places quite unsuited to their habits. Sometimes in a small court, surrounded by high walls, and the hen-house a cellar under the street pavement—a condition the very worst for fowls. The floor of the court is generally covered with dirt, and the small vessel which is intended to contain water is as often dry as plished with *clean* water, while the food is thrown upon the dirty court-floor. Add to these the fact that the sun never shines upon the hen-house, or only for a few minutes in the afternoon, when the fowls are about to retire to roost. Ducks are treated in even a less ceremonious manner than hens; having no water, their feathers become begrimed with dirt, and their food is given them in a state little else than dirty puddle. It is impossible fowls can thrive in such circumstances; and to purchase such at a poulterer's, they cannot be deemed wholesome food.

Sand, Dust and Water for Fowls.—One cause of suffering to hens is the want of sand or gravel and lime, to assist the trituration of food and the formation of the egg-shell. Another source of suffering to them is the want of dust to burrow in and shake amongst their feathers, in order to destroy the vermin which annoy their skin; and ducks and geese suffer as much from want of water to wash in and clean their feathers.

Facts about Eggs.—Few eggs are worth the trial of hatching if more than a month old; their condition, however, is greatly influenced by the season and the state of the weather. An egg retains its freshness longest in moderately cool weather; very hot weather destroys vitality in a few days; and an egg having been frozen is also useless for hatching. Failures in hatching arise from want of impregnation in the egg—from age, commonly called staleness, whereby life has become extinct—from weakness of the vital energy of the eggs, produced by age, lowness of keep, or ill-health of the parent, in which cases the chick partially develops itself, but dies before the full period of incubation.

Eggs may be brought to life, but unless the process of incubation be properly executed, the birds will be weakly, ill-conditioned, and die a short time afterwards.

To prevent the yolk of weak eggs settling by its specific gravity, and adhering to the shell, it is useful to pass the hand over them, so as to change their position every twenty-four hours. The egg of a strong healthy bird, at the time of protrusion from the body, is almost completely filled with yolk and albumen. If examined a few days after, by holding it toward the light, a small cell of air will be discoverable at the larger end, which increases with the age of the egg. This contraction of its internal substance, by condensation of the more volatile parts of its contents, causes the absorption of the atmosphere through the pores of the shell. When the cell is large in any egg, it is unfit for incubation; nevertheless, in a good egg, as incubation proceeds, this cell becomes considerably enlarged, probably from evaporation by heat and the vital action going on within the shell. The cell serves an important purpose in the economy of this mysterious process, by supplying the chick with its first inspiration of air. An egg will not hatch *in vacuo*.

Phenomena of Incubation.—The progressive series of phenomena, daily observable during the process of incubation in the egg of a common fowl, are curious and instructive. In an impregnated egg, previous to the commencement of incubation, a small spot is discernible upon the yolk, composed of a membraneous sac containing fluid matter, in which the embryo of the future chick swims.

1st day.—At the expiration of twelve or fourteen hours after incubation has commenced, the matter within the embryo evidently bears a resemblance to a head; vesicles assume the shape of the vertebral bones of the back.

2d day.—In thirty-nine hours the eyes make their appearance; vessels join together indicating the navel, the brain, spinal marrow, rudiments of the wings, and principal muscles; the heart is evidently proceeding.

- 3d day.—At its commencement the beating of the heart is visible ; some hours after, two vesicles containing blood appear, one forming the left ventricle and the other the great artery ; the auricle of the heart is next seen, and pulsation is evident.
- 4th day.—Wings assume a defined form ; the brain, the beak, the front and hind parts of the head visible.
- 5th day.—Liver seen ; circulation of the blood evident.
- 6th day.—Lungs and stomach distinguishable ; full gush of blood from the heart distinct.
- 7th day.—Intestines, veins, and upper mandible visible ; brain becomes consistent.
- 8th day.—Beak opens ; formation of flesh on the breast.
- 9th day.—Ribs formed ; gall-bladder perceptible.
- 10th day.—Bill formed ; first voluntary motion of the chick seen.
- 11th day.—Skull becomes cartilaginous ; protrusion of feathers evident.
- 12th day.—Orbits of sight appear ; ribs perfected.
- 13th day.—Spleen in its proper position in the abdomen.
- 14th day.—Lungs enclosed within the breast.
- 15th day. { Mature state approached ;
16th day. { yolk of the egg still out-
17th day. { side of the body.
- 18th day.—Audible sign of life outside the shell ; piping of the chick heard.
- 19th day. { Increase of size and strength ;
20th day. { yolk enclosed within the
21st day. { body ; chick liberates it-
self by repeated efforts
made by the bill, seconded
by muscular exertion of
the limbs.

Testing Eggs for Chicks.—On the eighteenth day the eggs may, by very simple means be tested for the presence of chicks. Place the eggs gently into a basin of water heated to about 102 degrees Fahr., and every egg containing a chick will speedily show signs of life by swinging about in the water. The eggs which lie perfectly still may be regarded as rotten, and may be thrown away so as to enable the hen to devote her attention to the fertile eggs.

Embryo of the Chick.—The embryo of the chick is not in every egg placed precisely in the same situation, but varies considerably. Generally it develops itself within the circumference of the broadest part of the egg ; sometimes it is found higher, sometimes lower ; and when held before a strong light, has an appearance, when a few days old, somewhat resembling the meshes of a spider's web, with the spider in the centre. As it increases in size, the bulk of the contents of the egg decrease, so that when the bird is completely matured, it has ample space to move, and to use its limbs with sufficient effect to ensure its liberation.

The *position of the chick* in the shell is such as to occupy the least space. The head, which is large and heavy in proportion to the rest of the body, is placed in front of the belly, with its beak under the right wing ; the feet are gathered up like a bird trussed for the spit ; yet in this singular manner, and apparently uncomfortable position, the bird is by no means cramped or confined, but performs all the necessary motions and efforts required for its liberation with the most perfect ease, and with that consummate skill which instinct renders almost infallible.

The chicken, when it breaks the shell, is heavier than the whole egg was at first.

Formation of Feathers.—In regard to the formation of feathers in the chick of a bird, Raspail has the following observations : "If we examine," he says, "the epidermis of a *sparrow*, as it comes from the egg, we shall find that we can isolate each of the small bottles, which the vesicles that form the rudiments of hairs assume the shape of, as well as the nerve of which it seems to be the terminal development. It might almost be supposed that the object viewed was the eye of a *mollusca*, with its long optic nerve. The summit of this vesicle is open, even at its early period, to afford a passage for a cylindrical bundle of small fibres, which are also cylindrical, and which are nothing else than the barbs, as yet single, of the feather. If, afterwards, we examine a feather at a more advanced period, we may, by a little address, satisfy ourselves that its

tube is formed and grows by means of spathæ one within another, of which the external ones project over the inner ones, so that the tube seems as if divided by so many diaphragms. The interstices of these diaphragms are filled with a fatty liquid, which condenses in them gradually as the summits of the spathæ approximate and adhere to each other."¹

Artificial Hatching.—The ancient Egyptian system of hatching eggs in ovens has been modified and adapted to practical wants in this country in an admirable manner. By artificial incubators, eggs may now be hatched successfully in unlimited numbers without the aid of sitting hens. For a long time artificial incubators were mere toys—expensive luxuries for the rich. But many machines are now in use which are simple, most effective, and comparatively inexpensive. In these there is to be found effective regulation of the temperature, maintaining it at the natural heat of a hen, provision of moisture, and a supply of fresh air, all of which are essential to successful hatching. Where large numbers of chickens are bred, an incubator will be found of the greatest service, both for continuous hatching and when hens desert their nests.

Caponing.—*Capons* of the common fowl are formed both of the cock and hen chickens, when they are fit to leave the hen, at about six weeks old. Chickens are transmutated into capons by destroying the testicles of the male and the ovaries of the females; the latter being known by the French name *poularde*.

The testicles are attached by a membrane to what is called the *backbone* of the carved fowl. They are destroyed by laying the bird on its near side, keeping it down, removing a few feathers, and making an incision through the skin of the abdomen, and, on introducing the fore-finger through the incision, first the one and then the other testicle is obliterated by pressure of the finger. In the case of the hen, the ovary is nipped off by the thumb-nail, or cut off by a knife. The incision is stitched up with thread, and little danger is apprehended of the result. To facilitate the process,

there are instruments sold by various makers.

The effect of castration is enlargement of the body of the fowl, and increased delicacy of its flesh; but its flavour is in no way improved. Time was when capons were more plentiful at the table than chickens, so that even kain-rent was paid in them. But the conversion of fowls into capons is now almost abandoned in Scotland, as an unnecessary and troublesome operation—and will not probably be resumed as long as a well-fed delicate chicken can be procured with little trouble,—although the London market is always well supplied with them.

Turkey-poults are converted into *poulardes* by the same operation, which produces similar effects upon their size and condition.

Temperature for Incubation.—We are not aware that any experiments have been made to ascertain the exact temperature which is maintained in a nest containing eggs under incubation. Boswell simply says, "To have eggs productive, they must be subjected to an equable temperature of about 96° Fahr. during at least three weeks."² This is about blood-heat. F. Malézieu states that the Egyptians in their hatching apparatus maintain a heat of from 63° to 72°; and that Gerard, in his hatching establishment at Paris, is content with a heat of 66° to 70°.³ Judging from the heat of the body of a fowl, and the long and constant sitting, we should expect the temperature to be higher than the blood-heat of man, in a nest devoted to hatching.

Now, it is generally accepted that 104° is the temperature for incubation; but it has frequently been proved in incubators that hatching will take place from 102° (or even 101°) to 106°. They will not hatch with the heat at 100°, or below 95°.

Poultry Dung.

Anderson has analysed the dung of domestic poultry, obtained in as fresh a state and as free of foreign matters as was possible. The specimens were sup-

¹ Raspail's *Org. Chem.*, 283.

² Boswell, *Poul. Yard*, 85.

³ Malézieu, *Coqs. Domes.*, 49, 58.

plied by John Gibson, Woolmet, and the results were:—

<i>Pigeon Dung.</i>	
Water	58.32
Organic matter	28.25
Phosphates	2.69
Sulphate of lime	1.75
Alkaline salts	1.99
Sand	7.00

	100.00
Ammonia	1.75
Phosphoric acid in the alkaline salts equal to 0.20 phosphate of lime, .	0.10

<i>Hen Dung.</i>	
Water	60.88
Organic matter and ammoniacal salts	19.22
Phosphates	4.47
Carbonate of lime	7.65
Alkaline salts	1.09
Sand	6.69

	100.00
Ammonia	0.74
Phosphoric acid in the alkaline salts equal to 0.15 phosphate of lime .	0.70

<i>Duck Dung.</i>	
Water	46.65
Organic matter and ammoniacal salts	36.12
Phosphates	3.15
Carbonate of lime	3.01

Alkaline salts	0.32
Sand	10.75

	100.00
Ammonia	0.85
Phosphoric acid in the alkaline salts	trace.

The small proportion of ammonia deserves notice.

<i>Goose Dung.</i>	
Water	77.08
Organic matter and ammoniacal salts	13.44
Phosphates	0.89
Alkaline salts	2.94
Sand	5.65

	100.00
Ammonia	0.67
Phosphoric acid in the alkaline salts equal to 0.26 phosphate of lime, .	0.12

Three-fourths of this dung consists of water, less than one per cent of phosphates, and two-thirds per cent of ammonia, while the alkaline salts are large.

The conclusions from these analyses are, that pigeon dung has a value not exceeding three times that of farmyard manure, and that the other kinds of poultry dung scarcely, if at all, exceed it in value.¹

PARING AND BURNING.

Paring is the removal of a thin portion of the surface of the ground, with what may be growing upon it. *Burning* is the reduction by fire to a state of powder, of what has been pared off.

Object of Paring and Burning.—The object of the process is to assist in reducing rough surface-soil into a workable condition more speedily than could be accomplished by the slower influences of tillage and cropping.

The practice was at one time pursued to a considerable extent, but has very properly lost in repute.

As to the advantages and disadvantages of paring and burning there is great diversity of opinion amongst practical farmers. For the sake of those not acquainted with the process, we may here briefly state the arguments for and against the practice.

Advantages of Paring and Burning.—The advantages which result from the operation are—

(1) The change produced in the mechanical condition of the soil, the texture being altered—opened up—especially upon stiff clays, by the admixture of the ashes which result from burning.

(2) In peaty soils, or where a large amount of rank and coarse vegetation covers the ground, a complete change is quickly effected by the process—rendering the future breaking-up of these soils by the plough a matter of easy accomplishment.

(3) Leas and old pasture are frequently infested so much by the larvæ of insects, notably wire-worm (*Elateer lineatus*) and the grub of the daddy-longlegs

¹ *Trans. High. Agric. Soc.*, Jan. 1864, 170.

(*Tipula oleracea*), that the prospect of the corn crop is rendered doubtful. These, as well as the seeds of noxious weeds, &c., are destroyed by this practice.

(4) Burning is one of the quickest agents employed in agriculture for the conversion of the dormant ingredients of the soil into an active or soluble form. Heat breaks up the various compounds, separating the acids from the alkaline bases, which, forming more simple compounds, are to a greater extent soluble in water, and in consequence in a fit state to be assimilated by the roots of plants.

Disadvantages of Paring and Burning.—These advantages are obtained at the sacrifice of all the organic portion of the soil, which, being volatile, is dissipated by combustion, passing into the air in the form of gaseous bodies. It is also found that while potash is rendered more soluble by the action of heat, phosphoric acid is rendered nearly insoluble. Over-burning also frequently occurs, and this on a clay soil will convert the residue into brick-dust, a spreading of which may increase the friability of a soil, but can have no action in increasing its fertility, as it becomes insoluble matter. Then, in peaty soils, in dry weather, the former may ruin its producing power by the total destruction of the humus or vegetable matter.

Useful on Certain Soils.—From the foregoing it would be inferred that paring and burning might be carried out with advantage on stiff clays, where the loss of the small amount of organic matter which may be present is compensated by the increase of soluble inorganic matter; or on a soil which is made up largely of inert vegetable matter, such as peat; and on soils infested with larvæ, or seeds of weeds. Some calcareous soils might perhaps also be burned to advantage.

Lime Essential.—But no matter what soil is burned, the full benefit of the operation cannot be obtained unless lime is present. Lime is absolutely necessary for the liberation of potash and soda. It is good practice, therefore, to give a coating of lime where such is deficient before the work of paring and burning is commenced; while after completion the

soil ought to be heavily manured with nitrogenous manure.

Paring and Burning Condemned.—Still, with due recognition of all that has been claimed for the practice, we are bound to say that we regard it as entirely out of keeping with the spirit of the age. This view of the matter is well expressed by Mr George Brown, Watten Mains, Caithness, who, writing for this edition, says: "The practice is objectionable, and is based upon wrong principles. All the advantages claimed for it may be derived by following the ordinary routine of farm practice. If a farmer has rough land let him plough it early in spring, summer, or autumn—the earlier the better—and leave it to the ordinary forces of nature until the following spring; sow it then with oats, and again plough early, taking another crop of oats. In the third year it will be ready for a turnip crop. If a little rough after sowing, give a turn of a heavy roller along the drills, and a heavy crop will be the result. This method (which is in accordance with sound practice, backed by the latest researches of science), the writer has seen pursued with success upon hundreds of acres of waste land and heath when first reclaimed."

Methods of Paring and Burning.—Having thus given expression to the prevailing views for and against paring and burning, we now append some notes as to the different methods of carrying out the process.

Various implements are employed to execute paring and burning. The common No. 5 garden spade, fig. 334, with a sharp edge and its corners a little worn by work, removes rough herbage very well, and the turfs can be set up at the time by the workmen to be dried. But the labour with it entirely is expensive, and is seldom incurred.

Flaughter-spade.—A more expeditious implement is a spade of a different form, fig. 335; the face of which is angular and sharp, the blade 9 inches broad and 15 inches long; the straight side of which is turned up



Fig. 334.
Common
spade.

square 3 inches, with a cutting-edge in front; the helve is 5 feet long and flat, provided with a broad cross-handle 2 feet long, fastened at right angles to the helve. The blade is set at an angle to permit the handle to be elevated to a man's haunches, while the blade works flat upon the ground. It is called in Scotland the *flaughter-spade*, from the Teutonic verb to flaunch or take off the skin.

The mode of using this implement is this: "The workman is provided with a short leather apron faced with two boards



Fig. 335.—*Flaughter-spade at work.*

in front of the groin, the apron being buckled round the waist and round the upper part of the thighs. The blade of the instrument is laid flat on its sole, and its point is made to enter the ground by a push of the body of the workman upon the handle placed against the boards in front of his groin, and there held by both hands. The body gives successive pushes, longer or shorter, as the nature of the ground admits; and the point is made to dip deeper, keep level, or move upwards, by the direction of the hands, according to the thickness of the surface to be removed. At each push the point cuts forward under the turf, while the cutting edge severs the loosened turf from the solid surface. When the turf is 1 or 2 feet in length, according to the state of the surface, it is turned upon its back or side, on the pared surface on the left hand, by a sudden jerk of the handle. The edge of the spade is kept sharp with a scythe-stone. The thickness of the turf removed depends on the strength and skill of the workman, but it seldom exceeds 2 inches even in the soft-

est parts of the ground, and more often $1\frac{1}{2}$ inch. It takes a man one week to turn over one acre of ground, and he is paid 3s. or 4s. a-day, or 20s. an acre, for his hard work."

Paring-plough.—A more expeditious method still is to pare off the surface with a horse and plough. An English paring-plough, made by Vipan & Headly, Leicester, is represented in fig. 336.

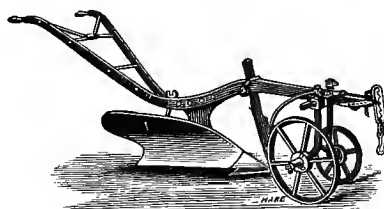


Fig. 336.—*Paring-plough.*

This plough is specially adapted for paring the tough surface off an old pasture about to be broken up, or for paring stubbles to facilitate the removal of surface weeds. It pares to a depth of from 1 to 3 inches, and with a pair of horses will cover from $1\frac{1}{4}$ to 2 acres per day.

The ordinary plough may be fitted for paring by having the feather of its share widened to from 12 to 15 inches. Fig. 337 is the share of the common plough, the breadth of whose feather is 10 inches, but by welding a wing 3 inches in breadth,

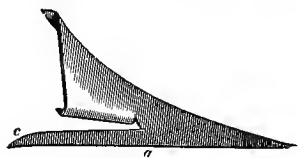


Fig. 337.—*Paring-sock.*

a Breadth of sock, 10 inches.

c Ear of feather, 15 inches in breadth from land-side.

having a sharp edge upon the outer side of the feather, the paring-face is increased to 15 inches in breadth from the land-side of the share. When the paring is finished, the wing can be cut off, and the share is again fit for ordinary use. The mould-board cannot lay over so broad a furrow-slice as 15 inches as it lays over in lea; the broad furrow-slice being partly rolled over upon itself, which is in its favour for drying.

Paring with the plough is, of course, much less expensive, as well as more expeditious, than paring with the flauchter-spade. Where the ground is even, the plough with wide share will turn over the entire surface; but in uneven and much-broken ground, where stones abound, it cannot be used, and the flauchter-spade must be employed; while the common spade is used in small deep hollows, or among thick masses of herbage. Thus all the implements may co-operate to complete what one alone could not do so well.

When the turfs are laid over by the spade, the workmen might set them up one against the other, though not so neatly as by hand. The flauchter-spade, taking up a long thin turf, cannot get quit of it without either laying it flat or setting it partly on edge. The broad continued turf laid over by the share of the plough must fall flat upon the ground, and be set up by hand to be dried. A *paring-plough*, which has been used in parts of England in the fens, pares the turf by means of two angular shares with the wings facing each other, and just crossing the centre line, one being a little before the other; and they are attached to shanks, placed in front of the mould-board, upon which the turf is raised in a manner similar to the furrow-slice in ordinary ploughing, and is set on its edge upon the pared ground, ready to be dried, as neatly as if done by hand.

Expeditious Paring.—Perhaps the most expeditious mode of procedure would be to take a couple of tines out of a common grubber and cross the land to be pared, then start an American chilled plough at the required depth. The breadth of the share and curve of the mould-board are suitable for the work, and by the previous crossing with the grubber-tines, the surface would be left in good-sized turfs for burning.

Time for the Process.—Paring may be executed any time during the winter and spring, but it is best and most easily done from February to April. It is difficult to do when the ground is dry and hard, but in boggy land it is best done in dry weather. While boggy land is very wet it cannot be done at all, the footing then being insecure, and the soil soaking with water; nor in clay land, when wet, as the surface soon becomes poached.

Drying the Sod.—The sods are set up on edge against one another in the way best to expose the largest surface to the air, to be dried in the quickest time for being burned. The long continuous turfs turned over by the ploughs require to be cut in convenient lengths with the spade before they can be set up to dry. In dry weather they are ready to be burned in about two weeks.

Process of Burning.—In burning, the fires must be begun with some combustible materials—as wood, chips, shavings; and at first they must be strictly attended to, in order to have the *first* turfs completely dried. After these have begun to burn, surround them with fresh sods, to keep the fire in a smouldering state, and not to flame or burn fiercely. A number of fires should be lighted one after the other, the field-workers carrying the turfs to supply them with fresh sods, placing them thickest on the windward side to keep down the force of the fire. This being the object, the turf, after the first dried ones, should not be too dry before the burning begins. The heaps are supplied with turfs until they attain a large size, capable of containing from ten to fifteen cart-loads of ashes, and the larger the heap the less effect has the air on the ashes.

The dried and burning turfs from one heap will supply fire to begin the burning of other heaps. To prevent the fire breaking into combustion through the night, the heaps should be well covered with fresh sods in the evening, partly to be removed in the morning. When the fire gets dull, a hole in the windy side, punched into the heap with a stake, will give it life. In a large heap there is no fear of the fire being extinguished, although there be no symptoms of activity on the outside. A heavy rain cannot put out the fire of a large heap.

To obtain good results, the burning should not be conducted in a thoughtless manner, but done to a plan previously fixed upon.

A Good Plan.—A good plan is to burn one row of heaps, then another, and to begin at that side of the field most convenient to plough the ground. Having gathered the turfs on both sides of a line of heaps, a space of ground will be cleared of turf; and as one line of heaps

is constructed and burning, let another be begun from the end where the former line finished, until all the field has been heaped and burning. The charred turfs of the previous line will be easily carried across the ground to the line to be formed.

Cooling the Heaps.—The time that may elapse before the burned heaps become cold depends on the state of the weather, but it will be considerable if the heaps are allowed to cool of themselves. The hot ashes may be spread to cool, if required soon; but should wind arise after a heap has been broken, the ashes will be scattered, or be blown off the ground altogether. Caution is requisite in opening up a heap.

The Ashes.—When thick turf has been laid over by the plough, it will afford more ashes than the ground requires at one time. To avoid a superabundance of ashes, some pare as much turf in strips as will just supply the ashes wanted. To effect the stripping, the ear of the feather of the share is turned up with a cutting-edge. But where the herbage is rough, the strips left are as difficult to reduce as ever.

The better plan is, to pare and burn all the surface, and carry off the extra ashes to another field about to bear a green crop; and as carrying away ashes implies robbery of the land which has supplied them, a substitute should be provided in farmyard or other manure.

The burning of heaps in line clears the ground for the plough, which is feered between the heaps, to ridge the land in any form desired; and before the land is ploughed the ashes are spread upon it. This is the simplest mode of applying the ashes; for if they are not spread until after the dung for turnips has been laid on, as some writers recommend, the ashes will have to be carried off the field, and then brought back when wanted.

Time to Plough in Ashes.—"There are two methods, one to spread and plough in immediately, the other to spread immediately, but to have them exposed to the atmosphere some months before turning in. Mr Wedge, on the thin sandy soil on a chalk bottom of Newmarket heath, had in one a treble experiment: part was pared and burnt in the spring, and the ashes spread and

exposed till ploughing in the autumn for wheat; part pared and burnt late, the ashes left in heaps, and spread just before ploughing the wheat; the third pared and not burnt at all, by reason of bad weather. The first was by far the best, the second the next, and the third beyond all comparison inferior."¹ The superiority of the results from the first method was, no doubt, due to the ashes having in their exposure absorbed ammonia from the atmosphere.

Changes involved in Burning Soil.—The chemical and physical changes which occur in the burning of soil may be stated thus: Combustion and decay are synonymous;—the ultimate results from each are similar, but the proximate organic compounds are different. Combustion acts quickly, and dissipates organic matter in the form of carbonic acid, ammonia, and watery vapour. Decay acts more slowly, and allows these volatile substances to recombine with the alkalies and acids present in the soil, thus forming soluble salts, such as carbonate of lime, and nitrate of potash, or lime. Chief of the inorganic compounds is silicate of ammonia, which cannot be held as plant-food; but, according to Professor Tanner, in combination with this compound there are others—viz., silicate of potash and lime in certain proportions—forming double silicates. This compound is broken up by the action of heat, and the silicic acid having a greater affinity for ammonia, the potash is driven out and recombines with other free acids present. Lime, being rendered caustic by the process also, comes into contact with salts of potash, and liberates the base and combines with the acid.

Thus we learn that a constant change is taking place, the complex or insoluble compound being rendered simple or soluble, all being regulated by chemical affinity.

Apart from chemical action, burned clay, charcoal, &c., have a great power of absorption, and many maintain that the ammonia lost by burning is fully compensated by the power the burned residual matter has for absorbing this wonderful agent in plant-growth.

¹ Pott's *Brit. Far. Cy.*—art. "Par. Burn."

SUMMER.

THE WEATHER.

As spring is the restoration of life to vegetation, and the season in which the works of the field are again in activity, so summer is the season of *progress* in vegetation and in the works of the field. This advancement involves no difference of practice, only impressing into its service many minor works for the first time, in assistance to the greater. Many of these minor operations being manual, and performed in the most agreeable season of the year, they are regarded with peculiar interest and delight by the light-hearted farm-workers.

Atmospherical Complications in Summer.—The atmospherical phenomena of summer are not only varied, but of a complicated character, difficult of explanation, and apparently anomalous in occurrence. There are *dew*, which is a great deposition of water at a time when not a cloud is to be seen; a *thunderstorm*, which suddenly rages in the midst of a calm; and *hail*, which is the descent of ice and congealed snow in the hottest days of the year.

Dew.—The phenomenon of *dew* is familiar to every one residing in the country. In the hottest day of summer, the shoes become wetted on walking over a grass-field about sunset, and they may be wetted as thoroughly as in wading through water. Wells investigated the phenomena of dew more closely than any other man of his time. His experiments, as detailed in his instructive and amusing essay on that subject, appear to have been very satisfactorily conducted, and the theory which he established by these experiments has been generally embraced by philosophers.

Cause of Dew.—Briefly, the cause of dew is unreciprocated radiation—the radiation of heat from the earth, plants, and other bodies upon which dew is formed. The earth during the day both absorbs and gives out heat. The supply of heat for absorption of course ceases with the setting of the sun, but the earth and bodies upon its surface continue to

radiate or emit heat during the night. Objects which are good radiators, such as grass, flowers, and foliage generally, give out heat readily, and thus when during night they emit heat without receiving any in return, their temperature falls below that of the atmosphere which surrounds them. The cold surface of these plants attracts and condenses the vapour in the adjacent air, which deposits itself in the form of dew. Hoar-frost is similarly formed, the condensed vapour taking the shape of hoar-frost when the temperature of the earth is below freezing-point, or 32° Fahrenheit.

The reason why little or no dew is formed when the sky is clouded is that the clouds, being good radiators, give back as much heat as they take away from the earth, thus maintaining an almost even balance of temperature between the earth and the surrounding air.

Beneficial Influence of Dew.—The deposition of dew is a happy provision of nature. Often when the rainfall is insufficient, the wants of vegetation are supplied by dew. This is particularly the case in tropical regions where there may be little or no rain for months, and where, owing to the rapid radiation of heat at night, and the great evaporation of moisture from the soil into the surrounding atmosphere during the day, abundant dews are deposited.

Dew is often found upon plants when bare soil and stones close at hand show no traces of it. This arises from the fact that plants have much greater radiating power than soil and stones, and thus the former fall more quickly in temperature after sunset. Wind tends to prevent the formation of dew by carrying away the particles of vapour before the adjacent colder bodies have been able to condense them.

Measuring Dew.—To measure the quantity of dew deposited each night, an instrument is used called a *drosometer*. The most simple process consists in exposing to the open air bodies whose exact weight is known, and then weighing them afresh after they are covered

with dew. According to Wells, locks of wool, divided into spherical masses of $3\frac{1}{2}$ inches diameter, are to be preferred to any other thing for measuring the deposit of dew. All circumstances that favour radiation equally contribute to the formation of dew. A body that is a good radiator and a bad conductor of heat, will therefore be covered with a very abundant dew. Thus glass becomes wet sooner than the metals; organised bodies are wetted more quickly than glass, especially when they are in small fragments—because, as the heat passes with difficulty from the one to the other, that which is lost is not replaced by that which is transmitted from the interior to the surface of the body. Locks of wool are therefore well suited to these experiments, and become covered with a very abundant dew. The moister the air is, all other things being equal, the more considerable is the quantity of dew that falls in a given time.

Dalton computed the amount of dew which annually falls at five inches. In fine weather, in the evening, the vapour-plane being destroyed, and the nubific principle, as Forster observes, ceasing to act, the vapour so deposited comes down in dew. Dew, however, is not the result always of the stratus cloud, and it differs from the wet mist of the cirro-stratus of the lower atmosphere.

Heavy Dews Foretelling Rain.—In our country, nights with abundant dews may be considered as foretelling rain; for they prove that the air contains a great quantity of the vapour of water, and that it is near the point of saturation.

Thunderstorms.—Summer is the season in which electricity is most active in displaying its existence.

The electric fluid accumulates in the clouds of vapour. When two clouds, thus provided with electric matter beyond their usual state, are not far from each other, the electricity of the one always becomes *positive*, and that of the other *negative*. They thus attract and approach each other; and when they come so near that the force of the positive electricity is able to overcome the resistance of the air between the positive and negative clouds, the fluid leaves the positive and enters into the negative cloud in lightning in such quantity as

to restore the equilibrium of both. The forcible passage of the fluid causes such a concussion in the air as to give rise to the noise which is heard in *thunder*.

The time taken by the electric fluid to pass from one cloud to another is inappreciable, but the velocity of sound is calculable. It has been calculated that for every $4\frac{1}{2}$ seconds of time which elapse after seeing the lightning to hearing the thunder, the clouds are situated one mile from the auditor.

Lightning.—Lightning is of three kinds. First, *forked*, or *zigzag*, lightning; second, *sheet-lightning*; and third, *ball-lightning*. Ball-lightning is regarded as very dangerous, and unfortunately the lightning-conductor is no protection against injury from it.

Motion of Electricity.—The motion of the electric fluid is most commonly from the clouds to the earth, though numerous examples exist of its having followed an opposite direction. It is probable, however, that in most cases of electric explosion the fluid leaves both clouds, or the cloud and the earth, at one time. However this may be, the stroke always goes in the most direct line, even through substances of the least conducting power. Animals are frequently struck, because their fluids easily conduct the fluid; while the shock given to the body seems to be through the nervous system.

Lightning - conductors.—Hence lightning-conductors have been recommended not only to draw off the fluid quietly from the atmosphere into the earth, which they certainly do when attached to houses, but also with the view of lessening the number and virulency of thunderstorms, which it is doubtful that any number of conductors would effect.

Thunder has never been heard at a greater distance than 14 miles from the flash of lightning. The report of cannon has been heard at a much greater distance. Indeed it is stated that the cannonading at the battle of Waterloo was heard at the town of Creil in the north of France, a distance of 115 miles from the field of battle.

Utility of Thunderstorms.—Thunderstorms are of great use in the economy of the atmosphere. The surplus electri-

city is disposed of to the earth, the surplus vapour is condensed and sent down to the earth in rain, the air is prevented from becoming stagnant, the extraneous matters floating in the air are brought down to the earth, whether these be in a solid or gaseous state.

Hail in Summer.—The fall of ice from the atmosphere in hot weather is a phenomenon not easily solved. That both snow and ice are required in the formation of *hail* there cannot be a doubt.

Hail generally falls in the hottest hours of the day in Spain, Italy, and France. It falls in Europe generally in the day, and seldom in the night.

Sleet.—Small hailstones mixed with snow and rain are termed sleet. The largest are sometimes surrounded with a slight film of ice. Sleet falls in winter and spring during gusty weather, and rarely accompanies storms, but always falls during gales. When the weather is variable, such gusts of cold wind seem a necessary condition for the formation of sleet.

Summer Rain.—The character of rain in summer is refreshing. Even in a rainy season, though we may feel displeased at being kept within doors on a summer day, we feel assured that it will in a great measure be absorbed by the varied mass of vegetation which is in constant activity during this season. Since the experiments of Hales proved that a sunflower plant, $3\frac{1}{2}$ feet high, and an ordinary-sized cabbage, on the average perspire 22 ounces of water, and consequently absorb as much every twenty-four hours,¹ one may judge of the immense quantity of water required daily to supply the wants of vegetation. And when it is known that evaporation, besides, carries an incredible amount of vapour direct from the surface of the ground into the atmosphere, one may wonder whence all the requisite moisture can be derived, rather than imagine that too much has been provided.

The boundary-line of the province of summer rains in Europe proceeds W. from the Carpathian mountains to the N. of the Alps, through the middle of France, the W. of Holland, and by the N. part of the Gulf of Bothnia, through

the White Sea to the Arctic Ocean,² and it includes all that large portion of Europe to the E. of it.

Rain without Clouds.—Every one may have observed rain to fall without the appearance of a cloud. When the equilibrium of the higher regions is violently disturbed, especially when any cold N. winds come into collision with those from the S., it may happen that rain falls from a serene sky. Large drops are seen to moisten the earth, and yet at the zenith the sky is blue. The vapours condense into water, without passing through the intermediate state of vesicular vapours as clouds. Humboldt gives several examples of the kind, and Käemtz remarks from his own observations that the fact is not very rare, having observed it two or three times annually.

Summer Wind.—The character of the winds in summer in this country is gentle and refreshing. This is the season for the land and sea breezes. In fine weather, on the sea-coasts, no movement is perceived in the air until eight or nine o'clock in the morning, when a breeze from the sea gradually rises, and increases in strength till three o'clock in the afternoon, when it decreases, and gives place, after a short period of calm, to a breeze from the land towards the sea, which rises soon after sunset, and attains its maximum of velocity and extent at the moment of sunrise. The direction of these two breezes is perpendicular to the coast-line; but if another breeze arise at the same time, both are modified in various ways. On the E. coast of this island, when the wind blows from the E. the sea-breeze is strong, and the land-breeze weak; and on the W. coast, the land-breeze is stronger than the sea-breeze. These effects will be the contrary with a W. wind. In a wind from the N. or S., both the land and sea breezes will be changed in their direction respectively to the N.E. and S.W. The sea-breeze is very weak in gulfs, and the land-breeze is as weak on promontories.

A day wind betwixt the mountains and plains exists in the same manner as the land and sea breezes, though to a less degree.

The alternation of all these winds is

¹ Hales's *Stat. Ess.*, i. 12, 15.

² Johnston's *Phys. Atl.*—"Meteo," Map iv.

explained by the unequal heating of the land and of the sea, and of that of the mountains and the plain; and as continents are hotter in summer and colder in winter than the contiguous sea, the sea-breeze ought to predominate in summer, and the land-breeze in winter.

In summer, when the wind is variable, rain is indicated, and also when the wind blows along the surface of the ground and raises the dust upwards. When currents of air are seen to move in different directions, the upper one will ultimately prevail. When it is uncertain whether there be any breeze, the lifting up of a wetted finger will instantly feel the current, and indicate the quarter from whence it comes.

In summer, especially in July, the wind blows chiefly from the W.—the predominance of W. winds over E. at this season attaining its maximum; and at the same time the N. winds become more common; whence it follows that the mean direction of the wind in this season is N. of the annual mean.

When the wind blows strongly from any quarter, even from the S.W., which is the warmest wind in summer, for two or three days in succession, the temperature of the air is diminished, sometimes as much as 20°, and seldom less than 10°. When small whirlwinds are seen raising the dust upon the roads or fields, it is a sign of dry weather.

Evaporation.—In proportion as the sun rises above the horizon, evaporation increases, and the air receives a larger quantity of vapour. The fact of the rising of vapour from the ground may be distinctly observed in summer by the flickering of distant objects seen through it; and as the air, by its gravity, opposes an obstacle to the rise of vapour, the air becomes further and further removed from the point of saturation, its humidity becoming more and more feeble. The rate increases until mid-day, when the maximum occurs, and in different months it occurs sooner or later. The absolute quantity of vapour diminishes, until the time of the highest temperature of the day, without however attaining a minimum so low as that of the morning. As the temperature rises during all this space of time, it follows that the air is farther and farther from the point of

saturation: after having attained its minimum, the quantity of vapour again increases very regularly until next morning, while the air becomes relatively more and more moist. Vapour being the result of the action of heat on water, it is evident that its quantity must vary in different seasons. The quantity of vapour attains its maximum, 11.626 per cent, in July, the month in which the air is driest. Evaporation is nearly twice as active in summer as in spring.¹

Light.—*Light* is a most important element in nature for the promotion of vegetation in summer. Its properties are most evidently manifested in this season, and have been shortly and forcibly enumerated by Lindley. "It is to the action of leaves," he observes—"to the decomposition of their carbonic acid and of their water; to the separation of the aqueous particles of the sap from the solid parts that were dissolved in it; to the deposition thus effected of various earthy and other substances, either introduced into plants, as silex and metallic salts, or formed there, as vegetable alkaloids; to the extrication of nitrogen, and probably to other causes as yet unknown,—that the formation of the peculiar secretions of plants, of whatever kind, is owing. And this is brought about principally, if not exclusively, by the agency of *light*. Their green colour becomes intense, in proportion to their exposure to light within certain limits, and feeble, in proportion to their removal from it; till, in total and continued darkness, they are entirely destitute of green secretion, and become blanched and etiolated. The same result attends all their other secretions; timber, gum, sugar, acids, starch, oil, resins, odours, flavours, and all the numberless narcotic, acrid, aromatic, pungent, astringent, and other principles derived from the vegetable kingdom, are equally influenced, as to quantity and quality, by the amount of light to which the plants producing them have been exposed."²

The advantage that summer possesses over the other seasons as regards light, is seen in its comparative duration in

¹ Käemtz's *Meteo.*, 92.

² Lindley's *Theo. Horti.*, 52.

the respective months. Summer indeed enjoys more than double the light of winter, a half more than spring, and a third more than autumn. Thus—

In Winter,

November	has	8	hours	10	minutes	of	light	a-day.
December	"	7	"	8	"	"	"	"
January	"	7	"	44	"	"	"	"
Making a								
mean of	7	"	41	"	"	"	"	"

In Spring,

February	has	9	hours	30	minutes	of	light	a-day.
March	"	11	"	49	"	"	"	"
April	"	14	"	9	"	"	"	"
Making a								
mean of	11	"	49	"	"	"	"	"

In Summer,

May	has	16	hours	11	minutes	of	light	a-day.
June	"	17	"	16	"	"	"	"
July	"	16	"	45	"	"	"	"
Making a								
mean of	16	"	44	"	"	"	"	"

In Autumn,

August	has	14	hours	34	minutes	of	light	a-day.
September	"	12	"	23	"	"	"	"
October	"	10	"	17	"	"	"	"
Making a								
mean of	12	"	25	"	"	"	"	"

Besides its existence for a greater number of hours each day, light is of greater intensity in summer than in the other seasons, because it is then transmitted through the atmosphere at a higher angle. The light of the sun or of the moon, in its passage across the meridian, is dazzling to the eye, whilst we can gaze without difficulty at either body when near the horizon, because the rays cannot so easily penetrate through the thick stratum of atmosphere and of vapour they have there to traverse, in which, moreover, many of them are absorbed.

Heat of the Sun.—As heat always accompanies light with the solar rays, its intensity increases with the light. It would appear that a very large proportion of the heat of the solar ray is absorbed in passing through the atmosphere, and that the proportion is increased as the sun approaches the horizon.

Summer Weather Prognostics.—In summer, weather prognostics are numerous. Falling-stars generally indicate the approach of a thunderstorm. Fire-balls are not uncommon on warm summer nights.

The *barometer* remains pretty stationary in summer, and comparatively high, any remarkable oscillation being a sudden fall before a violent wind from the S.W. It was an observation of Dalton, that in summer, after a long continuance of fair weather, with the barometer high, it generally falls gradually, and for one, two, or more days, before there is much appearance of rain. If the fall be sudden, and great for the season, it will probably be followed by thunder.

The *thermometer* is also steady and high, only indicating a great fall during a hail-storm. The *air* is clear and dry in summer, the clouds high, and the wind breezy. The changes from this state are occasioned by thunder and hail storms, and such changes are always sudden and violent.

Animals are numerous in summer, and constantly in the air, and their covering of hair and feathers being peculiarly sensible to the changes of the atmosphere, gives rise to such actions in the animals as are significant of approaching changes in the weather. Ducks, geese, all water-fowl, the guinea-fowl, peacock, crows, frogs, and sparrows, make much noise before a fall of rain. Bees roam but a short distance from their hives, and ants carry their eggs busily before rain. Magpies chatter much before wind. Spiders cover everything with their gossamer when the weather is to continue fine. *Wild-flowers* indicate changes in the atmosphere as sensibly as animals. Chick-weed expands freely and remains open fully, in a continuance of fine weather. When it, with the trefoil and convolvulus, contracts its petals, rain may be expected. Particular forms of *clouds* also indicate both steady and changeable weather, as thus:—

If woolly fleeces strew the heavenly way,
Be sure no rain disturbs the summer day.

When clouds appear like rocks and towers,
The earth's refreshed by frequent showers.

Summer Proverbs.—The metrical *proverbs* of summer are not many.

May.

A cold May and a windy,
Makes a full barn and a findy.

May, comes she early or comes she late,
She'll make the cow to quake.

Beans blow—before May doth go.
 A May flood—never did good.
 Shear your sheep in May—and shear all away.
 A swarm of bees in May
 Is worth a load of hay.
 Look at your corn in May,
 And you'll come weeping away.

June.

Look at your corn in June,
 And you'll come home in another tune.
 Calm weather in June—sets corn in tune.

July.

A swarm of bees in July—is not worth a fly.
 A shower in July, when the corn begins to fill,
 Is worth a plough of oxen, and all belongs
 theretill.
 No tempest, good July !
 Lest corn come off blew by.

Rainbow Prognostics.—The prognostics connected with the rainbow are: After a long drought the bow is a certain sign of rain; and after much wet, of fair weather. When the green is large and bright, it indicates rain; and when the red is the strongest colour, both wind and rain are indicated. If the bow break up at once, there will follow serene and settled weather. When the bow is seen in the morning, rain will follow; if at noon, settled and heavy rain; and at night, fair weather. The appearance of two or three rainbows indicates fair weather for the present, but settled and heavy rain in two or three days after. Very often only a portion of the arc appears, and it is indicative of rain.

Twilight.—The appearance of twilight depending on the state of the sky, foretells to a certain extent the weather of the following day. When the sky is blue, and after sunset the western region is covered with a slight purple tint, we may expect that the weather will be fair, especially if the horizon seem covered with a slight smoke. When the horizon at sunset is occupied to some height with densely orange-coloured vapour, heavy wind will come in twenty-four or thirty hours. When the horizon at sunset is of crimson or vermilion colour, the wind will be accompanied with heavy rain. When the horizon is green at sunset, rain will follow next day. After rain, isolated clouds, coloured red and well illuminated, at

sunset, announce the return of fair weather. A twilight of a whitish yellow, especially when it extends to a distance in the sky, is a sign of wet weather on the following day. We may expect showers when the sun is of a brilliant white, and sets in the midst of a white light, which scarcely permits us to distinguish it.

The prognostication is still worse when light clouds, that give the sky a dull appearance, appear near the horizon. When the twilight is greyish red, in the midst of which are seen portions of deep red that pass into grey, scarcely permitting the sun to be distinguished, vesicular vapour is very abundant, and we may calculate on wind and approaching rain.

Daybreak.—The signs drawn from daybreak are somewhat different. When it is very red we may expect rain; whilst a grey morning announces fair weather.

SUMMARY OF SUMMER FARM-WORK.

Calendar and Agricultural Seasons.—Practical farmers know well that farm-work cannot be sharply divided in accordance with the months of the calendar. Indeed the farming seasons, as commonly understood, differ considerably from the calendar seasons. For instance, there are the autumn and spring seed-times, which stretch respectively into winter and summer. It must thus be remembered that in arranging the division of the farm duties in this work it was the agricultural seasons rather than the calendar months that were considered.

Moreover, while it has been deemed prudent to adhere in the main to the original plan of the work in treating of the various operations of the farm as they come round in rotation, we have occasionally departed from the plan for the sake of convenience, or to lessen the amount of repetition, of which indeed, as with actual farm-work itself, there must be a good deal. But in any case, in a work, the practical utility of which is the main consideration, we should never hesitate, for the sake of clearness, to resort to repetition.

Root Sowing.—Early in summer the

land for the root crops is worked, cleaned, drilled, dunged, and sown. The culture of roots is a most important and busy occupation, employing much labour in singling and hoeing the plants for the greater part of the summer.

Fat Cattle.—Feeding cattle not to be put to grass are now got rid of as soon as the state of the markets warrants. There is usually a deficiency of fat cattle for disposal early in summer, the winter supply becoming exhausted before grass-fed animals are fit for slaughter. It is thus a good plan, when it can be carried out conveniently, to have a few fat beasts for sale early in summer.

Fat Sheep.—The fat sheep are also sold, except when desired to have their fleece, in which case they are kept until the weather becomes warm enough for clipping.

Repairing Fences.—Before stock is put on grass, the hedger should mend every gap in the hedges and stone walls, and have the gates of the grass fields in repair.

Grazing Stock.—Young cattle, sheep, and cows are put on pasture, to remain all summer. Cattle and sheep graze well together, cattle biting the grass high, while sheep follow with a lower bite. For the same reason, horses and cattle graze well together. Horses and sheep, biting low, are not suitable companions on pasture. Horses, besides, often annoy sheep.

Horses.—Horses now live a sort of idle life. They escape from the thralldom of the stall-collar in the stable to the perfect liberty of the pasture-field, and there they do enjoy themselves. In the opinion of many farmers it is better for work-horses to have forage at the steading than to be grazed on the fields. The brood-mare brings forth her foal, and receives immunity from labour for a time.

Haymaking.—Haymaking is represented by poets as a labour accompanied with unalloyed pleasure. Lads and lasses are doubtless then as merry as chirping grasshoppers. But haymaking is in sober truth a labour of much toil and heat: wielding the hayrake and pitchfork in hot weather, for a livelong day, is no child's play.

Weaning Lambs.—The weaning of

lambs from the ewes is now effected, and marks of age, sex, and ownership are stamped upon the flock.

Forage Crops.—The forage crops on farms in the neighbourhood of towns are now disposed of to cowfeeders and carters.

Dairying.—Butter and cheese are made on dairy-farms in quantities which the supplies of milk warrant.

Weeds.—Summer is the best of all seasons for making overwhelming attacks upon weeds, those spoilers of fields and contaminators of grain. Whether in pasture, on tilled ground, along drills of green crops, amongst growing corn, or in hedges, young and old, weeds should be day by day exterminated. And their extermination is, in many cases, most effectually accomplished by the minute and painstaking labour of field-workers; for which purpose they are provided with appropriate hand-implements.

Insect Attacks.—This is the season in which all manner of insects attack both crops and stock, much to their injury and annoyance.

Fallow Land.—In anticipation of next year's crop, the fallow land is worked, cleaned, manured, and limed, if necessary, in readiness for wheat seed in autumn.

Top-dressing.—Top-dressings of specific manures upon growing crops are applied for the promotion of their growth and fecundity, at the fittest state of weather and crop.

Hours of Labour.—The hours devoted to field-work in summer vary in different parts of the country. In some parts it is the practice to go as early as four o'clock in the morning to the yoke, and the forenoon's work is over by nine, time being given for rest in the heat of the day. The afternoon's yoking commences at one o'clock, and continues till six. Thus ten hours are spent in the fields. But in most parts of the country the morning yoking does not commence till six o'clock, and, on terminating at eleven, only two hours are allowed for rest and dinner till one o'clock, when the afternoon's yoking begins, terminating at six p.m. In some places the afternoon yoking does not commence till two o'clock, and, finishing at six, only nine hours are spent in the fields; or it is continued till seven

o'clock. In other parts, only four hours are spent in the morning yoking, when the horses are let loose at ten o'clock, and, on yoking again from two till six in the afternoon, only eight hours are devoted to work in the fields, the men being employed elsewhere by themselves for two hours.

Many farmers maintain that the best division of time is to yoke at five o'clock in the morning, loose at ten, yoke again at one, and loose at six in the evening, giving three hours of rest to men and horses at the height of the day, and ten hours of work in the field. One drawback to this plan is that the horses have not, without their night's rest being unduly curtailed, had time to feed sufficiently before the day's work begins.

Day-labourers and field-workers, when not working along with horses, often work from seven till twelve, and from one till six o'clock in the evening, having one hour for rest and dinner. When labourers take their dinner to the field, this is a convenient division of time; but when they have to go home to dinner, one hour is too little for dinner and rest between the yokings—and rest is absolutely necessary, as neither men nor women are able to work ten hours without an interval of more than one hour. It is a better arrangement for field-workers to go to work at six instead of seven, and stop at eleven instead of twelve, when they have to go home to dinner.

When field-workers labour in connection with the teams, they must conform with their hours.

Rest.—The long hours of a summer day, of which at least ten are spent in the fields—the high temperature of the air, which suffuses the body with perspiration—and the oft-varying character of field-work in summer, bearing hard both on mental and physical energies, cause the labourer to seek rest at an early hour of the evening. None but those who have experienced the fatigue of working in the fields, in hot weather, for long hours, can sufficiently appreciate the luxury of rest—a luxury truthfully defined in these beautiful lines :—

"Night is the time for rest.

How sweet, when labours close,

To gather round the aching breast
The curtain of repose—
Stretch the tired limbs, and lay the head
Upon one's own delightful bed!"

JAMES MONTGOMERY.

The Farmer's Duties.—Every operation, at least early in summer, requires the constant attention of the farmer. Where natural agencies exert their most active influences on animal and vegetable creation, he requires to put forth his greatest energies to co-operate with the very rapid changes they produce. Should he have, besides his ordinary work, field experiments in hand, the demands upon his attention and time are the more urgent, and he must devote both assiduously if he expect to reap the greatest advantage derivable from experimental results.

The Farmer's Holiday.—Towards the end of summer is the only period in which the farmer has liberty to leave home without incurring the blame of neglecting his business. Even then the time he has to spare is very limited. Strictly speaking, he has only about two or three weeks before the commencement of harvest, in which to have leisure for travel. A journey once a-year to witness the farm operations of other parts of the kingdom, or of foreign countries, enlightens him in many uncertain points of practice. He there sees mankind in various aspects, his mind becomes widened and raised above local prejudices, and a clearer understanding of places, manners, and customs is afforded him when reading the publications of the day. A month so spent may, in its experience, be worth a lease-length of local reading and of stay-at-home life.

HAY-STACK FOR HORSES.

It is the custom in many parts not to break upon the hay-stack until the busy work of spring has begun. This, however, will depend upon the supply of other food for horses, such as good oat-straw or good bean-straw. When these are plentiful, little or no hay may be used till well into spring.

Taking in Hay.—As much of the hay-stack is brought in at a time as will fill the hay-house. Each portion of

the stack cut off from its top, 4 or 5 feet in breadth, should have its covering removed, and the remainder on the stack firmly secured, otherwise the wind may blow it away entirely.

Hay-knife.—The implement used for cutting hay is the hay-knife, fig. 338, which is a convenient form. It will be observed that the line of the back of the blade is not at right angles to the handle, a position which gives the cutting edge of the knife an inclination to the line of section, and consequently affords it, in its downward stroke, a force to cut the successive straws of hay, which it could not do were the stroke perpendicular to the length of the blade. The person who cuts the stack is the steward, and in using the knife he kneels upon the part he is cutting off, with his face to the body of the stack.

This form of knife requires considerable force in its use, and unless the edge

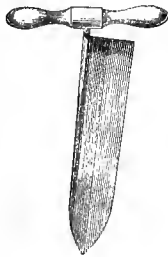


Fig. 338.—Hay-knife.

is kept keen with a whetstone, and the hay firm, it makes bad work.

A hay-knife which some prefer is in the form of the dung-spade, which, being used standing, is wielded with much greater force, and makes a deeper cut; and having two sharp sloping edges, it cuts equally well to the right or left.

A very expeditious form of hay-knife is that shown in fig. 339. (J. G. Rollins & Co., Ltd., American merchants, Old Swan Wharf, London.)

Method of Cutting a Hay-stack.—In cutting off a breadth of hay across the stack, the stack should be left perpendicular and the cutting horizontal. When the dace is not cut down to the ground, straw should be placed upon the cut portion left, to protect it from rain, and a hurdle or two placed upon the straw to prevent it being blown off. The hay is usually conveyed to the hay-house in a cart, as in the case of grain to the sheaf-barn.

Hay for Young Horses.—Young horses should receive hay after the stack has been broken into, straw becoming too hard and dry after March. Moreover, it is expedient to improve their condition to prepare them for grass.

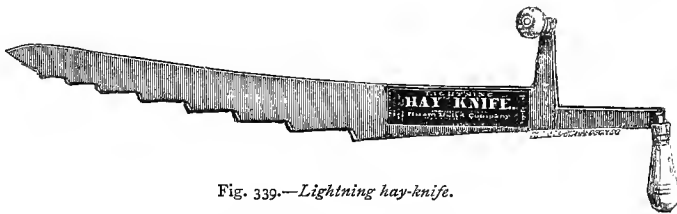


Fig. 339.—Lightning hay-knife.

Feeding cattle rarely receive hay in Scotland, but in England meadow-hay is given to feeding cattle either alone, with some straw, but more frequently chopped hay and straw together, or in union with oilcake, or with linseed prepared. On dairy-farms, cows generally receive hay after having calved, either as steamed chaff or dry fodder.

FLAX CULTURE.

Flax (*Linum usitatissimum*, Nat. Order *Linace*) is cultivated for fibre or for seed, or for both. In this country it is culti-

vated most largely in the north of Ireland, where it is grown with great success to supply fibre to the extensive linen-mills of Ulster. The Irish farmers both grow the crop and prepare the fibre for the linen-mills. In most other parts, notably on the continent of Europe, the farmer merely grows the crop and leaves its manipulation to others. In order to obtain the finest fibre the flax has to be pulled before the bolls or seed are ripe, and thus a twofold return of seed and fibre is seldom obtained from the one crop.

As already explained (vol. i. p. 257), linseed, the seed of flax, possesses great

value as an article of food, especially for cattle.

Soil for Flax.—The flax plant requires a deep mellow loamy soil, abounding in vegetable matter, and equally removed from strong clay and thin gravel. On clay the plant grows too strong and branchy, yielding coarse fibre, and on gravel it is stunted in growth. Any soil in too high condition causes flax to be rank, branching, and coarse.

Rotation for Flax.—The finest flax is best obtained after corn or potatoes. In the north of Ireland, where flax cultivation is pursued extensively and with great success, it is not considered good practice to grow flax after lea. It is difficult to get lea-land into a sufficiently fine tilth, and insect attacks are more frequent after lea than after wheat or potatoes. Flax should not follow turnips, but it does well after potatoes. Flax should not be repeated on the same land at shorter intervals than about seven years; some say nine years would be better still. Flat land is preferable to undulating, hilly uneven land rarely producing flax of a uniform reed.

Tillage for Flax.—Whether after cereals or lea, the land for flax should be ploughed early in winter, to receive the full effects of the frost. It cannot

be in too fine a state of pulverisation when the seed is sown. To promote this fine state of the soil, cross-ploughing should be executed early in spring, taking care to avoid wet weather, or the soil in a waxy state, as dry weather following renders the soil difficult to be pulverised. Clods left on the surface, after a double turn of the harrows, should be reduced by a clod-crushing implement.

The cross-ploughing in spring should be done about two months before sowing. Medium land after potatoes will do with one ploughing from four to six weeks before sowing. Heavy land after potatoes should be ploughed as early in the year as possible. Plough shallow, about 4 inches deep, after potatoes. It is recommended that as far as possible weeds should be removed by forks and graips before the seed-bed is prepared. Flax delights in a firm, even seed-bed, and if the land is dry naturally or well drained, it thrives best broadcast or in rows on the flat. In drills it is more apt to be uneven in length, and it is very important that flax should be as uniform in length as possible. Light land should not be too much stirred, but heavy land cannot be too much pulverised.

Clod-crushers.—Crosskill's clod-crusher, shown in perspective in fig. 340,

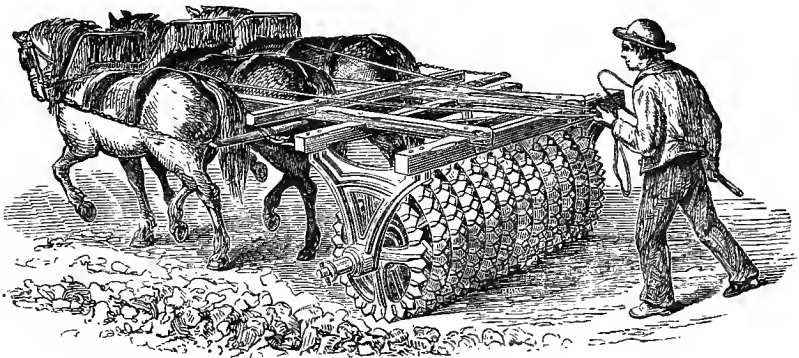


Fig. 340.—Crosskill's clod-crusher.

is a most efficient implement. The roller consists of a number of toothed wheels, supported on feathered arms, and an eye formed in the centre fitted to move easily on the axle of the roller. Fig. 341 shows a side view of one of

those wheels, by which its action upon the soil may be easily understood.

When such a great number of angles, acting like so many wedges, are brought into contact with the indurated clods, they infallibly split them into numerous

fragments, and the repetition of the process produces a well-pulverised surface. The effect is quite different from that of the plain roller, by which, if a clod does not crumble down at once with its pressure, it is forced into the soil in a solid state.

This clod-crusher has been but partially used by Scottish farmers, though extensively in use in England—perhaps on account of the greater extent of clay soils there, which are always subject to induration by drought. Where the im-

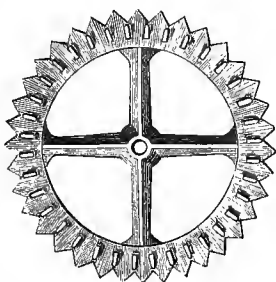


Fig. 341.—Side view of one wheel of the clod-crusher.

plement has been tried in Scotland, the results have proved equally favourable on strong and light soils—in pulverising the strong and consolidating the light.

Norwegian Harrow.—Another very useful pulverising implement is the Norwegian harrow, shown in fig. 342, and made by C. Clay, Wakefield. The action of this machine is to reduce large clods into very small ones, by the insertion of the points of the rays into them, to split them into pieces by their reiterated action. The larger clods are split into smaller pieces by the first row of rays, the second row splits these into smaller ones, and the third row splits those smallest pieces into still smaller ones; so that, by the time the clods have undergone those various splittings, they are probably sufficiently pulverised.

Sowing Flax.—The time for sowing flax will of course depend partly on the climate of the district and on the charac-

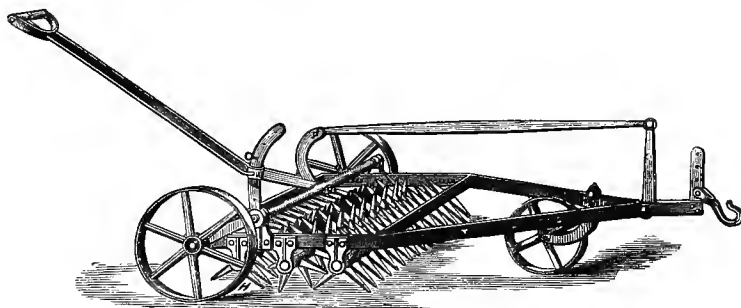


Fig. 342.—Norwegian harrow.

ter of the particular seasons. As a rule, from the last week in March till the third week in April is the flax seed-time. The young flax plants, if the sowing has been done too early, are liable to injury from frosts, which cause the plant to branch, thereby greatly lessening the value of the crop.

Prepare a fine, smooth, firm seed-bed with the harrow and roller. Some harrow, roll, and then sow; others harrow, roll, and harrow again, and then sow. Mark off the land on the flat for the casts of seed with poles or footprints. In some cases, to facilitate weeding, it is sown in rows 8 to 10 inches apart, but generally broadcast.

Seed.—Dutch seed is best suited for

heavy soils and after green crop, and Riga seed for medium and light lands. The former produces the finer fibre, and is usually cleaner than the Riga seed. The latter, indeed, should invariably be put through a flax-seed sieve, made for the purpose of perforated zinc, before being sown, as thereby considerable trouble in removing weeds may be saved.

As to the quantity of seed, if the crop is grown for the fibre, from 2 to 2½ bushels per acre should be allowed; if for seed, 1½ bushel will suffice. Flax seed is sown by the hand, but as the seed is very slippery it must be done by a skilful person. The seed should be taken hold of by the thumb and two

foremost fingers, like grass seeds, and thrown forward in sharp casts, with short quick steps, and being dark-coloured, is easily observed to fall upon the rolled ground in regular broadcast. A strip with a light harrow will suffice to cover the seed. Flax seed is oblong lenticular in shape, having a smooth oily surface, feels heavy, and should be plump and fresh. As good seed is of great importance in the success of this crop, flax seed beyond a year old should never be sown.

Grass Seeds with Flax.—Land is frequently sown out into grass with the flax crop. Italian rye-grass is injurious to the flax on account of its vigorous growth, but perennial rye-grass, clovers, and natural grasses may be sown with impunity. These should be sown immediately after the flax seed, and the two harrowed in together with a light harrow. If it is desired to have Italian rye-grass after flax, the seed may be sown as soon as the flax is pulled in July.

As a catch-crop for districts where the climate is suitable, scarlet clover (*Trifolium incarnatum*) may be sown when the flax is pulled, and this will provide a useful cutting in the following May, after which the land may be prepared and sown with turnips. Others sow rape or winter vetches and rye after flax for spring food for stock.

Top-dressing Flax.—Although the flax crop does not bear being sown upon dung, a top-dressing of bone-dust of 10 or 12 bushels to an acre, after a white crop, may often be given with advantage, especially if the crop is making slow progress.

But the best plan for flax is to have the land in high condition from previous manuring, so that top-dressing may not be necessary. The Belgians profusely top-dress their flax-ground with liquid manure (in which have been dissolved both rape-cake and nightsoil), to the amount of 2480 gallons to one acre.¹

Weeding Flax.—The only attention which the flax crop requires in summer is to keep it free from weeds. These will appear as soon as the crop itself; and when the crop can be identified from them, the ground should be weeded.

Being in broadcast, and thickly sown, the only practicable way of weeding flax ground is by the hand. As the plant is firm and elastic, the stem is not injured by the weeders treading on it, if they are careful. The weeders should not wear shoes, so as to avoid injuring the flax. The weeding should be done effectually, and at intervals, till the plants are from 4 to 7 inches high. Close hand-weeding is costly, but the increase of crop will more than repay the outlay.

Besides the common surface and root weeds which infest the soil, there are others special to flax; as Gold of Pleasure, *Camelina sativa*, the seed of which is imported among the flax seed; the flax-dodder, *Cuscuta europea*, which adheres parasitically to the flax plant, and materially injures its fibre. "It is a plant," says a writer, "which germinates in the ground, and sends up a slender threadlike stem, which, twisting itself about, soon touches one of the stems of the flax amongst which it is growing. As soon as this takes place, the dodder twists itself round the flax, and throws out from the side next to its victim several small processes, which penetrate the outer coat or cuticle of the flax, and act as suckers, by which the parasitical dodder appropriates to its own use the sap which has been prepared in the flax, upon which the growth of the flax depends. The dodder then separates itself from the ground, and relies solely upon the flax for its nourishment, producing long slender leafless stems, which attach themselves to each stem of flax that comes in their way. Thus large masses of crop are matted together, and so much weakened as to become almost useless. This plant produces great quantities of seed, which is usually threshed with the flax seed, and sown again with it in the succeeding year. Several years since, I took considerable trouble to ascertain if all foreign flax seed was mixed with that of the dodder, and was led to the conclusion that the American flax seed is nearly free from this pest, and that that from Russia, and especially from Odessa, is peculiarly infected with it."² A thorough weeding will remove this pest from the soil before it has the power of injuring the flax plant.

¹ Radcliff's *Agric. Flan.*, 42.

² *Garden. Chron.*, Feb. 10, 1844, 189.

From the time the weeding is finished the crop needs no further attention till the pulling time approaches, usually in July.

PULLING, STEEPING, AND DRYING FLAX.

Pulling.—The flax plant is pulled up by the root. The pulling is done after the plant has flowered and the seed attained a certain degree of maturity in the capsule or boll which contains it. As to the proper time to begin pulling, great care and judgment must be exercised. If pulled too soon the fibre will be weak; if allowed to ripen too much, the fibre will be dry and coarse.

The test for pulling, according to Henderson, is this: "I have found the test recommended by Boss, to ascertain the degree of ripeness that gives the best produce with the finest fibre, perfect. It is this: Try the flax every day when approaching ripeness by cutting the ripest capsule on an average stalk across, horizontally, and when the seeds have changed from the white milky substance which they first show to a greenish colour, pretty firm, then is the time to pull. The old prejudice in favour of *much ripening is most injurious*, even as regards quantity; and the usual test of the stalk stripping at the root and turning yellow, and the leaves falling off, should not be depended on. Where there is one man that pulls too green, 500 over-ripen."

Method of Pulling.—When thus ripe, the flax should be pulled in this way, as described by Henderson: "I use the Dutch method, by catching a few stems of the flax at a time close below the bolls, which allows the shortest of the flax to escape. With the next handful the puller draws the short flax, and keeps the short and the long each by itself, to be steeped in separate ponds. It is most essential to keep the flax *even* at the root-end, and this cannot be done without time and care; but it can be done, and *should always be done*. The *beets* or sheaves should always be small, equal-sized, straight and even, and should never be put up in stooks or windrows, but taken to the pond the day they are pulled, or the day after at longest, especially in bright weather; for the dis-

coloration produced by the sun on green flax will never be removed till it goes to the bleacher, and will give him some trouble also."

Rippling.—On being pulled, the plant is deprived of its bolls or seed-capsules by rippling, which consists of drawing the head or boll end of the stem through the teeth of an iron comb 8 inches in length, set upright upon a form, across which two men sit opposite each other, and ripple their handfuls alternately, the bolls falling on a barn-sheet spread under the form.

Another convenient arrangement is to have the comb bolted to a plank, securely fastened to the body of a cart from which the wheels are removed. When the cart is full of bolls or seeds, raise it on to the wheels and remove the bolls to where they can be dried.

The arrangement of labour should be such that the rippling goes on simultaneously with the pulling. The rippled plants should be tied in sheaves, to be taken to the watering-pool to be steeped. Some steep the bolls on the plants, but no good is attained thereby.

The Bolls.—The green bolls or seed should be at once spread over lofts to dry. Turn them frequently, and when partially dry they are taken to a corn-mill and finished on the kiln moderately heated.

Steeping.—Next comes the steeping, a most important process. The object of steeping the flax plant is to separate the outer fibre of the stem from the interior pith by disintegration. The adhesive substance between the fibre and pith is mucilage, which is the sooner dissolved the sooner the plant is steeped. If steeping is so long continued as to affect the texture of the fibre, the flax will be injured; and should it not be continued until the pith may be easily loosened, much labour will be required to get rid of it.

Proper steeping, then, is not only an essential, but a nice process, and clear instructions regarding it should be scrupulously followed. Henderson says: "The water brought to the pond should be pure from all mineral substances, clean and clear. The water from large rivers is generally to be preferred; but spring-water which has run some hundred yards becomes soft, and will have deposited

any mineral impurities it may have contained ; but that immediately from the spring seldom does well. If the water be good and soft, it is injurious to allow it to stagnate in the pond before being used for steeping. I put in two layers, each somewhat sloped, with the root-end of each downwards : one layer at a time is said to be safer, and perhaps is so, although I have tried both ways, and have observed no difference. The flax should be placed rather loose than crowded in the pond, and laid carefully straight and regular. Having an abundant supply of water, I do not let any into the pond till the first layer is first placed in it. I cover the flax with sods laid perfectly close, the shear of each fitting to the other. Thus covered, it never sinks to the bottom, nor floats above the water, nor is affected by air or light. It is generally watered in eleven or thirteen days. A gentle stream should, if possible, always pass slowly over the pond ; it carries off impurities, and does not at all impede due fermentation. Flood and impure water should be carefully kept off ; and perhaps the best way to do this is to make a drain or ditch around the pond. The greatest cause of injury in steeping is exudation of water from the sides or bottom of the pond. Stripe and discoloration are mostly imputed to the quality of the water brought to the pond ; whilst in most cases the water oozing from the sides and bottom of the pond itself is the cause. Even if such water were pure, which it seldom is, it is injurious ; but when impregnated with iron or other materials, it does immense harm. If such ponds must continue to be used, the injury may be partially amended by draining around the sides and ends, at 6 or 8 feet distance, and 18 inches deeper than their bottom, and filling the drains with tiles or stones. No other thing I know of does so much injury as this springing of water within the pond."

Water deeply tinged with iron is certainly very injurious to the flax ; but a slight tinge of iron in the only supply of water available should not prevent a farmer from growing flax, if the conditions otherwise are favourable.

The utmost care should be exercised in deciding when the flax has been sufficiently watered. The Dutch test which is

recommended by many authorities is thus described by Henderson : "Try some stalks of average fineness by breaking the woody part in two places, about 3 inches apart, at the middle of the length ; catch the wood at the lower end, and if it will pull downward freely for those 3 inches, without breaking or tearing the fibre, it is ready to be taken out. This trial should be made every day after fermentation subsides, for sometimes the change desired is rapid. Flax is more frequently injured by too little than too much of the water."

Drying. — Continuing, Henderson says : "Great care and neatness are necessary in taking the flax out, as broken or crumpled flax will never reach the market. Set the sheaves on end against one another as taken out of the pond, to drain the water off them the more quickly. Spread the flax on the same day it is taken out, unless it happens to be heavy rain. Light rain does little harm ; but, in any case, spread the next day, for it will heat in the pile, and that heating will be destructive."

Flax "should be spread even, straight at its length, not too thick, and well shaken, so that there shall be no clots ; indeed, if possible, no two stalks should adhere. I have ever found it injurious to keep it long on the grass : it is in the steep the wood is decomposed ; on the grass the fibre is softened, and the wood little, if at all, affected. I rarely let it lie more than five days, sometimes only three : one year it had only three days, and I never had better flax. It should never, if possible, be spread upon the ground where it has grown — it claps down, and the clay and weeds discolour it : clean lea, or lately cut meadow, is the best ground."

When it has to lie long on the grass owing to rainfall, the flax may occasionally suffer from mildew. To guard against this it is deemed advisable by some to lift the flax in handfuls by the boll end, and set it up on the root end in the form of a hollow cone, with the boll ends twisted a little to keep the cone together. But in the case of high winds following this practice, the flax is liable to injury by being blown about.

Lifting. — "Lifting, like all other operations, requires care and neatness

to keep the flax straight in its length, and even at the roots. This operation is too frequently hurried and coarsely done. If the steeping and grassing have been perfect, flax should require no fire; and to make it ready for breaking and scutching, exposure to the sun should be sufficient; but if the weather be damp, the flax tough, and must be wrought off, then it must be fire-dried. Such drying is always more or less injurious; and if it be put on the kiln in a damp state, it is ruinous—it is absolutely burnt before it is dry. All who can afford it should keep such flax over to the ensuing spring or summer, putting it dry into stacks, when it will work freely without fire-heat.

“The proper culture and preparation of flax require more care, exertion, and expense than the old slovenly method; and those who will not give those requisites, would do wisely to abstain from growing flax altogether. Any other crop will abide more negligence. Flax is proverbially either the very best or the very worst crop a farmer can grow.”¹

Scutching.—This is more distinctly a part of the manufacturing process, and therefore does not come within the scope of this work.

Growing and Saving Seed.—The late Mr Michael Andrews, Secretary of the Flax Supply Association for the Improvement of Flax in Ireland, contributed an instructive paper on Flax Culture to the ‘Journal of the Royal Agricultural Society of England’ in 1881. Those who may desire fuller information on the subject would do well to consult that paper.²

In regard to flax seed, the supply of which is principally foreign, Mr Andrews says: “In this climate home production would be too precarious to depend on; and another consideration is, that to treat flax so as to save seed suitable for sowing reduces the quality of the fibre. The saving of seed for sowing, however, is not sufficiently attended to in Ireland, and it would be desirable that growers of flax should reserve a small portion of each year’s crop for seed—of course as-

suming that the crop is grown from Riga seed. The portion set apart for seed production should be sown rather thinner than that from which no sowing-seed is intended to be taken, and it should be allowed to ripen on the foot. Poor stunted spots often occur in flax-fields which might be judiciously left to mature, and save the seed therefrom.

Selecting Seed.—“Seed must be selected by its appearance, choosing it of a bright colour and plump, and as free as possible from imperfect pickles; but even with all these characteristics the farmer may not procure a really good article. The surest method of obtaining genuine seed is to purchase a known brand from a reliable importer.”

Old Seed.—It is said that in Belgium two-year-old seed is preferred to new. Mr Andrews prudently observes, however, that “no seed beyond one year old should be sown without testing its vegetating power.”

Manurial Value of Flax-pond Water.—It has been believed by many that the water in which flax has been steeped possesses considerable manurial value. This, however, is very doubtful, and would not likely repay the cost of pumping and distributing.

FLAX-GROWING IN GREAT BRITAIN.

It is at first sight somewhat strange that a crop which is grown with financial success in Ireland and in many foreign countries should have never come into culture in England and Scotland.

Formerly Grown.—For domestic purposes very small patches of flax have been grown in some parts of England and Scotland for a very long time. But it has never taken rank in these countries as an ordinary farm crop. Indeed even the small patches of flax or lint for domestic use have in most cases become things of the past. The “lint-pools,” once dotted pretty freely over Scotland, have nearly all disappeared, and many of the Scotch and English farmers of the present day have never seen a stem of flax growing.

Recent Trials.—Between 1880 and 1887 there was a good deal of discussion as to the propriety of introducing flax as a farm crop in England and Scotland. In several parts of the country the crop has

¹ Henderson’s *Cult. of Flax*, 1.

² *Jour. Royal Agric. Soc. Eng.*, sec. ser., vol. xvii., part 2, 408.

been tried upon small patches, but the results financially have not been sufficiently good to warrant any great extension of the enterprise.

Outlet for Flax Straw.—The main hindrance to the successful cultivation of flax in England and Scotland is the want of a profitable outlet for the flax straw. In the north of Ireland flax-growing flourishes because, in the extensive linen-mills of that industrious province of the Green Isle there is a sure and ample demand for the straw. There, indeed, flax is grown almost for the sole purpose of supplying flax fibre to these linen-mills. The two industries go hand in hand, the one being essential to the success of the other. Little attention is given to the seed, for the reason that, by allowing the seed to ripen, the fibre of the flax, the main concern of the Irish flax-grower, would be somewhat injured in quality.

It has been well shown in the various trials conducted that the climate and soil in most parts of Great Britain are well suited for the successful growth of both flax straw and flax seed. The unfortunate thing is that, until a better market can be found for the straw, the value of the crop when it is grown is not sufficient to adequately remunerate the grower.

Uses of Flax Seed.—For flax seed, or linseed, as it is more commonly known, there will always be a reliable and satisfactory market. Its high feeding properties are well known, and it is an article which is easy of transport.

Uses of Flax Straw.—With the flax straw the case is different. It makes admirable thatch, but the demand for this purpose would never be worth reckoning. Its most remunerative use is the manufacture of linen. Unfortunately in England and Scotland there is no such demand for it for this purpose as there is in Ulster. Whether or not the demand may arise, or could be raised up by any concerted action, is a very doubtful point.

Flax Straw for Paper-making.—Flax straw is also adapted to the manufacture of paper. Its value for this purpose, however, is kept severely in check by the abundance of other commodities which are more suitable, and which—by the processes of manufacture now known—can be manufactured at less outlay. It is just possible that methods of paper-

making may yet be discovered which will provide a remunerative outlet for flax straw in that ever-growing industry.

Experiments in Flax-growing.

An interesting experiment in the growing of flax as a farm crop was carried out by Mr Richard Stratton, The Duffryn, Newport, Monmouth, beginning in 1880. He was induced to make the trial by Mr Reed, manager of the Ely paper-works, Cardiff, who had been using flax straw in the manufacture of paper, and who agreed to pay Mr Stratton £4, 10s. per ton for the flax straw, straight from the threshing-machine.

For his first crop Mr Stratton selected a field of eight acres, a sandy loam of moderate depth resting on gravel. In the previous winter (1879-80) about 15 tons of farmyard manure per acre had been ploughed in. Having previously grown three successive crops of oats, the land was in poor condition. In the spring of 1880 the field was twice scarified and dragged, and in the second week of April the flax seed was sown, $1\frac{1}{2}$ bushel of seed per acre being drilled in eight inches apart. The crop was weeded at a cost of about 2s. per acre, and about a week after the wheat, it was ready for harvesting, the pulling, tying, and stooking costing £1 per acre. Wild vetches and "goose grass" spoiled some patches, yet the eight acres gave the following return:—

Yield per acre.	Value per acre.
22 bushels seed at 8s.	£8 16 0
32 cwt. straw at 4s. 6d.	7 4 0
	£16 0 0

This result was so satisfactory that Mr Stratton decided to repeat the experiment upon a larger scale. A field of 21 acres, of similar soil, also poor and foul, from having borne eight consecutive hay crops followed by spring wheat, was selected for the second trial. It was well tilled and cleaned in the autumn and spring, manured with 7 cwt. of damaged decorticated cotton-cake per acre, and sown, about the middle of April, with $1\frac{1}{2}$ bushel of flax seed. Hand-hoeing this time cost 5s. per acre. This crop came up admirably, and although there was a little shedding of seed, owing to wet weather having delayed harvesting,

the return was again satisfactory. It was as follows:—

Yield per acre.	Value per acre.
40 cwt. straw at 4s. 6d. .	£9 0 0
20 bushels seed at 8s. .	8 0 0
	£17 0 0

A third experiment was not so satisfactory. It was on tenacious soil, on the Old Red Sandstone formation. The previous crop was swedes, eaten off, for the most part, by ewes and lambs without any cake or corn. The land was not ploughed until the end of April, and then it could not be reduced to that fine tilth so essential for flax. The flax seed was sown at the rate of one bushel per acre about the 7th of May. Dry weather followed, and the crop came up much too thin, giving the following poor return:—

Yield per acre.	Value per acre.
15 bushels seed at 8s. .	£6 0 0
16 cwt. straw at 4s. 6d. .	3 12 0
	£9 12 0

This result is indeed only what might have been expected under such untoward circumstances, especially in view of the rough state of the ground. The ground was in such bad condition, and the season so unfavourable, that a crop of wheat on the other half of the same field realised only £6 per acre for both corn and straw.

Mr Stratton induced his friend, Mr T. R. Hulbert, North Cerney, Cirencester, to try a small field of flax on a poor shallow piece of soil, high on the Cotswold Hills. The preceding crop on this land was roots, eaten off by sheep, which had an allowance of corn as well. The seed (1½ bushel per acre) was sown in the first week of May. The crop produced 20 bushels of seed and 1 ton of straw per acre. For this Mr Hulbert realised £14, 10s. per acre—just about double the value of the corn crops on his farm in that very bad year—1881.

With these prices for the produce—8s. per bushel for seed, and £4, 10s. per ton for straw—Mr Stratton was thoroughly satisfied that flax would be more profitable to the grower than corn.

Advantages of Flax over Corn.—The advantages which, with the above prices, Mr Stratton claimed for flax over corn were stated by him as follows:—

1. More profitable.
2. Far less risky, being virtually rain-proof.
3. Being generally a new crop, it is an entire change for the land, and therefore desirable.
4. However strong the land may be, flax will not lodge seriously, unless pulled down by bind-weeds; so that on the land where barley would certainly be too heavy, flax may be grown without any danger of that kind.
5. Birds do not touch it at planting-time, though, when ripe, finches are very fond of it.
6. It may be planted later than spring corn, thus affording more time to clean the land.
7. It may be grown on land that cannot be depended upon to produce malting barley.
8. I believe it is practically proof against wire-worm.
9. Rabbits and hares do not eat it, though they will occasionally cut roads through it.¹

Disadvantages of Flax over Corn.—On the other hand, Mr Stratton found that the cultivation of flax cost about 10s. per acre more than wheat or barley, and harvesting also about 10s. more, while threshing flax by the ordinary threshing-machine was likewise rather more costly than the threshing of the common corn crops. Then the flax straw, being sold instead of consumed on the farm, costs perhaps 10s. per ton for delivery. These extra outlays, as compared with corn-growing, Mr Stratton estimated at 35s. per acre, which—with 8s per bushel for flax seed, and £4, 10s. per ton for flax straw—was far more than repaid by the greater value of the flax crop.

Loss of the Market for Flax Straw.—In the interesting account of his experiments which he published in the *Journal of the Royal Agricultural Society of England*, Mr Stratton explained clearly that the success of flax-growing in lieu of corn culture depended mainly upon whether or not the demand for flax straw for paper-making at the price of about £4, 10s. per ton would be maintained.

¹ *Jour. Royal Agric. Soc. Eng.*, sec. ser., xviii. 461.

This, unfortunately, has not been the case. The paper-makers, as has already been indicated, found a cheaper substitute for the flax straw in the "waste" from flax-mills, and owing to the loss of this market for the straw, Mr Stratton had to give up the growing of flax.

Will the Market return?—Whether or not a sufficient demand will open up again for flax straw for paper-making is uncertain. As to the probability of resuming the growing of flax, Mr Stratton, writing in 1889 to the editor of this work, says, "I am quite prepared to go on growing flax now, if I can get a fair market for the straw. I am strongly of opinion that it ought to be grown to a much greater extent in England than is done at present. I am fully persuaded that no country is better suited to it, either in regard to soil or climate, than the United Kingdom; and it does seem strange that while we grow almost none, all nations grow it, and send both seed and fibre here."

Flax Straw displaced.—In response to an application for information as to the circumstances which have led to the depreciation and disuse of flax straw in the manufacture of paper, Mr A. E. Reed courteously replied to us as follows, under date October 19, 1889:—

"When a few years back I arranged with Mr Stratton to grow some flax for the works of which I was then manager, esparto, straw, and rags were the fibres principally employed for making paper for cheap newspapers, together with a certain quantity of mechanically prepared wood pulp. At that time esparto (of which a larger quantity was used than any of the other fibres named), was standing at about £6 per ton for the cheapest sort, and went up indeed to £7. Flax straw not yielding so much fibre, and requiring more chemicals for its treatment than esparto, was not worth so much. I estimated its value to be about £2 per ton below esparto, and agreed to pay Mr Stratton £4 10s. per ton. But the high price of esparto stimulated the working out of processes for the chemical treatment of white pine wood, and the success of the methods employed has resulted in raw wood becoming largely used. In fact, at the mill which I am now managing nothing

but wood is used, and the paper made is suitable for fine printing and other papers. This wood can be delivered to English ports at about 30s. to 35s. per ton; and I consider it is quite equal to flax straw, except that it requires rather more expensive treatment, whilst the yield of fibre is about the same. Flax straw is therefore bowled out, except in districts where wood is not easily obtainable, and even then the use of the wood has operated to bring down the price of all other fibres. Esparto (cheapest kind) is now worth about £3, 15s. per ton, and straw is much cheaper than formerly; so also are rags and all other fibres. And I see no prospect of any change. The supply of wood is abundant.

"I think, however, there is an opening for improved methods of treating flax straw for producing fibre for textiles; and those interested should turn their attention to that. At present the flax used in this country is mostly imported."

The Flax Plant.

The flax plant is stated to be a native of Britain; and yet flax seed was not sown in England until A.D. 1533, when it was directed to be sown for the making of fishing-nets.¹

Ure says of the flax plant: "In it two principal parts are to be distinguished—the woody heart or boon, and the *harl* (covered outwardly with a fine cuticle), which encloses the former like a tube, consisting of parallel lines. In the natural state, the fibres of the *harl* are attached firmly not only to the boon but to each other, by means of a green or yellow substance. The rough stems of the flax, after being stripped of their seeds, lose in moisture, by drying in warm air, from 55 to 65 per cent of their weight, but somewhat less when they are quite ripe and woody. In this dry state they consist, in 100 parts, from 20 to 23 per cent of *harl*, and from 80 to 77 per cent of boon. The latter is composed, upon the average, of 69 per cent of a peculiar woody substance; 12 per cent of a matter soluble in water; and 19 per cent of a body not soluble in water, but in alkaline lyes. The *harl* contains, at a mean, 58 per cent of pure

¹ Haydn's *Dict. Dates*—art. "Flax."

flaxen fibre, 25 parts soluble in water (apparently extractive and albumen), and 17 parts insoluble in water, being chiefly gluten. By breaking the harl with either hot or cold water, the latter substance is dyed brown by the soluble matter, while the fibres retain their coherence to one another. Alkaline lyes, and also, though less readily, soap-water, dissolves the gluten, which seems to be the cement of the textile fibres, and thus set them free. The cohesion of the fibres in the rough harl is so considerable, that by mechanical means—as by breaking, rubbing, &c.—a complete separation of them cannot be effected, unless with great loss of time and rupture of the filaments. This circumstance shows the necessity of having recourse to some chemical method of decomposing the gluten. The process employed with this view is a species of fermentation, to which the flax stalks are exposed. It is called *retting*, a corruption of rotting, since a certain degree of putrefaction takes place.”¹

“James Thomson and Bauer have shown that the *fibres* of flax are transparent cylindrical tubes, articulated, and pointed like a cane; while the filaments of cotton are transparent glassy tubes, flattened, and twisted round their own axis. A section of a filament resembles, in some degree, the figure 8, the tube, originally cylindrical, having collapsed most in the middle, forming semi-tubes on each side, which give to the fibre, when viewed in a certain light, the appearance of a flat ribbon, with a hem or border on each edge. The uniform transparency of the filament is impaired by small irregular fissures, probably wrinkles arising from the desiccation of the tube. In consequence of this difference between the structure of linen and cotton fibres, Thomson and Bauer were enabled to ascertain that the cloth in which the Egyptian mummies are wrapt is always linen, and never cotton. It is clear from this that the opinion entertained by some, that what is called in our translation of the Old Testament *fine linen* of Egypt ought to be the *cotton cloth* of Egypt, is erroneous. We have no evidence from the cloth wrapt about

ancient mummies that the Egyptians in those early times were acquainted with cotton.”²

Flax is manufactured into twine, rope, and thread, and into fabrics, varying in texture from coarse bagging, employed to pack cotton or hops, to canvas, linen, cambric, and finest lawn.

“Formerly the seed of the flax was occasionally used with corn to make bread; but it was considered hard of digestion, and hurtful to the stomach. In a scarcity of corn which happened in Zealand in the sixteenth century, the inhabitants of Middleburgh had recourse to linseed, which they made into cakes, and which caused the death of many of the citizens who ate of it, causing dreadful swellings of the body and face.”³

HEMP CULTURE.

Hemp (*Cannabis sativa*, natural order *Urticaceæ*) is grown to a very limited extent in this country, chiefly in the counties of Lincoln and Dorset. The climate of Scotland does not suit it. It grows best in deep rich moist alluvial soil. Its mode of culture is in several respects similar to that of flax. Hemp responds well to a heavy dose of dung, the finest fibre being grown after a dressing of about 20 tons of dung, applied in the autumn before sowing.

Hemp is sown towards the end of April, in rows about 18 inches apart, with 3 to 5 pecks of good seed per acre. The plants are thinned out in the rows to nearly a foot apart. The plants throw up a rapid and bulky growth, so that little weeding early in the season is sufficient to keep the land clean. The crop is pulled, stacked, and steeped similarly to flax. The object of the steeping in water, of course, is to rot away the woody part of the stem and separate the fibre.

When the crop is growing, the ground should be watched after sowing until the plants are in leaf, to keep off birds of the finch tribe, which are very fond of hemp seed. Even the young plants are injured by them—the capsules of the seed, being brought above ground by the

¹ Ure's *Dict. of the Arts*—art. “Flax.”

² Thomson's *Org. Chem.*—“Veget.,” 849.

³ Phillip's *Hist. Cultiv. Veget.*, i. 208.

embryo, are greedily devoured by those birds. Care should be taken in weeding not to break the young plants, as, if broken, they will never rise again.

A good crop of hemp yields about 16 bushels of seed, and from 6 to 8 cwt of fibre per acre.

The hemp plant has the male and female flowers on different plants. The male plants are recognisable by the difference of their inflorescence, and in thinning a number of them must be left in order to the formation of the seed. The male plants ripen long before the female plants, and should be pulled first, so as to promote the formation of a good crop of seed.

The stem of hemp is upright, from 5 to 8 feet high, and is strong and branching. Its valuable fibre makes the cordage of our ships. It is a native of the cooler parts of India, and is not cultivated there for its fibre, but for its intoxicating property. Lindley says that "it appears to owe its narcotic properties to the presence of a resin which is not found in Europe. This resin exudes, in India, from the leaves, slender branches, and flowers; when collected into masses it is the *churras*, or *cherris*, of Nepal. Its odour is fragrant and narcotic, its taste slightly warm, bitterish, and acrid." The hemp plant of India is a legumen of the order *Fabaceæ*, *Crotolaria juncea*, the sun-hemp, which affords a coarse fibre, from which bags and low-priced canvas are largely prepared. "According to the observation of Vaucher of Geneva, the seeds of *Orabanche ramosa* will lie many years in the soil unless they come in contact with the roots of hemp, the plants upon which that species grows parasitically, when they immediately sprout. The manner in which the seeds of *Orabanche* attach themselves to the plants on which they grow has been observed by Schlauter. This writer states that they only seize seedlings, and are unable to attack roots of stronger growth."¹

An oil is expressed from the seed of hemp, which is "employed with great advantage in the lamp, and in coarse painting. They give a paste made of it to hogs and horses, to fatten them. It enters into the composition of black

soap, the use of which is very common in the manufacture of stuffs and felts; and it is also used for tanning nets,"² The proportion of oil from the seed varies from 14 to 25 per cent. The seed is used for feeding cage-birds, and all the finch tribe are remarkably fond of it.

The composition of hemp seed, according to Bucholz, is:—

Oil	19.1
Husk, &c.	38.3
Woody fibre and straw	5.0
Sugar, &c.	1.6
Mucilage	9.0
Soluble albumen (casein ?)	24.7
Fatty matter	1.6
Loss	0.7
	<hr/>
	100.0

HOP CULTURE.

The hop is the most speculative of all the farm crops grown in the United Kingdom. Its produce varies from little more than 2 to 20, or perhaps even 25 cwt. per acre, worth from less than the cost of picking to upwards of £20 per cwt. Many fortunes have been made and lost in the growing of this crop, around which has gathered a halo of romance which hop-farmers delight to contemplate and talk of.

The hop requires a fine climate and good land. Its cultivation in this country is confined mainly to the English counties of Kent, Surrey, Sussex, Hampshire, Worcestershire, and Herefordshire, and usually occupies less than 70,000 acres.

One feature of the agriculture of the principal hop-growing districts is, that the hop may be almost said to monopolise the attention of the farmer, with the result that the other crops of the farm occasionally suffer.

Soil for Hops.—The soil for the hop plant should be deep and mellow, and if resting on a fissured rock, so much the better. An old meadow forms the best site for a hop-ground. In every case the ground should be dry—not subject to stagnant water, and, if not naturally dry, it should be made so by thorough drainage. To afford sufficient room for the roots of the plants, the drains should be not less than 4 feet deep, and the distances

¹ Lindley's *Veget. King.*, 265, 549, and 610.

² Wisset's *Treat. Hemp*.

between them from 15 to 35 feet, according to the tenacity of the subsoil.

Preparing Land.—Land which is about to be planted with hops is either trench-ploughed or trenched by hand in the autumn before planting. In the former practice the land is ploughed deeply with an ordinary plough, followed by a subsoiling apparatus, to break up the hard bottom as shown in figs. 46 and 47, pp. 119 and 120, vol. i. If this plan is not thought advisable or practicable, then the land is dug by hand labour to the depth of two spades. It is considered a good preparation to fold sheep on the land and feed them well before ploughing or digging; and at the time of ploughing or digging a heavy dressing of farmyard manure is given.

Rearing Hop Plants.—Hop plants are raised from cuttings taken from the "hills," or plant-centres, when these are being dressed early in spring. The cuttings are reared in a nursery until about the end of the autumn of the same year, by which time they have formed a strong root. These sets, or young plants, may be purchased from those who give special attention to their culture, and good judgment is required in selecting the kind best suited for each particular locality. Local experience is the best guide as to this, as well as in regard to many other points in farm practice. Attempts to raise hop plants from seed have not been successful, owing to the strong tendency of the plant to revert to its wild type.

Planting Hops.—The planting takes place either just before winter sets in or early in spring. The cuttings or shoots are planted in "hills," two or three to each "hill," the "hills" being from 5 feet 9 inches to 6 feet 6 inches apart each way.

There are two modes of arranging the plants in a hop-ground—one in squares, the other in quincunx. Of these two modes the quincunx is, in some respects, the preferable, because the plants, standing independently, are more exposed to sun and air; a greater number of plants are placed on the same extent of ground, in the ratio of 120 to 100; and the ground can be cleaned nearer the plants with the "nidget" or horse-hoe. In fig. 343 is shown the square method, in which the

hills of hops are each surrounded, in a triangular form, by three poles. In cleaning the ground with the horse-hoe from *b* to *c*, one pole is closely passed at each hill on the right, and two poles are as closely passed on the left hand; and

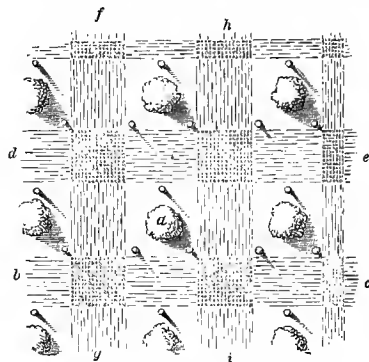


Fig. 343.—Square mode of planting hops.
a Square hill of hops with 3 poles.

the same happens in cleaning the ground from *d* to *e*. On cleaning the ground from *f* to *g* and *h* to *i*, one pole is passed closely on both hands at each hill. The lines in *b c*, *d e*, *f g*, and *h i*, represent the spaces of ground stirred by the horse-hoe. It will be observed that while one dark square piece of ground included between every four hills is stirred twice,

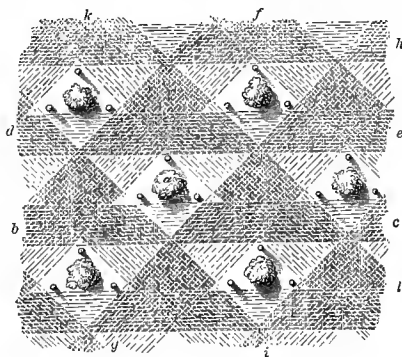


Fig. 344.—Quincunx mode of planting hops.

one square piece of ground surrounding each hill is left untouched by the hoe, and must be cleaned by manual labour at an enhanced cost, while the half of the ground is only once stirred.

In fig. 344 is shown the quincunx

method, in which each hop-hill is surrounded by three poles set in a triangular form, as in the square method. But here, in stirring the ground with the horse-hoe from *b* to *c*, and from *d* to *e* in one direction, and from *b* to *f*, and from *g* to *h* in a second direction, and from *d* to *i*, *k* to *l*, and *f* to *e* in a third direction, the ground is not only stirred close to each pole, which is as near the hop plant as any horse implement can approach, but the greatest proportion of it is twice, and some of it three times, stirred. Of the two modes, the quincunx saves manual labour in cleaning the smaller space of ground around each plant, but stirs the hoed ground oftener.

The maximum distance between the plants is regulated by the combination of the power of the soil and the nature of the variety of hops to produce the largest development of plant. The minimum distance is determined by the room required to keep the ground clean. In the maximum the distance should not exceed 7 feet, and for the minimum not less than $5\frac{1}{2}$ feet. With $6\frac{1}{2}$ feet as the distance, the number of hills in 1 acre is 1194 in the quincunx order, and 1031 in the square. The distances are set off by means of a measuring chain, and pins are stuck into the sites of the future plants.

The crop is not expected to give any produce the first year. In that season the ground between the hills may be utilised in growing potatoes, cabbages, or some such crop, though it is better not to do this, as the hop plants require a great quantity of manurial substance.

After Culture.—The vacant spaces between the "hills" must be well cultivated, and kept free from weeds, and heavily manured.

In the first spring a pole is placed in each "hill," and to this the young vines are tied, so as to be trained upwards. In the spring of the following year, when a crop is anticipated, the ground is again cultivated and manured, the hills dug with "spud" and hand-hoe; three poles stuck in at each hill, and any worthless suckers on the plants cut away. As the hop-vines grow up they are tied to these poles, which carry the vines high over a man's head. The "spud" is a

three-pronged fork or "graip," with broad points.

The vacant ground between the hills must be frequently cultivated during the season, a sort of horse-hoe, or "nidget" as it is called in Kent, being used for this purpose. In the month of June the "hills" are earthed up by the spade.

The hop-land has to be thoroughly dug or ploughed every autumn or winter, the "spud" being used for this purpose.

When labour is scarce a small plough is used, but this has little or no effect in lessening the cost, as there is after all a good deal of the land around the "hills" and stacks of hop-poles stowed away for winter, which must be dug by manual labour.

Early in spring the adult hop plants are dressed as soon as the soil is sufficiently dry to be worked satisfactorily. The old vines and fibrous growth of the previous year are cut away, and some fine earth is thrown over the "hills." The poles, which had been removed at the time of "picking," are replaced around the "hills," and after this until picking attention is confined to the cultivating of the vacant ground—that is, unless fungoid or insect foes attack the plants and demand serious treatment.

Manuring.—Hops are greedy for manure. The annual produce of a hop-ground consisting of hops and vines is very considerable, and as the perennial nature of the plant does not permit it to be placed in the category of those plants of the farm which follow each other in any given rotation, it is necessary to manure the ground at least once, if not twice, every year. The first manuring after the crop may be given in autumn or spring; and if in spring, the time is before the digging of the ground commences. The best plan is to apply the manure twice a-year: in the spring, with farmyard manure and woollen rags, and during the summer with some such manure as guano, rape-cake dust, superphosphate of lime. Of farmyard dung, from 25 to 30 cubic yards should be given to an acre. Black mould is an excellent application about the crown of the roots, and from 80 to 100 single horse-loads may be put on an acre. The dung and mould may be carted on the ground before poling, and if applied afterwards,

is drawn on to the land between the rows of poles in long narrow carts called "dollys" in Kent. Of woollen rags from 12 to 20 cwt. per acre; woollen waste or shoddy from 20 to 30 cwt. per acre; and guano rape-cake dust, and superphosphate of lime, 6 or 7 cwt. per acre, are convenient applications, in June and July, generally dug in closely around the "hills," and sometimes spread over the surface, and hoed in with horse-hoes or "nidgets." Mustard-cake makes a good manure for the hop plant.

Details of Dressing.—After the manuring and digging in spring, the plant-centres or stocks are *dressed*, and cuttings taken from them. These are nice operations, and require an experienced hand to execute them, otherwise the success of the future will be rendered doubtful. Mr Rutley writes thus particularly on this subject—after stating that one boy or woman opens around the stock of the hill, with a small narrow hoe, a little below the crown of the hill—"one man follows with a pruning-knife and a small hand-hoe, with which he clears out the earth on the crown of the hill between the sets or shoots of last year that were tied to the poles; and which, from having earth put on them the preceding summer, swell out to four or five times their original size, and form what we call sets or cuttings; and it is the cutting them off at the right part that should be particularly attended to, or great injury may be done. It is therefore necessary that the person cutting them should ascertain exactly where the crown of the hill is, that he may not cut them too low or too high; and the place where they should be cut off is between the crown of the hill and the first joint, for it is around the set close to the crown where the best and most fruitful bine comes. If the set is pared off down too close to the stock or crown, it takes away the part from where that bine comes, as little buds are seen ready to shoot forth at the time of cutting, which, if cut off, the bines come weakly and few. On the other hand, if the set is cut off above the first joint, which sometimes will be the case if the man in cutting does not pay the attention to it he ought, the bines which come from that or any other joint higher up the set

grow fast, but are coarse, hollow, or what we call pipy, and unproductive: all such should be discarded at the time of tying. Consequently the operation of cutting or dressing, on which the future well-doing of the plant so much depends, is not left so much to the judgment or skill of the operator as to his care and attention. Many planters have their hops dressed by the day, paying extra wages to persons in whom they can confide to do it with care. After all the old bine and runners, as the roots and small rootlets near the surface are called, are cut and trimmed off clean, some fine earth is pulled over the crown, and a circle made round with the hand-picker, to intimate where the hill is before the young shoots appear."

The dressing should be finished before the bines begin to show. Such of the sets as have two or more joints are selected to put into a nursery, or sold for that purpose. But the cuttings should be taken only from the most healthy bines.

Hop-poles.—Everything is now ready for the reception of the poles—for, the hop being a climbing plant, it is necessary that it be supplied with a pole sufficiently strong and long to support it effectively. The best poles are of ash, chestnut, larch, willow, oak cut in winter, birch, alder, beech, in the order enumerated.

Creasoting Poles.—Hop-poles are now universally treated with creasote at the ends, and this preparation makes them last about twice as long as before the practice was introduced. The creasote, purchased at about 2½d. or 3d. per gallon, is poured into a tank into which the poles are set on end and kept there, sunk about 18 inches in the creasote for fully twelve hours. By this treatment the end of the pole which is stuck into the ground is rendered quite impervious to wet. There are three standard lengths of poles, 12, 14, and 16 feet, and the cost of poles for one acre of hops would run from £30 to as much as £70.

Poling.—In most cases there are three poles to each "hill," but often only two, and in other cases the one "hill" has three poles, and the next only two. The two or three poles are set around each "hill" at equal distance

apart. A hop-pitcher makes a hole deep enough to give the end of the pole a firm hold of the ground, which should be about as many inches in depth as the pole is of feet in height. The pole is pushed down to the very bottom of the hole, and if it have any crook or set at the lower end, that is placed inwards, to be out of the way of the horses in "nidgetting" the ground; and the top should have a lean outwards, to give room to the bines to branch, and let in air and light, while the body of the pole should be as upright as possible, to give it the strongest position.

Tying up the Bines.—Whenever the bines shoot to a length to be fastened, they are tied to the poles. In some seasons when the bine comes very early the coarser bines are pulled out. Three of the best bines are selected to be tied to each pole, and the rest are cut away. Withered rushes are used for tying; and the tie is made with a slip-knot, so that the tying may give way as the bines enlarge in diameter. The tyings are done from near the ground up to 5 feet above it, and when above that height ladders are used, which stand independently upon the ground. The tying begins about the end of April. From 18 inches to 2 feet of the lower end of the bines may be stripped of their leaves, to allow air to get to the crown of the roots.

Substitutes for Poles.—There are other methods of poling hops, but these have not come into general use in this country. In Germany wire is extensively used as a substitute for poles, and this seems to be both economical and efficient.

Longevity of the Hop.—The power of some hop-grounds to produce a great crop year after year, when external circumstances are favourable, is extraordinary. Many grounds have borne crops for upwards of half a century, and some exceed in age an entire century. It must not be supposed from this, however, that any plant which had been planted at the formation of the ground remains alive such a length of time. Whenever a plant or an entire "hill" indicates symptoms of decay, it is removed, and another substituted; care being taken to plant the same kind of hop as that cultivated in the ground.

Insect and Fungoid Attacks.

The hop is unfortunately subject to serious injury from various insects and fungi. As to these attacks, see the chapter on the subject in this volume.

Harvesting Hops.

Picking.—The harvesting of hops is really autumn work, yet the brief description to be given of the process may be conveniently introduced here.

Hop-picking usually begins about the last days of August or the first week in September. The picking is a tedious process, demanding the employment of a great number of hands. As a rule the picking is done by bands of immigrants, men, women and children, who wander to the hop-growing districts from large towns and villages. The process generally extends over three weeks, and the immigrant pickers live in extemporised villages, in huts, hopper-houses, or tents provided for the purpose.

The process of picking is thus described by Mr Charles Whitehead, who has done much by his writing to improve the practice of hop culture¹:—

"The pickers are divided into companies of eight or ten, each of which is under the charge of a ganger or 'binsman,' who pulls up the poles for the pickers with wooden levers having iron teeth, called 'dogs,' and holds the 'pokes,' or sacks, or 'sarpliers,' for the measurer when he comes round to measure the hops that have been picked. In most cases the bines are cut about 2 feet from the ground, and the poles are pulled by means of 'dogs,' or wooden levers with iron teeth, and carried to the pickers, who pick the hops from them into the bins or baskets. Occasionally when the hops are not quite ripe, or when the plants are weak, the poles are not pulled, but left standing. The bines are cut 4 or 5 feet high, and the bines with hops upon them are pushed up and over the poles with forked sticks, as bines cut high and kept to the poles in an upright position do not 'bleed' so much, or lose so much sap as when cut short and left lying on the ground. The hop-grounds are marked out into as many

¹ *Jour. Bath and West of Eng. Agric. Soc.*, 1881, 208.

portions or 'sets,' containing 100 hills, as there are companies, for which lots are drawn by each binsman, so that there may be no wrangling about good or bad sets. The hops are picked into bins—long light wooden frames with sacking bottoms. There is one of these for every two adult pickers. In Mid and West Kent and the Weald of Kent and Sussex, and in Worcestershire and Herefordshire, these bins are used. In East Kent large baskets are used for picking into, holding 15 to 20 bushels. In Hampshire and Surrey the hops are picked into baskets holding 7 bushels, which are emptied into long bags, called 'sarpliers,' holding 14 bushels, in which they are taken to the kilns. In Kent, Sussex, Worcestershire, and Herefordshire the hops are measured into pokes—sacks holding 10 bushels—in which they are taken to be dried. The measurer, who generally takes from six to eight companies, is accompanied by a boy, who enters the number of bushels picked into a book kept by each picker, and into a book retained by himself.

"The *price* of picking hops ranges from 1¼d. to 3d. per bushel. The average price is 2d. per bushel. Binsmen are paid from 2s. 4d. to 3s. per day. Measurers get from 4s. to 5s. per day. Driers, who work night and day, earn from £2, 10s. to £3, 15s. per week. Before picking commences, the planter generally fixes a price for picking. Sometimes it is not fixed until after a day or two, that it may be better ascertained how the hops come down."

Drying Hops.—Immediately on being picked, hops are artificially dried. They are dried in square or circular kilns, 16 or 18 feet square or in diameter, on haircloth, and heated by Welsh coal, coke, or charcoal. The kiln-floor is situate at 10 to 13 feet above the fire, and the height of the kiln is 18 or 20 feet above the kiln-floor, surmounted with a cap-cowl 7 or 8 feet in height and 3 or 4 feet diameter in the bottom, a free circulation of air being kept up through the fire and hops to the top of the kiln. The hops require to be rapidly dried to keep the pickers in operation. The kilns ought to take 1 bushel of green hops on 1 square foot of flooring, and be filled twice a-day, giving from 9 to 12 hours to each kiln-

ful, so that from 200 to 250 bushels may be drying on one kiln at a time.

For two kilns of these dimensions, a cooling-room of 20 feet in width and 40 feet long is required. This should be on a level with the kiln-floor. And there should be another room of similar dimensions, under the cooling-room, for stowing and weighing the hops in the pockets.

Great caution is required to regulate the fires of the kilns. If too strong at first, when the hops are naturally moist, they will be drawn down to the haircloth and be much deteriorated in quality. The fire may be increased as the drying proceeds, and be pretty brisk near the last; but the heat should not much exceed that of 140° to 150° Fahr.

Hops shrink in bulk as they are drying. About 13 cwt. of coal, with a little charcoal, will dry one ton of hops.

Sulphur is also used in drying hops, from ¼ to 1 cwt. to 1 ton of hops. The object of using sulphur is to improve the colour of the hops. It is of importance to the seller to present his hops in the market with a light-coloured delicately greenish hue.

When taken from the kiln, the hops are laid in heaps on the cooling-floor, not only to cool, but to acquire a state of adhesiveness, which, though dry, causes them to lump together when squeezed in the hand, and yet not so much as to lose elasticity. This is an important point in preparing hops for packing, for if they are not sufficiently dry they will rot, and if too much dried they will become brittle, break into pieces, and be unsaleable.

The drying will cause a loss equal to about three-fourths of the weight in a green state—giving 1 lb. of prepared for 4 lb. of green hops.

Pocketing.—Hops are put into pockets in the stowing-room, through an opening in the floor of the drying-room, under which the pockets are suspended.

A *pocket* is 3 feet wide and 7½ feet long, consisting of 5 yards of cloth, weighing 5 lb., and contains 1 cwt. 2 qrs. and a few pounds gross weight of hops.

Hops cannot be too firmly packed in the pocket, and powerful screw-pressing machines are employed for the purpose. These presses, which are formed upon one principle, differing only in detail, are thus described by Mr Whitehead:—

"A wooden circular foot, just large enough to go into a pocket 3 feet in diameter, is fitted to a ratchet lever, which is worked up and down by handles. This is fixed immediately over the 'pocket hole' cut in the floor. The empty pocket is fastened to a movable frame or collar, so as to keep its mouth firm to the floor while it is being filled, suspended in mid-air. There usually are two posts set up below, into which two rods, connected with a wooden stand, run up to hold the pocket up and to keep it straight. In place of these guiding rods, some pressers have circular iron cases to surround the pocket and keep it from bulging. Pressers cost from £14 to £27."¹

The pocket is neatly sewn up, leaving a lug, or ear, projecting from each side of the sewn mouth.

The produce is then ready for the market.

Stacking Poles.—When the bines are cleared of the hops, they are taken off the poles, which are then put up in small conical stacks at equal distances apart on the hop ground, with the sharpened ends on the earth, having four equidistant divisions striding over the "hills." Each division of the stack should be bound round with three bines, deprived of their leaves and twisted into a rope, which binds the division close and compact, and prevents the poles being stolen, or makes a theft more easily detected. The small refuse poles are bound together, separating those which may be used for the young bines of the first year from those which may be burned into charcoal, or used as firewood.

The Hop Plant.

The hop, *Humulus lupulus*, belongs to the class and order *Dioecia Pentandria* of Linnæus, natural order *Urticaceæ*. Some plants have male flowers and others female flowers. It is generally believed that the hop was introduced into this country in 1524; but in *Notes and Queries* it is stated that in one of the covenants of a lease, granted in Kent in 1463-64, it is specified that the tenant shall receive "evry yere duryng the terme, an acre of wode competent and

of the best fewell, exceptes Hope tymbere."²

Varieties of Hops.—No fewer than about 160 varieties of hops are said to be in culture throughout the world. In this country only a small number are in regular cultivation, the principal of these varieties being—Goldings, Bramblings, Grapes, Jones, Farnham Whitebines, Mathons, Cooper's Whites, Fuggles, and Colegates. The Golding is generally acknowledged as the best variety in this country, but for certain localities other sorts are more suitable.

The selection of the most suitable variety for a given locality and soil requires considerable experience and good judgment. Whichever kind is chosen, it is desirable either to have only one variety within one hop-ground, or the varieties separated in the same ground. Different varieties require to be pulled at different times. It is desirable, in choosing different varieties, to have them to ripen in succession, in order that the hops may not all be ready for picking at the same time.

Male and Female Hops.—The male and female being on separate plants, there has been a good deal of discussion as to the necessity or desirability of planting male plants so as to ensure fertilisation. It is contended by many that there should be at least one male plant on each acre of hops. But in practice no attention is paid to this. The male plants, Mr Whitehead says, are generally grubbed up, and the fertilisation of the female plants left to chance.

Ash of Hops.—The composition of the ash of hops was found by Nesbit to be as follows:—

	Golding Hop.	Yellow Grape Hop.
Potash . . .	24.50	18.61
Lime . . .	15.56	23.75
Magnesia . . .	5.63	6.13
Phosphate of iron . . .	7.26	6.79
Sulphuric acid . . .	5.27	4.16
Phosphoric acid . . .	9.54	5.26
Carbonic acid . . .	2.61	3.36
Chloride of sodium . . .	7.05	3.18
Chloride of potassium . . .	1.63	2.21
Manganese . . .	...	1.59
Silica . . .	20.95	24.96
	100.00	100.00
Percentage of ash . . .	9.90	15.80

¹ *Jour. Bath and West of Eng. Agric. Soc.*, 1881, 214.

² 2d Series, ii. 276.

The quantity of mineral matter removed from the soil per acre by the different parts of the Golding hop plant is, according to Way and Ogston:—

	Flowers.	Leaves.	Bine.	Whole crop.
	lb.	lb.	lb.	lb.
Silica . . .	32.6	97.3	12.9	142.8
Phosphoric acid . . .	29.5	40.6	15.1	85.2
Sulphuric acid . . .	8.7	8.2	3.0	19.9
Carbonic acid . . .	3.4	52.4	15.4	71.2
Lime . . .	16.3	134.0	31.0	181.3
Magnesia . . .	8.2	21.1	4.9	34.2
Peroxide of iron . . .	1.1	0.8	1.0	2.9
Potash . . .	54.0	57.0	22.9	133.9
Soda . . .	...	...	...	...
Chloride of potassium . . .	15.3	10.0	19.9	45.2
Chloride of sodium . . .	1.3	13.6	3.4	18.3
Total . . .	170.4	435.0	129.5	734.9

The hop plant is peculiar in the quantity of phosphoric acid required for all its different parts: in this respect it far exceeds any other plant which we have examined. It may not be without reason, therefore, that the value of land which is devoted to hops has been referred to the great prevalence on it of the phosphate of lime. The chemical history of the greensand district is such as to bear out this view.¹

The composition of the ash of the flower of the hop, according to the analysis of Frederick Eggar, is:—

	Golding Hop.	Yellow Grape Hop.	Mean of analysis in 1 ton of hops.
			lb.
Potash . . .	24.88	25.56	29 5
Lime . . .	21.59	18.47	27 5
Magnesia . . .	4.69	5.27	7 5
Peroxide of iron . . .	1.75	1.41	2 4
Sulphuric acid . . .	7.27	11.68	12 3
Phosphoric acid . . .	14.47	17.58	25 2
Carbonic acid . . .	2.17	4.54	...
Chloride of sodium . . .	3.42	1.12	2 1
Chloride of potassium . . .	...	4.34	4 6
Silica . . .	19.71	9.99	25 0
	99.95	99.96	136 1

Percentage of ash, }
calculated dry } 5.95 7.21²

Spent Hops as Manure.—As spent hops are used for manure, the analysis of their ash, by Nesbit, may prove instructive:—

Potash . . .	1.45
Lime . . .	23.70
Magnesia . . .	2.75
Phosphate of iron . . .	2.50
Sulphuric acid . . .	3.05
Phosphoric acid . . .	4.10
Carbonic acid . . .	9.00
Chloride of sodium . . .	2.95
Chloride of potassium . . .	0.70
Silica (soluble) . . .	27.10
Sand and charcoal . . .	21.80
	99.10

Percentage of ash 10.40

Cost of Hop-planting.—The planting of hops is very costly. Mr Charles Whitehead, writing in 1881, states that "the cost of raising one acre of hop-land, taking the average of all the hop districts in the kingdom, is £25," made up in the following manner:—

Ploughing, subsoiling, and preparing the land . . .	£3 0 0
Manure, 30 loads at 5s. 6d. . .	8 5 0
Setting out and digging holes 2600 sets, at 3s. . .	1 5 0
Planting . . .	3 18 0
Nidgetting and summer cultivation . . .	0 8 0
Stakes or poles and setting . . .	2 0 0
One year's rent, tithes, and taxes . . .	1 10 0
	4 14 0

Total cost of raising an acre of hop-land . . . } £25 0 0³

Cost of Hop Cultivation.—Mr Whitehead gives the following as fairly representing the average cost per acre of cultivating an acre of hops in full plant:—

Manures, including winter and summer dressing, carting, and spreading . . .	£7 0 0
Digging, or ploughing and digging . . .	1 1 0
Dressing . . .	0 6 0
Poling . . .	0 14 0
Tying . . .	0 13 0
Pulling bines, and earthing . . .	0 4 0
Ladder tying . . .	0 5 0
Keeping land clean round hills . . .	0 7 0
Nidgetting and harrowing . . .	1 15 0
Annual average supply of poles . . .	4 15 0
Stripping, stacking pole, and making bines . . .	0 12 0
All expenses of picking, drying, selling an average crop of 7 cwt. per acre . . .	12 0 0
Rent, rates, tithe, taxes, repairs of oasthouse, interest . . .	7 0 0
Total . . .	£36 12 0 ⁴

¹ *Jour. Eng. Agric. Soc.*, xi, 515.

² *Ibid.*, ix, 145.

³ *Jour. Bath and West of Eng. Agric. Soc.*, 1881, 218.

⁴ *Ibid.*, 218.

Sulphuring and washing for blight would increase the cost in the former case from £1 to £3 per acre; and in the latter from £2 to £5 per acre.

Produce of Hops.—The produce of hops of course varies greatly with the seasons both as to quantity and quality. The average may be given at from 6½ to 7 cwt. per acre.

Price of Hops.—This varies remarkably, so great indeed as to invest the history of hop-growing with something of a romantic character. It has been as high as £30 per cwt. even as recently as 1882, but the importation of foreign hops, which rose from 24,662 cwt. in 1855 to 266,952 cwt. in 1885, has brought the price to a much lower level in recent years. The average has lately been frequently under £5 per cwt.

Hop-growing Risky.—The speculative, and therefore risky, character of hop-growing is well described by Mr Charles Whitehead, who says: "Hop-growing, even in the best districts, is a speculative business. There are men here and there who have made much money; but there are, on the other hand, very many who have lost much, and very many who are in pretty much the same position as they were twenty, or forty, or sixty years ago, when they began hop-growing, after having had the intense anxiety and worry which no one who has not had the experience of the changes and chances of this fickle crop can in any degree realise. No one who values peace of mind should cultivate hops, nor should any one who has not capital enough to 'stand the racket' of at least two bad seasons go into this business. Hop cultivation cannot be re-

commended to farmers who are trying to discover some culture likely to pay, or, at least, not to farmers in districts where hops have not before been tried, as besides the amount of capital that is requisite and the uncertainty of the crop, the demand for hops is limited strictly by the consumption of beer, and the competition of foreign countries is great. In seasons when hops are dear, substitutes, as quassia, for example, are used to a considerable extent, and the importations from Germany, France, Belgium, and the United States prevent prices from rising to famine point, as in the halcyon days when hops were worth £25 per cwt., and a small crop was hailed with satisfaction. The fluctuations in the acreage of hop-land show the uncertainties of this culture. Since 1878, for example, the acreage decreased from 71,789 acres to 64,943 acres, a decrease of 6846 acres. Since the duty was repealed in 1862 there have not been such sudden fluctuations in the acreage, as, for example, in the period between 1847 and 1849, when the acreage was reduced by 9530 acres; or between 1855 and 1857, when nearly 7000 were grubbed. These reductions, it need hardly be said, involve the loss of a great deal of capital, and are only made when it has become impossible by reason of bad seasons for planters to find money to work their hop-land properly."¹

Since Mr Whitehead wrote the above in 1881, the fluctuations in the acreage of hop-land have been considerable. Then it amounted to 64,943 acres, and rose to 71,327 acres in 1885. Since that date it has rapidly decreased, and now (1889) stands at 57,750 acres, the lowest point since 1866.

SOWING TURNIPS.

Advantages of the Turnip Crop.—The turnip crop plays a great part in British agriculture. For the light land in the northern districts of the British Isles, where the climate is too cold for the sugar-beet or even the mangel crop, the turnip crop is of primary importance. It enables the farmer to

clean and fallow his land, and at the same time to grow an immense quantity of nutritious cattle food, even from poor light soil. It has been said that the greatest improvement in arable land farm-

¹ *Jour. Bath and West of Eng. Agric. Soc.*, 1881, 220.

ing during the last hundred years is due to the introduction of the turnip crop into the rotation; thus providing, as it did, a cleaning and fallowing crop, and obviating any necessity for a bare fallow on light soils, and enabling the farmer, during the winter months, to keep a number and quality of cattle formerly impossible.

The turnip crop has, to a large extent, given to Scottish agriculture the eminence it has attained, and it has made the eastern half of Great Britain the greatest cattle-feeding district in the world. If properly managed, the crop is a moderately reliable and valuable one on the lightest and shallowest of soils; and although in some cases it has been too often repeated on the same land, whereby inferior crops and destructive disease have been produced, its introduction has been of immense advantage, and its place in the rotation cannot be filled so well by any substitute which has as yet been tried.

On stiff clay soils its cultivation is not of so much advantage. The cost of reducing these to a proper tilth for the seed is great, and if the weather is either too wet or too dry, the crop is precarious and uncertain. Then clay land is liable to be injured either by carting the roots off the land or by the treading of sheep in consuming them upon it.

Unlike the potato crop, the turnip crop is usually consumed on the farm, and the unappropriated matter returned to the soil. In properly constructed farmeries there should, therefore, by the growth and consumption of roots, be comparatively little waste of manurial elements, and consequently little exhaustion of the land.

Turnip-growing may be Overdone.

—The serious injury which the turnip crop has so frequently in recent years sustained from insect and fungoid plagues, together with the heavy costs involved in its cultivation, have somewhat weakened the hold which it obtained on the affections of the British farmer. The decline in the price of grain has also tended, indirectly, to lessen the area under turnips. It has been contended, with a good show of reason, that the unfavourable experience with the crop has been in a large measure due to an

attempt to grow roots upon the same land too frequently—that is, with too short an interval between the successive crops of roots. In speaking of the fungoid attacks upon roots, further reference will be made to this point, of the too frequent recurrence of the crop on the same land. Here it will suffice to say that it has been clearly proved that the growing of roots, like most other things, can be easily overdone, and that the results of an indiscretion with this tendency may be almost disastrous.

With this qualification, there are few who would not indorse what is said above as to the advantages of the turnip crop and the part it has played in building up the fabric of British agriculture.

Varieties of Turnips in Use.—In vol. i. pp. 160-169, some information will be found as to the varieties of turnips. The varieties now in use are very numerous. Of the Swedish turnip (*Brassica campestris, rutabaga*) there are over 20 field varieties, more or less widely cultivated; and of the common turnip (*Brassica rapa*) and hybrids there are more than 50 varieties in cultivation.

Swedes.—The Swedish turnip has a blue-green smooth foliage. It is a comparatively slow-growing plant, and therefore requires to be sown earlier than the common turnip. It requires for its successful growth, and will resist without injury, a greater degree of heat; is less watery; of harder texture; will stand several degrees of greater cold without injury; and will keep longer than the common turnip. The bulbs of some of the varieties are green-topped; some are purple or bronze-topped. The purple-topped varieties are usually more or less tankard in shape, and thus stand farther out of the soil. In consequence, they are more apt to be injured by severe frosts, and should be lifted and stored early. From their habit of growing well out of the ground, they are thought to be better suited for shallow soils than the green-topped varieties, the general shape of which is globular. The bulbs of the latter are more deeply seated in the ground, and are thus better protected from winter frosts.

Common Turnips.—The *Brassica rapa*, rough-leaved summer rape, or turnip, has rough foliage of a more decided

green colour. The yellow-bottomed varieties are looked upon as a cross between the swede and the white turnip. They grow more rapidly than the *Brassica* swede, and come to maturity sooner. They may therefore be sown successfully much later. They will grow on a poorer soil, and in a colder climate. The bulbs contain less solid matter, are more easily injured by hard frosts; they should therefore be used or pitted sooner than is necessary for swedes.

The varieties called *hybrid* are a cross between yellows and white varieties, and are usually soft in flesh, tankard in shape, and ill adapted for resisting hard frosts. The white-bottomed varieties are even more rapid in growth, more soft in texture, more easily injured, and more watery than the yellow-bottomed varieties.

Some varieties of the yellow-fleshed are green, some are purple-topped. The white-fleshed varieties are white, green, grey, purple, or red-topped. The latter are now but little cultivated, while the area occupied by the Swedish varieties is steadily increasing.

Produce of different Varieties.—Experiments, purposely conducted to test the point, and general experience in turnip culture, have shown clearly that there is a very wide range in the productive powers, not only of the various kinds of roots, but also of each individual variety, propagated and grown under different conditions. In the midland and southern counties of England the crop of swedes generally runs from 12 to 18 tons per acre; in Scotland, Ireland, and north of England, from 18 to 30 tons. Common turnips may give from 1 to 4 or 5 tons more per acre. Often, indeed, the extremes are still greater.

Much of course depends upon soil and climatic conditions, which are beyond the control of the farmer, and still more perhaps upon the system of culture, which is almost entirely within his direction; yet it is unquestionable that, by selecting sorts which have been distinguished for abundant production upon the different classes of soils, the yield of the crop may be sensibly increased. In regard to the feeding and keeping properties of roots, the same remark holds good. With turnips, as with all farm plants and

animals, the selection of the sorts best adapted for the surrounding conditions and the purposes in view, is a point which demands, and will repay, the most careful attention from the farmer. Indeed it is a point which the farmer who would be successful cannot afford to overlook or disregard.

Climatic Influences on Turnips.—The turnip has a moderate range of temperature. A summer isotherm of about 56°, with a moderately moist atmosphere, is the most favourable. Before getting into the rough-leaf stage, it is easily adversely affected with night frosts. These, with hot scorching days, such as are frequently experienced in the end of May and first half of June, are very inimical to the young turnip in its cotyledon stage, and often cause its destruction, and necessitate resowing.

Insect Attacks.—This condition is generally aggravated by the attacks of insects, such as the turnip-beetle (*Haltica*) and several kinds of weevils (*Curculio*), that puncture and nibble at the seed-leaves, which in dry weather tends to kill the plant from bleeding or drying up. At this stage insects seldom do much harm if the weather is damp, and the nights free from frosts.

Distribution of the Turnip.—The turnip is therefore a plant whose constitution is eminently suited to the damp and comparatively cold climate of the British Isles. The crop indeed reaches its most certain and highest development in the northern parts of the islands. The cool climate of Caithness, Orkney, and even Shetland favours its bulb growth. In the Hebrides it grows well, the damp air causing increased luxuriance of top.

In the south of England the turnip is often a failure in dry seasons. The hot dry winds occasionally experienced there are liable to kill the plants in the early stages, and to cause stunting, and sometimes mildew, if the growth is farther advanced. There, in some seasons the plant has a struggle for days and weeks with dry warm winds and a parched soil, and makes little progress until the shorter days and cool nights of autumn set in.

The turnip thrives in a temperature too cold for the profitable cultivation of cabbage, kohl-rabi, or mangels. These

in the British Islands do best in moderately dry warm seasons. Among grain crops, the oat luxuriates in a climate similar to what is required for the growth of turnips, and wherever heavy, well-filled oats can be grown, there the cultivation of the turnip will succeed.

Turnips in Foreign Countries.—The crop is cultivated in large breadth only in the British Isles. On the continent of Europe, if we except some parts of Denmark, the breadth of it is quite insignificant. In southern Europe maize is the chief forage crop. In middle and northern Europe the sugar-beet and potato take the place of the turnip in stock-feeding. In the older settled parts of Canada turnips are grown to some extent. The soils of Quebec and Ontario are generally highly suitable, but the summer is rather dry and warm for the turnip, and in consequence the average weight is only about two-thirds that of the British Isles, while the severe winter compels early storing in cellars. In New Zealand turnips are grown for sheep-feeding, and to save labour the seed is usually sown broadcast, and allowed to grow without thinning. In Victoria, Australia, the cost of labour has operated against the cultivation of turnips. The summer is too dry, but very promising and heavy crops, up to forty tons per acre, have been grown during the winter months.

Soils for Turnips.—The soils most suitable for turnip cultivation are those of a light friable description. The fine state of division to which these can be readily reduced favours the germination of the small seeds. On such soils cultivation is easy, and they also suit the habits of the plant, which spreads its roots like a network into every part of the soil.

Alluvial and sandy soils are the best for the turnip plant. Next come the lighter soils formed from trap or volcanic rocks, and the lighter soils resting on Silurian, Cambrian, Devonian, granitic, and New Red Sandstone rocks.

Clay Soils Unsuitable for Turnips.—The soils least suitable are the clays, from whatever derived. The London, Oxford, and Kimmeridge clays being especially stiff, are not well suited for turnip cultivation, partly from the great

difficulty in securing a braird among the rough particles in dry seasons, from the hardness of such soils preventing the free spreading of the roots, and from the absorbed and retained water injuring the roots in wet seasons. On the stiffer clays, which occupy a large area in the southern part of England, the cultivation of the crop is so precarious that it cannot be profitable in the average of seasons, although good crops are occasionally grown. Were it not that the working of the land for the crop acts upon the soil similarly to a bare fallow, its cultivation on these soils would not be attempted to any considerable extent.

TILLAGE OF TURNIP LAND.

Variety of Systems.—The system of tilling land so as to prepare it for the turnip crop necessarily varies greatly upon different classes of soils, and in the different parts of the country. The condition of the land as to foulness or freedom from weeds has likewise to be considered in deciding upon the system of tillage likely to be most effective and economical.

It has also to be remembered that in many farming operations there are variations in local customs, for which there is no apparent or sufficient explanation beyond the simple influence of long-continued usage. In regard to most branches of farm-work, it is assuredly true that there are several ways of doing the same thing,—several methods by which the same piece of work may be accomplished, and this, too, with almost equal efficiency, and with little difference in outlay.

That teaching which would seek to inculcate the idea that any one way is *the* right way and the *best* way, and all other methods wrong and inferior, is essentially narrow and unsafe, arising most likely from limited experience or a dogmatic spirit—or from both; for there is a close kinship between dogmatism and limited knowledge. The more one sees of the detail-work of farming in the various divisions of our own country and in foreign lands, the less inclined one is to dogmatise, the more indeed is one impressed with the almost infinite variety of methods and practices which farmers

may, with prudence and good results, pursue in the prosecution of their calling.

The introduction of these remarks at this particular point has been suggested by the fact that in his observations as to the methods of root culture in nearly every corner of the British Isles, and in foreign countries as well, the editor of this work has noted with special interest the almost endless variety in the details of practice. In perusing the remarks which follow as to the system of preparing turnip land, and in contrasting the practices described and recommended with different practices which may prevail in certain localities, it should therefore be borne in mind that it is not presumed by us that the methods described here are the only methods worthy of description and commendation. Indeed we will go further, and suggest that any farmer who has been moderately successful with methods different from those described here should think well before introducing a change, doing so at first only to a small extent, and in an experimental way. To describe all the good systems of root culture is out of the question. We, however, set forth the details of certain methods which we know to be pursued with success in different parts of the country.

Soil, Climate, and System of Tillage.—The character and condition of the soil are of course the main considerations in determining the system of tillage. Stiff clay land requires very different treatment from light friable soil. The former must not be touched in wet weather, or while it is in a very wet condition. The latter is much less liable to injury from unseasonable working.

The climate is also answerable for variations in systems of tillage. The comparatively mild open winter of the southern and lower-lying parts favours autumn and winter tillage. In the higher-lying and colder districts, with their severer winter, much of the tillage work must be delayed till spring.

Prevailing System.—The system which prevails most largely in the principal turnip-growing district of this country, is to plough the land with a strong furrow in the autumn or winter, allow it to lie in this condition under the disintegrating influences of winter, and in spring clear it of weeds and reduce it to the desired

condition for the reception of the manure and the seed. Unless the land happen to be exceptionally foul, or is of a strong clayey nature—in which cases other methods to be explained presently may be adopted—this system of autumn or winter ploughing and spring cleaning and manuring answers admirably for the turnip crop.

Normal Conditions.

In the first place, we will describe the process of preparing land for turnips, under what may for convenience be called *average or normal conditions*. By this term is meant land well, or at least moderately well, suited for turnips—heavy clays excluded; in average condition as to weeds, fertility, and drainage, and with average weather.

Exceptional circumstances will receive treatment subsequently.

Autumn and Winter Ploughing.—Turnips almost invariably follow a grain crop. As soon as practicable after the completion of the grain harvest, the stubble land intended for roots next year is—unless very foul—ploughed with a deep strong furrow, varying in depth according to the character and depth of the total surface-soil from perhaps 10 to 14 inches—rarely over 12 inches. In deep ploughing care has to be taken not to bring to the surface more than a very small quantity (if any) of the subsoil at one time. Many subsoils contain matter which is positively injurious to vegetation, and which, if mixed freely with the surface-soil, may for a considerable time have a deleterious influence on the crops. If the land be strong loam, it may be advisable to yoke three horses in the plough. When the land is very steep, and it is desired to run the furrow up and down the incline, the plan of going up-hill empty and taking a strong furrow down-hill is often resorted to. With this method no feerings are required after the first side furrow, as all the ploughs follow each other at convenient intervals in the one furrow.

A good deal of time, however, is unavoidably wasted by this plan, and farmers generally contrive to get a furrow each way by running the plough so to avoid the direct line of the incline. For ploughing with a strong furrow in

steep land the one way, ploughs described and illustrated in vol. i., pp. 117, 118, are very useful. With the one-way plough the furrow can always be thrown downhill, which of course lightens draught greatly.

In this strong furrow the land lies over winter, deriving much benefit from the frost and snow to which it is thus freely exposed.

Spring Tillage.—In average seasons the land intended for turnips, which has been ploughed in autumn or winter as just described, may probably not be touched again until the sowing of the grain crops has been completed. The spring working of the turnip land is usually begun in April, but the greater portion of it will most likely have to be gone through in May, some of it perhaps even later.

The extent and nature of the spring tillage will depend upon the character and condition of the land and the state of the weather. For even in what may still be called normal or average conditions, there are many variations which demand the careful consideration of the farmer.

Ploughing or Grubbing.—Most likely one spring ploughing will be sufficient, this time with a moderate furrow, perhaps from 6 to 9 inches deep. Many farmers now prefer to stir the land with some kind of strong iron-toothed implement of the grubber kind; or it may be a half-plough, half-grubber,—an implement having a mould-like sole, and iron spurs instead of a mould-board.

Whether it is advisable to plough the land, or only to drag it with a grubber or cultivator, will depend upon the kind of soil and the weather at the time. If the subsoil is very hard, the plough will pierce and loosen it more effectively than the grubber or cultivator. If the season is wet the plough is preferable, as much less injury is inflicted by the treading of the horses in ploughing, unless the grubbing is done by steam-power, which is very effective, if not done too deeply.

The cultivator gets over the land much more quickly than the plough. But if the soil is stiff or full of weeds, a second turn after harrowing and gathering will be necessary. By the use of the cultivator

the fine surface-mould produced by the winter frosts will be kept nearer the surface, and will make the germination of the turnip seed more certain. In stiff soils fewer of the large clods will be brought to the surface; in dry weather less evaporation from the surface will take place, and the success of the crop will be more assured.

Diggers and Cultivators.—Some of the implements intermediate between the ordinary cultivator and grubber and plough perform excellent work in the preparation of turnip land. The digger brought out by Messrs Barclay & Sellar, and manufactured by Messrs George Sellar & Son, Huntly, represented in fig. 345, is a good sample of these implements. This digger has coulter and shares just like a plough. The breast or mould-board, however, is totally different, inasmuch as it is made in two halves. The upper half turns the furrow-slice similarly to the plough. The lower half, being turned at an angle to the passage of the furrow, cuts off the under surface as it passes over, and allows it to fall loosely into the bottom. The effects produced are thus a combination of the plough and cultivator.

This digger may be used for other purposes besides preparing turnip land in spring.

Used on stubble land it pulverises the soil to a good depth, and turns only the upper few inches, thus exposing the roots of weeds which lie near the surface to the winter's frost, and leaving the soil thoroughly broken up. Amongst land after turnips it also does good work. While pulverising the soil it does not turn it over, and expose the dung, as is often done by the common plough.

Further reference to the use of the grubber or cultivator will be found in page 203 of this volume—vol. ii.—where illustrations will be found of Clay's cultivators.

Pulverising Ploughs.—By the attachment of revolving prongs, ploughs are made which, at the one operation, plough the land and pulverise it, throwing most of the weeds on to the surface. An excellent implement of this kind is that represented in fig. 346, made by T. Corbett, Shrewsbury.

Disadvantages of Grubbing.—The

drawbacks to grubbing are the putting down of the weeds by the hoofs of the horses, which press some of them beyond the grasp of the harrows following; and the hardening of the sub-soil due to the pressure of the horses' feet. Both these are points of some importance, yet grubbing or cultivating is on the increase.

Harrowing Turnip Land.—Whether ploughed or stirred, the land must be afterwards harrowed, the weeds picked off, and the large stones, if any, gathered.

If the weather permit, harrowing and rolling must be continued until the clods are reduced, and a fine mould formed.

Removing Weeds.—The harrowing brings the weeds loosely to the surface. Chain-harrows are frequently used to collect the weeds into heaps, and so are horse-rakes, the work being concluded by hand-rakes and forks, or graips. Hand-picking is preferred by many farmers, and is of course the most thorough system. The weeds may be burned in heaps on the field and the ashes scattered

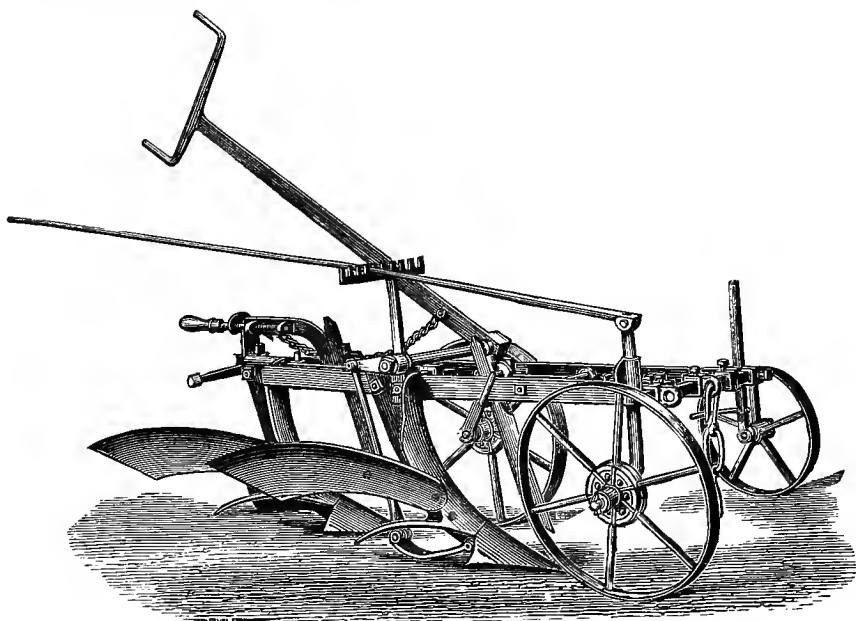


Fig. 345.—Barclay and Sellar's patent digger or cultivator.

around, or carted to some convenient corner to be united with lime to form a compost-heap. In the latter case care must be taken not to spread the compost on the land until the vegetable matter in it has been thoroughly decomposed.

Exceptional Conditions.

In soils well suited to turnips, and kept in good heart and condition as to cleanliness, the foregoing process of tilling and cleaning will most likely be sufficient to prepare the land for the sowing or laying down of turnips, as it is often termed.

But there are many circumstances

which render deviations from the prevailing system necessary or advisable. For instance, stiff clayey land, land which is excessively foul, and land unusually free from weeds, all receive peculiar methods of treatment. Again, the land may be both stiff and foul, and in this case still another plan will be adopted. The questions as to whether the roots are to be sown in drills or on the flat, and at what time the farmyard dung is to be applied—whether in the autumn or winter, on the flat in spring, or in drills at sowing-time—are also responsible for variations in the preparatory work.

Preparing Foul Clay Land.

This is often a serious undertaking. No progress can be made with it in wet weather. Indeed, any attempt to cultivate or clean clay land when it is in a wet condition must inevitably result in failure. Far better let men and horses remain idle than allow them to work stiff clayey land unseasonably. In this condition the more it is worked the greater is the injury inflicted.

When therefore the farmer has before him the unenviable task of having to clean a stiff clay land which is in very foul condition he must watch the weather carefully and seize every suitable day for the purpose.

Autumn Cleaning.—For cleaning

land of this kind the autumn is the best time—that is, if the weather should be favourable. Begin the work as soon as the grain crops are secured. The first operation will either be the cultivating (or grubbing) or the ploughing of the land with a shallow furrow,—a furrow just deep enough to turn over, but *not to bury*, the weeds. The depth of the first furrow is indeed regulated mainly by the character of the weeds, whether they are deep-rooted, creeping, or surface weeds. Some of the surface-weeds may be killed by being buried with a deep furrow; but couch-grass, docks, thistle, knap-weed, and other well-known troublesome weeds, require more drastic treatment. Grubbing or dragging and harrowing follow ploughing, and if necessary to break

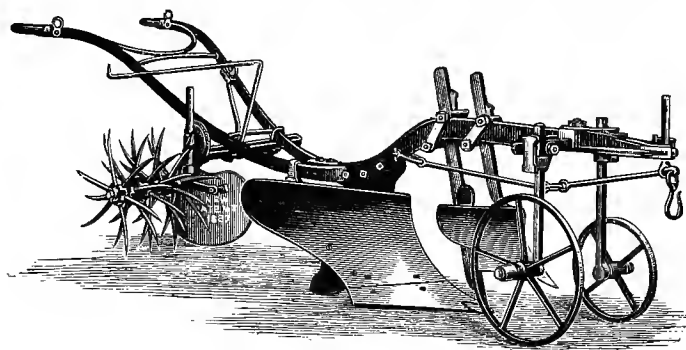


Fig. 346.—Digging and pulverising plough.

clods holding weeds, the land is then rolled, again harrowed, and the weeds collected and burned or carted away.

A Second Crop of Weeds.—An examination of the land may reveal the fact that it is still far from clean. In this case the whole process should, if the weather permit, be at once again gone over. The ploughing may perhaps be omitted. The grubber or cultivator, followed by the harrows, will take the remaining weeds to the surface, and this time, in particular, it will be advisable to hand-pick the weeds, so as to ensure that all the little particles of couch-grass roots may be removed.

Do not Break Weeds.—Excessive tillage is liable to break these weed-roots into small pieces, each of which, if left, will form a centre of filth. It is there-

fore important to have the weeds brought to the surface with as little knocking about as possible.

Cross-cultivation.—The subsequent ploughing and grubbing are usually given at right angles to or in a slightly different line from the preceding. The object of this cross-cultivation is of course to ensure that all portions of the soil may be stirred.

Steam-power for Cleaning Clay Land.—For the cultivating and cleaning of strong land steam-power is very suitable. The steam-cultivators go over the ground quickly, and they can be as easily regulated as to depth as implements for horse-labour.

Half-ploughing.—Land which is *excessively foul* is sometimes cleaned by another process,—a piecemeal method

known as break-furrowing, raftering, or half-ploughing. Only half the surface is at once disturbed, each furrow being thrown on to its own breadth of ploughed land. Harrowing and weed-collecting follow, and this fleece of weeds being removed, the strips of the land formerly undisturbed are then turned over by the plough, harrowing and weed-collecting completing the process. This is a tedious and costly process, which is not often adopted, and need not be resorted to except in such rare cases as where the land is so excessively foul that the entire mass of weeds in it could not be conveniently dealt with at one time.

This system is more frequently adopted for the purpose of killing surface-weeds. In this case the land lies over winter in the ridged-up appearance which the half-ploughing gives to it.

Autumn Dunging and Ploughing.

—Assuming that the weather has been sufficiently dry and free from frost to enable the farmer to complete in autumn and early winter the cleaning processes described above, the next step—with strong land intended for roots—will perhaps be to spread its allowance of farmyard dung and plough in this with a shallow furrow. This is the usual practice, and by far the best plan in stiff land of this kind, where the turnips are to be sown on the flat, and where there is a sufficient supply of dung ready in time for application before the last ploughing in autumn or early winter. The advantages of the autumn instead of the spring dunging of heavy land will be mentioned in dealing with the manuring of turnips. If the dung is not to be applied at this time, the land is turned over in a strong furrow before the rigours of winter fairly set in.

Spring Tillage of Strong Land.—The spring tillage of stiff clays intended for roots has to be carried out with the utmost care and caution. Clay is stubborn material, in the working of which the farmer, who has not before had practical experience of it, is liable to unwittingly commit errors, which may seem trifling at the time, but which may result in serious injury to the crop.

If the land has been cleaned and dunged in the autumn, the spring work is thereby greatly simplified. Lying over winter in a strong furrow the land

becomes pulverised and more easily prepared for the seed. In southern parts, where the winters are open, the spring tillage of this land is begun as early as possible—as early as January or February if the weather is sufficiently dry. It is then cross-ploughed at least once. Often, indeed, strong land is ploughed two or three times in spring, in the attempt to reduce it to that fine tilth which is so advantageous to the root-crop.

Grubbing or Cultivating in Spring.—Grubbing or cultivating is preferable to repeated ploughing in spring, for while the former leaves the finely pulverised soil on the surface, the plough turns this underneath.

By repeated harrowing, rolling, and grubbing or dragging, the rough strong land is reduced as finely as possible, and is thus prepared for the reception of the seed.

Preparing Clean Land.

When the land intended for turnips is in a cleanly condition, the preparatory tillage operations may be considerably lessened. As early as possible in the autumn or winter, the land, whether light or strong, is ploughed with a deep furrow or cultivated with a rank grubber. On strong clay land the dung—as much of it as is then made—is spread on the stubble just before ploughing.

In spring, strong clean land will require similar treatment to that just described in speaking of the preparation of foul clay land, which had been cleaned in the autumn.

Spring Tillage of Light Clean Land.

—But in the case of light land free from weeds, very little spring tillage may suffice. Indeed, such land may be allowed to lie in the winter furrow till the work of grain-sowing is finished. It may then receive a strip of the harrows across the winter furrow, be turned over once with the plough, or stirred by the grubber or cultivator, and again harrowed two or three times. In many cases this will be found sufficient; but if the tilth is not reduced as finely as desired, another turn of the grubber or cultivator and harrows may be prescribed, and with this the preparation will be completed.

Overworking Injurious.—Not un-

frequently injury is inflicted upon the turnip crop by the overworking of the land in spring. Turnips delight in a fine moist soil. The finer the soil is the better, but it must also be damp. In preparing turnip land, therefore, the farmer must strive not only to break down the soil but also keep in the moisture. This, as will be at once understood, is not so easy to accomplish. Repeated ploughing and opening up the land, late in spring and early in summer, encourages the escape of moisture. It is thus important that in dry districts the deep turning and stirring of the land should be done in autumn, winter, and early in spring, so that when the dry season has set in, shallow stirring and surface-scratching may be sufficient to provide the desired tilth.

The dissipation of moisture by spring tillage may be to some extent lessened by immediately following the ploughing or grubbing by harrowing and rolling.

Even in moderately moist climates this matter is deserving of more attention than farmers, as a rule, bestow upon it. Indeed it may be described as one of the cardinal points in successful turnip culture. The importance of retaining moist soil around the young turnip plant is perhaps the consideration which has been most powerful in maintaining the system of growing turnips on the flat in England.

Forking out Weeds.—A practice much pursued in England, with land not so foul as to require a special course of tillage to clean, is to send several workers over the stubbles in the autumn with graips or forks to dig out couch and other visible weeds. This is a good plan, likely to save after-labour in removing weeds.

It is the habit, indeed, of some particularly careful farmers, to send two or three labourers over the entire farm in this way, forking out any weeds to be seen, and giving special attention to head-ridges and sides of fences, which often form perfect nurseries for weeds.

Turnips on very Strong Clays.—In some cases in England, on very strong clays, which are by nature ill adapted for turnip culture, crops of swedes, which would delight the heart of any farmer, are occasionally grown. The main secret of success, in these instances, has nearly

always been the studied and careful preparation of the land. Such deep tillage and cleaning as the land receives are done in dry weather in autumn, when the dung is also put in. Then in some cases which we have known to be successful in an eminent degree, no further stirring of any kind is given to the soil till sowing-time, when, after a turn of the harrows, the seed is sown in rows on the flat.

This plan, of course, would not succeed in land containing many weeds; but on some of the strongest clays in England we have seen it carried out with the most gratifying results—upon land so strongly adhesive that it would sometimes exhibit in spring with little effacement the footprints made upon it by labourers five months before.

The chief difficulty in turnip culture, on strong clay land in a dry climate, is to obtain a strong regular plant. This is most effectually promoted by retaining the winter moisture in the soil. And the best method of conserving the moisture is to clean, dung, and plough the land in autumn, and stir it as slightly as possible after the advent of warm weather in the following season.

Still, when the farmer has done his very best, turnip-growing upon very strong clayey land will often fail. And while it is interesting and may be useful to record these instances of exceptional success, one cannot with confidence recommend the extensive culture of turnips upon such land.

Flat and Drill Systems of Sowing.

For some time at the outset turnips were without exception sown broadcast on the flat surface of the land. At one time, indeed, that was the universal custom with all farm crops.

Introduction of Drill Sowing.—For the introduction of that most serviceable system of drill sowing, we are indebted to Jethro Tull, whose writings, during the first generation of the eighteenth century, did much to promote the improvement of farm practice. In his book on 'Horse-hoeing Husbandry,' published in 1731, he advocated the system of drill-sowing wheat in narrow ridges. The success of the method attracted much attention, and it was soon after tried for other crops.

For turnips it was found specially suitable, and as early as 1745 the drilling of turnips was practised in Dumfriesshire by Mr Craig of Abbeyland. The system rapidly won many converts, and soon after the middle of the eighteenth century, turnip culture in drills or rows was being pursued successfully in various parts of the country, notably, besides Dumfriesshire, in Cumberland, Northumberland, Roxburgh, Berwick, and Norfolk. Indeed, to the last-named county, still noted for turnip culture, an improved system of turnip cultivation was as early as 1730 introduced from the Netherlands by Charles, Viscount Townshend of Rainham.

Turnips in Raised Drills.—In Scotland, Ireland, and the north of England, turnips are now universally grown in raised drills. This method, it is said, dates from about 1760, when it was begun by Mr Dawson of Harperton, Kelso. For districts with a moist or moderately moist climate, it has long ago proved itself to be superior to all other methods of root culture.

Disadvantage of Raised Drills.—The one drawback to raised drills is that throwing up the land in this form encourages evaporation, and thus intensifies the effects of drought. Mainly for this reason, the system of sowing in rows on the flat is preferred in the greater part of England.

Advantages of Raised Drills.—The system of raised drills possesses several advantages of the highest importance. In the first place, the gathering of the finely pulverised soil together in the raised drill, gives the roots the benefit of a deeper and freer soil than they would obtain on the same soil in the flat system. The stores of plant-food in the surface-soil, and the manure applied at the time, are brought into closer proximity to the young plants, whose growth in the early and most critical stages is thus effectually stimulated. The thinning and hand-hoeing of the crop are more easily and expeditiously accomplished in the raised drill than on the level surface, while the subsequent hand-hoeing and horse-hoeing, or drill harrowing, bring back the land to a nearly level condition by the time the crop is throwing out its spreading root-fibres.

Width of Drills.—This varies from 25 to 30 inches, the most general width being 27 inches. In narrow drills there is difficulty in covering rank dung thoroughly, and there is less facility for horse-hoeing. On the other hand, the yield of the crop per acre will be lessened by having the drills much wider than about 27 inches.

Drill-plough.—The raised drills are now most generally made by the drill-plough, the construction of which is well shown in fig. 347, in an improved

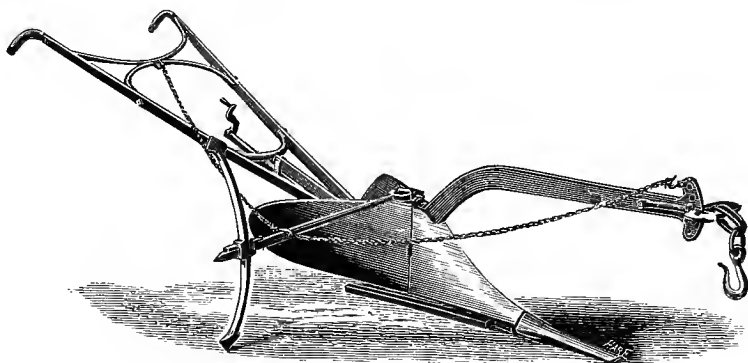


Fig. 347.—Drill-plough.

drill-plough made by Newlands & Son, Linlithgow. The breast and mould-boards of this, as of all other improved drill-ploughs, are formed so as to throw up

the soil loosely rather than to squeeze it together, as would be done by a wedge-shaped plough. The width of the drill can be easily regulated by the screw

shown between the shafts. The "marker" is adjusted to the corresponding width, and with these improved ploughs a skilful ploughman makes drills that are pleasing to the eye of a tasteful farmer—straight in line, and uniform in depth and width.

The *depth* of the drill must be sufficient to thoroughly cover the dung. Where there is no dung to cover, the drill may be shallower, yet deep enough to make the ridge complete on the top.

In many districts the drilling is done by the ordinary single plough. In drilling with the single plough, the tail of it is purposely kept high, which leaves the bottom of the drill narrow. One passage of the plough is quite sufficient for either opening or closing, and many consider it preferable to the double mould-board plough, unless for earthing up potatoes. One point in favour of the single plough for drilling is, that by it the clods are thrown over the drill and fall into the bottom of the previous furrow, instead of being thrown, as by the drill-plough, into the centre of the drill, above the dung and under the seed.

Raised Drills on Strong Clays.—The system of raised drills is not so suitable for strong adhesive clays as for more friable soils. Still even in very stiff land it is often practised with success. On land of this kind—which, as we have seen, may be seriously injured by much tillage late in spring—perhaps the best plan is to form the drills in autumn or winter, after the land has been cleaned, dunged, and ploughed. In these open drills the land lies till the time of sowing, when a light harrow, chain-harrow preferably, is drawn over the land in the direction of the drills. Any artificial manure to be given is then sown broadcast, the drills are set up by the drill-plough, and the seed at once sown.

This provides a moderately fine tilth for the seed on the top of the drill, and yet it does not unduly promote evaporation. But it leaves the soil hard a few inches below the surface, preventing the roots from developing freely, and thus tending to make the crop a small one.

Drilling on the Flat.—In the midland and southern counties of England, the prevailing system is to sow the turnip

seed on the flat surface in rows from 15 to 25 inches apart. As already explained, the main object in pursuing this plan is to avoid the dissipation of moisture, which is to a considerable extent unavoidable in raising the soil into loose ridges.

As a sort of general rule, it is recommended that, in districts with an average rainfall of less than 24 inches per annum, the flat system should be the prevailing one. A maximum crop is not likely to be obtained by this method, but in dry climates it is the safest, and is therefore extensively pursued in the south.

Width of Rows.—The rows on the flat are invariably narrower than raised drills. The most general width between the flat rows is from 18 to 20 inches, occasionally more and frequently less. With a greater width in the midland and southern counties of England, where the roots seldom attain the weights that are common farther north and in Ireland, the crop would fall off in yield per acre; yet it will be readily understood that the comparatively little space thus left between the rows on the flat does not permit of satisfactory horse-hoeing while the plants are growing. Moreover, the horse-hoeing cannot be begun so soon—not until the plants are sufficiently far up to ensure that they may not be unwittingly buried.

Broadcast Sowing of Turnips.—The broadcast sowing of turnips is now rarely practised. Where turnips are grown for the development of root, it is quite unsuitable.

Still, in certain cases, when a crop of turnips cannot be got in time to grow roots satisfactorily, a useful supply of green food in spring may be provided, only in a good climate of course, by sowing in August, with the broadcast barrow, from $1\frac{3}{4}$ to 2 lb. per acre of turnip seed. For this purpose the ground is harrowed before and after sowing, and then rolled.

When not to be systematically thinned, turnips do better sown broadcast than in rows.

In some parts of the south, where an abundant supply of field food for sheep is a matter of great importance, land planted with beans is occasionally thinly broadcasted with turnip seed. In a mild

autumn, after the harvesting of the beans, the turnips develop a wonderful bulk of very useful food.

PROCESS OF SOWING.

The actual details of the process of sowing turnips depend upon whether the raised-drill or flat-row system is pursued, and what manure has to be applied at the time of sowing.

Dunging and Sowing in Raised Drills.

Taking first the system which prevails in Scotland, Ireland, and northern counties of England, we find that the detail work of sowing—assuming the land to be already cleaned of weeds, and sufficiently pulverised—consists, in succession, of opening the drills with the drill-plough, carting the dung and spreading it in the drills, perhaps drawing a light harrow along the drills, sowing artificial manures most likely broadcast, covering in the drills with the drill-plough, and sowing the seed with the drill-sower.

Simultaneous Drilling and Sowing.

—Upon large holdings possessed of a sufficient force of horse and manual labour, all these processes go on at one time. The result in the crop is generally most satisfactory when there is no appreciable delay between the opening of the drills and the completion of the operation by the sowing of the seed. It is bad practice to open many more drills in one day than can be manured, closed, and sown before nightfall of the same day.

Stale Seed-bed Undesirable.—Turnip seed does not take kindly to a “stale” seed-bed. It comes away most satisfactorily when sown upon a freshly turned-up mould, fine in the texture, and tolerably moist—about two to four hours after the drills are closed in. When, therefore, it does happen that a portion of land has lain for a few days in finished drills unsown, perhaps on account of wet weather, some farmers consider it advisable to draw a light harrow along the drills, and set them up afresh with the drill-plough. This, however, takes time and labour when these can ill be spared, and unless the surface of the drills has become firmly packed or caked by heavy

rains, the harrowing down and drilling up again may be dispensed with.

The Force Employed.—The arrangement of the force of horses and workers in sowing turnips on a large farm, so that there may be no delay and no collisions or interruptions to any of the force, requires considerable skill and forethought. We will assume that there are two drill-ploughs at work, and that the force for carting and spreading dung and sowing manure will be sufficient to keep these fully employed opening and closing drills during the entire day. The number of carts, and men to fill them, required to keep the two drill-ploughs busy, will depend upon the proximity of the dung-heap to the drills, and the quantity of dung to be applied per acre. With the dung in heaps at the end of the field, and not more than about 15 tons of dung per acre, four carts, with one or two men to assist the carters in filling, should be amply sufficient. Assuming that the two drill-ploughs would open and close about four acres per day, the four carts would thus convey to the drills about 60 tons of dung per day, perhaps from 18 to 20 loads each, in the full working day of ten hours.

Four or five workers—men, lads, or women—will be required to spread the dung, one man will sow the artificial manure, and another will follow all with the two-drill turnip-sower, drawn, perhaps, by a good-sized cob or farmer's pony. The steward, bailiff, or griever (as the farm manager is variously called), or the farmer himself, usually sows the turnip seed, and as the turnip-drill takes two drills at a time, and the draught is very light, it will usually go over the whole day's opening and closing in rather less than a half-day. There will thus be employed in the “laying down” of about four acres of turnips eight horses, at least eight or nine men, and five or six lads and women for a whole day, and an additional man and horse for four or five hours. The cost, per acre, involved by the employment of this force would vary with the rate of wages, price of horses, and cost of horses' food in different districts and seasons.

Arranging the Force.—So as to avoid interruptions and ensure the maximum amount of work done in an efficient

and satisfactory manner, it is important to have the duties of each person clearly and intelligently defined and understood beforehand. About a dozen drills or so should be opened the night before, so that the full force may at once get to work in the morning.

Opening and Closing Drills.—As to the two teams with the drill-ploughs, the better plan is for the one to open and the other to close in the drills. In some cases the practice is for the two ploughs to follow each other, and open in the one direction and close in the other. This is apt to cause confusion and delay at the ends. In any case the amount of time occupied in turning at the ends is very considerable, far more than one would suppose without entering into minute calculations, and it will be readily understood that the loss of time at the ends would be appreciably greater if the teams have at every round to go along the ends of perhaps a dozen or fifteen drills, instead of each turning right round and going back on the same line. Moreover, by the one team opening and the other closing, there is less chance of the teams in the plough coming into contact with the carts on the end-ridges. This plan we would always adopt when there are two or more teams drilling.

In cases where there is only one drill-plough at work, the best plan is to open in the one direction and close in the other. This plan is followed where the single plough is used to open and close the drill with one furrow.

Another Method.—The following is another method of arranging the force, which some would prefer. In the evening before, 20 drills or so are opened, so that an immediate start may be made with the dunging operations in the morning. Three ploughs being used, they open the drills up-hill, and close them down the slope, if the field is not level. Three persons are placed at the dung-heap to load the four carts employed in dragging the dung. Each man throws the dung out of his own pair of carts, which come to the drills in rotation. This plan gives an interval of leisure to each man, so that he is not constantly kept in one position. A boy is sometimes employed

in driving the carts between the dung-heap and the drills. When the first drill receives its dung, 4 spreaders are placed in divisions of equal length along the drill. This enables the manager to check the work of any spreader, which can be readily known. A machine for sowing manure, and another for sowing turnips, completes the operations. There is no waiting in any division of the work, but the whole proceeds in a regular manner. In this way 12 horses, and 15 men, women, and boys, can lay down from 6 to 8 acres of turnips per day, without any undue pressure.

Carting Dung into Drills.—The old-fashioned method of emptying the dung from the carts in small heaps in every third drill is still in vogue in many parts of England. In Scotland and Ireland it has long since given place to the much more expeditious and economical plan of throwing the dung in graipfuls from the cart into the drill as the horse moves along. A careful workman distributes the dung in this manner with admirable precision as to quantity, and it is left so as to make the work of the spreaders comparatively easy. The spreading of the dung is rendered still easier if the carter throws the graipfuls into the side drill (next to the drills already dunged) so that the wheel of the next cart may not go over the graipfuls, which would be the case if the dung were, as is often the case, thrown into the drill in the centre of the cart. With short well-made dung thrown out in this way we have often seen two smart women spread as fast as one team with a drill-plough could open and close in.

Cart for Steep Land.—Ordinary farm carts are employed in carting out

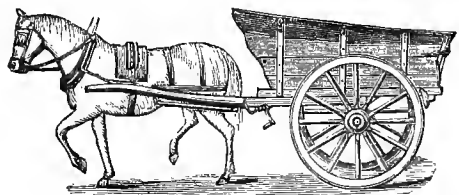


Fig. 348.—Farm tip-cart.

dung. In Div. vol. ii., p. 520, information is given as to the position of dunghills and

carting out dung, which should be consulted at this stage. In steep land, when a load has to be conveyed down-hill, a cart similar to that shown in fig. 348, made by the Bristol Waggon Works Company, will be found useful. It is a

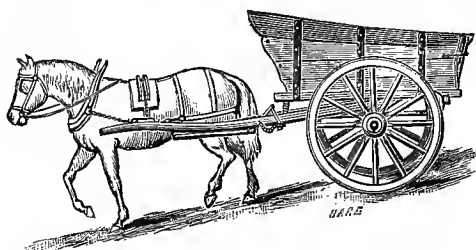


Fig. 349.—*Tip-cart going down hill.*

tip-cart, with screw arrangement, whereby the load may, as shown in fig. 349, be raised off the horse's back. Fig. 350 shows the same cart tipped so as to empty itself.

Dung-spreading Apparatus.—Appliances have been invented for spreading

the dung as it is thrown from the cart, but as yet these have not come into general practice. A very useful apparatus of this kind is that shown in fig. 351, invented by Mr Davidson, Mill of Clola, Aberdeenshire, whose inventive genius has been hindered but not discouraged by the terrible calamity of total blindness. This machine is attached to the rear of the cart, is fed with the dung by the carter, and scatters the dung by its revolving prongs. For spreading dung on the flat surface, say for top-dressing meadow or pasture, or where the dung is to be ploughed in, this apparatus is most serviceable. For spreading in drills it is not so well suited. It is difficult

to cover the dung perfectly when it is thus scattered all over the drills, instead of neatly spread in the hollow of the drill.

Sowing Artificial Manure.—The artificial manure is most generally sown broadcast by hand just before the drills

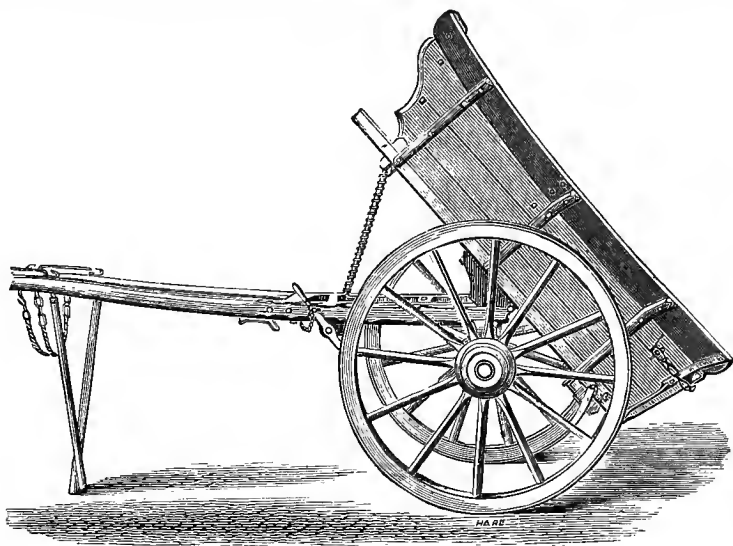


Fig. 350.—*Cart tipped.*

are closed in. It is a good plan to run a light harrow along the drills after the dung is spread, and before the artificial manure is sown. This helps to keep the quickly acting artificial manure nearer the rootlets of the young plants,

and likewise still further pulverises the seed-bed. When there are many clods, some roll the drills before sowing the artificial manure. The manure is sown along the drill rather than broadcast, and may be done so quickly by a two-hand

sower that one man will keep two drill-ploughs going, and supply himself with manure from the bags or carts deposited at the ends of the drills.

Machines are also used for sowing the artificial manure in turnip-drills—both

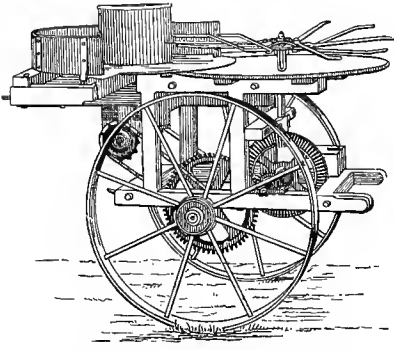


Fig. 351.—Dung-spreading machine.

broadcast and drill machines. See fig. 254, Div. vol. iii., p. 135.

Turnip Seed Drill.—Various have been the forms of turnip-sowing machines, and modes of distributing the seed. The old heavy square wooden-framed machine, and revolving seed-barrel once so common, is now seldom seen. Its weight was useful in heavy soils, but it was cumbrous, and the seed-barrel required great care to give an equal delivery. The improved modern turnip-drill sowing-machine is light, elegant, and easily managed. It consists of a simple iron frame, with shafts, handles, two rollers,

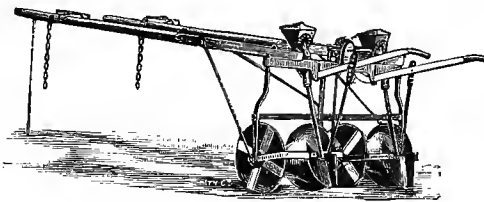


Fig. 352.—Turnip drill-sower.

seed-boxes, spouts, and coulters. The arrangements for working the seed-boxes, and for regulating the quantity of seed deposited, vary considerably, but the better known drills are all thoroughly efficient and reliable in working. The general formation of the modern turnip-drill is shown in fig. 352, which repre-

sents an excellent machine, made by James Gordon, Castle Douglas. Most of these modern drills can also be arranged with larger boxes for the sowing of mangels. Rollers can be attached to the rear of the machine, but these are only sometimes used.

Drilling Manure and Seed.—Manures are occasionally drilled along with the seed. In the raised drill system this is not often practised, as it is tedious and not of much practical advantage over broadcasting, unless where very small quantities are used. When large quantities of manures are used, they should be distributed over and mixed through the soil.

Water Drill.—The water drill, so common in the flat-sowing system of England, has been used with advantage in the north in dry seasons. It will sometimes secure a braird which would otherwise have failed. A stream of water, in which superphosphate may be dissolved, is run into the seed-rut. It acts as a moistener of the soil, and stimulant to the young plants.

Consolidating the Drill-top.—If the weather is very dry and the soil open, it is found advantageous to go over the drills a second time with the turnip machine, although no seed is sown. The rollers consolidate the drills, and make a braird more certain. A drill-roller made by Crosskill, Beverley, Yorks, is admirably suited for this purpose.

The braird seldom comes well if the soil is so damp that the rollers clog with earth.

Drill for Sowing on the Flat.

—A machine of a different description is employed for sowing turnip seed in rows on the flat surface. It is in general form similar to the Suffolk drill, shown in fig. 264, vol. ii., p. 195, but is provided with means for sowing either dry artificial manure or water or liquid manure along with the turnip seed.

Water Drill.—A well-known machine of this kind is represented in fig. 353, Chandler's patent, made by Reeves & Son, Westbury, Wilts. This drill may be arranged for sowing, in rows on the flat, any kind of root or corn seed along with water or liquid manure. A tank

is provided for the water with which the artificial manure is mixed, and by which the manure is carried down the coulters into the rows along with the turnip seed. The flow of the liquid is regulated by a valve, and the quantity allowed varies from about 200 to 700 or 800 gallons per acre.

Dry Drill.—The machine for sowing root seeds and dry artificial manure together, in rows on the flat, is very similar to the water drill. The artificial manure is mixed with ashes, generally

the ashes from burned weeds, and is carried on the drill in a receptacle, from which in regulated quantity it is deposited in the rows along with the seed.

Water and Dry Drills compared.—Both these drills are extensively used in the south of England. There is much difference of opinion as to their respective advantages and disadvantages. By the use of the water drill, the seed of course is provided with more moisture in the seed-bed. In average seasons this would most likely be an advantage, yet

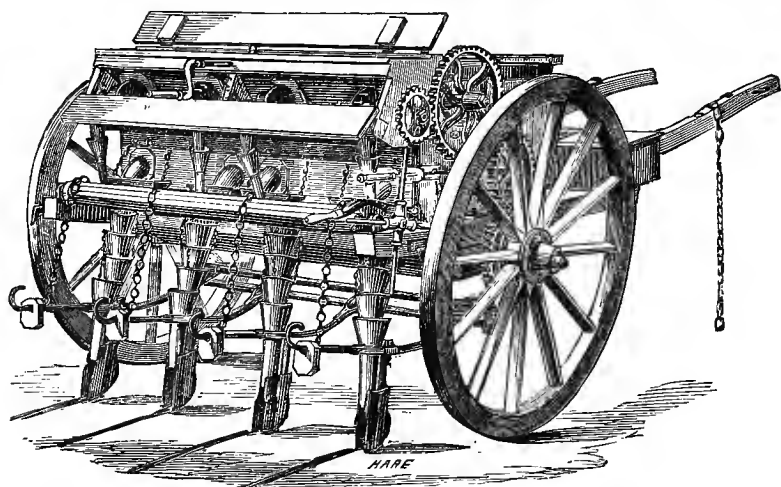


Fig. 353.—Seed and water drill.

it is maintained by many that it may often prove to be the reverse, or at any rate a doubtful advantage. In very dry seasons, for instance, it has been found in numerous cases that a stronger and more regular plant has been obtained from the dry drill than from the water drill. The reason assigned for this is that the superabundance of moisture at the very outset caused the seeds to germinate too rapidly, and set up a rate of growth which could not be maintained when the artificial supply of moisture began to fail.

Manure Injuring Seeds.—One important drawback to this system of applying artificial manures, guano especially, in close contact with the seed, is that the vitality of the seed is thereby apt to be injured or destroyed. Guano very often does much mischief in this

way, sometimes killing from a third to a half of the seeds sown. The obvious remedy for this is not to sow the guano along with the seed, but to incorporate it with the soil before, as is done in the northern system.

Time of Sowing.

The period for sowing the Swedish turnip in Scotland usually extends from the 10th May to the 1st June; for yellows, from the 20th May to the 20th June. In the south of England, and most parts of Ireland, the sowing may be almost a month later. But there, as in Scotland, turnips sown early have, as a rule, the best chance of becoming a full crop. Notwithstanding an occasional season in which mildew attacks the earlier sown crops, it is an undoubted advantage, if the land can be properly

prepared, to sow the seed as early as possible after the 10th May.

In the south of England late turnips are frequently sown up till the end of August, and occasionally even in September. In these cases, however, heavy crops of solid roots are not looked for.

Quantity of Turnip Seed.

The quantity of seed required varies with the season and soil. The seeds of the Swedish variety are about one-fifth larger and heavier than those of the common turnip, and a correspondingly larger quantity must be used. Swedes sown in May require from 3 to 5 lb. of seed per acre. The latter quantity of good seed should be used in the earlier part of the season, if the soil is rough or of a stiff nature. If the season is somewhat advanced, and the soil finely moulded, from 2½ to 3 lb. may be sown. For yellows sown in May the quantity may be from 2 to 3 lb.; if sown in June, from 1½ to 2 lb. may be sufficient. We have sown as much as 7 lb. of Swedish seed per acre, and although every seed seemed to germinate, frost and fly withered up the seed-leaves and necessitated resowing.

Thick and Thin Sowing.—While thick seeding is expensive and injurious, in some seasons producing a rush of spindly plants, it is not prudent to sow too thinly. Not a few crops have been lost where a little more seed would have saved them. Moderately thick sowing sometimes helps to ward off an attack of the fly. As the season approaches mid-summer, the weather gets warmer, the risk of fly diminishes, and a smaller quantity of seed is sufficient.

If the seeds could be evenly distributed, and if all could be depended upon to germinate and grow, 3 ounces of average yellow turnip seed, and 3½ ounces of swede seed per acre, would give a plant for every six inches of drill.

Selection of Turnip Seed.—Great care should be exercised in the selection and purchase of turnip seeds. It is sometimes mixed with old stock, or even with wild mustard seed killed by immersion for one minute in boiling water. Home-grown seed if fresh is more certain, and a smaller quantity will suffice. Fine plump seed is better than that which is

small and immature, and will produce a stronger plant and heavier turnip.

Depth for Turnip Seed.

The depth to which turnip seed should be put into the soil varies with the state of the weather and the condition of the soil. In dry weather, with the soil moderately dry, the seed should be put fully an inch under the surface. In wet weather, with plenty of moisture in the soil, from a quarter to a half inch will be sufficient.

MANURING TURNIPS.

Dependence upon Manure.—It is quite essential for root crops of all kinds that a dressing of manure, usually very liberal, shall be given for their own special benefit. Turnips are gross feeders: they produce a great weight of material in a comparatively short space of time, and must therefore, if their success is assured, have within easy reach an abundant supply of readily available plant-food.

It is a characteristic of the turnip crops that they fail entirely upon impoverished soil. Upon a deteriorating unmanured soil grain will continue to produce some considerable yield long after turnips have failed upon it completely.

This peculiarity has been well shown at Rothamsted. There Norfolk white turnips grown for three successive years on two plots—one with no manure, the other with 12 tons of farmyard dung every year—gave in roots (omitting tops or leaves) the following results per acre:—

	No manure.		12 tons dung.	
	tons.	cwts.	tons.	cwts.
1843	4	3¾	9	9½
1844	2	4¾	10	15¾
1845	0	13¾	17	0¾
Average	2	7¼	12	8½

On another piece of land an unmanured plot was cropped continuously on the Norfolk four-course system,—roots, barley, clover (or beans or fallow), wheat,—and while the turnips coming at intervals of four years fell from 3 tons 5½ cwt. in the first year (1848), to 1 ton 6 cwt. in the second crop of roots in 1852, and to 5 cwt. in the tenth crop in

1884, the barley following after these miserable crops of roots, without any manure whatever, gave the respectable average of $31\frac{3}{8}$ bushels per acre for the whole of the eleven crops grown in this way at intervals of four years.

It is thus evident that turnips readily exhaust the soil of the available supply of plant-food suitable to them, and that as foragers in poor soil they are not equal to the grain crops.

In quite an exceptional degree, therefore, turnips are dependent upon dressings of manure applied for their own special benefit. No farmer would ever think of attempting to grow turnips without an allowance of manure, in that or the previous season, no matter how fertile naturally or how high in condition the land may be.

An Exhausting Crop.—Assuredly the turnip crop is an *exhausting* crop. The fact that, in prevailing farm practice, it generally leaves the land better than it found it, is due, not to the influence of the roots, but entirely to the

tillage and cleaning the land received in preparation for the roots, and to the surplusage in the dressing of manure.

It was at one time supposed and contended that turnips enriched the land by their large extent of leaf-surface absorbing nitrogen from the atmosphere, and leaving it in the soil for the benefit of succeeding crops. Careful investigations have shown that this idea is not well founded, and that the root crop, if wholly removed from the land, is the most exhausting of all the ordinary farm crops grown in this country.

These considerations all tend to emphasise the importance of the question of "manuring for turnips."

Elements Absorbed by Roots.—First, let us see what are the elements and the quantities of these elements absorbed by an acre of turnips. Reverting to the table on page 63, vol. i., giving the weight and average composition of farm crops in pounds per acre, we find that the figures relating to common turnips and swedes are as follows:—

	TURNIPS.			SWEDS.		
	Roots, 17 tons.	Leaf.	Total crop.	Roots, 14 tons.	Leaf.	Total crop.
Dry matter . . .	lb. 3126	lb. 1531	lb. 4657	lb. 3349	lb. 706	lb. 4055
Total pure ash . . .	218	146	364	163	75	238
Nitrogen . . .	63	49	112	74	28	102
Sulphur . . .	12.2	5.7	20.9	14.6	3.2	17.8
Potash . . .	108.6	40.2	148.8	63.3	16.4	79.7
Soda . . .	17.0	7.5	24.5	22.8	9.2	32.0
Lime . . .	25.5	48.5	74.0	19.7	22.7	42.4
Magnesia . . .	5.7	3.8	9.5	6.8	2.4	9.2
Phosphoric acid . . .	22.4	10.7	33.1	16.9	4.8	21.7
Chlorine . . .	10.9	11.2	22.1	6.8	8.3	15.1
Silica . . .	2.6	5.1	7.7	3.1	3.6	6.7

Elements to be Supplied in Manure.—Now the next and all important question is, What proportion of these elements has to be supplied in manure? In ordinary farm practice the only essentials of manure are nitrogen, phosphoric acid, and potash. To most soils not by nature calcareous, lime has to be applied at intervals; but the functions of lime in the soil are well known to be so different from those of what are generally understood as manures, that we will not here

embrace the question of liming, but will assume that the soil is sufficiently provided with it. Of the other elements mentioned in the above table the natural supplies will almost invariably be ample enough for the wants of the crop.

Subordinate Elements.—On some soils the application of magnesium, calcium, and sulphur has produced a considerable increase in the weight of the turnip crop. But the good effects seem limited to certain soils; and are

probably due more to chemical and mechanical agency than to the supplying of direct food to the plant. Thus caustic and carbonate of lime act upon soils by disintegration, and by causing a more rapid decay of the organic matter, liberate nitrogen, which acts as a plant-food to all crops, and in the turnip give an increase of shaw equal to that obtained by a small application of sulphate of ammonia. The addition of sulphuric acid, especially in a free state, must act upon and change some of the soil constituents.

Uncertainties in the Manuring Question.—Confining attention, therefore, to those three important elements of plant-food—nitrogen, phosphoric acid, and potash—we have to consider what quantities of each of these should be applied to the different kinds of turnips in different conditions as to soil and climate. This, unfortunately, is not a simple mathematical question. There are so many uncertainties as to the character and contents of the soil, and so many disturbing influences in climatic variations, that the farmer, however scientific, careful, and capable generally, must always be to some extent working by chance. Moreover, the farmer has to keep in view the important considerations of profit and loss as well as the perfection of the crop. He is not content to discover merely what quantities of nitrogen, phosphoric acid, and potash would be likely to ensure a full crop of turnips. His great object is to learn what quantities of these elements should be applied in order to secure the greatest possible return for the outlay involved. The prudent farmer, like all prudent business men, works for profit. He wants not merely a *big* crop but a *paying* one as well.

Now in practice it is found that to apply to the land the exact quantities of essential manurial elements which analysis shows that the particular crop re-

moves, would not be efficient and economical manuring. The reason for this is twofold. In the first place, there are the stores of fertility already in the land, which may be sufficient to provide much of all, and all or the greater portion of some, of the elements. On the other hand, the whole of the plant-food in the manure applied may not, in an available form, come within the range of the roots of the crop for which it was intended.

For guidance in manuring, therefore, we have to rely largely upon practical experience as well as upon scientific formula. For instance, the general system of cropping pursued on the farm has to be considered,—whether the manure to be applied to the root crop has to serve for future crops, for what other crops, and for how many years the manuring is intended to last. This, indeed, is a most important point in arranging the allowance of manure for turnips,—a point which has been fully discussed in the chapter on “Manures and Manuring.” Another important consideration is the manner of utilising the crop of roots—whether they are to be in whole or in part consumed on the ground by sheep, or entirely removed.

Turnip-tops are now seldom removed from the land: they are either consumed on it, along with the roots, by sheep, or they are cut off when the roots are being pulled and ploughed in. In considering the after fertility of the land, the elements absorbed by the tops would therefore not have to be taken into account. In manuring for the roots, however, the entire contents of the crop must be kept in view.

Nitrogen, Potash, and Phosphoric for Turnips.—It is found, then, that crops of common turnips and swedes would absorb about the following quantities of nitrogen, potash, and phosphoric acid per acre:—

	COMMON TURNIPS, 17 tons (of bulbs).		SWEDES, 14 tons (of bulbs).	
	Bulbs and tops.	Per ton (of bulbs).	Bulbs and tops.	Per ton (of bulbs).
Nitrogen . . .	lb. 112.0	lb. 6.88	lb. 102.0	lb. 7.28
Potash . . .	148.8	8.58	79.7	5.69
Phosphoric acid . .	33.1	1.95	21.7	1.55

These yields per acre are above the average for England, and below what would be reckoned good crops in Scotland, Ireland, and the best turnip districts of the north of England. From these figures, however, it will be easy for any farmer by a simple mathematical question to form a useful *estimate* as to the quantities of these elements of plant-food which his crops of turnips are likely to absorb. We use the word *estimate* advisedly, because it should be remembered that such figures as these, giving the average composition of turnips, cannot be held to represent the composition in all cases with precise accuracy. Yet by multiplying the number of tons he expects to grow by the quantities per ton shown above, the farmer will come sufficiently near the actual facts to afford him a useful guide as to the supplies of these important elements of plant-food which should be available to his crops.

Chief Manure for Turnips.—To judge by these analyses of turnips, one would conclude that potash and nitrogen should bulk more largely than phosphoric acid in manures for turnips. In practice, however, it is found that such is not the case. The dominant element in all special manures for turnips is phosphoric acid. It must in some form or other be applied to all soils, and in many cases constitutes the sole application for the turnip crop.

Experiments in Pure Sand.—Many useful and interesting sets of experiments have been conducted with the various elements of plant-food applied to different farm plants in pure, utterly barren sand. The conclusions pointed to by experiments of this kind carried out by Professor Jamieson of Aberdeen, are stated by him as follows:—

1. That neither sulphur, nor magnesia, nor lime is required to be in *manures*.

2. That nitrogen, phosphorus, and potassium are the only elements that are required in manures.

3. That nitrogen influences chiefly the cereal crop.

4. That phosphorus influences chiefly the root crop.

5. That potassium does not influence any of the usual crops so much as nitrogen and phosphorus do, nor has it shown

a dominance over one class of plants more than another.

It was found in this barren sand that the turnips came to nothing where nitrogen was withheld; that when phosphorus was withheld the turnip crop was as complete a failure as when everything was withheld; and that without potassium the turnip crop was very poor and deficient.

Experiments on Average Soils.—In the years from 1879 to 1882, Mr John Milne, Mains of Laithers, Aberdeenshire, made experiments with test manures for turnips in general field cultivation on forty-seven farms in the north-east of Scotland, representing all classes of soil found there. To one plot all the chief ingredients found in the ash of turnips, as well as nitrogen, were applied. From each of the other five plots one ingredient was withheld in turn.

The average deficiency of crop in plots where nitrogen was omitted was 11 per cent; where phosphorus was omitted, 33 per cent; where potassium was omitted, 15 per cent; where magnesium was omitted, 4 per cent; and where calcium sulphate was omitted, 1 per cent.

These indicate the relative potency of the different ingredients in growing turnips on average soils, and show the powerful influence of phosphorus, the moderate influence of potassium and nitrogen, and the inconsiderable influence of calcium, magnesium, and sulphur, on the weight of the turnip crop.

Gloucestershire Experiments.—An elaborate series of experiments upon various manures in the growth of swedes was carried out by Professor Wrightson, under the auspices of the Cirencester Chamber of Agriculture, in the years 1868-1876. The conclusions arrived at are summarised as follows:¹—

1. That poor land, and in poor condition, derives the greatest benefit from artificial dressings.

2. That land in high condition has been proved in many cases to derive little or no benefit from the use of artificial dressings.

3. That land in this (Cirencester) neighbourhood appears to be satisfied with moderate dressings, and the use of

¹ *Fallow and Fodder Crops*, 113.

heavier dressings is not attended with commensurate results.

4. That 3 cwt. of ordinary mineral superphosphate per acre has given the most economical result (along with dung) during several years' experience over hundreds of plots.

5. That guano, nitrate of soda, organic matter, and even farmyard dung diminish the germinating power of swede seed, and cause a blankness in the crop when they are brought into contact with the seed.

6. That guano and nitrate of soda applied to the growing swedes increase the crop, but scarcely to an extent to warrant their general use.

7. That the average increase in swede crops, from the use of 3 cwt. of superphosphate (along with dung) amounts to 5 tons 6 cwt. per acre. That in some cases the increase has been *nil*, while in others it has been as much as 14 tons per acre.

Nitrogen for Turnips.

In farm practice it has not been found that any considerable direct application of nitrogen has been repaid by an increase in the turnip crop. Yet it has been proved that the presence in the soil of readily available nitrogen is essential for the healthy growth of the crop.

Atmospheric Nitrogen Insufficient.

—With their broad leaf-surface, turnips have been credited with the ability to draw a considerable quantity of nitrogen

from the atmosphere. There is reason, however, to suspect that the powers of the root crop to procure nitrogen for itself and succeeding crops in this way has been greatly overestimated. At any rate it is evident, as shown in Professor Jamieson's experiments in barren sand (p. 356), and by other similar experiments, that the turnip in its very earliest stages cannot abstract from the atmosphere sufficient nitrogen for its development.

Nitrogen in the Soil.—Thus a certain supply of nitrogen in the soil itself is indispensable. Practical experience has tended to show that, in most soils in good average condition as to cultivation and fertility, the turnip will find as much nitrogen as it can profitably take up. Certainly wherever a reasonable quantity of short or well-rotted farmyard manure is applied, there will be little or no need for any further direct application of nitrogen.

On the other hand, where no dung can be spared, and where it is known or suspected that the soil is deficient in available nitrogen, the application of a small quantity will most likely produce an increase in the crop.

Rothamsted Experiments with Nitrogen for Turnips.—In a series of experiments at Rothamsted with Norfolk white turnips and swedes grown for four successive years (1845-1848), the following results—per acre—were obtained:—

Norfolk White Turnips.

	Roots.		Leaves.		Total.	
	tons.	cwts.	tons.	cwts.	tons.	cwts.
No manure	1	4	0	17	2	1
Ammonia salts=45 lb. nitrogen	1	7	1	0	2	7
Mineral manures alone . .	8	4	2	14	10	18
Do. with 45 lb. nitrogen . .	9	18	4	6	14	4

Swedes.

	Roots.		Leaves.		Total.	
	tons.	cwts.	tons.	cwts.	tons.	cwts.
No manure	2	6	0	6	2	12
Ammonia salts=45 lb. nitrogen ¹	3	17	0	6	4	3
Mineral manures alone . .	7	5	0	10	7	15
Do. with 45 lb. nitrogen . .	8	18	0	11	9	9

¹ In a later experiment of a similar kind, nitrate of soda gave rather better results than ammonia salts.

From these figures it will be gathered:

1. That in all cases the nitrogenous

manure made a slight, but in no case a great, influence upon the produce.

2. That by itself the nitrogenous manure was more effective upon swedes than white turnips.

3. That in the case of white turnips the increase traceable to nitrogenous manures occurred chiefly in the leaves or tops, so that in this case there was very little gain in feeding material from the application of the ammonia salts.

Nitrogen producing Leaves.—The significance of this last result is indicated by the fact that in the plot which received the highest nitrogenous manuring there was nearly as much dry solid matter per acre in the leaf—which for the most part only becomes manure again—as in the root, which may be said to be the only edible portion of the crop.

With the swedes the results are altogether more satisfactory. With these nitrogenous manure had very little influence on the leaf, the proportion of which to root is always small in the swede. Such increase as the ammonia salts effected in the swedes took the shape of useful feeding matter in the bulb.

Dr Gilbert's Conclusions.—In summarising the results of the Rothamsted experiments upon different manures for turnips, Dr Gilbert submits the following conclusions in reference to *nitrogenous manures*:—

1. It is entirely fallacious to suppose that root crops gain a large amount of nitrogen from atmospheric sources by means of their extended leaf-surface. No crop is more dependent on nitrogen in an available condition within the soil; and if a good crop of turnips is grown by superphosphate of lime alone, it is a proof that the soil contained the necessary nitrogen. In fact, provided the season be favourable, the *condition* of the land, as far as nitrogen is concerned, may be more rapidly exhausted by the growth of turnips by superphosphate than by any other crop.

2. A characteristic difference between the uncultivated and the cultivated turnip root is, that the cultivated root contains a much lower percentage of nitrogen, and a much higher percentage of non-nitrogenous constituents, especially sugar, by the accumulation of which the percentage of nitrogen is reduced. Yet

it is under the influence of nitrogenous manures that the greatest amount of the non-nitrogenous substance—sugar—is produced.

3. If nitrogenous manures are used in excess—that is, in such an amount as to force luxuriance, that the roots do not properly mature within the season—there will be, not only a restricted production of root, but an undue amount and proportion of leaf.

4. Excess of nitrogenous manure tended to lower the percentage of dry matter and increase the percentage of nitrogen in the roots.

English Practice.—Notwithstanding the importance which the Rothamsted experiments place upon nitrogen for the turnip crop, it is not the rule in English practice to apply nitrogenous manures directly to turnips. As to this point, Professor Wrightson remarks: “Ammonia salts and nitrate of soda, although producing an increase of leaves, do not greatly increase the yield of bulbs. Their effect, when applied alone on exhausted soils, is trifling; but where there is an abundance of available mineral food, an increase is no doubt effected by their application. This increase is, however, not commensurate with the expense, and the wiser system is to employ superphosphates in root cultivation, and hold back the ammonia salts and nitrate of soda for application on the cereals or grasses.”¹

Experiments with Nitrogen at Carbeth.—At Carbeth, Killearn, Stirlingshire, in the years 1882 to 1885, Mr D. Wilson, jun., M.A., F.C.S., conducted an interesting series of experiments on the growth of yellow turnips with various manures. In those years 38 plots on different fields were dressed with 10 to 13 tons of rich covered-court dung, and to 19 of these plots $\frac{3}{4}$ cwt. of nitrate of soda, or its equivalent in sulphate of ammonia, was also applied per acre. The results were:—

	Average of 19 plots, per acre.	
	tons.	cwts.
Dung	20	12
Do. and $\frac{3}{4}$ cwt. nitrate of soda or sulphate of ammonia	21	4

¹ *Fallow and Fodder Crops*, 70.

The increase from the nitrogenous manure was thus only 12 cwt. per acre; and as the $\frac{3}{4}$ cwt. nitrate of soda cost about 8s., the 12 cwt. extra of roots entailed an outlay at the rate of 13s. 4d. per ton. Plainly, therefore, in this case it was not profitable to apply nitrogenous manure with dung.

In the same series of experiments (which are reported fully in the *Transactions of the Highland and Agricultural Society*, for the years 1884, 1886, and 1887) artificial manures alone were also tried in the growth of turnips. In this case the application of nitrogenous manure gave a very different result.

Of 34 plots dressed with artificial manure, 17 received $1\frac{1}{2}$ cwt. per acre of nitrate of soda or its equivalent in sulphate of ammonia, and 17 plots no nitrogenous manure, but the same treatment otherwise. The result was almost regularly an increase of one-fifth in the produce of bulbs from the nitrogenous manure. In other words, when in an unfavourable turnip year the plots without nitrate of soda gave 12 tons of roots, the nitrate of soda plots gave $14\frac{1}{2}$; while in a good year with 20 tons without nitrate of soda, there was grown a 24-ton crop with the nitrogenous manure.

Mr Wilson thus arrived at the conclusion that while turnips are not, upon soils in average condition, nearly so dependent upon supplies of soluble nitrogenous manures as the cereals, it will pay in most soils, when growing them without dung, to use a little nitrate of soda, say fully 1 cwt. per acre.

Nitrogen is most likely to be required for roots when the soil is deficient in organic matter, and where the climate is warm and dry.

Potash for Turnips.

Although potash bulks largely in the analysis of the root crop, the application of potash in the form of manure would not in all cases be followed with advantage. In most soils there are great natural supplies of potash, and, as a rule, all the additional potash required will be provided in a moderate dressing of farm-yard dung. But in certain soils, notably those of a light sandy and gravelly nature, and in cases in which little or no dung is

applied, it is more than probable that the addition of a small quantity of potash to the dressing of manure would be profitable.

Many instances have been observed of quite a remarkable increase in the crop from a moderate allowance of potash. These of course have taken place where all the elements and conditions necessary for the production of a large crop of roots are present excepting available potash. In manuring, the farmer should never forget the significance of the law of minimum—that law whereby the produce is limited, not by the combined quantity of all the elements present in the soil, but by the producing power of the supply of the essential element present in the smallest proportion.

Thus when potash is deficient, the application of it is followed by a marked increase in the crop.

Potash is usually most deficient in light gravelly soils in poor condition. Still it is the exception rather than the rule for land to be in need of potash for turnips. The conclusion which the majority of experimenters and observing farmers have arrived at is, that unless there is good reason to suspect that the particular field is deficient in available potash, it need not be included in the manure.

An Excess of Potash Injurious.—Indeed it has been found in several cases that an excess of potash has injuriously affected the yield of roots, as in the Highland and Agricultural Society's experiment referred to on page 180 of Divisional vol. iii. At Carbeth, Stirlingshire, Mr Wilson had similar experience. Potash salts equal to 2 cwt. of kainit per acre were tried on 22 plots, alongside 22 similar plots without potash, but dressed also with dung as the other plots also were. The results were:—

	Average of 22 plots, per acre.	
	tons.	cwts.
Dung alone	21	9
Dung with 2 cwt. kainit	20	13
Decrease due to the potash, 16 cwt. per acre.		

Tried at Carbeth without dung on four different soils, potash gave a profitable increase in roots in only one soil. In the other cases the supply of potash already in the soil was sufficient. As

to excess of potash, Mr Wilson remarks that "the mineral acids combined in these salts seem to be set free, and to do mischief to the crop."

Mr Wilson therefore advises the withholding of potash, unless it is believed from actual experiment or observation that there is a deficiency of it in the particular field.

Test the Soil.—Here again let us urge the farmer to watch closely and test every year the condition of his land as to its supplies of the leading elements in plant-food. See pp. 91-94 in Divisional vol. iii.

Phosphates for Turnips.

In all manures specially adapted to turnips, the dominant element should be phosphoric acid. Under all circumstances, in all soils and situations, with dung and without dung, it is the almost invariable practice to furnish turnips with a phosphatic dressing in some form or other.

Phosphatic Manures Alone.—Upon average soils in good condition as to tillage and general fertility, wonderful crops of roots are frequently grown by the application of phosphatic manures alone. Thus at Rothamsted, under conditions not favourable to such large yields of roots as are obtained in Scotland, superphosphates alone (consisting of 200 lb. bone-ash dissolved in 150 lb. of sulphuric acid per acre) produced, on an average of nine crops grown in a four-course rotation, 8 tons 4½ cwt. of swedes per acre—or 6 tons 10 cwt. more than was grown upon an unmanured plot alongside.

Phosphates with other Manures.—But while this result is in itself remarkable, it is important to note that in the same series of experiments at Rothamsted, another plot dressed with "mixed manure" produced in the nine years an average of over 15½ tons per acre. This "mixed manure" was both complete in composition and liberal in quantity. It consisted of 300 lb. of sulphate of potash, 200 lb. sulphate of soda, 100 lb. sulphate of magnesia, 200 lb. bone-ash, 150 lb. sulphuric acid, 100 lb. sulphate of ammonia, 100 lb. chloride of ammonium, and 2000 lb. of rape-cake per acre.

It will be interesting to present these results here in tabulated form:—

	Average per acre of 9 crops of Swedes in 4-course rotation.		
	Roots.	Leaves.	Total Produce.
	tons. cwts.	tons. cwts.	tons. cwts.
Unmanured . .	1 14%	0 5½	2 0
Superphosphate .	8 4½	0 16½	9 0¾
Mixed manure . .	15 12½	1 13½	17 6½

Too much Reliance on Phosphates.

—There is a tendency in some parts of the country to place too much reliance upon phosphatic manures alone for the turnip crop. This should be guarded against, for with imperfectly balanced manuring the results cannot be fully satisfactory. It is more than probable that in many cases where phosphatic manures alone are applied, the addition of a small allowance of nitrogenous and potassic manures would very substantially increase the produce of the crop.

This would not likely be the case in land which is naturally fertile and in good heart from liberal manuring with dung and other lasting manures in previous years. But in land in poor or medium condition, it would, in all probability, be advantageous to add small quantities of nitrogenous manures and potash to the phosphates.

Superphosphate Manuring Exhausts the Soil.—In the economical manuring of any particular farm crop, it is important to keep in view the after condition of the soil—that is, the effect which, under the dressing of manure now applied, the crop is likely to exercise upon the general fertility of the soil.

In the manuring of turnips this consideration demands more attention than many farmers have been in the habit of giving to it. For it is tolerably well authenticated that by the injudicious—the excessive or exclusive—use of superphosphates for turnips, the standard fertility of the soil has in many cases been appreciably lowered. Indeed, as we have already seen, Dr Gilbert states that "there is perhaps no agricultural practice by which what is

termed the *condition* of land—that is, the readily available fertility due to recent accumulations—can be to so great an extent exhausted by one crop, as by growing turnips by superphosphate of lime alone, provided, of course, that the season is favourable.”

This point was illustrated by the series of experiments at Rothamsted just referred to. On the plot which received no manure in all the ten years, the barley which succeeded the root crops averaged no less than $31\frac{5}{8}$ bushels per acre; while on the plot which received for the turnips 200 lb. of bone-ash, and 150 lb. of sulphuric acid converted into superphosphate every fourth year, the average produce of the barley fell to $26\frac{7}{8}$ bushels per acre. The advantage of the liberal dressing of mixed manures applied to the roots was seen in the barley crop, which rose to an average of $40\frac{1}{4}$ bushels per acre.

Recouping the Soil.—The exhaustion of the soil which thus takes place by the growth of turnips from exclusive or excessive dressings of superphosphates may be prevented, or rather recouped, by the consumption on the ground, not only of the root crop but also of some other food, such as cake or grain, by sheep. This is extensively done in many parts of the country, and is especially commendable where dung cannot be spared for the root crop. Indeed it is the rule in many districts to consume on the land by sheep the whole or greater part of any section of the turnip crop which had not received farmyard dung and was grown solely by artificial manure.

Phosphates with Dung.—In the four years' experiments at Carbeth, Stirlingshire, already referred to, the only artificial manure sown along with dung which repaid its cost in an increased crop of roots was superphosphate, applied at the rate of from 3 to 5 cwt. per acre. From a large number of plots in different fields and in different years, dressed with from 10 to 13 tons of rich covered-court dung, the addition of 5 cwt. of superphosphate gave an average increase of 2 tons 10 cwt. per acre in bulbs. The dung given here was sufficient to supply all the phosphoric acid required by the roots. The increase from the addition of superphosphate is therefore attributed

mainly to its assisting the plant with easily assimilated phosphoric acid before it could lay hold of the more slowly acting dung. Another advantage is, often one of great importance, that the quickly acting superphosphates force the plants more rapidly past the stage in which they are attacked by the fly.

Phosphates without Dung.—Mr Wilson also experimented with phosphates without dung, and with and without the aid of other artificial manures. On land at Carbeth which is evidently above average fertility, the average produce of roots without dung or phosphates was 7 tons 17 cwt. per acre. With 8 cwt. 25 per cent superphosphate, the average produce rose to 17 tons 19 cwt.—an increase of 10 tons per acre.

Cheapest Phosphate for Turnips.—An important question, as to which there is a good deal of difference of opinion, is that of the most economical form of phosphate for the turnip crop.

From 1840 to 1870, Peruvian guano and roughly crushed bones, with the occasional addition of dissolved bones and superphosphate, were the manures chiefly employed to supply the nitrogen and phosphates to the turnip crop. Since the Chincha Island deposit of guano became exhausted, the other deposits, being inferior in ammonia and high in price, are comparatively little used. Crushed bones, more finely ground than formerly, are still in much repute for turnip manure in all light soil districts; while on the heavier soils dissolved bones and, still more, superphosphate, have become the general manures.

Mineral Phosphates.—Notwithstanding some opinions to the contrary, carefully conducted experiments have shown that phosphates from mineral sources, such as rock guano, coprolites, Carolina phosphates, and the phosphate from the Thomas-Gilchrist steel slag, when finely ground, act on the turnip crop almost as well and nearly as fast as the phosphate in finely crushed bones, while the mineral phosphates can usually be bought at a much less price per unit. So long as mineral phosphates are much cheaper, the farmer in favourable circumstances as to soil and climate may do well to use them, in part at least, in place of crushed bones; taking care that the

grinding is as fine as possible, and avoiding all the phosphates of alumina, and the crystalline apatite, which latter should always be dissolved before application.

Discrimination in use of Mineral Phosphates.—To use undissolved mineral phosphate successfully as a turnip manure, the farmer must exercise not a little discrimination. Some mineral phosphates will give excellent results in one soil, while in another soil, not very different in appearance, the effects will be disappointing. Indeed, the potency of phosphates varies so much, owing to physical condition, pulverisation, and structure, as well as owing to the varying influence of soils apparently similar, and also climate, that their general unpopularity is easily understood, for the average farmer cannot be expected to study the varieties, soils, and influences which render the use of this manure profitable. An exception is phosphatic slag, which is invariably effective on light and medium soils.

The various forms of phosphate are fully described in the chapter on "Manures and Manuring," pp. 102-120, Divisional vol. iii.

Superphosphates.—Superphosphate of lime, the characteristics of which are fully discussed at pp. 116-118, Divisional vol. iii., is now extensively used as the source of phosphoric acid for turnips. In great parts of England, where the soil and climate are dry, it is indeed almost the only form of phosphates now used for turnips along with dung. In many cases it has been found the most economical form of phosphatic manure for this crop, producing a heavier yield than the same value of crushed or dissolved bones.

At Carbeth, Mr Wilson compared superphosphates with equal money's worth of ground Charleston phosphate. He obtained in four years an average of 10 per cent more weight of bulbs from the superphosphate than from the ground mineral phosphate. Mr Wilson also contrasted the superphosphate with Thomas slag. The results again were in favour of the former, at the existing prices of the two articles. Mr Wilson likewise considered the phosphates in guano dearer than those in superphosphate; but in contrast with the same value of

steamed bone-flour, the superphosphate failed at Carbeth to sustain its supremacy. Steamed bone-flour mixed with superphosphate produced 13 cwt. more per acre than an equal money value of superphosphate alone. Mr Wilson adds that, making allowance for the nitrogen contained in steamed bone-flour, more phosphoric acid is got for the same money in this form than in superphosphate.

Along with dung, Mr Wilson prefers superphosphate (mainly for its quick action) to all other forms of phosphates. Without dung, he would provide the phosphates in a mixture of steamed bone-flour and superphosphates.

The Aberdeenshire experiments, described on pages 170 to 175, Divisional vol. iii., have a very direct bearing upon this point. Note in particular what is said (page 173) as to the influence of phosphates rendered soluble by sulphuric acid upon the tendency to "finger-and-toe," and as to fineness of grinding or perfect disaggregation (pages 172 and 174) being as effective as dissolving in sulphuric acid.

Climate and Soil to be Considered.

—In deciding as to the form of manure used, the characteristics of the climate and soil must be carefully considered. As to this point, Mr John Milne, Mains of Laithers, Aberdeenshire, who is a practical chemist as well as an extensive experimenter and successful farmer, remarks:—

"In cold wet districts, or if the crop is late in being sown, the quantity of soluble phosphate should be increased, as its effect is to force the crop to early maturity. In these circumstances, if farmyard manure is applied, little or no nitrogenous manure should be used, as its tendency is to keep the crop growing longer, and thus retard its maturity. Undissolved mineral phosphates always act best in warm early seasons, and do not show quite so well as soluble phosphates in cold wet years.

"In manuring, the farmer should be guided by the quality of his soil, the period of sowing, and probable character of the weather. If his soil is rough or stiff, the sowing late, or the climate cold or wet, a pretty large proportion of soluble, precipitated, or very finely ground

phosphate is advisable. If the soil is soft, the season early, and the climate dry, the phosphate need not be so finely divided, and a larger proportion of nitrogen may be beneficially used."

Farmyard Manure for Turnips.

In prevailing farm practice this is the standard manure for turnips. It is the rule—which, however, has a good many exceptions—to apply the whole or the greater portion of the farmyard dung to the potato, turnip, and mangel crops. The prevalence of the practice is a tolerably sure indication that a dressing of dung is well suited to the turnip crop.

We have seen (p. 353) how marked was the influence of repeated dressings of dung in growing turnips at Rothamsted—12 tons of dung every year having in three years raised the produce of white Norfolk turnips from 9½ tons to over 17 tons per acre.

Supplementing Dung.—But while a dressing of dung is highly beneficial to the turnip crop, it may be found advisable to supplement it with some more quickly acting fertilisers, such as superphosphate, nitrate of soda, and potash. Much will of course depend upon the condition and quality as well as the quantity of the dung. Well-rotted dung acts more quickly than fresh dung, while if it has been enriched by the consumption of concentrated foods, it will be still more efficacious. It is highly important that the plants be pushed forward rapidly in their earliest stages, so that they may get beyond the ravages of insects. For this purpose a dressing of some quickly acting phosphatic manure will be a valuable supplement to the more substantial but slower farmyard dung. As we have seen, superphosphate or a mixture of very finely ground mineral phosphate and steamed bone-flour will likely be most suitable. When dung is applied to soils in good condition, only a small quantity of any readily acting phosphate is required, and when quick growth is wanted superphosphate will serve the purpose very well. Still, if the price per unit, instead of per ton, and the residue of ingredients left in the soil for future crops, are taken into account, superphosphate is found to be at present the most costly manure in the market.

Too much Forcing Injurious.—On the gravelly and lighter soils, and especially for yellow turnips, too much forcing in the first stages is injurious, except in cases of very late sowing. Its usual effect is to aggravate the difficulty of singling the plants in proper time. It renders the crop more apt to set and even to mildew at a later stage. The turnips will be of inferior feeding quality; and the early rapid growth distinctly increases the tendency to anbury.

Is Dung Essential in Turnip Culture?—This question has been much discussed. It is still the subject of difference of opinion. Many noted agriculturists, including Professor Wrightson, contend that good crops of swedes cannot be grown without dung. Others hold that it is not by any means essential, and that better results will be obtained by applying the dung to other crops, such as potatoes, or on pasture or meadowland, and growing the turnips entirely or mainly with substantial artificial manure. It is going too far, we think, to hold that swedes cannot be grown advantageously without dung. As a matter of fact, good crops of swedes *are* grown without dung; and the feeling is gaining ground that some proportion of the excessive dressings of dung which are often applied to swedes might be more advantageously utilised for other purposes.

Assuredly it is most desirable that a substantial dressing of good farmyard dung should be available for swedes. It is the best foundation of all for a successful crop; and, as a rule, it will be found the safest practice to devote the main portion of the dung to the swedes. But while dung is probably necessary to ensure a maximum crop of swedes, it is not absolutely essential for the production of a profitable crop. In some cases it may be desirable to grow a greater breadth of swedes than the available supply of dung will cover; and this may be done by the use of artificial manures. Generally, however, it is deemed prudent to substitute yellow turnips when the dung becomes exhausted.

It would be unnecessarily restricting the operations of the educated and skilful farmer to tell him that he must not attempt to grow swedes without farmyard dung.

The softer varieties of turnips are grown very extensively, and with great success, without the slightest particle of dung, great care, skill, and liberality being of course necessary in these cases in the use of artificial manure, so as to maintain the fertility of the land. Unless the turnips are consumed on the land by sheep, it will most likely be necessary to top-dress some of the other crops which follow upon the land which received no dung for the roots.

Quantities of Manures for Turnips.

The quantities of manure applied to the root crop vary greatly throughout the country. The ruling influences are the climate, the natural character of the soil, its condition as to accumulated fertility or exhaustion, the purposes for which the roots are intended, and the general system of farming pursued.

Yield and Quantity of Dung.—

The consideration which most largely regulates the amount of manure—that is, where the objectionable practice of applying all the manure for the rotation with the root crop has been abandoned—is the suitability of the district and the field for the production of a heavy or light crop of roots. Where a crop of 25 to 30 tons per acre is to be looked for, the allowance of manure must, as a matter of course, be much larger than where the yield is not likely to exceed 12 to 15 tons. These figures roughly represent the respective yields of the best turnip-growing districts of Scotland, Ireland, and the north of England, and in the midland and southern counties of England, and thus in the latter the prevailing quantities of manure applied are much less than in the green isle and north of the Humber.

The general questions to be considered in deciding as to the quantities of manure for the various crops have already been fully discussed in the chapter on “Manures and Manuring,” Divisional vol. iii. pp. 89-185. See in particular pp. 126-135. Here, therefore, a very few notes as to the prevailing customs will suffice.

Scotch Dressings.—In Scotland, in the north of England, and in Ireland, the allowances of dung vary from 5 to 20 tons per acre, and the accompanying

dressings of manure from 3 to 8 or 10 cwt. of phosphatic manures, $\frac{1}{2}$ to 3 cwt. of nitrogenous manures, and $\frac{1}{2}$ to 3 cwt. of potash salts. More general quantities of dung run from 8 to 15 tons. Along with from 10 to 12 tons of dung, from 3 to 5 cwt. of phosphatic manures, 1 cwt. of nitrate of soda or sulphate of ammonia, and 1 to $1\frac{1}{2}$ cwt. of kainit, would be a liberal dressing. For swedes some farmers give as much as 12 to 14 tons of good dung, 4 cwt. of mineral superphosphate, 2 to 3 cwt. crushed or dissolved bones, 1 cwt. of nitrate of soda, and 1 cwt. of kainit. Others curtail the artificial manure to about 3 or 4 cwt. superphosphate, $\frac{1}{2}$ cwt. of nitrate of soda, and $\frac{1}{2}$ cwt. of kainit. Often the two latter are omitted altogether; still more often the potassic manure is omitted, and the small allowance of nitrogenous manure included.

Advantage of Heavy Dressings

Questionable.—Several of these dressings of artificial manures along with dung are assuredly very heavy. Many careful and successful farmers are doubtful as to the economy of such liberal and costly additions to the supplies of dung. By his carefully conducted experiments at Carbeth, Stirlingshire, Mr Wilson was led to the conclusion that the usual practice in many turnip-growing districts of expending from 30s. to £2 per acre upon artificial manure, to apply along with dung, is not a profitable one, and that in many of these cases half the rent of the land might be saved by reducing this outlay.

Certainly the once practised method of applying manure—dung, bones, and guano—to the turnip crop to serve for the entire rotation, has been exploded as thoroughly unsound. The allowance of dung for the rotation may of course be, and is still, applied to the roots, and with good effect; but with the artificial manure the case is entirely different. In regard to these, it is a safe rule to apply no more at any one time than you expect the first crop will profitably utilise or repay. A reasonable exception to this rule would be a dressing of crushed bones, particularly for grass land.

Moderate Dressings of Dung.—When the supply of dung is not suffi-

cient to go over the entire root break, it is a good plan to lessen the allowance per acre, and make the dung go as far as possible, increasing the quantity of artificial manure in proportion. Better far give 8 tons to the entire break than 12 tons to a certain portion, and none to the remainder—better especially for the after fertility of the land.

Artificial Manures alone.—When no dung can be spared, the allowance of artificial manures has to be very liberal. In some cases the allowance is as high as from 5 to 6 cwt. superphosphate, 2 to 3 cwt. steamed bone-flour or crushed or dissolved bones, 1 to 2 cwt. of nitrate of soda, and 2 to 3 cwt. of kainit. In other cases, again, from one-half to two-thirds of these quantities are supplied, the potash often being omitted altogether. In many cases superphosphate at the rate of 8 to 10 cwt., and 1 to 2 cwt. of nitrate of soda, constitute the sole dressing. Others use a portion of finely ground mineral phosphate.

But the variations in the individual dressings are so numerous that it would be impossible to fairly represent them here.

Southern Dressings.—The most general dressing in England, where a crop of from 12 to 18 tons is expected, is from 8 to 12 tons of dung and 3 cwt. of superphosphate per acre. A small allowance of guano or nitrate of soda, from $\frac{1}{2}$ to $\frac{3}{4}$ cwt. per acre, is often drilled along with the superphosphate and the turnip seed, but this plan is regarded by many leading authorities as unprofitable.

Necessity for Individual Judgment.—In arranging the quantities of manure for turnips, as in most other farm operations, the circumstances of each individual case must be carefully considered. General rules are subject to many variations, which each farmer must decide upon for himself. A careful study (aided by a few experiments, which should always be going on) of the condition of the soil and its capabilities under favourable circumstances as to fertility will be the safest guide as to the most profitable quantities of manure to apply. It is a point in farm management which demands the very best attention from the farmer.

Application of Manure for Turnips.

The general methods of applying manures, and the principles upon which these should be regulated, have already been dealt with (pages 126-135 Divisional vol. iii.) What is said there should be carefully studied in connection with the culture of turnips.

Dung.—As to the merits and demerits of the various practices of applying dung in the autumn, and on the flat surface, and in the drills in spring, enough has been said in the pages just referred to.

Upon heavy lands where the dung is available in time, the best and most general practice is to plough down the dung with a shallow furrow in the autumn or early in winter.

Where this has not been done, and where the turnips are to be sown on the flat surface, the dung is spread on the flat surface and ploughed down with a moderate furrow early in spring. Late dunging in this case is not to be commended, as the rank dung would be liable to unduly encourage the escape of moisture by keeping the surface soil open.

The general practice where the turnips are grown in raised drills, is to spread the dung in the bottom of the drills at the time of sowing the seed; yet, as just explained, if the land is stiff and the dung available, autumn dunging, even with sowing in raised drills, is in many cases a beneficial method. It lessens work at sowing-time, and the dung helps to disintegrate the adhesive soil.

Artificial Manure.—The most general practice with all kinds of artificial manure for turnips, is to apply it at the time of sowing the seed, as described on page 350.

Southern Customs.—In England, wherever the turnips are sown in rows on the flat surface, the artificial manure is generally drilled in along with the seed with the dry or water drill, as already explained (p. 351). Guano, nitrate of soda, and sulphate of ammonia are, however, liable to injure the germinating power of the turnip seed when thus brought into contact with it. To obviate this, the nitrogenous manures (when such are given) are sometimes sown broadcast, and harrowed in just before or

after the seed is sown. Indeed, in many cases in England all the artificial manures are thus sown broadcast, although with a light application sown in this way the crops grown in rows on the flat are very often disappointing. Broadcasting artificial manures is more satisfactory with raised drills, as in this case the scattered particles of the manure are gathered towards the plants by the operation of the drill-plough.

For the flat-row system the best plan perhaps is, where the superficial dressing consists entirely of superphosphate, to drill the whole of it along with the seed, and where other manures as well as superphosphates are given, to drill the greater portion of the superphosphate along with the seed, and sow the re-

mainder with the other manures broadcast, and harrow in, following with the roller.

Potash is in many cases found to give the best results when sown in the previous autumn.

Top-dressing Turnips.—The practice of top-dressing turnips is rarely pursued. If nitrogenous manure is required, some consider it a good plan, especially in wet climates, to hold it back till the plants are about ready for singling, and then apply it in the form of a top-dressing of nitrate of soda.

Singling and Hoeing.

Influence of Weather.—The seed-leaves usually appear in from three to seven days after sowing. The plants

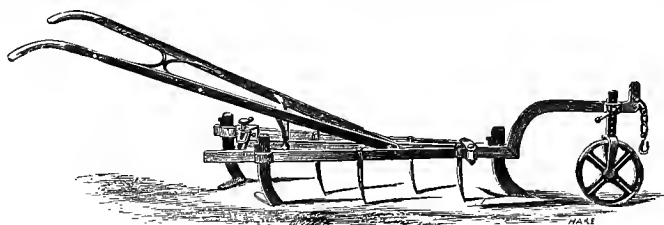


Fig. 354.—Scotch drill-scuttler or horse-hoe.

grow rapidly in fine dry weather, if the nights are free from frost. Until the

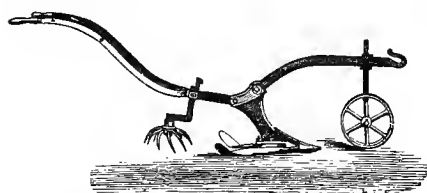


Fig. 355.—English horse-hoe or turnip-scuttler.

plants are of considerable size, heat and dryness favour their growth, while at this stage much rain is not favourable, and on clay soils in wet seasons they are sometimes to be seen with red leaves, "sojered," after which they seldom develop into a satisfactory crop. At a later stage, when the plants are 20 to 30 inches across, dry weather is unfavourable, and on dry soils they will luxuriate in wet weather. If the subsoil is retentive, however, a very heavy rainfall is injurious, and will some-

times almost drown the crop and prevent its farther growth. A dry warm autumn is always favourable for bulbing; but after December heat starts the roots and tops anew, tends to run the tops to seed, and deteriorates the quality of the bulb.

Turnips should be singled when the leaves measure about an inch across.

Drill-harrowing or Horse-hoeing.—But before singling or hand-hoeing is commenced, several operations may be performed which will make the labour of hoeing more easily performed, and by farther loosening the soil tend to pro-

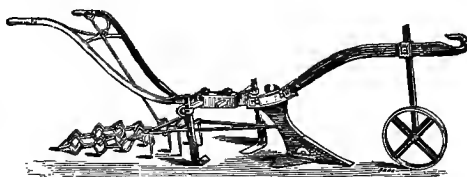


Fig. 356.—Horse-hoe and harrow.

mote the growth of the plants. If the weather is dry, the drills should be run

between by a drill-harrow or scuffler, let in as deeply as possible. But the width stirred should not exceed twelve inches,

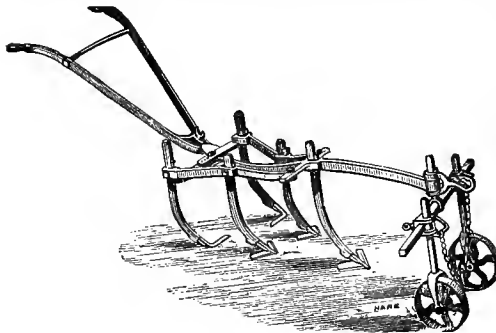


Fig. 357.—Turnip horse-hoe.

for if set wider the land will be too much drawn away from the plants before the process of singling is finished, and the raised drill too much reduced.

Fig. 354 (Sellar & Son, Huntly) represents a type of a drill-harrow, scuffler, or horse-hoe, which is largely used in Scotland. An ingenious and modern English turnip horse-hoe or scuffler, made

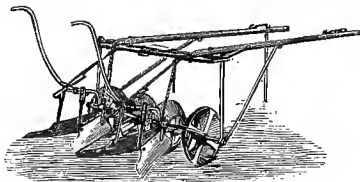


Fig. 358.—M'Kidd's drill-scarifier.

by S. Corbett & Son, Wellington, Salop, is represented in fig. 355. Other two very useful implements of the kind, but of different patterns, and made respectively by T. Corbett, Shrewsbury, and Vipan & Headly, Leicester, are shown in figs. 356 and 357.

Horse-hoes are made to take two or more drills at a time. English scufflers or horse-hoes are made so as to work either in the raised drills or in narrower rows on the flat system.

Harrowing across Flat Rows.

—In the south a sort of drag-harrow, in some cases similar to a light Scotch drill-harrow, is drawn right across the flat

rows before the first horse or hand hoeing, the object being to loosen the surface-soil, pull out surface-weeds, and thin out the plants a little. Careful turnip-growers in the north do not approve of disturbing the plants thus early and in such an irregular fashion.

Drill-Scarifier.—A drill-scarifier, first brought out by Mr M'Kidd, Thurso, Scotland (and shown in fig. 358), is used on some farms in the north for paring away the sides of the drills, thus destroying weeds, and bringing the drills into the intended form, leaving less to be done by the hand-hoe. The implement, as made by various firms (that here illustrated being made by T. Hunter, Maybole), somewhat resembles an improved turnip-sower without the seed-boxes. The centres of the bevelled rollers

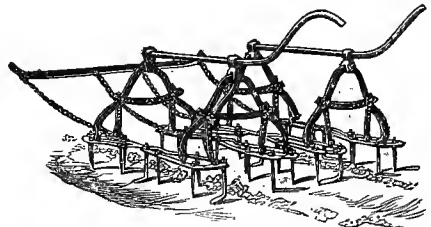


Fig. 359.—Dickson's turnip-cleaner.

are left out, so as not to injure the plants, and four steel plates for paring the edges of the drills are attached to the frame. The plates can be attached to an ordinary turnip-sower, if the rollers are made so that the centre part can be removed.

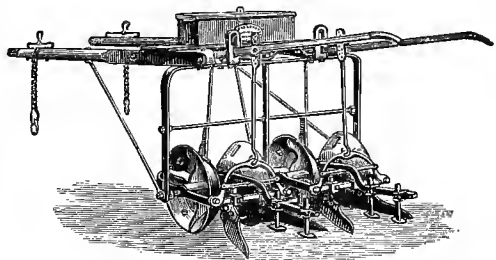


Fig. 360.—Briggs's turnip-thinner.

Turnip-cleaner.—Dickson's double-drill turnip-cleaner, made by Thomas

Hunter, Maybole (shown in fig. 359), is a useful implement for working up close to the turnip plants.

Thinning-machines.—To perfectly single turnips by machine is practically impossible. Several more or less successful machines have, however, been constructed to thin the plants in raised drills, and render the work of singling more easy to accomplish either by hand or hoe. If the soil is fine, and the braird equal, these machines are an undoubted saving of labour. Two successful machines of this kind are here illustrated—fig. 360, patented by General Briggs of

to the width usually left between the plants.

Process of Hand-hoeing on Raised Drills.—As already mentioned, the tur-



Fig. 363.—Turnip hand-hoe.

a Thin iron plate. b Eye of plate. c Wood shaft.

nips should be thinned when they measure about an inch across, when the tops are well into the rough or second leaf. The hoer ought to be taught to draw

the hoe towards himself or herself in pulling out the spare plants, and to work as lightly as possible. If the plants are pushed away from the hoer, a deeper hold of the soil must be taken, a greater quantity of soil will be removed from the remaining turnips, the drills will be more pitted and levelled, and the plants thus too much denuded of support. Hoers generally take pride in their work, striving to leave the drills as high and symmetrical, and as smooth

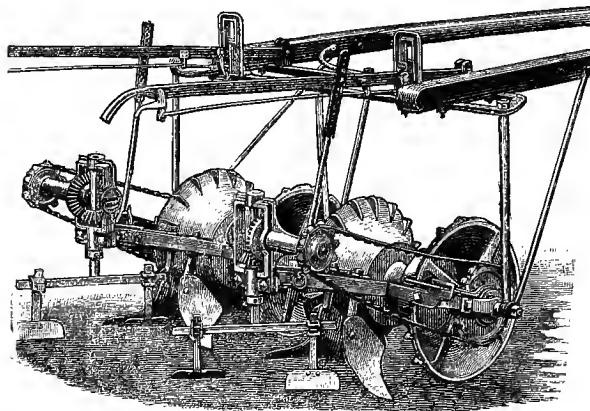


Fig. 361.—Wardlaw's turnip-thinner.

Strathairlie, Largo; and fig. 361, patented by T. Wardlaw, Toughmill, Dunfermline.

Hand-hoes.—The hand-hoe used in thinning turnips is a simple instrument. Yet even in it improvements have been introduced in recent times. Instead of

the shaft or handle being closely attached to the blade, it is now often made with a bow-shaped attachment, as shown in



Fig. 362.—Improved hand-hoe.

fig. 362. A hoe of this pattern works more lightly and cleanly than the hoe of the old shape, shown in fig. 363. The length of the blade of the hoe varies from 5 to 8 inches, according

in the surface as possible, all weeds thoroughly removed—uprooted, not cut—and the plants thinned to precise distances as arranged, care being taken to leave strong well-formed plants, and never two together.

Hoeing-matches.—In some parts of the country hoeing-matches in the evening are quite an institution, and there is often great enthusiasm amongst the rival hoers—the farmers' families and servants of the surrounding district. These friendly contests are very properly encouraged by farmers, for they stimulate tasteful and careful hoeing, which in turn has a considerable influence upon the yield of the crop—far greater than would be at first thought imagined.

Good and Bad Hoeing.—It is quite within reason to say that the difference in the yield between a carefully hoed piece of ground—hoed as we have in-

licated above—and another hoed carelessly, with irregular intervals between the plants, weak plants left instead of strong, two plants sometimes left together, and the drills cut deeply into, and weeds only partially removed,—in short, between good and bad hoeing,—may very easily amount to from 2 to 4 tons per acre!

Hand-hoeing in Flat Rows.—Here, also, the plants should be drawn towards the hoer. Indeed, as will be readily understood, the great part of the hand-hoeing on the flat must be done in this way, as it is more difficult to push out weeds in the flat row than on the raised drills.

Speed of Hoers.—The amount of work done by hoers varies according to the soil, the width of the drills or rows, the intervals left between the plants, the thickness of the seeding, and the stage at which the hoeing is done. If the soil is clean in raised drills, the plants not too thick, and taken at the proper size, an average hoer should overtake an imperial acre in from twenty-five to twenty-seven hours. If circumstances are very favourable, it may be done even in twenty hours; and if very unfavourable, it may take forty to forty-five hours to single an acre. If the drills are well scarified, the work is much lighter.

Expert men-hoers often go over the ground almost as quickly in the flat-row system of the south, where the rows may be only from 18 to 20 inches apart. But it would be all the better for the crop if a little more pains were taken with the hand-hoeing than is often the case.

In Scotland, Ireland, and the north of England, women do a large portion of the hoeing; but in the midland and southern counties of England it is performed almost entirely by men and lads.

Thinning by Hand.—In some cases when a greater breadth of plants comes forward at one time than can be gone over with the hand-hoe as quickly as may be considered desirable for the sake of the crop, thinning by hand is resorted to. This is an expeditious method of averting injury by the overcrowding of the young plants. In the long-run, how-

ever, it increases the cost of thinning and hoeing.

The better system of management, therefore, is to have a sufficient force of hoers to overtake the thinning as the plants become ready for the process. In average seasons the sowing is done so that the plants come forward to the hoe in breaks; but irregularities in the weather may upset this arrangement, and result in a pressure of work at certain times in the hoeing season, perhaps justifying recourse to hand-thinning if an extra force of hoers cannot be obtained. In any case, some farmers, who are particularly careful of their turnip crop, would give the preference to the hand-thinning, because by it a little more care can be exercised in leaving the strongest plants.

In some parts the thinning is done partly by the hoe and partly by hand. The hoers go on before, taking gaps out of the row of plants, leaving little bunches of perhaps three to half-a-dozen plants, while lads and women follow, and single these bunches by the hand, taking care to leave in the strongest and most promising-like plant in each bunch.

Transplanting Turnip Plants.—Common turnip plants cannot be transplanted with success. With swedes, however, transplanting is often done, to fill up blanks in the drills. The results are fairly satisfactory, sometimes yielding nearly half the weight of an average bulb.

Distance between Plants.

There has been much discussion, and there is still wide difference of opinion, as to the distances which should be left between turnip plants. The prevailing practice in this matter has undergone many modifications and alterations since the introduction of turnips as a regular field crop throughout the country generally.

Mr Stephen Wilson's Experiments.—Probably no one has given closer or greater study to the botany of the common farm crops than Mr A. Stephen Wilson, North Kinmundy, Aberdeenshire, author of that interesting work entitled *The Botany of Three Historical Records*. Mr Wilson carried out in the

three years prior to 1879 an exhaustive series of experiments, extending over several farms, on numerous fields and with different kinds of turnips and swedes, with the view of throwing light upon the subject of turnip-thinning. In the *Transactions of the Botanical Society of Edinburgh*, 1876-77, and in a pamphlet entitled "Agricultural Botany: Turnip Singling," published by John Rae Smith, Aberdeen, in 1879, Mr Wilson records the results of these experiments, which are unquestionably the most elaborate, searching, and reliable of the kind that have as yet (1889) been made in this country. It will be interesting to contrast here the conclusions arrived at by Mr Wilson with the prevailing practices throughout the country as to the distances left between turnip plants.

Peculiarities of Turnip Seed.—It is calculated that there are about 140,000 seeds of the common turnip (the seed of swedes being a trifle heavier) in a pound weight, and that with drills 27 inches wide and 3 lb. of seed sown per acre, about fourteen times as many seeds are planted as are intended to grow. As the result of carefully conducted experiments,¹ Mr Wilson found that large turnip seeds produced heavier bulbs than smaller seeds; and by way of emphasising the importance of selecting good seed and good sound heavy-producing varieties of roots, he remarks:²—

"Our turnip seeds are not to be regarded as mere indifferent starting-points, which, like a gun-ball answering the charge of powder, will go forward the obsequious messenger of some grasping phosphate. A turnip seed is a fully formed plant. It has two leaves tightly wrapped round its root. And within the substance of these two leaves, or cotyledons as they are called, it has a store of milk or papp, needing only to be moistened by water to enable it to start in the world and walk a little without manure of any kind. So long, indeed, as its own sandwiches hold out, most other kinds of food are poison. But no two seeds are alike, or equally furnished for

the journey in the drill; and therefore we must study the character and capacity of our little embryos. Some of them have a faultless constitution, and if their disagreeable neighbours were hoed out of the way, would acquire the enviable brascical corpulence of eight or ten pounds. Others have a taint of some insidious disease, or the hopes of their youth are set upon by a myriad of the spores of plasmodia, and thus they may protract a miserable existence under a diameter which would be discreditable to a parsnip. We have therefore to endeavour to find out to what weight the average plant will attain. We have to find out the extent of ground in which a turnip will attain its greatest dimensions. We have to find out whether the greatest individual dimensions are consistent with the greatest crop. And, involved in this, we have to ascertain whether our plants should be permitted to go on to their greatest size, or should be checked at a certain bulk by limitation of the spaces in which they grow. In virtue of certain, presently unknown, properties, some varieties naturally acquire a greater bulk than others; and we have to consider whether our crops, without any additional outlay of manure, might not be augmented by a more general adoption of the most prolific varieties."

Weight without Singling.—Assuming that 3 lb. of the seed of common turnips were allowed to grow at equal distances in 27-inch drills, there would be about 420,000 plants in an acre, with little more than half an inch to each plant. In this space the plants would probably attain a weight of nearly half an ounce each. This would give a total weight of about 6 tons per acre without thinning.

To what distance should the plants be thinned in order to secure the maximum weight per acre? This was the question which Mr Wilson endeavoured to answer.

Trials at 6, 9, and 12 Inch Distance.—In 1877 Mr Wilson experimented with greystone globes and swede turnips, thinned in 27-inch drills to 6, 9, and 12 inches between every two plants. The following were the results:—

¹ *Trans. Bot. Soc., Edin.*, 1876-77.

² *Ag. Bot.*, 10.

Interval.	No. of Plants per Acre.	GREYSTONE GLOBES.		SWEDES.	
		Average Actual Weight.	Total Theoretical Weight per Acre.	Average Actual Weight.	Total Theoretical Weight per Acre.
12 inch . . .	19,360	lb. 1.70	tons. 14.29	lb. 2.50	tons. 21.61
9 " . . .	25,813	1.42	16.36	1.95	22.47
6 " . . .	38,720	1.15	19.88	1.54	26.62

The year 1877 was unfavourable for turnips, and these weights are far below the average of Mr Wilson's district of Aberdeenshire, which is noted for its production of turnips. Moreover, this experiment was conducted on a small scale, so that a calculated instead of an actual weight per acre had to be shown. It was therefore decided to carry out an experiment in the following year on a much more extensive scale.

From this first trial it is seen that, although the individual roots were heaviest with the greatest width, yet by far the greatest weight per acre was obtained with the short intervals of 6 inches—the 6-inch distance beating the 12-inch by 5.15 tons per acre with greystone globes, and by 5 tons per acre with swedes; while the advantage of the

6-inch over the 9-inch was 3.50 tons per acre with greystone globes, and 4.15 tons with swedes.

Twelve Inches Discarded as too Great.—This result in regard to the 12-inch distance so fully coincided with trials previously conducted by Mr Wilson, that he decided to discard that interval as greater than could be justified in practice.

Trials with 6, 8, and 9 Inch Intervals.—The next series of experiments were restricted to intervals of 6 inches, 1 link or 7.92 inches (practically 8 inches), and 9 inches. These trials were conducted in 1878 on seven fields on seven different farms, and all the work of planting, singling, numbering, and weighing was done by Mr Wilson himself. The results were as follows:—

	COMMON TURNIPS. Average of several varieties.			SWEDES. Average of several different kinds.		
	Actual Weight of Plant.	Actual Weight per Acre.	Theoretical Weight per Acre.	Actual Weight of Plant.	Actual Weight per Acre.	Theoretical Weight per Acre.
6 inch	lb. 1.84	tons. 28.64	tons. 31.88	lb. 1.83	tons. 25.48	tons. 31.61
8 " } . . .	2.40	26.61	28.78	2.22	24.22	26.52
9 " }						

Deficiency in Weight at Greater Distances.—Mr Wilson points out that in order to give as heavy a total yield per acre, the roots at 9-inch and 1 link intervals would need to bear in weight

to the weight of the roots grown at intervals of 6 inches the proportions of 150 and 132 to 100. How far short they fell of this will be shown at a glance in the following table:—

	COMMON TURNIPS.			SWEDES.	
	6 Inch.	1 Link.	9 Inch.	1 Link.	9 Inch.
Proper proportion for equal weights per acre	100	132	150	132	150
Actual average proportion . . . . .	...	114	138	119	126
Percentage deficiency in weight at the greater distances . . . . .	...	18	12	13	24

Mr Wilson's Conclusions.—In referring to the details of his experiments, Mr Wilson remarks that over the seven fields on the seven farms, with several different kinds of turnips, they show such uniformity as hardly leaves any doubt that in general 6-inch intervals will ensure a heavier crop of swedes or of common turnips than either 8 or 9 inch intervals. Indeed, he says he satisfied himself, after all his trials with many sorts of turnips, in favourable and unfavourable seasons, under ordinary rotation of cropping, that 6-inch intervals will give a heavier crop than any wider interval.

And these conclusions derive special importance from the fact that Mr Wilson is no mere theorist or enthusiastic reformer. He is, indeed, a most painstaking, scientific, and thoroughly impartial experimenter. We have no hesitation in saying that the most implicit reliance may be placed upon the accuracy and genuineness of his experiments.

It is, of course, a different matter to consider how far the conclusions arrived at by Mr Wilson might be advantageously extended into ordinary farm practice.

Prevailing Intervals.—These experiments by Mr Wilson, and other more limited trials, have tended to shorten the intervals left between turnip plants in certain districts. The prevailing intervals are still, however, considerably wider than Mr Wilson would advise. Where the system of raised drills obtains, the intervals most general are from 10 to 12 inches in the cases of swedes, and from 8 to 10 inches for common turnips. A good deal depends upon the known habit of the particular variety of roots, whether

it is inclined to develop large or medium bulbs. The soil and climate must also be considered, for under conditions which favour the growth of large roots the intervals should be longer than where small roots are expected.

The space between the plants should of course vary with the width of the drill, or between the rows of plants if the crop is grown on the flat surface. The most general width of the raised drill is 27 inches, and, as will be readily understood the plants may be left nearer each other in these wide drills than in the much narrower flat rows which abound in the midland and southern counties of England. These flat rows are usually only from 16 to 20 inches apart, and so the intervals between the plants there most frequently vary from 13 up to 16 inches for swedes, and about 2 or 3 inches less in the case of other varieties of turnips.

Growing Roots in Squares.—There is little doubt that the maximum weight per acre of roots would be obtained by growing them at equal distances apart in all directions, in squares of one foot or 14 inches for instance. Indeed it was found by experiments in Canada that a better crop resulted from placing the plants in the centre of a square unit than in the middle of an oblong unit, as in the case of common drilling.

Advantages of Drills.—But there is a practical advantage in the drill and row systems which far outweighs any loss in the produce of roots. The cleaning and tilling of the land are facilitated, and thus by growing them in tolerably wide rows or drills the root crops take the place of the costly "fallows" of olden times.

Medium and Large Roots.—One

important point which should be kept in view in discussing and deciding as to the best intervals to be left between turnips is the ascertained fact that, as a rule, medium-sized bulbs show a higher specific gravity and contain a greater percentage of useful feeding material than exceptionally large-sized roots. This is the case in a very marked way with the common varieties of turnips. It is slightly different with most kinds of swedes. "Large" and "small" are comparative terms. It is claimed for most of the improved varieties of swedes that the larger they grow the more nutritious they become. What is meant in this case of course is, not roots of abnormal dimensions, but what the practical farmer would regard as large roots grown under normal conditions.

The object of every farmer should certainly be to grow a big—that is, a heavy—root in relation to the space allotted to it. What has been taught by investigations as to the nutritive properties of roots of different sizes is not that small varieties of roots should be cultivated, but that the maximum quantity of good feeding material per acre is more likely to be obtained by growing (at shorter intervals) a greater number of medium-sized roots than a smaller number (at longer intervals) of abnormally large roots—this, too, even although in both cases the gross weight of the produce may be equal. In other words, three medium roots—"big-little" roots—weighing each 3 lb., and grown in, say, 30 inches of an ordinary drill, will, as a rule, contain less water and more solid nutritive matter than two bulbs of $4\frac{1}{2}$ lb. each, grown in the same area of ground.

Moderate Intervals.—The teaching of modern investigation is therefore decidedly in favour of shortening the intervals between the turnip plants. For common turnips from 6 to 9 inches should perhaps be the range in drills from 26 to 28 inches wide, and for swedes about 2 inches more. In flat rows from 16 to 20 inches wide, suitable intervals would be from 9 to 11 inches for common turnips, and from 11 to 14 inches for swedes. In dry seasons favourable to mildew the wider intervals will likely give the best results. The free exposure of the plants to the atmos-

phere, as in wide singling, has a tendency to check the development of mildew.

Irregularity in Growth of Turnips.—Notwithstanding every care taken to single the plants at equal distances, it will usually be found after the crop has made some progress in growth that irregularities appear both in the distances apart and in the size of plants. Unless the seeding is very liberal, plants are apt to appear and grow somewhat irregularly, especially in dry weather. A good hoer will strive to leave a strong plant, even if an extra inch or two beyond the distance intended. After hoeing, plants are occasionally pulled up by crows and wood-pigeons, and cut across by wire-worm and grub-worm. Some of the plants receive other injuries which prevent growth. The smaller and more backward get shaded and overtopped. The available supply of manure is appropriated by their more vigorous neighbours. The manures, especially dung, are seldom too well spread; so that an average field will show not a little irregularity both in size of bulbs and distance apart. Indeed it is only on the most fertile and easily pulverised soils, and under the most favourable circumstances of soil and climate, that the bulbs approach equality of size and regularity of distance apart.

After Cultivation.

The cultivation required by turnips after the singling has been completed consists of hand-hoeing once or twice, and horse-hoeing between the rows of plants two, three, or more times. The season and condition of the land as to weeds and tilth will regulate the number of hoeings.

About ten or fourteen days after singling, the horse-hoe or drill-harrow is run along the drills or between the rows of plants, to stir up the soil and eradicate weeds. The second hand-hoeing may follow in a few days, the hoers removing all weeds left by the horse-hoe or drill-harrow, and loosening, but not displacing, the earth around the plants. If in any case two plants have been left together, in singling one should now be carefully pulled by hand.

Care in Hoeing Strong Plants.—It is no doubt beneficial, except in times

of drought, to stir the soil around the plants even after they have grown almost to cover the drill with their tops. In this operation, however, the greatest care must be exercised not to cut the rootlets, which are now spreading like net-work in all directions, and which cannot be cut or seriously disturbed without less or more injury to the crop. For this reason the third hand-hoeing is often abandoned.

Earthing-up Turnips.—It is sometimes found beneficial, chiefly on wet soils, to earth-up turnips immediately after the second hand-hoeing. The main advantage of this is, that surplus surface-water is carried away more freely. In dry soils, however, the earthing-up may do more harm than good. Some of the rootlets may be cut or injured by the plough, and their development thus impaired. Then the sharp, deep furrows are troublesome, even dangerous, in case of sheep feeding on the roots, as sheep may get upon their backs in the ruts, and perish if not released in time.

If earthing-up is to be done at all, it should be carried out as soon as possible after the second hoeing. The younger the plants the less will be the injury or disturbance to the rootlets. But the earthing-up of turnips is neither a general, nor, as a rule, a commendable practice.

Turnip Pests.

Birds of Prey.—No sooner is the seed of the turnip sown than animals begin to prey upon it. Pigeons are eager to pick up the uncovered seeds. Various small birds, such as linnets and finches, run up the drills just as the cotyledons are appearing above ground, pull up the plants, and devour the softened seeds. In some seasons these birds do such injury as necessitates the resowing of acres of turnips. When the turnip gets into the rough leaf, rabbits and wood-pigeons nip off the leaves and thus retard the growth of the plants.

Protecting the Seeds.—The seeds may be protected from birds by rubbing them with red-lead before sowing. Paraffin has also been tried with success, but it is not so safe as dry lead.

Insect and Fungoid Injury.—The insects and fungi which prey upon turnips are numerous. These are dealt with

in a chapter in this volume devoted specially to the insect and fungoid pests of the farm.

Conditions influencing Nutrition in Turnips.

Careful and observing feeders find marked differences, not only in the keeping, but also in the feeding properties of the several kinds of both swedes and yellow turnips in cultivation.

Soil and Nutrition in Roots.—The soil has a decided influence on the quality of the turnip crop. A heavy clay soil produces roots of good and nutritious quality. A light medium soil will also produce roots of a fattening quality, but a moorland soil with red subsoil or pan will produce bulbs that are less nutritious. On moorland soils turnips seldom grow much in autumn after the tap-root reaches the subsoil, and small bulbs of poor quality are the result. Peaty soils, if they contain a mixture of other ingredients, usually produce large roots, but of soft and spongy quality, producing dark-coloured dung in the cattle using them.

Manures and Nutrition in Roots.—Professor Jamieson of Aberdeen, who conducted for the Aberdeenshire Agricultural Research Association an elaborate series of experiments on the growth and composition of the turnip crop, found the composition of the bulb to be largely influenced by the manures applied.

The application of nitrogen increased the percentage of water, and lowered the percentage of solids in the bulbs. In the crop grown in 1876, the forty-five yellow turnips he selected, grown with nitrogenous manures, contained an average of 8.31 solids. Twenty-five grown without nitrogenous manures, contained an average of 9.18 solids. Ten selected Swedish turnips, manured with nitrogenous manures, contained an average of 10.19 solids; ten not manured with nitrogenous manures, an average of 10.43 solids.

Subsequent experiments, and also those made by Professor Jamieson in Huntingdon and Kent, confirmed these results. He found that small-sized bulbs yielded about one per cent more solid matter than large bulbs. Other experimenters have found the solids diminished by the use of soluble phosphate in the manure.

Nutrition in Large and Small Roots.—Dr Aitken made an analysis of turnips grown on sixty plots, manured variously, at Pumpherston experimental station in 1882; and Mr David

Wilson, jun., Carbeth, made analysis of turnips from twenty-seven plots, also variously manured, at Carbeth, Stirling-shire, in 1884. The following are the results:—

	Average Weight of each Bulb.	Percentage of Dry Matter in fresh Turnips.	Composition of 100 parts Dry Matter.							Percentage of total Nitrogen Albuminoid.
			Albuminoids.	Non-Albuminoid Nitrogen $\times 6.25$.	Extractive Matter free from Nitrogen.	Sugar.	Ash.	Fibre.	Total Nitrogen.	
Average analysis of turnips from 60 plots, Dr Aitken	oz. 27.6	8.71	7.72	1.34	74.26		5.98	10.79	1.446	85.2
Average analysis of turnips from 27 plots, Carbeth .	25.4	8.91	6.06	6.76	15.23	52.95	7.47	11.54	2.056	47.3

It would thus seem that whatever tends to increase the size of bulb, or weight of the crop, has a tendency to increase the percentage of water, and lower the percentage of solid matter in the bulbs, whether it be by the application of nitrogenous manures, the use of much soluble phosphate, or wide distances between the plants; and that the composition and quality of the yellow turnip is more

easily affected than those of the swede. If a good feeding and keeping quality of yellow turnip is desired, too much soluble phosphate should not be used, the application of nitrogenous manure should be restricted—as large quantities retard the ripening and induce a coarse watery bulb—and if the soil is good, the distance between the plants should be kept rather small than large.

SOWING MANGELS.

The mangel-wurzel, known more commonly as mangel, also as mangold, is embraced in the general term of “root crops.” It belongs, however, to a race of plants quite distinct from the *Cruciferae*, to which turnips and cabbages belong. The mangel cultivated on farms is the *Beta vulgaris* of the natural order *Chenopodiaceae*. It is really a cultivated form of the wild sea-shore beet found in countries of the temperate zone. It was first grown as a garden plant, and it is understood that the field mangel was raised by crossing the red and white varieties of garden beet, the great development of root and distinctive fea-

tures being obtained by persistent careful cultivation and selection.

Professor Wilson states that the mangel was introduced into this country in 1786 by Thomas Booth Parkins, who obtained the seed in Metz. It is cultivated largely in France and Germany for the production of sugar. It is grown in the United Kingdom solely as food for stock.

Climate for Mangels.—Mangels require different climatic conditions from those most favourable to turnips. Dry, hot summers are best suited to mangels. They thrive admirably, and yield a great weight per acre, in the southern counties

of England and in the warmest parts of Ireland; but even in the best favoured districts of Scotland they are unreliable, and north of the Tweed are grown only to a very limited extent. Mangels stand drought much better than turnips.

Soils for Mangels.—Mangels need good soils. Thin poor soils, and the bleak, cold, high-lying lands upon which turnips luxuriate, are quite unsuited for mangels. Rich alluvial loams in high condition and well cultivated are best adapted for mangels, and they also grow well on strong lands in a warm climate, if these are carefully prepared and liberally manured. For the strong lands of the south of England they are better suited than turnips.

Cultivation for Mangels.—The preparation of land for mangels is in the main similar to that for turnips. And having already discussed so fully the various methods of autumn and spring tilling, cleaning, and manuring land for turnips, it will be unnecessary to do more here than point out wherein these practices should be varied to suit the mangel crop.

Autumn Tillage.—The great object to be aimed at in preparing land for mangels is to have it cleaned, dunged, and deeply ploughed in autumn. When the land is stiff these should be done as early in autumn as possible, generally before the end of October. Deep autumn ploughing is especially beneficial for mangels, and where the subsoil is inclined to form into a "pan," it should be broken up by subsoil ploughing.

It is a good plan, after the land has been thoroughly cleaned and deeply ploughed in September or October, to at once open drills, spread the dung, and cover in the drills just as at seed-time for turnips. Some recommend that before spreading the dung a drill-grubber should be run along to loosen the bottom of the drills. In these ridges the land lies throughout the winter, admirably exposed to the disintegrating influences of the season, and is found easily prepared for the seed next spring.

Spring Tillage.—When the land has been cleaned, ploughed, and dunged in drills in autumn, as just described, little has to be done in the way of tillage in

spring. A light harrow is drawn along the drills (not across them), the drills are again set up by the drill-plough, and the seed thereupon sown. Such artificial manure as is to be given may be sown broadcast either before the harrowing or before the setting up of the drills.

When the dung has been simply ploughed in with an ordinary furrow in autumn, the land has to be grubbed and harrowed in spring just sufficiently to secure as fine a tilth as possible. Deep spring ploughing when the land has been dunged in autumn is not to be commended.

It often happens, most generally in fact, that a sufficient supply of dung is not available till well into the winter or early in spring. In this case the land is cleaned in the autumn and left in a strong furrow till early spring, when it is grubbed or ploughed, or both, then harrowed, drills opened—if the raised drill system is pursued—the dung spread, artificial manure sown, the drills closed, and the seed sown.

Strong land should be stirred as little as possible in spring. Mangels, like turnips, delight in a fine moist seed-bed, and it is difficult to obtain this with much stirring of strong land late in spring.

Drills and Flat Rows.—Mangels are sown both in rows on the flat and in raised drills. The latter is the better plan, as it affords greater facilities for the after tillage and cleaning of the land. The rows on the flat usually vary from 18 to 25 inches wide, and the raised drills from 25 to 28 inches.

Mangel Seed.—The seed of mangels is encased in a rough woody capsule which makes germination very slow, unless special means are taken to hasten it. For this purpose the seed is steeped, for from 12 to 36 hours, before sowing—by some in warm water, by others in cold water, and by others again in liquid manure. If warm water is used, 12 to 14 hours should be sufficient. The seeds, when removed from the steep, are spread on a wooden floor, or on canvas cloth or sieve, and allowed to attain such a state of dryness as will prevent adhesion. In some cases the saturated seed is coated with a quantity of

finely powdered charcoal, which is freely mixed with it.

The seed is then sown either by the flat-row drill or raised-drill machine, as the case may be. The peculiarities of the mangel seed necessitate the attachment of specially devised seed-boxes. Water or ashes may be sown along with the mangel seed, as in the case of turnips.

Quantity of Seed.—The quantity of mangel seed sown per acre is usually about 6 or 7 lb.

Time of Sowing.—Mangels have to be sown earlier than turnips. April is, as a rule, the best month for mangel sowing, but portions of the crop are usually sown earlier, sometimes even as early as February. When, owing to a crop of winter rye or some other catch crop occupying the land, or when, from some other cause, it cannot be prepared sooner, sowing may be done in May. After the middle of that month it would be very risky.

Manures for Mangels.

Dependency on Manure.—Mangels require, and will under favourable conditions repay, liberal manuring. It would be useless to attempt to grow them upon scanty fare.

They produce an extraordinary yield in a comparatively short space of time. To enable them to realise their full capabilities in this respect, an ample supply of the kinds of plant-food best suited to them must be furnished in a readily available condition. And the farmer must discriminate as to the kinds of plant-food to be supplied.

Ingredients absorbed by Mangels.

The following table, compiled from that on page 62, Divisional vol. i., shows the quantities of nitrogen, potash, and phosphoric acid—the three chief manurial elements—taken out of the soil by a crop of mangels weighing 22 tons of roots per acre:—

	Roots. lb.	Leaves. lb.	Total. lb. per acre.
Nitrogen . . .	96	51	147
Potash . . .	222.8	77.9	300.7
Phosphoric acid	36.4	16.5	52.9

Elements of Manure for Mangels.

—These figures, compared with the corresponding analyses of a crop of turnips,

show at a glance that the manurial wants of the mangel differ considerably from those of the turnip crop. Phosphates are essential for both, but do not by themselves exercise such a marked effect on mangels as on turnips. On the other hand, nitrogen, so little required for turnips, must be freely given to mangels. Then mangels will turn heavy dressings of good farmyard dung to better account than turnips can, while the palate of the mangel would seem to delight in having its food seasoned with a substantial pinch of common salt.

Phosphates for Mangels.—The exhaustive series of experiments with various manures for mangels conducted at Rothamsted have shown that while superphosphate is essential in a complete manure for mangels, it gives but a poor return in this crop unless accompanied by a liberal dressing of nitrogenous manure. The following table shows the small effect of superphosphate, as also of mixtures of mineral manures, upon mangels:—

Average for eight years, 1876-83.

	Per acre. tons. cwt.	
No manure	4	9
3½ cwt. superphosphate per acre	5	2
3½ cwt. super., 500 lb. sulphate of potash	4	10
3½ cwt. super., 500 lb. sulphate of potash, 200 lb. common salt, and 200 lb. sulphate of magnesia		
	5	14

In these plots the mangels were grown year after year and removed from the land. Upon this impoverished soil the mineral manures alone were unable to appreciably raise the crop above the yield on the plot which had no manure of any kind for eight years.

But in conjunction with other manures a moderate dressing of superphosphate was found to be profitable in these experiments, as it has certainly been in ordinary farm practice. The truth of this remark will be shown clearly when we come to speak of the effect of "mixed manures" for mangels.

Nitrogen for Mangels.—The influence of nitrogenous manures upon mangels is quite wonderful. The following shows the results obtained in eight years' continuous cropping with mangels at Rothamsted:—

Average for eight years, 1876-83.

	Per acre.	
	tons.	cwt.
No manure	4	9
550 lb. nitrate of soda, equal to 86 lb. nitrogen	13	17
400 ammonia salts, equal to 86 lb. nitrogen		
Do. and rape-cake, equal to 184 lb. of nitrogen	7	7
Rape-cake, equal to 98 lb. nitrogen		
	11	7
	11	6

This result of an average of 13 tons 17 cwt. of mangel roots for eight years from a dressing of nitrate of soda alone is certainly very remarkable, all the more so when the exhausted condition of the soil is kept in view. In the first year of the trial, when the land may be supposed to have been in an average condition of general fertility, nitrate of soda alone raised the yield from 6 tons 10 cwt. with no manure to no less than 20 tons 13 cwt. per acre. It is further remarkable, as showing the importance of readily available nitrogen for mangels, that even where a heavy dressing of farmyard dung had been spread, the addition of nitrate of soda gave a marked increase in the crop. This result will be shown under the heading of "Mixed Manures for Mangels."

A point of striking importance brought out here—and quite in keeping with practical experience—is the fact that the more slowly acting forms of nitrogenous manures have not given such a satisfactory yield of mangels as the quickly acting nitrate of soda.

Salts of ammonia, for instance, which yield up their nitrogen more slowly than nitrate of soda, have throughout the Rothamsted experiments—by themselves and in conjunction with other manures—had a much weaker effect upon mangels than the nitrate of soda. It will be noticed presently that the best results from ammonia salts were obtained when the dressing of artificial manures included a liberal supply of potash.

Similar remarks would apply to rape-cake. By itself or in conjunction with superphosphate it acted slowly, but with plenty of available potash present it gave as good results as did nitrate of soda.

The lesson which the practical farmer would perhaps draw from these results

is that along with a liberal dressing of mixed manure, including superphosphate and potash, the slower forms of nitrogenous manure, such as ammonia salts or rape-cake, might be used with good effect, but that when the crop has to depend upon what is already in the soil for much of its food, especially potash, the more readily active form of nitrate of soda should be selected for mangels.

Potash for Mangels.—The results obtained by the application of potash for mangels at Rothamsted have been somewhat erratic. Potash is, of course, of no use alone. As a constituent of a mineral dressing it was of little or no account. With the quickly acting nitrogen in nitrate of soda, it had only a slight effect. With the more slowly acting forms of nitrogenous manures, ammonia salts and rape-cake, it exercised a marked influence.

Dung for Mangels.—A substantial dressing of farmyard dung would seem to be even more desirable for mangels than for turnips. From dung, as from all suitable manures, under favourable circumstances, the former certainly give a much larger production per acre than the latter. The following table shows the marked influence of dung upon the mangel crop in the Rothamsted experiments:—

Average of eight years, 1876-83.

	Per acre.	
	tons.	cwt.
No manure	4	9
14 tons dung	15	10
550 lb. nitrate of soda	13	17
3½ cwt. superphosphate	5	2

It has been found in practice that to produce the maximum yields of mangels a liberal dressing of dung, along with other manures, is quite essential. Yet it is important to observe that, as will be shown presently, wonderfully large yields were obtained at Rothamsted from artificial manures alone.

Salt for Mangels.—It is not in the least surprising that the application of common salt has been found in general farm practice to substantially increase the yield of mangels. The plant, we have seen, is indigenous to the sea-coast, and its ash is found to contain from 25 to

50 per cent of common salt. The late Dr A. Voelcker applied salt to mangels on deep sandy soil, and obtained an increase of 2 tons 6 cwt. per acre from 3 cwt. of salt; 5 tons 11 cwt. from 5 cwt. salt; and 4 tons 1 cwt. from 7 cwt. salt. Sir James Caird has stated that a liberal dressing of salt, about 5 cwt. per acre, may increase the produce of mangels by 10 tons per acre.

In the series of Rothamsted experiments already referred to, the application of salt, along with other artificial manures, increased the yield in all cases. In some special investigations into the use of salt as a manure, Sir John Bennet Lawes and Dr Gilbert have obtained results unfavourable to salt. Indeed, Sir John states that in his special trials the salt seemed to check the growth of man-

gels, the produce of which, without salt, was 21 tons 2 cwt.; with 5 cwt. salt, 20 tons 10 cwt., and with 10 cwt. salt, 18 tons per acre.

These results at Rothamsted indicate that the application of salt is not desirable in all circumstances. Yet it is well established in farm practice that a moderate dressing of from 2 to 5 cwt. of salt will, as a rule, be profitable.

Mixed Manures.—Having noticed briefly the effects of the chief manurial elements by themselves, we shall now glance at the results obtained from mixed dressings. The results of the Rothamsted experiments on mangels in the eight successive years 1876-1883, may be conveniently shown in the following table:—

Yearly Dressing. Per acre.	Average of Bulbs for eight years. Per acre.	
	tons.	cwt.
No manure	4	9
3½ cwt. superphosphate	5	2
550 lb. nitrate of soda	13	17
400 lb. ammonium salts	7	7
2000 lb. rape-cake and 400 lb. ammonium salts	11	7
2000 lb. rape-cake	11	6
14 tons dung	15	10
14 tons dung	21	9
550 lb. nitrate of soda, equal to 86 lb. nitrogen		
14 tons dung	22	6
400 lb. ammonium salts, equal to 86 lb. of nitrogen		
14 tons dung	25	1
2000 lb. rape-cake		
400 lb. ammonium salts	22	8
14 tons dung		
2000 lb. rape-cake	15	13
14 tons dung		
3½ cwt. superphosphate	23	10
14 tons dung		
550 lb. nitrate of soda	22	1
14 tons dung		
3½ cwt. superphosphate	24	13
400 lb. ammonium salts		
14 tons dung	22	17
3½ cwt. superphosphate		
2000 lb. rape-cake	16	18
3½ cwt. superphosphate		
550 lb. nitrate of soda		

Yearly Dressing. Per acre.	Average of Bulbs for eight years. Per acre.	
	tons.	cwt.
3½ cwt. superphosphate	9	10
400 lb. ammonium salts		
3½ cwt. superphosphate	12	8
2000 lb. rape-cake		
400 lb. ammonium salts	12	17
3½ cwt. superphosphate		
2000 lb. rape-cake	4	10
3½ cwt. superphosphate		
500 lb. sulphate of potass	17	9
3½ cwt. superphosphate		
500 lb. sulphate of potass	14	15
550 lb. nitrate of soda		
3½ cwt. superphosphate	22	10
500 lb. sulphate of potass		
400 lb. ammonium salts	17	14
3½ cwt. superphosphate		
500 lb. sulphate of potass	5	14
2200 lb. rape-cake		
Mineral manures, consisting of 3½ cwt. superphosphate, 500 lb. sulphate of potass, 200 lb. chloride of sodium (common salt), and 200 lb. sulphate of magnesia	19	10
Above mineral manures		
550 lb. nitrate of soda	16	1
Above mineral manures		
400 lb. ammonium salts	25	14
Above mineral manures		
2000 lb. rape-cake	19	13
400 lb. ammonium salts		
Above mineral manures		
2000 lb. rape-cake		

These results tabulated as above will repay careful consideration.

Conclusions.—The principal conclusions which this consideration will point to are:—

1. *In regard to Dung and Nitrates.*

That even with a liberal dressing of dung a further supply of nitrogen, in the form of artificial manure, gives a large increase in the crop.

That the largest dressing of nitrogenous manure gave the heaviest crop.

That with dung the different forms of nitrogenous manures tried, nitrate of soda, ammonium salts, and rape-cake, are nearly equal in efficacy.

2. *Dung and Superphosphates.*

That the addition of superphosphates to dung gave hardly any increase in the crop.

3. *Dung, Superphosphates, and Nitrates.*

That with dung, and quickly acting nitrogenous manure in the form of nitrate of soda, the addition of superphosphate gave a moderate increase in the crop, fully 2 tons per acre, on the average for the eight years.

That with dung, and the more slowly acting forms of nitrogenous manures, such as ammonium salts and rape-cake, the addition of superphosphate had very little influence on the crop.

4. *Superphosphate and Nitrates.*

That a mixture of nitrogenous manures and superphosphate produced more than double the yield from superphosphate alone, and from 1 to 3 tons more than the yield from nitrogenous manures alone.

That the increase from the addition of superphosphate was largest with the quickly acting nitrogenous manure in the form of nitrate of soda.

5. *Superphosphate and Potash.*

That the addition of potash to superphosphate produced no increase, but rather the reverse on the crop.

6. *Superphosphates, Nitrates, and Potash.*

That the addition of potash to the mixtures of nitrogenous manures and superphosphates produced a remarkable increase in the crop.

That this increase is greatest with the slowly acting nitrogenous manures—greatest of all in the plot which had most nitrates in the form of ammonium salts and rape-cake.

That the addition of potash to the ammonium salts, rape-cake, and superphosphates increased the yield by from close on 5 to over 10 tons per acre, as compared with an increase of only about half a ton on the plot which received superphosphates and nitrate of soda.

That the less dependency of the nitrate of soda plot upon applied phosphates and potash would seem to be due to the greater power which the quickly acting nitrate of soda (as compared with the more slowly acting nitrogenous manure) exert upon the capabilities of the crop to ransack the soil for the phosphoric acid and potash it already contains. This conclusion would support the general opinion among practical farmers, that nitrate of soda is not only itself a valuable source of plant-food, but possesses the additional attributes of a stimulant, enabling the crops to utilise more largely the supplies of other elements of plant-food which exist in the soil.

7. *Mixed Mineral Manure and Nitrates.*

That a mixture of mineral manures, consisting of superphosphate, potash, common salt, and sulphate of magnesia, had by itself very little influence upon the mangel crop.

That the addition of nitrogenous manure to this mineral mixture at once raised the crop to, in several cases, nearly the level of the yield from dung and nitrogenous manures.

That the highest average over the entire series was obtained from mineral manures and the heaviest dressing of artificial nitrogenous manure, in the shape of ammonium salts and rape-cake, exceeding the dung, ammonium salts, and rape-cake by an average of 13 cwt. per acre over the eight years.

That dung and ammonium salts beat mineral manures and ammonium salts by 6 tons 5 cwt. per acre.

That dung and nitrate of soda beat mineral manures and nitrate of soda by about 2 tons per acre.

That nitrate of soda is thus a more

suitable form of nitrogen to accompany mineral manures than ammonium salts.

8. Common Salt.

That with all kinds of nitrogenous manures the addition of common salt seemed to increase the yield—the increase from common salt and sulphate of magnesia being from about $1\frac{1}{2}$ to 3 tons per acre.

Farmers must think for themselves.—It cannot be doubted that from experiments conducted by others—such as these just described—farmers may derive much information that will be useful to them. Yet conclusions which may be thoroughly sound in regard to one set of circumstances cannot be said to have a general, or even a very wide application. So great is the variation in soil, climate, and system of cropping throughout the country, that each farmer must think for himself as to the particular dressing of manure that will be best adapted for his own special circumstances. He must study the climate, the nature of the soil, its condition as to fertility, abundance or deficiency of any of the essential ingredients of plant-food. Careful observation in this way, aided by test experiments on his own farm, and by a consideration of experiments conducted by others, will enable him to pursue such a system of manuring as may be expected to give satisfactory results.

Useful Dressings.—In general practice farmyard manure is almost always applied. To obtain a maximum crop, and yet maintain the land in a high state of fertility, a liberal allowance of dung may be regarded as essential.

Still it has been shown in the Rothamsted experiments that in certain circumstances a mixture of artificial manures, consisting of from 3 to 4 cwt. of superphosphate per acre, 5 cwt. of sulphate of potash, 2 to 3 cwt. of common salt, and 4 or 5 cwt. of nitrate of soda, and perhaps a little rape-cake, might produce a fairly satisfactory crop of mangels without any farmyard manure.

A heavier dressing of dung may with advantage be given to mangels than to turnips. From 12 to 16 tons of good dung are often applied with good results. Along with this a liberal allowance of artificial manure would be from 2 to $3\frac{1}{2}$

cwt. of superphosphate, 2 or 3 cwt. of common salt, and 2 to 3 cwt. nitrate of soda or sulphate of ammonia. In many cases even larger quantities of artificial manures are applied; but with land in good average condition as to fertility these doses should as a rule be sufficient.

With a full allowance of dung there will seldom be much necessity for the application of special potash manure. If there is any reason, however, to suspect that there is a deficiency of potash in the soil, from 1 cwt. to 2 cwt. of kainit per acre should be applied.

As to whether it should be nitrate of soda or sulphate of ammonia which should be used along with the dung, the farmer must think for himself. He will especially consider the market price of the two commodities at the time, and buy whichever happens to be the cheaper. See what is said as to nitrate of soda and sulphate of ammonia at page 107, Divisional vol. iii. In a rainy climate and wet seasons sulphate of ammonia will most likely give better results than nitrate of soda.

The condition of the dung as to rotteness should also be taken into account in deciding whether to sow nitrate of soda or sulphate of ammonia. In well-rotted dung there is more readily available nitrogen than in fresh dung. With fresh dung, therefore, nitrate of soda would as a rule be preferable to sulphate of ammonia.

Application of Manure for Mangels.

Read what is said in the special chapter on "Manures and Manuring," as to the general principles to be observed in applying the various manures to land, pp. 126-135, Divisional vol. iii.

Dung.—If dung is available it should be applied in the autumn, and ploughed down or spread in drills, and covered in. If it cannot be applied in the autumn or winter, and if the mangels are to be sown in rows on the flat surface, the dung should be spread and ploughed in as early as possible in the spring. Where the mangels are to be sown in raised drills, and the dung cannot be applied till spring, it is spread in the bottom of the drills at sowing-time, as in the case of turnips—carted out and spread as described for turnips.

Artificial Manures.—Perhaps the most general plan is to sow these by the hand or machine in the drill or row at the time of sowing the seed, as for turnips. As a rule, however, it will be found advantageous to reserve the whole or greater part of the nitrogenous manure, especially if it happen to be nitrate of soda, and apply it as a top-dressing some time in July. The allowance of common salt is also by many held back till July, when some careful farmers apply a mixture of from $1\frac{1}{2}$ to 2 cwt. of nitrate of soda, and 2 to 4 cwt. of common salt in two sowings.

There is no denying the advantage of such a top-dressing for mangels. It has been well established in extensive practice. By holding back the nitrate of soda till the plants are ready to make use of its nitrates, loss by washing into the subsoil and drains is avoided.

Theoretically, one would expect that the slower acting sulphate of ammonia should give better results by being applied at the time of sowing. Nevertheless, some farmers prefer to use it as a top-dressing—prefer it to nitrate of soda for this purpose also. These are points as to which hard-and-fast lines cannot in all cases be followed.

Thinning and After Cultivation.

Preliminary Cleaning.—Mangel plants are slower in growth at the very outset than are those of turnips. To keep down weeds, therefore, it may be necessary to horse or hand hoe the rows or drills before the plants are ready for thinning. This preliminary hand-hoeing need be resorted to only in narrow rows on the flat, or where weeds are encroaching injuriously upon the plants. The horse-hoe or drill-scarifier will suffice, as a rule, in raised drills.

Thinning.—As soon as the plants show a fairly strong leaf, they should be thinned and hand-hoed as in the case of turnips. From 12 to 16 inches are common intervals between the plants. The narrower the drills, the greater should be the interval between the plants in the rows.

As with turnips, it has been found (by the late Dr A. Voelcker and others) that mangels of medium size usually contain more solid nutritious matter than mangels

of excessive size. And by moderate, rather than large, intervals between the plants, the maximum yields of good food per acre are likely to be obtained.

After Hoeing.—The treatment of mangels after thinning is, in regard to hoeing by hand and horse-power, very similar to that of turnips. The horse-hoe or scarifier should be kept at work as long as the leaves of the roots will permit.

Transplanting Mangels.—The young mangel plant may be successfully transplanted. Blanks in the rows should be filled up by transplanting. This should be done with care, so that the tap-root may be dibbled right down into the soil. Unless the weather is showery at the time or the soil moist, the transplanted plants should receive a spray of water.

Very heavy mangels have been grown experimentally from plants raised in a seed-bed (sown in January), and planted out in February. How far this system could, with advantage, be extended into farm practice is uncertain.

Injuring Mangel Plants.—Mangels are peculiarly liable to suffer from injuries to the leaves of the plants. Cuts or bruises to the leaves, even if inflicted when the plants are very young, do not heal up as would be the case in turnips—they remain as open, “bleeding” sores, robbing the plant of not a little of its life-juice, and rendering it liable to ready attacks of frost and decay. In the thinning of mangels, therefore, the plants should be guarded with the greatest care.

Varieties of Mangels.

There are many sub-varieties of mangels in use. The principal sorts are the long red, red globe, and orange and yellow globes. The last two are the hardiest, of excellent quality, with good keeping properties, and suitable to most soils in which mangels grow satisfactorily. The long red mangel is extensively grown on heavy soils, and produces great crops in favourable circumstances. They stand high out of the ground, and are therefore exposed to damage from early frosts. The red globe is better suited for lighter soils.

Produce of Mangels.—This varies greatly—from 12 to over 50 tons per acre.

From 30 to 35 tons are considered good crops in moderately favourable years.

Diseases and Insect Attacks.—The mangel suffers less than turnips from

fungoid attacks. The mangel maggot often injures the crop by feeding on the leaves. See the chapter on insect attacks.

KOHL-RABI, CARROTS, AND PARSNIPS.

These subsidiary varieties of root crops are well worthy of the attention of farmers. Often by cultivating patches of these the revenue of the farm may be appreciably increased.

KOHL-RABI.

Properly speaking, the kohl-rabi should not be classed with the root crops. Its bulb is formed by an enlargement of the stem or stalk, and it is thus grown for its stem and not for its root. Nevertheless it falls into the rotation with the root crops, and is cultivated for the same purposes, namely, to provide winter food for farm stock.

Kohl-rabi was cultivated in this country as far back as 1734, but it was not generally known till about 1837.

Advantages of Kohl-rabi.—Kohl-rabi undoubtedly possesses high merits as a field crop, and it is surprising that in England especially its cultivation has not extended much more widely than has been the case. In Scotland, and other parts well suited for turnips, there there may be little necessity for it, but on the stiff clay and soft fen lands of England, which are well suited for kohl-rabi and badly fitted for turnips, it ought to be grown more largely.

The advantages of kohl-rabi as a field crop are thus forcibly stated by Professor Wrightson:¹—

“It is subject to no diseases, and few insect attacks. Like the turnip, the young plants are liable to the depredations of the turnip flea-beetle, but in a less degree to swedes and turnips. It thrives on two classes of soils upon which turnip cultivation cannot be very successfully carried out—namely, upon

the stiffest classes of clays, and the fen-lands of East Anglia. It possesses great powers of resistance to drought, and in fact thrives best in hot and dry seasons. It is exceedingly hardy, and resists frosts successfully. The crop may therefore be left over till the spring of the year. The leaves are of the same quality for feeding purposes as the stems, and resemble rape or kale leaves in nutrient properties. It is well suited for cow-feeding, as it does not impart an unpleasant flavour to milk. It is well adapted for sheep-feeding on the ground, because the bulb being supported upon a footstalk it can all be eaten without the waste which is inevitable when turnips are fed. It is an excellent feed for ewes and lambs in the spring, as it supplies leafy herbage as well as more solid food.”

Uncertain Crop.—Perhaps the influence which has been most instrumental in restricting the cultivation of kohl-rabi is the belief that it is rather uncertain in its growth—liable to grow to a mass of leaves with insufficient development of bulb. This drawback is being gradually removed by the raising of improved varieties which are more reliable in their development.

Soil for Kohl-rabi.—Kohl-rabi grows well on all soils adapted to swedes, and may also, as we have seen, be cultivated with success on stiff clays and fen lands.

Tillage and Manuring.—These should be very similar to what are best suited for mangels—deep autumn tillage and dunging, grubbing or cultivating in spring, with a liberal dressing of nitrogenous manures.

Planting or Sowing.—Kohl-rabi may be sown either on the flat or in raised drills exactly like turnips; or the plants may be raised in seed-beds, and transplanted into rows 25 to 27 inches apart, with from 10 to 16 inches between

¹ *Fallow and Fodder Crops*, 190.

the plants. The seed should be sown in the seed-bed fully two months before the time for transplanting, as the plants should be about 8 inches high before being transplanted. From 10 ounces to 1 lb. of seed sown thinly in rows a foot apart, in a well-prepared seed-bed, should produce sufficient plants to cover one acre.

Some particularly careful farmers always raise a few kohlrabi plants with which to fill up blanks and odd corners in the root field.

Time for Sowing.—The seed may be sown in the drills in April. Transplanting may take place from the first of May till the middle of August.

Thinning and Hoeing.—When sown directly in the field the plants are thinned like turnips, with wider intervals between the plants—from 10 to 15 inches. The after tillage and hand-hoeing is exactly the same as for other root crops.

Produce.—From 20 to 25 tons per acre are common crops. Occasionally the produce reaches from 30 to 35 tons or more.

Varieties.—The varieties of kohlrabi most largely in use are the green round, green oblong, purple round, and purple oblong.

CARROTS.

Carrots (*Daucus carota*, Natural Order *Umbelliferae*) are more of a garden crop than a crop for general field culture. Yet on most farms with suitable soil a small patch of them may be grown with advantage. Carrots are, in limited quantity, excellent food for horses; and with capital results the carrot-tops may be used as food for cows in milk.

	Carrot-leaves.
Water	82.2
Albuminoids	2.2
Carbohydrates	7.0
Fat . . . .	.5

“From this it will be seen that carrot-leaves compare favourably with any of the other articles of food, and although considerable latitude be allowed for variation in the analyses of the samples here given, there is still room enough for

Carrot-tops as Food for Stock.—

The high feeding value of carrot-tops is not generally known or acknowledged among farmers, for the tops are, as a rule, left on the ground, just as in the case of turnip-tops. Writing on this subject, Mr John Speir, Newton Farm, who grows carrots extensively for the Glasgow market, says:—

“Where carrots are grown the carrot-leaves form an excellent class of food for any kind of farm stock. They are relished extremely by both sheep and cattle, dairy cows doing particularly well on them. A good few tons of leaves are yielded by each acre of well-grown carrots, and a ton of carrot-leaves appears to me to be more valuable than the same weight of turnips.

“To dairy cows I have fed carrot-leaves regularly for over a dozen years, and the longer I use them the more I prize them. I have repeatedly been laughed at for the opinions I held regarding the value of carrot-leaves, by those who had little or no experience of their use, my friends saying they were not worth the cartage, and that I was impoverishing the land by taking them to the cows. I grant I was decreasing the fertility of the land, but I was increasing my milk production, and there was no greater occasion why these carrot-leaves should not first pass through the bodies of animals before being applied to the land, than should a second crop of hay or clover, diseased potatoes, or for that matter of it, any palatable farm crop, be it a first or second one.

“**Analysis.**—In support of this view are appended, for the sake of comparison, the analyses of the digestible constituents of a few similar plants, as given by Professor Stewart.

Cabbage.	Turnips.	Potatoes.	Pasture Grass.
84.7	92.	75.	80.
1.8	1.1	2.1	2.5
8.2	6.1	21.8	9.2
.4	.1	.2	.4

much to be said in favour of carrot-leaves. If we allow the stock themselves to be the judges, the point will be easily settled, as the carrot-leaves will be taken

in preference to almost any of the other foods named.

"I may here mention in support of this view that it is well known that hares and rabbits travel long distances to feed on carrot-leaves, and they are as dainty in regard to their food as any animals on the farm. In my own case I have for very many years used the produce of from 15 to 20 acres annually with the most satisfactory results, while throughout the country generally it is only the few here and there who do use them anything like extensively. Those farmers who allow them to lie and rot would be considering they were extremely careless if they allowed even a tithe of the same weight of turnips to lie rotting in the fields, while they pay no attention to what is an equally if not more valuable crop, although at the same time a more perishable one.

"**Storing.**—This last, in fact, is one of the greatest difficulties in using a large breadth of carrot-leaves, yet by judicious management in consumption, the cold season of the year during which they come into use, and by keeping them in very small heaps in the field, their consumption may extend over a period of from one to two months, according to the area to be consumed and the number of stock to consume them."

Soil for Carrots.—Carrots, having a strong deep root, require soil of considerable depth. A good sandy loam is best adapted for the crop. We have seen excellent crops of carrots on well-manured land with a mossy tendency.

Tillage and Manuring.—The land must be deeply cultivated in the autumn. If the subsoil is stiff, it should be loosened by the subsoiler. Autumn dunging is generally preferred, but where this is not convenient the dunging may be done in spring, as for other root crops. Carrots will take as heavy dunging as any of the root crops. The dressing of artificial manure applied may consist of from 2 to 3 cwt. superphosphate and 1 to 2 cwt. of nitrate of soda, sown as a top-dressing just after singling, or in two portions, one before and the other after singling.

If the land has been dunged and well tilled in the autumn, little cultivation in spring will suffice. A fine tilth and a

loose range for the searching root are very desirable. Yet harm may be done by overworking the land in spring.

Cleaning for Carrots.—It is specially important to have the land for carrots as thoroughly cleaned as possible. The leaves of the carrot are small, compared with those of mangels and turnips, and the growth of weeds is thus encouraged by the large amount of space which remains uncovered.

Sowing Carrots.—Carrots are usually sown about the end of March and beginning of April. They may be sown in rows on the flat, from 15 to 18 inches apart, or in raised drills from 27 to 30 inches wide. In the latter case, two rows of seed are sown on the one drill. The wide raised drill is preferred by many, because of the greater facility it affords for cultivating and cleaning the land.

Preparing Carrot Seed.—About 6 lb. of seed will sow an acre. The hairy covering of the seeds makes their separation rather difficult, and to overcome this difficulty it is a good plan to mix the seed with fine sand, perhaps at the rate of $1\frac{1}{2}$ to 2 bushels of sand per acre. The seed and sand should be thoroughly intermixed by rubbing with the hands; moisten the mixture with water, spread it out on a dry floor, turn daily, sprinkle with water if it become dry, and when it has lain from a week to ten days in this form, it should be sown, just before the seed germinates. When this preparatory process is gone through with proper care, the plants will come up more quickly than if sown without the week or ten days of incubation. This is an important point, because the carrot plants are so tiny in their earliest stages that, when sown on the flat surface, they are liable to be covered and overcome by weeds.

In many cases a little oats, barley, or turnip seed is sown along with the carrot seed for the purpose of indicating the rows, and thus enabling the hoe to be used with freedom before the carrot plants are very clearly visible.

It is unsafe to use old carrot seed. It should be the produce of the previous year's crop.

Thinning Carrots.—The plants should be thinned when the leaves are

from 1 to 3 inches high. Intervals of from 4 to 8 inches, according to the variety grown, are left between the plants. When grown on raised drills, with two rows on each drill, the plants are singled so that they alternate rather than sit directly opposite or abreast in the two rows. Horse and hand hoeing should be pursued as with other root crops.

Carrots and Rye.—The late Professor Wilson described a practice followed by some enterprising Continental farmers, in which crops of rye and carrots are grown upon the same land, so as to overlap each other in rather an ingenious way. He said: "In the light-soil districts of Belgium and Holland, where carrots are cultivated to a far greater extent than with us, it is a common practice to grow them mixed with a crop of rye or flax. In the former case the rye is sown early in the autumn, so as to root well before the winter sets in, and thus come early to harvest the following year. In the spring the carrot seed is sown broadcast as late as the growth of the rye will admit of the harrows being used to cover the seed. This germinates and continues its growth until the rye is ready for cutting, which usually takes place about the second or third week in June. It is then mown with a cradled scythe, care being taken not to cut it so close as to injure the top of the root of the young carrot plants, which by this time have acquired a size about the thickness of one's finger. The field is cleared as quickly as possible of the stooks, the harrows are sent over the ground to disturb the surface, and to drag up the roots and stubble that are left, while the remaining weeds are carefully removed by the hand. The liquid-manure cart follows with a supply of rape-cake mixed up with 'purin,' and in a few days the young plants begin to show themselves again; and by the end of the autumn are in a condition to yield a weighty crop of roots, which, when forked up in the usual manner, leaves the land in excellent condition, both chemically and mechanically, for the succeeding crop of corn."

Varieties.—There are many varieties of carrots in use. The best known are James's Intermediate, the Altringham

long red, white Belgian, large red, and short red.

Produce.—The produce in average seasons should reach from 12 to 20 tons per acre. It is sometimes more, often less.

Certain species of wire-worms and the carrot-louse (*Aphis dauci*) attack and damage the crop.

PARSNIPS.

The parsnip is the *Pastinaca sativa* of the same Natural Order as the carrot, *Umbelliferae*. Indeed, the two plants are so very similar in their habits of growth that the remarks as to soil, tillage, and manuring for carrots may be held as applying also to parsnips.

Parsnips go still deeper into the soil than carrots, and grow to their best in a heavier loam than that which carrots specially delight in. In the south the parsnip seed—6 or 7 lb. per acre, with a little oat, barley, or turnip seed, as with carrots—may be sown as early as February.

Parsnips are usually grown in rows on the flat surface about 14 or 15 inches wide, and the plants are thinned to from 6 to 8 inches apart.

Among the varieties of parsnips most largely grown are the long-rooted parsnip, the Student, the long Jersey (or hollow crowned), large Guernsey, and Cattle parsnips.

Both parsnips and carrots are found growing wild as a weed in this country. No doubt the cultivated varieties have been raised from these.

It will be seen from analysis on page 266, Divisional vol. ii., that the parsnip is possessed of very high fattening properties.

FORAGE CROPS.

In pages 253-260, Divisional vol. iii., information is given as to the cultivation of forage crops which should be perused at this point. Note in particular the directions as to successional sowings of vetches and the sowing of the seed of cabbages, thousand-headed kale, and rape in the summer months.

SUMMER CULTURE OF CORN CROPS.

The corn and pulse crops require a share of the farmer's attention in the summer months, particularly in the earlier part of the season. By horse and hand hoeing, weeds are kept down and the land stirred, with much benefit to the crop. In many cases a moderate top-dressing of manure is applied with advantage, while, in wet seasons, the farmer must see that surface-water is not allowed to lie on any portion of his crops.

CULTURE OF BEANS.

Beans require a good deal of labour and attention in summer.

Beans in Raised Drills.—The spring work in connection with bean-sowing was completed (see p. 205, Divisional vol. iii.) by the harrowing of the drills about a fortnight after the seed had been sown.

Horse-hoeing.—As soon as the young plants growing on raised drills have attained 2 or 3 inches in height, the common drill-grubber or scuffer should remove the weeds that have appeared between the drills in the interval of time since the drill-harrowing. The grubbing will also reduce the clods and loosen the soil generally.

Hand-hoeing.—The field-workers follow the scuffer with the hand-hoe, and remove the weeds growing around the plants, and displace clods that are seen to interfere with the plants. The workers should be careful in using the hoe amongst bean plants, which are very tender and easily cut and bruised.

After the plants have risen about 1 foot in height, which they will soon do in good growing weather, the blossom will begin to appear; and its appearance is with many the signal to finish the work amongst the crop. Time may be found to again drill-grub between the drills, and hoe the sides of the drills along the plants; but if not, the double mould-board plough should, as the last operation, set the earth up to the roots of the

plants, to give them a firm footing on the top of the drill.

Rows on the Flat.—The summer culture of beans growing on flat ground in rows is the same, in as far as scuffling, hoeing, and drill-grubbing the ground are concerned, as on the raised drill. Almost the only difference is that the land is not set up with the double mould-board plough.

No Harbour to Weeds.—No amount of horse and hand hoeing should be grudged that may be necessary to make and keep the land free from weeds. It should be remembered that one of the objects in having beans sown in drills is to have the land well worked and cleaned.

Broadcast.—When beans are grown broadcast, no implement but the hand-hoe is of any avail in clearing the ground of weeds; and as hand-hoeing would require to be performed much oftener than time will allow, to keep the ground as clean as it should be, the consequence is that a crop of broadcast beans affords a harbour to weeds, unless growing weather pushes the bean plants forward to smother the weeds.

Cropping Beans.—After the bean plant has grown until all the pods are set, the practice of the garden indicates that, when the top of the plant is cut off in moist weather, at that period of its growth the crop will be sensibly increased. This is a probable result, it being a common observation that in moist weather the bean has a great tendency to grow in height long after the pods have ceased to form. As long as this tendency continues, the pods and beans do not enlarge; and the only mode of checking it is to cut off the top, when the vigour of the plants' growth will be solely devoted to the nourishment of the fruit.

CULTURE OF PEAS.

Although a common practice is to sow peas along with beans, yet, as they are also cultivated alone, it is necessary to bestow attention on them when so culti-

vated. When sown broadcast, the pea plant, growing quickly, especially in moist weather, soon overspreads the weeds growing along with it. But though it overspreads, it does not entirely destroy them. The consequence is, that the ground is left by the pea crop in a foul state.

When sown in rows, in every third furrow of the plough, or in raised drills, the ground is scuffed, hoed, and drill-grubbed, as are beans when sown in rows on the flat.

These operations require to be rapidly performed, the quick and straggling growth of pea-stems affording neither time nor room for dilatory work

CULTURE OF WHEAT

The amount of attention which the wheat fields demand in the summer months depends mainly upon the time they had been sown.

Autumn Wheat.—Autumn or winter sown wheat may be too far advanced in growth before the advent of summer to permit of any cultural work being given to it in that season. Such horse-hoeing or harrowing as it may require will therefore be performed in spring. The state of the autumn-sown wheat in summer depends on the weather in winter and spring, and the nature and condition of the soil upon which it was sown.

Over-luxuriance in Autumn Wheat.—Mild weather in winter will cause it to grow luxuriantly; and if the mildness continue till spring, the plants may, from over-luxuriance, lie down in spring, and become blanched and rotted at the roots. In the early part of winter, if the ground is dry, sheep may eat down luxuriant wheat to a considerable degree. Even if not folded on it, sheep will do much good to luxuriant wheat by trampling upon it for a while every day, and eating off the tops of the plants.

But the winter luxuriance is frequently checked, and even the plants destroyed, by severe frosts at night and bright sunshine during the day in March. Should the winter luxuriance continue till spring, sheep cannot then crop it uniformly, and should not be allowed to attempt it. If luxuriance only commenced in spring,

sheep can restrain it then as well as in winter.

Cropping Rank Wheat.—The winter luxuriance can be restrained in spring only by mechanical means—by cutting off the tops with the scythe. This may be done safely until the plant puts forth the shoot-blade, perhaps as late as the end of April. Before commencing cropping with the scythe, some of the most forward plants should be opened to ascertain the position and length of the ear, which should not be touched. The leaves cut off lie on the ground to decay. The advantage of cropping wheat when over-luxuriant is, that rain will no longer hang upon it, and air and light will have access to the stem to strengthen and support it. The risk of lodging is thereby greatly lessened. Spring wheat rarely becomes too luxuriant in summer, and requires no expedient to check its growth.

Soil and Over-luxuriance.—Of the classes of soils which produce over-luxuriance, dry deep clay loam is most apt to do it in a mild autumn and winter; and thin clay land, upon a retentive wet subsoil, is most liable to destroy wheat in March. Even when showing no luxuriance, and the crop promising, yet by the injurious effects of March weather the plants may not only be sickly and scanty, but too late to tiller.

Weeding.—The weeding of the cereal crops in summer where the land is foul is an indispensable work for their welfare. If the crop should be too far advanced to permit horse labour, the weeding must be done solely by the hand or with manual implements; if not, both manual and horse implements may be employed—that is, where the seed has been sown in drills. Among broadcast grain, weeding must be performed by the hand and with manual implements. An effective tool for this purpose is the simple weed-hook, fig. 364. It consists of an acute hook of iron, the two inner edges



Fig. 364.—
Weed-hook.
a Acute hook
with 2 sharp
edges.

of which are flattened and thinned to cut like a knife, and which are as far asunder at one end as to embrace the stem of succulent herbaceous plants which are destined to be cut down. The cutting-hook is attached to a socket, which takes in the end of a light wooden shaft about 4 feet in length, which is fastened to it with a nail or screw, the hook having such a bend as that its under surface shall rest upon the ground, while the worker uses the shaft in a standing position. A sharp spud with a cross-head handle is the best instrument for cutting weeds with strong stems—as docks, thistles—with a push.

The best way for field-workers to arrange themselves, when weeding broadcast corn, is for two to take one ridge, each clearing one-half of the ridge from the open furrow to the crown. On weeding amongst corn, the point of the weed-hook is insinuated between the stems of corn toward the weed to be cut, and on its stem being taken into the sharp cleft of the hook at the ground, it is easily severed by a slanting cut upwards towards the worker. The weeds, cut over, are left on the ground to decay; but no weed should be allowed to grow *beyond* the time of its flowering. Docks should be pulled up by the root and carried away and burned.

Hoeing Drilled Wheat.—Wheat sown in rows may be weeded with the hand-hoe, or with horse-hoes. The hand-hoe is used by field-workers, who each take one row between the drills. To prevent jostling, the worker in the centre of the hand takes the lead in advance position, while the others follow on each side in echelon. Where drilled crops occupy much extent of ground, the ordinary number of hand-hoers are unable to clear the weeds before the crops advance too far to go amongst them. Hence the need of the more expeditious horse-hoe.

Horse-hoeing.—There are many forms of horse-hoes for cleaning the ground between the rows of corn. The improved kinds are light in construction,

yet sufficiently durable, and do their work admirably, cleaning from six to a dozen rows at a time. One form is shown in fig. 365. The coulters used in these horse-hoes are of many different patterns, in some cases fixed upon one cross-bar, and in others upon two bars, the one in front of the other.

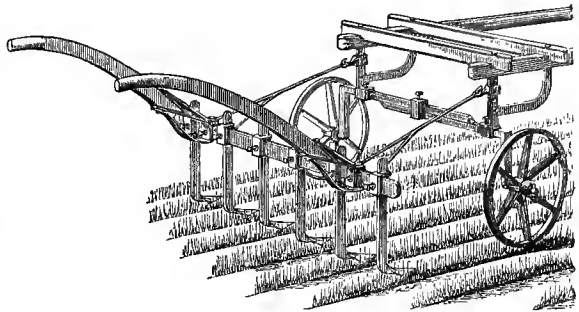


Fig. 365.—Steerage horse-hoe.

These hoes go over the ground quickly, and are easy work for one horse.

The horse-hoeing of corn should be intrusted to a careful man and a steady horse. A steady horse will not leave the row he walks in from end to end of the landing. A young horse is unsuited for this work. A careful man to steer the hoes is as requisite as a steady horse; otherwise the hoes may run through the rows of corn-plants, tearing them up as well as the weeds.

As already indicated, to wheat sown in the preceding autumn or winter this horse-hoeing has usually to be given in spring, that is, if given at all.

Top-dressing Wheat.—If the crop is not making satisfactory progress, or if it is considered desirable for any reason to top-dress wheat late in the season, this may be done during the month of May. Mild moist weather is most suitable for the process. At this late period of the season a dressing of nitrate of soda, perhaps from 1 to 2 cwt. per acre, would likely give the best result. Some would add 2 cwt. of superphosphate. It is considered a good plan to delay a portion of the more quickly acting manures to be sown as a top-dressing in this way. See pages 135-169 and 201, Divisional vol. iii.

Flowering Season.—The flowering season is critical for wheat, since a differ-

ence in the weather of June may affect the yield to upwards of 50 per cent. Should the weather be rainy and windy in the flowering season, the produce will inevitably be scanty. Rain alone, unless of long duration, does not affect the produce as much as strong wind, which seriously injures the side of the ear exposed to it. Showers and gentle breezes do no harm; but sunshine, heat, and calm are the best securities for a full crop.

CULTURE OF BARLEY.

Such weeding and hoeing as the barley may require is usually given as in the case of wheat.

Removing Charlock.—The barley crop is especially liable to be infested with charlock, *Sinapis arvensis* (sometimes known as “skeylock,” “wrinch,” or wild mustard). It is a most troublesome weed, and, if left to its freedom, would, in many cases, most seriously injure the crop. Formerly the only remedy was to pull up the charlock plants by the hand; but this process was too costly and tedious to be practicable upon large areas. At last, however, the genius of the inventor came to the aid of the farmer, and a machine (the “Koldmoos Weed Eradicator”) is now made by which the weed may be expeditiously removed, or at least severely checked.

This machine consists of a revolving drum set on wheels, with an arrangement of comb-like teeth, protruding from and retiring into the drum during its revolution. When the charlock comes into full bloom, it is some inches higher than the braird, and the teeth of the machine grasps the heads of the plants, and either tears them up by the roots or detaches them from the stem. The crop thus obtains considerable if not complete relief, while the charlock is prevented from seeding.

Top-dressing Barley.—Barley may be top-dressed like wheat. From 1 to 2 cwt. of nitrate of soda and 2 cwt. superphosphate would be a good late dressing. (See pages 210-211, Divisional vol. iii.)

Barley is not much affected by the weather in the flowering season, since rain and strong wind seldom then come at the same time.

CULTURE OF OATS.

The weeding of oats is not often practised when the seed has been sown broadcast, except to remove docks or thistles. When the thistle flourishes amongst corn, it is extremely troublesome to reapers at harvest. This plant should not be cut down till it has attained 9 inches in height, otherwise it will spring from the root, and require another weeding; and by the time it has attained 9 or 10 inches, the oats will be about 1 foot high. In weeding oats in broadcast, the field-workers may be arranged in the manner described for wheat.

Charlock is also a troublesome weed amongst oats. It may be removed as described in the case of barley.

A light top-dressing of from 1 to 1½ cwt. nitrate of soda and 2 cwt. superphosphate per acre, is sometimes given to the oat crop early in May. (See page 214, Divisional vol. iii.)

Oats are as little affected by weather in the flowering season as is barley. Both are in flower about the same time, and the weather must be stormy for successive days to injure either.

CULTURE OF RYE.

Rye has become almost obsolete as an ordinary corn crop in British husbandry. It is now chiefly confined to Northern Europe, on poor, loose, sandy soils which are not suited for other kinds of grain. In the south it is grown as a sort of forage or catch crop, to be consumed on the land by sheep.

Rye, sown in spring, runs through its courses rapidly, and comes early to maturity in summer. The straw thus attains a considerable height before the ordinary weeds make a formidable appearance, so that summer hoeing or weeding is seldom necessary.

CROSS-FERTILISATION OF GRAIN.

It may be useful to introduce here the following notes by Mr John Speir as to the cross-fertilisation of grain, with the view of obtaining improved varieties of renewed vigour:—

Degeneracy of Grain.—Most varieties of fixed types of plants appear to degenerate or become weakly after having been subjected, for a number of years, to the forcing influences of modern cultivation. Comparatively speaking, indeed, only a short time elapses between their introduction and the time when they commence to show signs of decay. With the grains this is in part averted by repeatedly and continuously using seed grown in some different locality, so that their rate of degeneration is slow in proportion to that of some other farm crops—potatoes, for instance.

As a rule, however, new varieties of grain, if otherwise good, are more vigorous in growth than most old ones, and in consequence their production is a matter of great importance to the arable farmer. The grains have not been improved to an equal extent with most other farm crops.

Mr Knight's Efforts.—Previous to the middle of the present century most of the new varieties of grain were natural crosses or sports, which were perpetuated and increased by selection. It appears that Mr Knight, a celebrated horticulturist who lived during the latter half of the last century, introduced a considerable number of new varieties of grain; but although he was aware how cross-breeding was done, it does not appear that he obtained any of the varieties he introduced by directly crossing them. His method of procedure was to grow a number of varieties together, in the hope that a favourable natural cross might be produced. In this way he was able to introduce several new varieties, which were of such a strong constitution that, during the years 1795 and 1796, when most grain in this country was blighted, the varieties thus obtained are said to have more or less escaped.

Mr Raynbird's Experiments.—In 1851 Mr Raynbird and Mr Maund showed ears of cross-bred wheats at the great International Exhibition held in London in that year. These are supposed to be the first direct cross-bred grains which were ever offered to the public; and although many of them were considered more as curiosities than anything else, still one of them attained considerable popularity as Raynbird's Hybrid in after-years.

Mr P. Shirreff's Experiments.—About this date Mr Patrick Shirreff of Haddington commenced his experiments in cross-breeding and selection. In the twenty years or so during which he persevered in the work, he succeeded in introducing several new varieties; but although he may be considered the first methodical cross-breeder of grain, he still says he was as successful in getting new varieties from mixtures by natural crossing as from those directly fertilised.

Recent Experiments.—About the year 1882 Mr Sharman, of the firm of Messrs James Carter & Sons, London, commenced experiments in the cross-breeding of wheats, which have been attended with a good deal of success. These experiments have been since carried on, and ten new varieties are offered to the public, most of which, as far as appearance of the grain is concerned, look well. All more or less differ in character, some having long straw, and some short. Others have slender straw, while many are stout; some are very early, while others ripen about the usual time. Messrs E. Webb & Sons, Wordsley, Stourbridge, are also carrying out extensive experiments upon the cross-breeding of grain, and here again considerable success has been attained.

Process of Cross-fertilisation.

In regard to the cross-breeding of grains it may be here mentioned that in all grains and flowers, as in animals, there is a male and female, and the process consists in fecundating the female of one variety with material called pollen taken

from the male of another. The process, although a little delicate, is not by any means difficult, and to carry it out does not require any special training in, or knowledge of botany.

Organs of Fructification.—The accompanying sketch, fig. 366 (for the use of which we are indebted to Messrs A. & C. Black), represents the organs of fructification, much enlarged, of a spikelet of wheat, the chaff-scales being removed for the sake of convenience. The round part, *o*, is the ovary, and what ultimately is the grain; the feathery parts, *s*, are the two styles, or female portions of the flower; while *e* represents the three stamens, or male portions of the flower. The tops of stamens are called anthers,

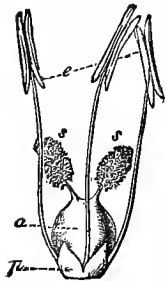


Fig. 366.—Organs of Fructification in wheat.

while the tops of the styles are called stigmas. In all the grains the organs of fructification are very much alike, so that what is said regarding one, as a rule will apply to all. For the purpose of effecting cross-fertilisation of any variety, the anthers, *e*, are cut away before they are old enough to have deposited any pollen on the stigmas. If such

has happened, cross-fertilisation cannot be effected, and all labour in that direction will be lost.

Male and Female Influence.—Messrs James Carter & Co. have found in their trials that the length of straw is, in the bulk of cases, regulated by the male parent, while the length and form of ear appear to generally follow the female parent. In the animal kingdom, it is also found that in the majority of cases the male has the preponderating influence in forming the body, while the female generally imparts the greatest impression in regard to temper. In neither the one case nor the other, however, do these rules always hold good, as sometimes the produce bears no resemblance to either parent, so that although they may be true in a general way, it is the most that can be said of them.

Details of the Process.—As wheat is perhaps the easiest of all the grains to

fructify artificially, a description of the process, as applied to it, shall be given. A variety having been selected, the stigmas of which it is desired to impregnate with the pollen-dust from the anthers of some other variety, the ear is taken as soon as it comes out of the sheath, and all the seed-vessels or spikelets are cut off except one, two, or three. This mutilation of the ear assists considerably the future operations, and if more than one seed-vessel is left on each ear, they should be left as far apart as possible. An ear is now procured of the variety which it is intended to use as a male parent, and which, if possible, should be about from three to five days out of the sheath, while the ear which has been prepared, and on which it is intended to operate, should not be over two days out of the sheath, otherwise risk of self-fertilisation will be run.

For convenience in carrying out successfully the delicate process of fertilisation, the operator should provide himself with a very small pair of forceps, so as to be able readily to pluck out the anthers from the one flower, and lift up those of the other. These may be made of a strip of thin steel, brass, or tin, about a couple of inches long, and quarter of an inch wide. Both ends of this strip are narrowed to about one-sixteenth of an inch broad at the points, the strip being then carefully bent over a lead pencil placed at the middle, while the two points are brought together and held in position by the finger and thumb. The ear, which it is intended to make the male parent, is then taken, and the spikelet gently opened by pressing the point of one of the fingers on the tips of the glumes, *B*, and palea, *A* (chaff), fig. 367. The chaff-scales having been thus opened, the anthers, *e*, will be exposed to view. The slender stems which support these are called filaments, which the operator now takes hold of with the forceps, and plucks out, laying each on a sheet of paper in order to be readily taken hold of again when required.

Enough anthers having been procured, the prepared ear, which it is intended to make the female parent, is taken, the chaff-scales *very carefully opened* as already described, and the anthers plucked out. If both ears have been

taken at the proper stage, the anthers of the one which it is intended to make the female parent will present a decided greenish tint, while the others will be more of a cream colour.

In plucking the anthers from the female parent, care should be taken to catch them by the *filaments only*, otherwise, if caught by the anthers (if too ripe), a portion of the pollen might be

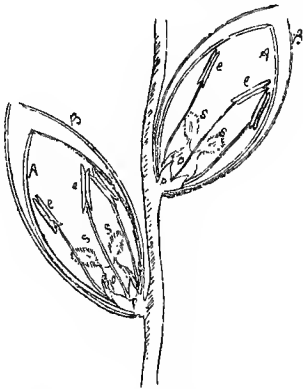


Fig. 367.—Organs of fructification in wheat.

shed on the stigmas, causing self-fertilisation. While the chaff-scales are being held open with the one hand, the anthers on the sheet of paper should be caught by the forceps, and dropped on the top of the stigmas, the chaff-scales or palea being then *very carefully closed*. In putting in the anthers, they are none the worse, but all the better, of being caught and pressed by the forceps, as if nearly ripe this forces out the pollen, there being no occasion to catch them by the filament, as when taken out. Care should, however, be taken not to bruise the feathery stigmas, otherwise fertilisation will not proceed. If the palea or chaff-scales are *not most accurately closed*, damp gets in and rots the feathery portion of the stigma, thus preventing fertilisation.

The pollen-dust retains its fertilising properties for several days, so that, although the female parent is not ripe enough for fecundation when the operation is performed, it becomes so very soon after, and long before the pollen-dust becomes useless.

The ear should now be securely tied

to a stake and labelled with the names of both parents.

Time of Natural Fecundation.—

It is a general belief among farmers that the grain is being fecundated when the anthers—or bloom, as it is called—appear on the outside of the ear. Such, however, is not the case, as fecundation has already been carried out, the expulsion of the anthers being an effort of nature to rid herself of what is now so much useless material, and the presence of which might interfere with the formation of the grain. The plant opens the chaff-scales and thrusts these out in good weather only, and as soon as they fall off by decay, or are broken off by the wind, the palea are again closed.

Good Weather Essential.—At this stage of the life of the plant, good weather appears to be necessary, not for the fertilisation of the plant, as has generally been supposed, but to prevent damp getting inside the palea at the time they are partially opened to get clear of the anthers. The smallest portion of damp getting on to the feathery stigmas causes them to rot; so that the farmer's idea, that good weather is necessary at this stage to ensure a full crop, is quite right, although its effect is slightly different from what it is popularly supposed to be.

Period for Crossing.—In order to prolong the period during which crossing may be successfully carried on, a portion of the plants with which it is intended to operate should be cut over near to the ground before and after the stalks are formed, which has the effect of producing a late crop of ears. In this manner the period of crossing may at least be doubled.

First Year usually Unsatisfactory.

—Seeds of grain which are produced by artificial crossing have a habit of always presenting themselves the first year in anything but a pleasing form. Whether or not this is brought about by injury to the stigmas or ovary during manipulation, or by the imperfect closing of the chaff-scales, it is difficult to say, so that inexperienced experimenters should not be discouraged when they are in the first year rewarded for their trouble with a badly formed or badly coloured grain, as the next season may quite change its

character. It is generally the second year, and it may be the third or fourth, before the true type of a grain can be said to be permanently fixed.

Percentage of Success.—In a favourable season, and in the hands of an experienced operator, from 25 to 75 per cent of the spikelets operated on may produce grains, while, if the operation is clumsily done, none may be produced.

Protecting the Ears.—As soon, however, as it is seen that the flowers have set, the ears should be encircled by fine wire gauze, or strong muslin, to prevent birds destroying the grain. The operation of crossing, for the sake of convenience, is generally performed near the side of a wheat plot; and the fixing of a stake to each plant is a necessity for identification, and this stake is almost sure to be made a resting-place by the sparrows and other small birds which infest the sides of wheat fields, so that if unprotected many grains are sure to be lost.

After Culture.—When the grains are ripened and thoroughly dried, they should at once be sown in 3- or 4-inch pots, one in each, in which they may be grown till late autumn or early spring, when they should be transferred to a piece of specially prepared land in the middle of an ordinary wheat field. Here they should be planted at least one foot asunder each way, with a space a foot or two clear from the ordinary crop. By giving the plants so much room, each tillers to its full extent, while the grain when ripe runs little risk of being stolen by birds.

Details of Messrs Carter's Experiments.—Mr H. Evershed gives the following details of Messrs Carter's experiments, in the *Journal of the Royal Agricultural Society of England*.¹—

"In crossing red and white wheat together, a white sort called Fill-measure, with smooth chaff and square ears, was crossed with Selected Red Square Head wheat as the male parent. The offspring has longer straw than either parent, and longer ears than the male, which has, however, clearly influenced the cross-bred offspring in the shape of the ear and the colour of the grain. This same successful cross turns out to be satisfactory in regard to quality, as well as being

one of the earliest wheats next to the Talavera group.

"Another cross between Royal Prize Red and another long-eared variety exhibits a curious freak, since the long, square, thick-set ears are distinct from those of either parent. In another cross between the same red wheat and a long-eared white wheat, as male, the influence of the latter has been most potent in the colour of the grain; while, curiously enough, the offspring ripens a fortnight earlier than either parent.

"A cross between a woolly-chaffed white wheat and a smooth-chaffed club-headed red for male, proves exceedingly productive and vigorous, one plant having yielded sixty ears, and a field crop having produced at the rate of fifty-four bushels per acre. The colour of the grain shows the influence of each parent alike.

"In another case square-headed white, female, and long-eared white, male, have produced a wheat which proves to be the last sort to thrust its ear from the sheath of the stem, while, next to Talavera, it is one of the earliest to mature. Except that the ear is closely packed, it favours most the male parent, having an ear and grain of the same colour and the same length of straw.

"A cross was effected between Talavera and Royal Prize Red for the purpose of obtaining the early habit and superb quality of the former, combined with the vigorous constitution of the latter. The result proves a decided success, the offspring of the cross, or rather the latest selection from it, possessing the desired qualities.

"The selection from a cross between a bearded April wheat and an American bearded variety proves earlier than either parent, with grain quite equal to that of the well-known Russian Kubanka. This, of course, is a spring wheat, and the habit derived from its parents must be kept up by constant sowing in spring.

"One of the most singular results of crossing is found in a sort which has received the characteristic name of Bird-proof. The female parent was Fill-measure, the male an American bearded wheat, and the cross exhibits sharp-pointed awns on some of the glumes at the apex of the ear—a defence which birds have shown themselves shy of approaching."

¹ Sec. Ser., vol. xxv. part 2, p. 260.

INSECT AND FUNGOID PESTS.

INSECT INJURY TO CROPS.

Amongst the many troubles which farmers have to contend against, few are so vexatious as the growing injury to their crops and stock from insect agency. The need of plain knowledge of how to meet the evil is therefore year by year more urgently demanding attention—the need increasing steadily as the increase in amount of cropped or stocked ground constantly affords a greater amount of food for the pests.

Services of Entomologists.—To the researches of John Curtis, afterwards to those of Professor Westwood, Life President of the Entomological Society, and still working in his honoured old age on this useful labour, we are indebted for a series of observations extending over many years, throwing light on the histories and means of prevention of insect pests of the farm, the orchard, and the garden. Then the valuable contributions made by our own agriculturists, of the successive attacks and means of lessening losses therefrom, which have been recorded each year now for twelve years in the annual reports of Miss Eleanor A. Ormerod, the Consulting Entomologist of the Royal Agricultural Society, form in themselves a most valuable library of reference, and especially as being in great part the precise record of agricultural work carried on by practical men.

Space does not allow us to enter here on detailed histories of insect attack. We refer merely to a few of the commonest kinds, and of the most troublesome of these we give figures, with a few observations serving as guides to the kind of treatment which has been found practically useful.

The epitome given in the following observations has been in part compiled by Mr F. W. Silvester, Recorder of Economic Entomology of the Herts Natural History Society, from various sources, but mainly by permission of Miss E. A. Ormerod (Consulting Ento-

mologist of the Royal Agricultural Society of England), from the reports above mentioned, and other of her publications.

Miss Ormerod's personal study of these subjects and her publications are too well known to require comment, and we feel favoured in being permitted to avail ourselves of her serviceable work, and likewise of the illustrative figures, in several cases from her own pencil, which she kindly permits us to use.

The arrangement adopted by Miss Ormerod—that is, of alphabetical sequence—has been adhered to, and each of the attacked crops, and the pests which infest it, are dealt with separately.

BEANS.

Bean Aphis.

The black bean blight (*Aphis rumicis*), (fig. 368), is one of the very few insect attacks which can often be checked satis-

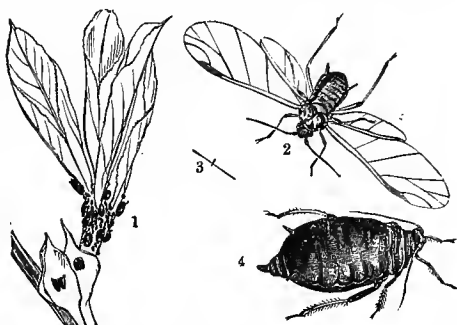


Fig. 368.—Bean aphid (*Aphis rumicis*, Fabr.)

1, Bean-shoot, with aphides; 2, Male, magnified; 3, Natural size; 4, Wingless female, magnified.

factorily by direct treatment when the insects are settled on the plants.

The attacks are begun by a few wingless females establishing themselves near the top of the bean-stalks at flowering time. These produce living young, and one generation succeeding another in rapid succession, the upper part of the plant soon becomes coated with the colliers, and a mere filthy mass of insects

and the sticky juices drawn from the plants.

Treatment.—The infested tops of the beans should be cut off as soon as "the colliers" appear. This treatment is very successful, if care is taken to carry off the infested tops and to destroy them. A healthy luxuriant growth in this, as in all cases of attack, is important. In garden cultivation, soot, or any dry dressing to make the bean-tops unpalatable to the aphides, is sometimes of service, especially if applied after rain, so as to adhere to the black lice and shoots.

Bean-seed Weevils.

These are chiefly injurious in this country by lessening the germinating power of the seed. Necessarily, as the plant in its first growth depends on the nutriment contained in the seed—where this nutriment is diminished in proportion to the amount of the future seed-leaves which are removed, the growing power is lessened, and a bad start made, which tells on the future plant-growth. This kind is certainly now naturalised, whether it was originally British or not. Curtis's name *granarius* is retained, as it is that under which he describes this species, but it appears that the species described is considered to be that which we know as *Bruchus rufimanus*.

Infested beans may be known by having a little round depression of the skin covering the end of the larval gallery; those that have been infested, by round holes where the beetle has escaped.

Prevention.—The great safeguard is to avoid sowing infested seed—a great deal of which is imported into this country—and in infected districts to change the crop frequently.

Where beans or peas are known to be infested, the beetles or chrysalids within may be destroyed by steeping. Water alone has been found in laboratory experiments to answer the purpose. For preparing seed for fields, the following dressing has been used: "Blue vitriol," 1 lb.; Macdougall's sewage carbolic, 1 pint; water, 6 quarts. The above dressed 6 bushels of beans, and the result was satisfactory in all ways.

The following simple and effective method of clearing beans or peas infested with weevils is recommended by

Mr George Brown, Watten Mains, Caithness: "Procure an air-tight vessel—one of the tanks for holding water on board ship is an excellent article for the purpose. Put the beans or peas into this, filling up to within a foot of the top. Level the surface of the beans or peas, and set a lighted candle upon it. Close up the vessel so as to be quite air-tight. The burning candle uses up all the oxygen and develops carbonic acid, which is fatal to all animal life. This plan I have seen successfully adopted in South Africa for killing weevils in rice. When the tank is opened the entire surface is found to be covered, perhaps to a considerable depth, with dead weevils."

BEEET AND MANGEL.

Beet Carrion Beetle.

Beet and mangel crops are sometimes attacked by the beet carrion beetle (*Silpha opaca*), which begins to prey upon the leaves as soon as they appear above ground, giving great trouble to the sugar-beet growers in France.

The grubs are much like the wood-lice in shape, black and about three-quarters of an inch long when full grown.

Prevention.—As the eggs are laid in putrid matter, it is advisable (to avoid repeated attacks) to put the manure on in autumn, and only use artificial at the time of sowing. Stronger manures, such as offal and sea-weed, or shore refuse, may bring it; and as it winters in decayed leaves, they should be removed. Mr Fisher Hobbs's turnip-fly preventive, consisting of lime, gas-lime, sulphur, and soot (the proportions of the mixture are given further on, under the head of Root Crops), has been found of service.

When the mangel is swept off in the seed-leaves, it is advisable to put in immediately another kind of crop. Turnips, carrots, parsnips, potatoes, peas, beans, and cabbage have been recorded as succeeding perfectly on land where the mangels had been destroyed.

Mangel-leaf Maggot.

Another well-known beet and mangel pest is the maggot of the *Anthomyia betæ*, Curtis (fig. 369). This damages the crops by feeding on the pulp of the leaves, which it often reduces to nothing

but dry skin. These white legless maggots are about the third of an inch long, of a yellowish white colour, and as soon as they are hatched, voraciously bore

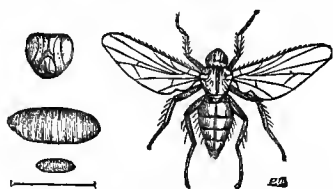


Fig. 369.—Beet-fly (*Anthomyia beta*, Curtis).

Female, magnified; Line showing spread of wings, natural size; Head, magnified; Pupa, natural size and magnified.

through the skin of the leaf by the aid of two black hooks within the head-end.

Prevention.—Autumn cultivation, and measures to ensure a rapid growth, are the best means to combat with these maggots. Paraffin-oil has been applied with success in the preparation of a mixture. Eight parts water, and one part soft-soap thoroughly incorporated, form the lye which takes mineral oil, and is said to amalgamate with whatever proportion of this may be added, the in-

attack in cases where the crop is still young and can bear thinning. The plants should be carried away and destroyed, and thus the maggots within will be got rid of before they can turn to chrysalids, and thence to flies, to start new attack.

Cabbages suffer very much from white

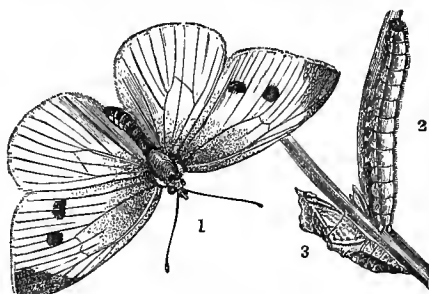


Fig. 371.—Small white cabbage butterfly (*Pieris rapae*, Latreille)

1, Female butterfly; 2, Caterpillar; 3, Chrysalis.

butterfly caterpillar attack. We give illustrations of the two principal offenders,—the large white cabbage butterfly (*Pieris brassicae*, Latreille), (fig. 370), and the small white cabbage butterfly (*Pieris rapae*, Latreille), (fig. 371). Leaves on which the eggs are laid should be picked off, and the caterpillars searched for and destroyed. The caterpillars are more common in gardens, where they find congenial shelters, than in large open fields. Measures to promote a healthy growth should be adopted.

The ichneumon fly (*Microgaster glomeratus*) comes to our aid as a natural enemy to these caterpillars, in which it lays its eggs. The maggots from these eggs feed inside on all the parts not necessary to the caterpillar's life till the time comes for it to change to the chrysalis, when, instead of turning, it dies. The small yellowish cases collected in bunches much resembling silkworm cocoons, often seen on cabbages, are those of the ichneumon maggots. They should not be destroyed.

The great measure of prevention is searching for the chrysalids, which may be sometimes collected in handfuls from shelters under eaves, boards, &c., in the

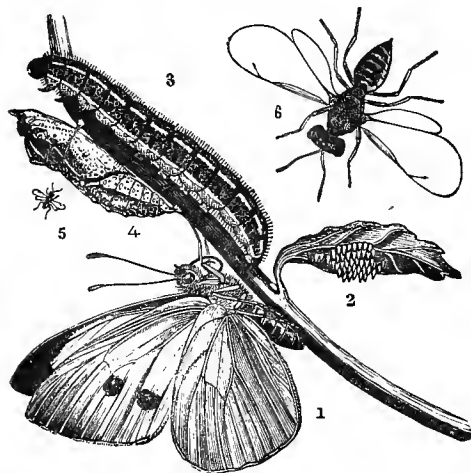


Fig. 370.—Large white cabbage butterfly (*Pieris brassicae*, Latreille).

1, Female butterfly; 2, Eggs; 3, Caterpillar; 4, Chrysalis; 5 and 6, Parasite Chalcid-fly (*Pteromalus brassicae*) natural size and magnified.

gredients being mixed in a boiling state—of course applied cool.

Hand-pulling of the plants has been found to answer in checking increase of

neighbourhood of gardens; and sending boys on the ground to hand-pick the caterpillars, has been found useful as a remedy on the broad scale wanted in garden-farming.

CORN CROPS.

The following are some of the kinds of insects more especially prevalent in corn crops.

Corn Aphis.

With the corn aphis (*Aphis granaria*, Kirby), (fig. 372), we are almost unable to cope, as nothing can be done to get rid of it when on the corn ears: little is known of its winter habitat.

Daddy Longlegs.

Great damage is done to corn and turnip crops by the grub of the daddy long-legs (*Tipula oleracea*, Linn.), (fig. 373), which gnaws the young plant just below the surface of the ground, and thus stunts its growth. The crane-flies, as they are also called, deposit their eggs in neglected grassy spots—meadows and marshes.

The flies and grubs may be found throughout the summer; but when the

Prevention.—In methods of prevention and remedy three great points should be considered—

1. Any measures tending to lessen the quantity of eggs laid.
2. Methods of cultivation which will

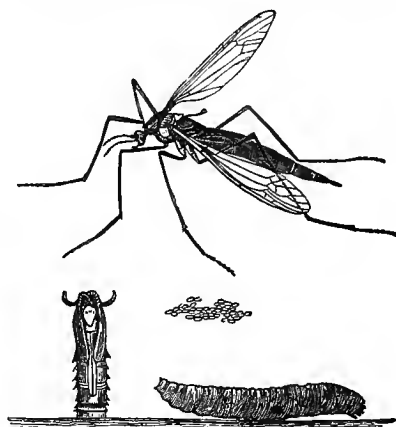


Fig. 373.—Daddy longlegs (*Tipula oleracea*, Linn.) Fly (after Taschenberg); Pupa and larva (after Curtis).

destroy the egg or grub in infested ground, as deep ploughing, Crowskill-rolling at night,¹ penning sheep, dressing with gas-lime, paring and burning—a practice now seldom pursued—and draining.

3. Manurial agents to encourage the healthy growth of the plant. Applications of soot are beneficial, as is also guano and a mixture of salt—4 cwt. to the acre; and *nitrate of soda* is particularly serviceable, as its use is beneficial to the plant and injurious to the grub. A spray of paraffin from the Strawsoniser (see p. 409) would probably kill the grub.

Corn-fly.

Another great enemy to our corn-fields is the ribbon-footed corn-fly (*Chlorops teniopus*, Curtis), (fig. 374). The injury is caused by the egg of the *Chlorops* being laid either on the lowest part of the ear itself or at its base, whilst the plant is young; and by feeding of the

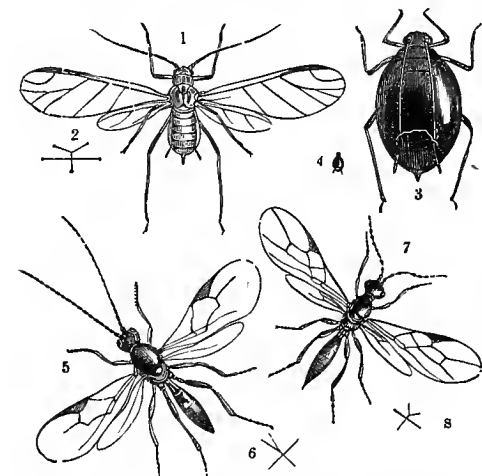


Fig. 372.—Grain aphis (*Aphis granaria*, Kirby).

1-4, Aphides, winged and wingless, natural size and magnified; 5 and 6, *Aphidius avenae*; 7 and 8, *Ephedrus plagiator* (parasite flies), natural size and magnified.

latter change to the pupa state, especially from July to September, they can do no harm.

¹ This is best at night or as early or late as can be managed, as the grubs are then more on the surface.

maggot hatched from it the growth is checked, and consequently the proper

Prevention.—Damp parts of the field appear to be liable to be infested.

Drainage should be resorted to, and the application of any nitrogenous or ammoniacal manure combined with phosphates, to promote the healthy growth of the plant; as a great safeguard against attack is to keep the plant in good condition.

Corn Saw-fly.

The corn saw-fly (*Cephus pygmaeus*, Curtis), (fig. 375), attacks by piercing a hole in the stem whilst it is young and soft, and laying an egg therein. Within this stem the maggot feeds, first making its way upward, and piercing the knots of the stem in its passage. Afterwards it descends, still within the stem, and about harvest-time gnaws a ring round the inner part of the stalk, just at the ground-level. Consequently on this injury the stem falls, and thus much damage is caused, both by loss on the ear and the twisted

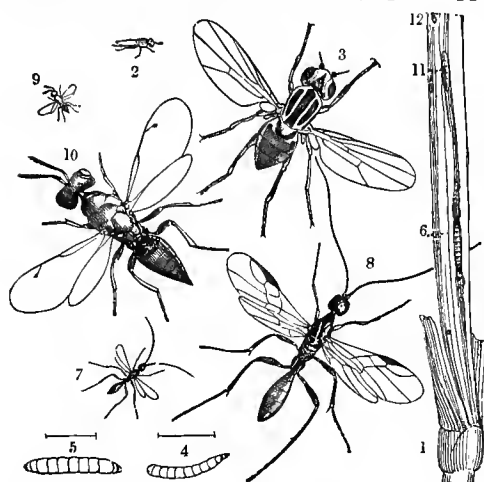


Fig. 374.—Ribbon-footed corn-fly; Gout (*Chlorops teniopus*, Curtis).

2-6, Larva, pupa, and fly of *Chlorops teniopus*, natural size and magnified parasite flies; 7 and 8, *Colinus niger*; 9 and 10, *Pteromalus nitens*, natural size and magnified; 1, 11, and 12, Infested corn-stem.

development of the ear is prevented. The distinctive mark of the *Chlorops* attack is the pitchy-brown furrow, from

state of the straw.

Prevention.—The maggot winters in the stump; therefore any measures to destroy the infested stubble before the saw-fly comes out, in about the May of the following year, are the best means to prevent recurrence of attack.

Hessian Fly.

In 1886 a new pest was discovered in England. The Hessian fly (*Cecidomyia destructor*, Say), (fig. 376), was found to

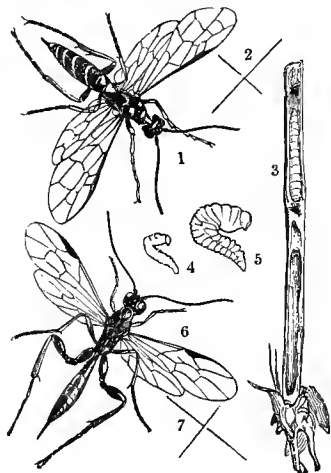


Fig. 375.—Corn saw-fly (*Cephus pygmaeus*, Curtis).

1 and 2, Saw-fly, magnified and natural size; 3, Stem containing larva; 4 and 5, Larva, natural size and magnified; 6 and 7, Parasitic fly (*Pachymerus calcitrator*) magnified and natural size.

the base of the ear down to the first knot in the stem.

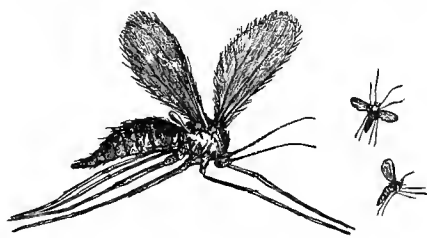


Fig. 376.—Hessian fly (*Cecidomyia destructor*, Say).

be present in some barley-fields near Hertford.

The following abstract, from a German source, gives its life-history: "The larvæ live in the haulm of wheat, rye, and barley.

The female flies usually lay their eggs on the young leaves twice in the year—in May and September—out of which eggs the maggots hatch in fourteen days. These work themselves in between the leaf-sheath and the stem, and fix themselves near the three lowest joints, often near the root, and suck the juices of the stem, so that later on, the ear, which only produces small or few grains, falls down at a sharp angle. Six or eight maggots may be found together, which turn to pupæ in spring or about the end of July, from which the flies develop in ten days.” —(Stett. Ent. Zeit., xxi. p. 320.)

Miss Ormerod (from whose pamphlet on the subject this information is taken) found, on visiting the infested fields, the stems doubled sharply down a little above the joint, as shown in fig. 377, lower

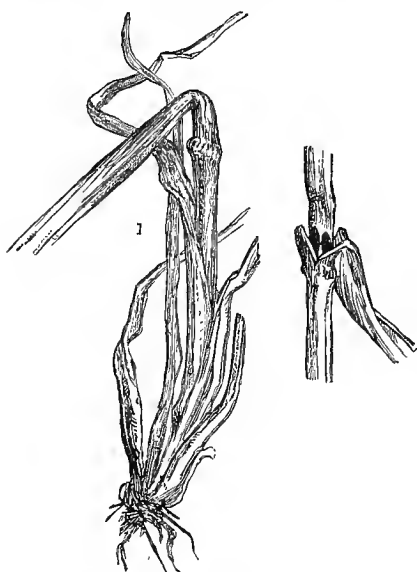


Fig. 377.—Hessian fly attack on barley.

1, Bent barley stem; 2, Leaf bent down, showing “flax-seeds.”

down; and between this double and the joint there lay, closely pressed to the stem and covered by the sheathing-leaf, the flax-seed-like chrysalis-cases. The injury is caused by the fly-maggots, lying at the same spot, sucking the juices from the stem, which is thus weakened, and falls.

The Hessian fly has commonly two broods in the course of the year—the

winter attack to the young plants, and the summer attack to the growing straw. The flies which come out in August or September from the “flax-seed” chrysalis-cases (sheltered above the second joint of the straw from the ground), lay their eggs, we are informed by various observers — Professor Riley, the State entomologist, amongst the number—in the grooves on the surface of the leaves, or between the stalk and sheath where loose, and, as soon as the footless larva or maggot hatches, it makes its way down the leaf to the base of the sheath, which in the young winter wheat is at the crown of the root.

This form of attack has not yet been reported in England. The summer attack with us is started chiefly from flax-seeds or chrysalids which have survived the winter. The flies from these “flax-seeds” come out in spring, or about the beginning of May, and as, where the corn is running up to stem the tender ground-leaves are no longer to be found, which are used for autumn egg-laying, the flies have no choice, but they lay them instead, as we know, so that the maggot,



Fig. 378.—Chlorops. Stem attack showing maggot furrow.

when hatched, shelters itself between the stem and sheath, just above the first or second joint from the ground, and there it turns to the flax-seed chrysalis, from which the autumn brood presently come out.

How the pest came to this country we do not know, and very likely never shall. All evidence points to it having come from Russia and the east of Europe. In all probability it came either in foul corn, and was distributed in cheap screenings—or it may have come in straw; but the examinations of nearly a year of straw at receiving ports did not disclose more than one infested stalk.

Prevention.—Our chief method of prevention is in *late sowing*, so that the young wheat will not be up until the autumn brood is dead—this is a most important precaution. All measures to secure hearty good growth are very desirable; so is rotation of crop, and it should be borne in mind that strong-stemmed corn is less liable to attack than the kinds of which the outside is more readily injured by the maggot.

One most important measure to prevent recurrence of attack from infestation present in any locality is *destruction of siftings*, in which the flax-seeds, as they are called, are thrown by the threshing-machines. These chrysalids are often present in great numbers, and would if left be the origin of next year's attack; and if burnt together with the rubbish in which they lie great danger will be spared. Miss Ormerod, in the preface of her second report on this subject, thinks "the experience of last season has removed much cause for anxiety" on the score of the Hessian fly; and the attack of 1888—so far as reported—was enormously less in amount than that of 1887.

It may be of use to mention the differences between the three great corn pests. Hessian fly attack is at once known by the stem falling at an acute angle, usually about the second joint (fig. 377). The special mark of *Chlorops* attack is the pitchy-brown furrow, from the base of the ear down to the first knot of the stem; whilst the corn saw-fly (*Cephus*

pygmaeus) cuts the corn off near the ground (fig. 378).

Wheat-midge.

The "red maggot" or larva of the *Cecidomyia tritici*, Kirby, (fig. 379), so troublesome in Canada, often does harm by injuring young grains of wheat in the ear. The *C. tritici*, or wheat-midge,

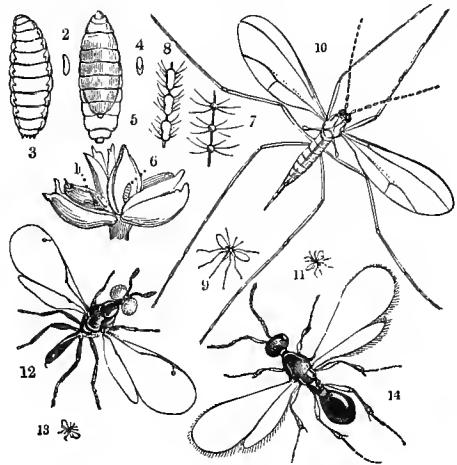


Fig. 379.—Wheat-midge (*Cecidomyia tritici*, Kirby).

1, Infested floret; 2-6, Larva and cased-larva (? pupa), natural size and magnified; 7 and 8, Joints of antennae, magnified; 9 and 10, *C. tritici*, natural size and magnified. Parasite flies: 11 and 12, *Platygaster tipulae*; 13 and 14, *Macroglenes penetrans*, natural size and magnified.

is like a very small gnat, of the shape figured above, and of a yellow colour.

When the wheat blooms in June, the midges may be seen laying their eggs, especially during the evening. The maggots, which are orange colour and legless, but wrinkled transversely into folds, by means of which they wriggle themselves along, are in large numbers stored with the corn when cut, while others, which leave the ear, go down into the ground.

Prevention.—To destroy the maggot in screenings, or to resort to such methods of cultivation as will destroy it when in the ground. Deep ploughing with a skim coultter, which will take off a thin slip, and bury this down under a succeeding land slice. Chaff and rubbish from the threshing-machines should be burnt; firing the stubbles is good; also destroying such wild grasses as the midge

is known to frequent, notably the wild oat, *Avena fatua*.

Wire-worm.

We now come to a most important injurious insect, whose ravages are very widespread, the wire-worm or grub of

waste and destroy more than they require for food.

The egg from which this grub is hatched is laid either in the earth close to the root of a plant, or between the sheathing leaves near the base of the stem. On being hatched, the grub or wire-worm eats into the stem just above the true root, and sometimes eats its way up to the middle of the stalk. Wire-worms are said to live five years in the grub state: they go down deeper in the ground as the frost increases; they feed voraciously near the surface till the time has come to turn to the chrysalis (or pupa); they then go deep into the soil, and form an earth-cell in which they change, and from which the perfect beetle comes up through the earth in two or three weeks, generally about the first weeks in August, or they may pass the winter in this state, and the beetles develop the next spring.

Prevention.—As clover leys and broken-up pasture-land often swarm with these grubs, paring and burning is advantageous, care being taken to burn the rubbish as soon as possible, or the wire-worm will soon secure itself below. Soot and guano has stopped the mischief on a bad crop of oats. Nitrate of soda and salt are beneficial, also soda ash. Rape-dust is a good stimulating manure, and rape-cake, as has been proved, acts beneficially by enticing the wire-worms from the crop.

Moles, rooks, plovers, and peewits assist us greatly in keeping down wire-worms, and it should be borne in mind white mustard has been found to act well as a clearing crop on infested land.

Ear Cockles.

"False ergot," "purples," or "ear cockles" attack of ears of wheat (a small purple gall-like growth), is caused by the eel-worms (*Tylenchus tritici*), (fig. 382), of the family *Anguillulide*. The colour is yellowish white, and the largest wormlets are from a seventh to even a quarter of an inch in length.

Prevention.—As a method of preven-

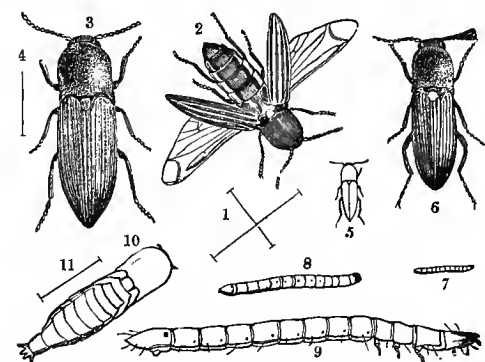


Fig. 380.—Wire-worms; Grubs of Click beetles (*Elatér lineatus*, *Elatér obscurus*, and *Elatér sputator*, Linn.; and *Elatér ruficaudis*, Gyll.)

1 and 2, *E. lineatus*; 3 and 4, *E. obscurus*; 5 and 6, *E. sputator*, natural size and magnified; 7, Larva of *E. sputator* (?); 8 and 9, Larva of *E. lineatus*, natural size and magnified; 10 and 11, Pupa of wire-worm magnified—the straight lines show natural length.

various kinds of click beetles. (See fig. 380.)

These may easily be known by their hard shiny yellow appearance, like a short bit of flattened wire. They should be distinguished from the grubs of other insects, and insect allies which pass

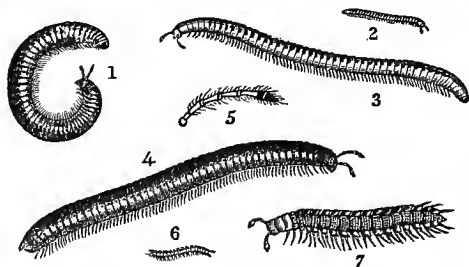


Fig. 381.—False wire-worms.

Snake millepedes: 1, *Julus Londinensis*; 2 and 3, *J. guttatus*, natural size and magnified; 4, *J. terrestris*; 5, Horn; 6 and 7, Flattened millepede, *Polydesmus complanatus*, natural size and magnified.

under the name of false wire-worms, millepedes, or *Julus* worms, shown in illustration (fig. 381). From their method of gnawing roots or underground shoots, and then going to another plant, they

tion, "pickling" with sulphate of copper, or dilute sulphuric acid, is supposed to be of service in killing the wormlets in the cockle-galls.

Another species of eelworm—the *Tylenchus devastatrix* of Kuhn, is the cause

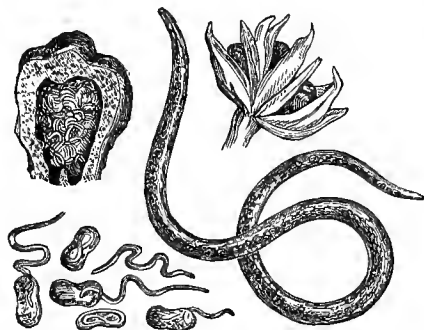


Fig. 382.—Ear cockles (*Tylenchus tritici*).
Wheat cockle-gall; Eelworm.

of very serious injury to different crops, and especially to oat plants and clover. In oats the small microscopic eelworms which infest the inside of the plant give rise to the deformed bulb-like growth at the base of the stem known as "tulip-root" (fig. 383). In clover, one of the most common forms of disease, or "sickness," as it is called, is also owing to the presence of the *T. devastatrix* in the shoots, which are often shortened and thickened in growth; and in bad cases have the side shoots stunted into mere rounded bunches of leaves aborted into scales, set thickly along the stems.

The use of a mixture of phosphate of potash and phosphate of ammonia, at the rate of about 4 cwt. the acre, has been found to answer extremely well as an application where eelworm is present, and deep ploughing (with a skim coulter), so as to bury down the surface of the land where infested crops have grown, is a very serviceable method of prevention.



Fig. 383.—Tulip-rooted
oat plant infested by
eelworm.

The attack of this destructive species of nematode or thread-worm has for some years been specially studied for practical use (as well as scientifically in connection with two of the chief Continental experts) by Miss Ormerod, and details of the progressive observations will be found in her yearly reports. A complete account of the attack in connection with clover, with notes of serviceable means of remedy, and also good figures of the wormlet, appear in her Thirteenth (1889) Annual Report.

Before quitting corn pests we must just allude to the corn thrips (*Thrips cerealium*, Haliday) which infest damp spots and late-sown corn. Draining and good cultivation are the only practicable remedies.

HOPS.

Hop-fly.

Hop plants, both above and below ground, are liable to attacks from several kinds of insects, and the losses to planters occasioned by the hop-fly have been almost incalculable. It appears they have been of more frequent occurrence during the past fifty years.

The hop aphid is of the genus *Phorodon*, so named from the toothed or gibbous form of the first joint of the antennæ, and from the toothed frontal tubercles, which are most developed in the wingless viviparous females. For the mode of attack, and for the remedies and further details, the reader is referred to the Report of Mr C. Whitehead, our highest authority on hop-growing.¹ The following notes, taken almost entirely from Mr Whitehead's writing, contain observations of some of the chief hop pests, and common methods of treatment.

Hop Aphid (Aphis humuli), (fig. 384).

The hop-aphid appears upon the hop plants generally about the beginning of May, and if the conditions of temperature and of the plants are favourable, it propagates with astonishing rapidity. The never-ending still-beginning swarms live entirely upon the sap of the plants, and suck it up by a kind of pumping process

¹ Report on Insects Injurious to Hop Plants, by Charles Whitehead, Esq., F.L.S., F.G.S., prepared for the Agricultural Department. Eyre & Spottiswoode.

with their monstrously long beaks, attacking first the youngest and smallest leaves of the leading shoots, which are more succulent than the older leaves. After a week or two the growth of the plants is checked, and they struggle in vain to reach the tops of the poles. Their juices

This is applied by means of large garden-engines, with strong pumps, the jets being held under the leaves by men. In the case of large plantations, horse washing-machines are used. To ensure success the wash must be applied as soon as the lice are seen on the leaves, and must be continued till all these have been cleared off.

The *Coccinellæ* (ladybirds) are the hop-fly's great natural enemies, and they have often been known to appear in such large numbers as to avert an impending blight.

Minor measures consist in carefully removing what may be shelters of infestation, as pieces of dead bine, &c., before February, and the application during the winter of lime, soot, and caustic substances round the stocks.

Wire-worm in Hops.

Wire-worms, the larvæ of the striped click-beetle, *Agrotis lineatus*, are the first enemy to attack the hop. They often do much mischief by gnawing the sets directly they are planted, and eating off the radicles and shoots as soon as they are formed. This plague is most prevalent upon land that has been broken up from old pasture. Several acres are sometimes so much destroyed as to require replanting. The plan recommended by Mr Charles Whitehead for getting rid of wire-worms in a hop-ground, is to put pieces of mangel, carrot, or turnip or rape-cake close round the "hills," and to examine these once or twice a-week, and capture the wire-worms that have burrowed into them.

Slugs.

Little black slugs, if undisturbed, attack and devour the shoots or bines as they appear. This plague may be pretty effectually prevented by sprinkling quicklime over the "hills" very early in the morning.

Cone-fly.

The hop cone-fly or fever-fly (*Dilophus vulgaris*), which revels in manure-heaps, is often troublesome, and so is the hop-

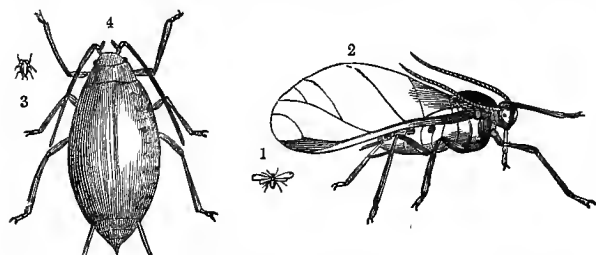


Fig. 384.—Hop aphid; Green fly (*Phorodon humuli*, Schrank).
1 and 2, Female aphid, natural size and magnified; 3 and 4, Larvæ or "nits," natural size and magnified.

are exhausted by the continuous suckings of these insects, and the respiratory action of the leaves is stopped as to their under surfaces, upon which the aphides always congregate and feed, by their filth and exuviae, and upon their upper surfaces by the "honey dew," a peculiar glutinous sweet secretion ejected from the bodies of the aphides; this falling upon the leaves effectually prevents them from absorbing oxygen into their tissues. After this, which, as a rule, happens from three weeks to a month after the appearance of the insects, the plants give up, the leaves turn black and fall off, and all chances of a crop are lost.

Prevention.—Professor Riley's observations during the past season have proved the migration of *Phorodon humuli*, Schrank, between plum and hop—an important fact, previously much believed in, but not absolutely demonstrated. Therefore, when damson-trees are infested in the neighbourhood of hop-grounds, they should be washed with soft soap, &c., to prevent this migration.

The best remedial measure is to use the well-known hop-wash, the composition of which is—

- 100 gallons of water, soft water if possible, or, if hard, with soda added.
- 4 to 5 lb. of soft soap.
- 6 to 8 lb. of quassia, boiled well to get full extract.

jumper (*Euacanthus interruptus*, Linn.), fig. 385, for which the only remedy proved to be practical and effectual, is to hold tarred boards or sacking on two sides of the plant, low down in the

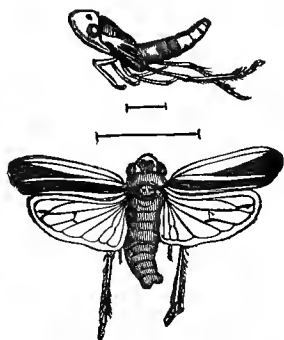


Fig. 385.—Hop-jumper (*Euacanthus interruptus*, Linn.)

alleys, and to have the poles smartly tapped with a stout stick. Washings do not appear to have any effect on the jumpers.

Hop-flea.

The hop-flea (*Haltica concinna*, Curtis), like its congener the turnip-flea, rejoices in cloddy ground, so it is desirable to well work round the plant-centres early, and get a good season all over the plantation as soon as possible after poling.

One means of preventing the spread of these beetles is to have the pieces of the old bines moved away after hop-picking. After a bad attack, lime, soot, &c., should be applied in October.

The caterpillar of the ghost moth (*Hepialus humuli*, Stephens), and the hop-bug (*Lygus umbellatarum*), which lives by suction, are two other hop pests, but not so important as the hop aphid and the red spider (*Tetranychus telarius*, Linn.), fig. 386.

Red Spider.

The red spider, which is so troublesome in hot and dry seasons, is neither an insect nor a spider, but, strictly speaking, a "spinning mite"—that is, belongs to the genus *Tetranychus*, of the order *Acarina* or mites. Mr Andrew Murray thus describes its work: "On leaves (especially the under side of them) it

finds a fit hold, and spins its web, affixing the threads to the prominences and hairs of the leaf; and under this shelter a colony, consisting of many of both sexes in maturity, and young in all their ages, feed and multiply with rapidity. The plant soon shows the influence of their presence in its sickly yellow hue; the sap is sucked by myriad insect-mouths from the vessels of the leaf, and its pores are choked by excremental fluids."

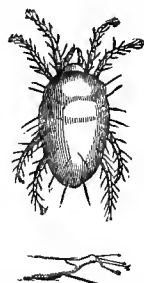


Fig. 386.—Red spider (*Tetranychus telarius*, Linn.)

Prevention.—The hop-wash, previously described, is the only effectual remedy. Poles should be well shaved before they are set up, as their bark harbours these mites, and many other insects injurious to hop plants.

Thousand Legs.

On undrained lands the thousand legs (*Julus Londinensis*, *J. guttatus*, &c.) are often troublesome.

Prevention.—Thorough cultivation of the land, especially turning the surface early in the year, and removing all vegetable and decaying matter which would serve as a shelter for them. Where nitrate of soda or salt can be applied so as to reach them in solution, this is an immediate destruction to the spotted millepede the *Julus guttatus*, and salt, lime, nitrate of soda, and other alkaline applications are found serviceable as deterrents.

Hops are also liable to attack from the hop frog-fly (*Eupteryx picta*, Fab.), the hop dog-caterpillar of pale tussack moth (*Dasychira pudibunda*, Linn.), and the caterpillar of the hop-vine snout moth (*Pyrallis rostralis*, Linn.), the injuries of which may be lessened respectively by use of tarred boards or syringing.

ONIONS.

Onions—an important crop in the south of England—are often attacked with most disastrous results by the onion-fly (*Anthomyia ceparum*, Bouche), fig. 387. The injury is caused by the

maggots feeding inside the onion bulbs, which are often completely destroyed. These maggots may be found as early as May. When hatched the maggots make their way into the lowest part of the bulb, where they feed for a fortnight, and then go down into the earth, and turn into the chestnut-coloured "fly-

has been tried with success both in England and Canada.

Where onion-beds have been much infested, it is a good plan to trench down the surface-soil in autumn, and so bury the maggots or chrysalids that may remain on the ground too deeply to cause further mischief.

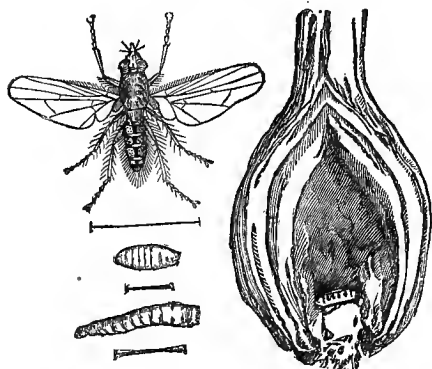


Fig. 387.—Onion-fly (*Anthomyia ceparum*, Bouche).

cases." From these the fly comes out in ten to twenty days in summer, and proceeds to egg-laying, and so the destruction goes on as long as the onions remain and the warm weather lasts.

Prevention.—Miss Ormerod has noticed that the onion-maggot can creep from an infested bulb to those near, and to avoid this spreading it is important to carefully remove each injured bulb, with the earth round it. Or the bulb may be destroyed by letting a few drops of carbolic acid fall on it, which will spread through the decayed tissues, and kill the grubs, but will do no harm, as nothing live is growing on the spot.

Amongst the remedies that have been tried are sprinkling sand saturated with paraffin amongst the onions, also putting on a dressing of soot on a damp morning. And in garden cultivation, watering with soap-suds and house-slops is a good old-fashioned remedy.

A most effectual method of *preventing* attack occurring, is to grow the onions in trenches, and keep the bulbs so far covered with earth that the fly cannot reach them to oviposit. This

PEAS.

Peas are often attacked by the caterpillars of the pea moth (*Grapholita pisana*, Curtis). These cause the "maggoty peas" often found in old pods when the crop is maturing.

Prevention.—In gardens where the peas are picked green, a large number of maggots are destroyed with them; but in field cultivation, where the attack is noticeable, the haulm should be cleared away and burnt, or it may be burnt along the rows where it has stood, to destroy the caterpillar in the ground. It has been found to answer the purpose if it is buried beneath wet manure. Alteration of cropping, so that peas are not taken too often on infested ground, is a desirable means of prevention.

Pea and Bean Weevils.

The greatest enemies to leguminous crops are the pea and bean weevils (*Sitona lineata*, Linn.; *Sitona crinita*,

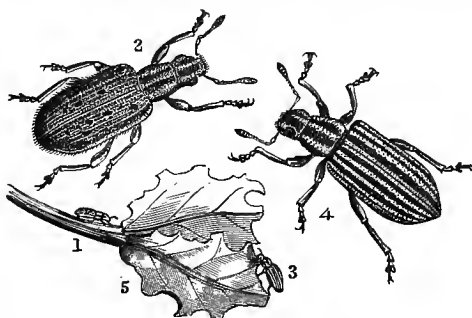


Fig. 388.—Pea and bean weevils (*Sitona lineata*, Linn.; *Sitona crinita*, Olivier).

1 and 2, *S. crinita*, natural size and magnified; 3 and 4, *S. lineata*, natural size and magnified; 5, Leaf notched by weevils.

Olivier), fig. 388. The attack is known by the leaves being scooped out at the edge. The beetles begin their ravages at the outsides of the leaves, and often eat all except the central rib. The striped

pea weevil *Sitona lineata* is of an ochreous or light clay colour, the horns and legs are reddish. The spotted pea weevil (*Sitona crinita*) is rather smaller and more of a grey colour; the wing-cases have short bristly hairs down the furrows, and are spotted with black.

The maggots have been found, by the observations taken in the last few years, to feed at the roots of peas and clover, and may be found in large numbers at clover roots during the winter. The weevils until lately were supposed to feed by day, and shelter themselves in the ground under clots or rubbish at night, but more recently they have been observed to be night-feeders also.

Prevention.—As pea crops suffer most from weevil attacks in the early stages of their growth, it is most important the soil should be well pulverised, and an available supply of manure beneath to push on the growth of the plant. Dressings of lime and soot (applied when the peas are wet) are good. Starlings and insectivorous birds are very fond of these weevils; but it has been observed that though these birds visited an infested field in large numbers, not one house-sparrow was seen till the peas were large enough to peck out of the pod.

Care should be taken to have the weevils swept out from the bottom of waggons and carts when the crop is being carted home, and also to remove them from platforms of the threshers, and burn them.

POTATOES.

The potato, which has become such an important factor in the rotation of most farmers, was, in the year 1877, threatened with the Colorado beetle (*Doryphoru decemlineata*, Say), fig. 389; but as it has not yet obtained a footing, and as our climate

is too cold for it, we are likely to escape the attack. In case it should appear, the subject is before the public in the Government circular.

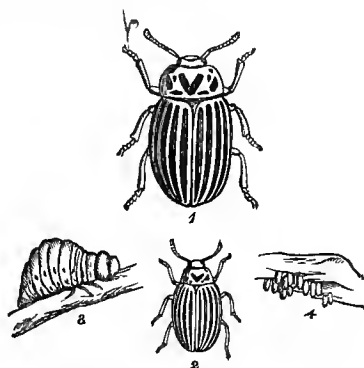


Fig. 389.—Colorado beetle (*Doryphoru decemlineata*, Say).

The eggs, figured above, are laid on the young shoots or beneath the leaves of the potato; the grubs are orange or reddish, and change to pupæ in the ground; and the beetles are also distinguishable by their orange colour and by having (besides a large black spear-

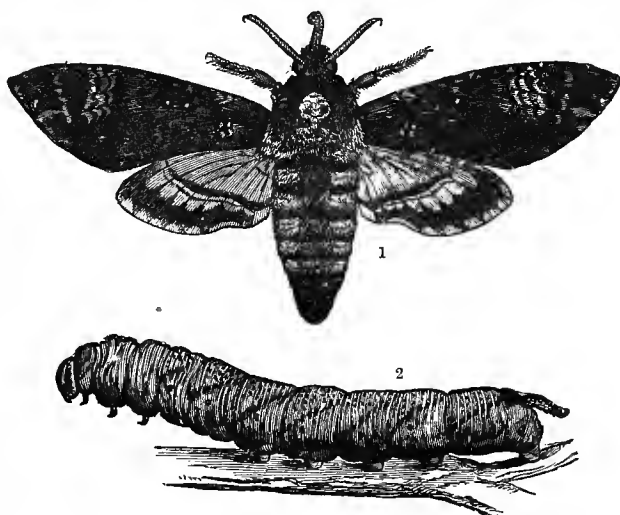


Fig. 390.—Death's-head moth (*Sphinx atropos*).

1, Moth; 2, Caterpillar.

shaped mark on the back) ten black stripes on the wing-cases—five stripes upon each.

The caterpillar of the death's-head moth (*Sphinx atropos*), fig. 390, is sometimes found in large numbers feeding on potato-leaves. It usually feeds by night; and when it is noticed as doing great damage, it is advisable to resort to hand-picking in the twilight, or by moonlight,—the great size of the grubs renders them easily distinguishable.

TURNIPS.

The annual loss incurred by insect pests injurious to turnips and other root crops is of serious proportions, while many of the remedies found to be of practical service are within the reach of every farmer. A great deal of useful information relating to the turnip-fly will be found in Miss Ormerod's Report on the widespread ravages of this troublesome pest in 1881.

The Turnip-fly.

The fly, or, more properly, the flea-beetles (*Phyllotreta nemorum*, Chevrolat), fig. 391, live through the winter—in a torpid state, or otherwise, according to

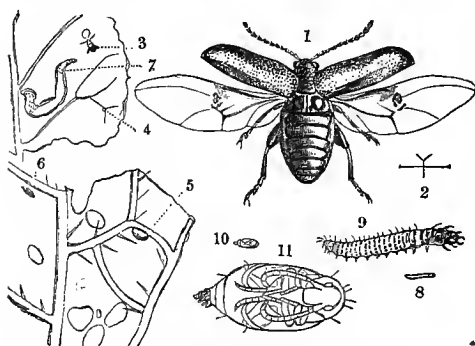


Fig. 391.—Turnip-fly (*Phyllotreta nemorum*, Chevrolat). 1-3, *H. nemorum*; 4 and 5, Eggs; 6-9, Maggot; 10 and 11 Pupa; all natural size and magnified.

the amount of cold—and under such shelter as is afforded only too often by rough ground, stones, or apparently almost any kind of moderately dry field rubbish.

With the return of sunshine they come out to trouble us, and feed, until the turnips and cabbage are ready for them, on shepherd's-purse, Jack-by-the-hedge, ladies' smock, charlock, and other wild Cruciferae.

Prevention.—As the fly will appear before turnips are sown, it is most important to clear away charlocks and other weeds suitable for its food.

One spring, a field in good tilth, ready for turnips, suddenly became a mass of charlocks. This was entirely cleared away by the fly, which again appeared and preyed on the turnips when sown. Had the precaution of harrowing up the charlock as soon as it appeared been taken, the turnips would in all probability have been saved.

In coping with the turnip-fly the following *especial points* should be observed: 1st, cleaning the ground; 2d, destroying rubbish round the fields, or any rough nooks which might serve as winter shelters to the flea-beetles; 3d, so preparing the ground by good cultivation and plenty of manure that the growth of the turnips may be pushed on vigorously past the first leaves, in which they are most subject to the fly: where it is possible, autumn cultivation is desirable, so that at turnip-sowing the upper surface will only require slight disturbance, and thus the moisture beneath, which is a great desideratum for the young turnips, will remain to aid the growth; 4th, all dustings, dressings, &c., should take place when the dew is on the leaf, and the fly exposed to them, *not* in bright sunshine, when the fly would escape. If a rapid healthy growth can be ensured, the young plants are less likely to succumb. The old adage—

“Where clods prevail
The turnips fail”—

speaks volumes. The importance of keeping the moisture in the ground at sowing-time, and the advisability of autumn cultivation, thick seeding, rolling in the early morning when the dew is on the plants, are points to be attended to.

Mr Fisher Hobbs's celebrated remedy for the fly is as follows:—

“1 bushel of white gas-asbes” (gas-lime) “fresh from the gas-house, 1 bushel of fresh lime from the kiln, 6 lb. of sulphur, and 10 lb. of soot, well mixed together and got to as fine a powder as possible, so that it may adhere to the

young plant. The above is sufficient for two acres, when drilled at 27 inches. It should be applied very early in the morning *when the dew is on the leaf*, a broadcast machine being the most expeditious mode of distributing it; or it may be sprinkled with the hand carefully over the rows."

In all probability it will be found that "Strawsonising" (see below) the infested crop with some liquid or dry mixture which will kill the insects, will be the most practical remedy of the future.

THE STRAWSONISER.

This machine has been employed with such marked success in preventing the

ravages of the turnip-fly and other crop pests, that particular notice of it should be made here. It was invented by Mr G. F. Strawson, Newbury, Berks, and is likely to prove one of the most important inventions of the time to farmers and growers of bushes and trees. This machine was first exhibited at the show of the Royal Counties Agricultural Society at Bournemouth in 1888, and its remarkable accomplishments have become speedily known.

It is really an air-power distributor, and it introduces for the first time the pneumatic power in the cultivation of field crops.

In its agricultural form (as shown in fig. 392) it is a light machine on a pair of wheels, and drawn by one horse. The

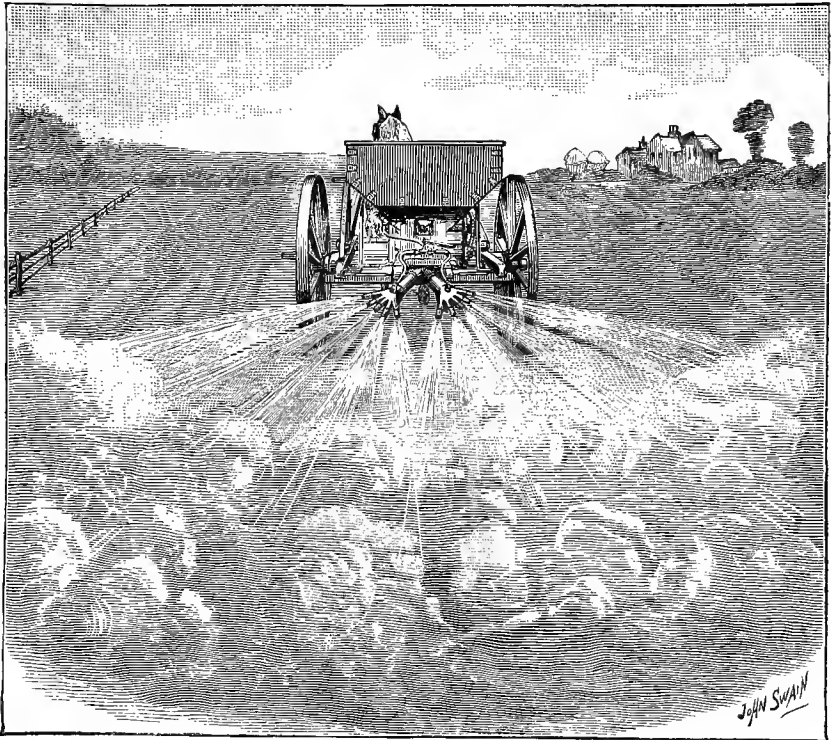


Fig. 392.—The Strawsoniser at work.

revolution of the road-wheels gives, by suitable gearing, a strong blast of air from a powerful blower; over this blast of air is placed the hopper containing

the material to be spread, either dry or liquid, which is gradually fed into the current. The quantity to be fed is, in the case of liquids, regulated by cocks.

There is therefore, practically, no limit to the accuracy of adjustment; like water it may be turned on from the tiniest jet to a full stream. In the case of solids, a sliding shutter regulates the quantity, which can be instantly started or stopped by levers in command of the driver. The machines are constructed chiefly of iron and suitable metal to give requisite strength and durability. The regulation and management of the machines are very simple.

By the use of this ingenious machine the thinnest and most attenuated films can be spread evenly over land or growing crops.

The almost omnipresence of minute insect or fungoid devastators demands that the distribution should be nearly perfect in order to reach their microscopic bodies. In many trials the ravages of the turnip-“fly” or flea-beetle have been completely checked by distributing 1 gallon of paraffin to the acre with this machine. Freshly slacked lime, and also lime and sulphur finely prepared, have also been effectual when put on in the same way.

The pneumatic power is so perfect an agent that it can deal effectively with fine particles that are invisible to the naked eye, or those larger and heavier substances, such as the grains of nitrate of soda, clover seeds, and wheat maize, &c. Nitrate of soda, for instance, may be spread over the land most perfectly in quantities from 28 lb. to 4 or 5 cwt. per acre, while it will also sow farm seeds at the rate of from 10 lb. to 4 bushels per acre.

Besides being useful for these ground crops the machine may be made to distribute vertically or horizontally as occasion may require, to suit the applications to various plants, such as hops, vines, shrubs, and trees. Its use is also suggested for spreading salt on snow, and sand on slippery roads, as well as disinfectants over cattle runs, market, streets, and other places.

The Green Fly, &c.

The green fly, or turnip aphid (*Aphis rapæ*, Curtis), fig. 393, common to so many plants, is especially hurtful to

turnips, swedes, and many other crops. It is chiefly found on the under sides of the leaves, and is most troublesome in dry seasons. Titmice, ladybird beetles and their grubs, are its natural enemies.

Prevention.—Washings—i.e., drenchings with soap-suds, or even with pure

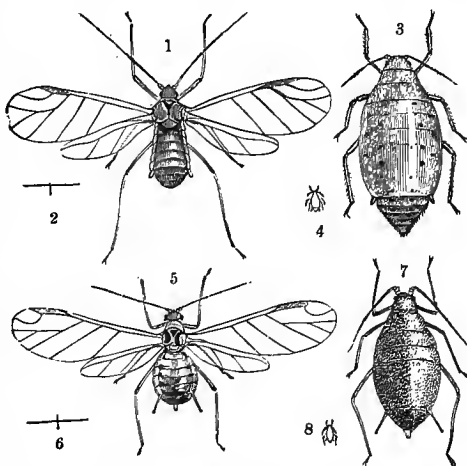


Fig. 393.—Turnip aphid; Turnip green fly (*Aphis rapæ*, Curtis; *Aphis florisorapæ*, Curtis).

1-4, *Aphis florisorapæ*; 5-8, *Aphis rapæ*, natural size and magnified.

water—and also waterings, especially with manure-water, are serviceable in garden cultivation, but up to the present time have been rarely attempted for field use. Now, in all probability, the fluid or dry dressings given by the “Strawsoniser” mentioned above will be of great use.

The turnip-leaf is also attacked by maggots of two kinds of *Diptera*—*Phytomyza nigricornis*, Macquard, the black leaf miner; and *Drosophila plana*, Fallen, the yellow leaf miner. These, and caterpillar of the diamond-back turnip moth (*Cerostoma xylostella*, Curtis), though seldom observed, sometimes clear all before them.

Dart Moth Maggot.

The caterpillar of the common dart moth (*Agrotis segetum*, Westwood), fig. 394, is often very destructive. Whilst the plants are young they gnaw off the tops, or drag the leaves down to their burrows to be eaten during the day. When the bulbs are formed, they estab-

lish themselves inside and feed on them. Sometimes 12 or 14 have been found in one root.

Prevention.—*Catch cropping* is a good remedy for the destruction of these caterpillars, and, where possible, turning

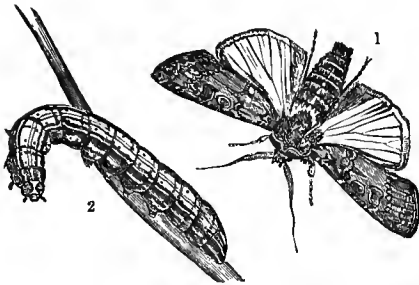


Fig. 394.—Dart moth (*Agrotis segetum*, Westwood).
1, Moth; 2, Caterpillar.

up the earth round plants and hand-picking. The encouragement of birds that especially feed on them, such as the crow, the rook, and the partridge, is worthy of attention.

Bird assistance in destroying injurious insects is not sufficiently appreciated.

The caterpillar of the heart and dart moth (*Noctua exclamatoris*, Linn.), and all other surface caterpillars, should be dealt with in the same way.

Turnip Saw-fly Grub.

The mischief caused by the grubs of the turnip saw-fly (*Athalia spinarum*, Fabricius), fig. 395, is very great, in

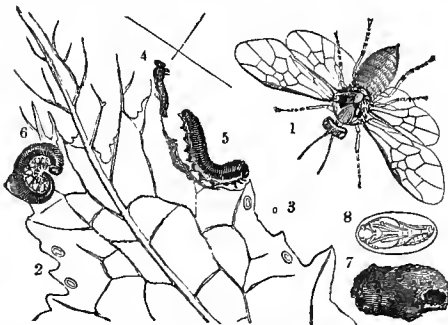


Fig. 395.—Turnip saw-fly (*Athalia spinarum*, Fabricius).
Caterpillars, pupa, and pupa-case; Saw-fly, magnified, with
lines showing natural size.

consequence of their voracious appetites (they begin to feed as soon as hatched)

and the rapid succession of broods. They are known as “blacks,” “black palmers,” “niggers,” &c. They will sometimes clear off the leafage of a whole field. The following diagram (fig. 396) will give an idea of their destructiveness.

One saw-fly will lay from 200 to 300 eggs, and these will hatch in five days, or less in warm weather. When full grown, in about three weeks they go down to the earth and spin a silken cocoon; from these cocoons the saw-flies emerge in about three weeks. It should be remembered that, when they are changing their skins (that is, every six or seven days during the time they continue in the grub form), if they are disturbed they die; for if they lose hold with the pair of feet at the tip of the tail during the operation, they cannot fix themselves so as to pull themselves out of the old tight skin, and therefore they perish in it.

Prevention.—Some think it a good plan, in order to effect this dislodgment, to draw a very light bush-harrow over the turnip-leaves. When the attack is bad, it is well to delay hoeing. The application in moist weather of nitrogenous or ammoniacal manure, and watering with liquid manure in drought, are measures worthy of attention, it being remembered that a rapid growth is the greatest safeguard against all kinds of insect attack.

Weevils, &c.

In reference to some of the many insect attacks on turnips, Mr John Milne, Mains of Lathers, Aberdeenshire, writes:—

“If the turnip crop is destroyed by the fly (or beetle), harrowing down the drills and re-forming them before resowing will cover and destroy many of the beetles.

“Two varieties of weevil, *Curculio*, are also very destructive to the young turnip plants. They, indeed, sometimes do more mischief than the turnip-beetle. The most destructive one is the little *Curculio*, *Ceutorhynchus contractus*, one-fourteenth inch long, which punctures the seed-leaves with its rostrum. When approached, it suddenly drops to the ground, draws in its legs and snout, and remains immovable for some time. The *C. as-*

similis, which rears its larva in the turnip seed-pod, attacks the plant also at this early stage.

"No practical remedy has been suggested for the attacks of small weevils, which prey upon the young turnip plants. Reducing the soil to a fine powder prior to drilling, and hard rolling of the drills, will no doubt mitigate their attacks, which are most destructive where the soil is rough and unpulverised. The grain fields should be kept free of char-

Mr George Brown, Watten Mains, Caithness, referring to the weevils which attack turnip plants, says: "The weevils are small and black. They fix on the under side of the cotyledons or seed-leaves, which are quickly eaten off, leaving nothing but the stalk. In some years, fields are totally cleared by this insect. In one instance I sowed a field of 20 acres three times before getting the turnips into the rough leaf. The second sowing was literally blackened by myriads of weevils. The copper-lime cure would have saved the first sowing."

As to the turnip saw-fly, Mr Brown remarks that "these are not easily dislodged. They are the worst enemies we have to contend with. Attacks are rare, but, when they do occur, no practical remedy is as yet known."

General Observations.

The above short observations are given by no means as a manual of reference. They form only a very brief record (with the assistance of the figures) of what are some of our chief in-



Fig. 396.—Turnip saw-fly grub at work.

lock, as both the turnip-beetle and weevil feed upon it as they do upon turnips.

"The most effective remedy for the nigger caterpillars of the saw-fly is poultry, which should be turned into the infected fields, in as large numbers as possible. Rooks and some other birds, as well as pigs, will devour the larva. Brushing them off the leaves, then stamping and covering them, have been tried with more or less success. Cutting ditches may help to circumscribe their attacks. Thunderstorms are said to sometimes kill them.

"To mitigate the attacks of the turnip *Aphis*, man is almost powerless. They possess such extraordinary fecundity that their increase is amazing."

sect pests, and of various measures which are applicable for prevention, or for lessening the amount of their ravages.

One great point needed to help agriculturists in fighting against farm insect pests, is that they should have information at hand, or be able to gain it by reference, as to the whole history of the destructive insect, and thus know at what stage of its life the pest lies most surely under power of prevention.

When the attack is in full progress, it is far more likely than not that any application to check it by attempting destruction of the insects will merely be an additional expense. Manurial or fertilising dressings that will push on a vigorous and rapid growth are our best hope under these circumstances. But some of

the worst attacks, which it is almost impossible to deal with when in possession, may be greatly mitigated by previous measures of cultivation of the land, or of destruction of sheltering rubbish, or sometimes by special dressings.

Where land can be left free for a sufficient length of time to turn the application to a safe and serviceable manure, dressings of gas-lime, which in caustic state is poisonous alike to insect and vegetable life, are of great service.

The careful dragging and burning of stubble, couch grass, and rubbish generally from the surface of the field harvested in autumn, would in itself destroy many pests; and all measures to secure good growth are amongst the best preventives of damage from attacks of the crop insects which more or less are sure to occur, together with the crops they feed on.

Mr George Brown, Watten Mains, Caithness, who has given much attention to the combating of insect pests in farm crops, writes: "Insect attack is most serious at the most critical period of the growth of the plants—that is, when the plant has exhausted the food-supply of the seed, and is becoming dependent upon the soil. From this we infer that plenty of food in a readily available form, within easy reach of the plant at this juncture, will, as a rule, be the best remedy. But the difficulty often is to detect an attack before the ravages become too apparent. For this very close observation will be necessary.

"Climatic influences have everything to do with the life-history of insects. A certain amount of heat is necessary for their development into the larva. Now I have observed that if we have very warm weather when the turnip seed is being sown, followed by a spell of cold weather, we are certain to have our turnips seriously attacked by the fly and weevils. It is the same with the grub, *Tipula oleracea*. I fancy the warm weather so hastens the development of the insect embryos that they become contemporaneous with the braird in its early stages, and then, when cold weather sets in, the plants are checked in their growth, and thus fall a ready prey to their insect enemies.

"Unfortunately, most of the remedial

measures which have been recommended, although they may have been found effective on a small scale, are not quite practicable where large fields have to be dealt with. In other cases, the cost of application under former conditions was greater than the farmer cared to face. Now, however, we are all hopeful that that most ingenious machine, the 'Strawsoniser,' may lift us out of our difficulties, and enable us to effectually, and at moderate cost, do battle with most of the insect enemies of our crops. For turnip-fly or weevil, a solution of 6 lb. sulphate of copper, 6 lb. caustic lime in 100 lb. of water, sprayed by the 'Strawsoniser' over an acre, would seem to be the best and most practicable remedy. Paraffin is also useful. In all probability it will, in the near future, become a recognised farm practice to send the 'Strawsoniser' over a crop suffering from an insect attack."

Literature on Farm Insects.—For those who wish to study the prevention of crop insects *in extenso*, there is much excellent information available in the papers by John Curtis, published in the early numbers of the *Journal of the Royal Agricultural Society of England*, and also procurable in collective form in the volume entitled *Farm Insects*, by John Curtis, a work that contains many excellent illustrations, several of which the publishers, Messrs Blackie & Sons, have kindly permitted us to use here.

The reports on "Injurious Insects of Great Britain," prepared for the Agricultural Department by Mr Charles Whitehead, give an immense mass of useful information in plain wording, with plentiful illustration, and at the cost of a few pence for each report. In the *Manual of Injurious Insects*, a single octavo volume, and in the yearly Reports of Miss Ormerod, the Consulting Entomologist of the Royal Agricultural Society of England, there is much useful information, these reports being especially contributed from agriculturists of practical as well as scientific observation.

For those who wish to study the subject of injurious insect prevention in other countries, the Reports of the Entomological Society of Ontario, published

yearly by order of the Canadian Parliament, may be mentioned as embodying excellent information, both scientific and practical.

The same remarks apply to a great extent to many of the Reports of the Department of Agriculture, and of the State Entomologists of various of the States of America. In these, however, the scientific entomological information is often given in such full detail and technical phraseology as to make them of little service excepting to trained entomologists.

For those who are disposed to pursue the subject into another language, the German work, *Die praktische Insekten Kunde*, by Professor E. L. Taschenberg, in five parts, may be commended. This work, indeed, has perhaps no equal for sound information both on the practical and entomological bearing of the subject. It lays before the reader not only the life-histories of the insects referred to, but also descriptions of them in every stage, besides giving beautiful illustrations of many kinds. It also enters at length into methods of prevention and remedy.

FUNGOID ATTACKS ON CROPS.

Farm crops are unfortunately subject to injury from the attacks of vegetable as well as animal enemies. The number of fungi known to attack and live upon the cultivated crops of the farm is almost countless. Some of them are comparatively harmless; others are exceedingly destructive.

We cannot here attempt anything like a full account of the many fungoid attacks to which crops are liable. We deal at considerable length with two of the most destructive, club-root or anbury in turnips (*Plasmodiophora brassicæ*, Wor.), and the potato disease (*Peronospora infestans*, Mont.) A few others we will refer to briefly. Those who desire to study fully the life-history of the various fungi which prey upon farm and garden crops may, with advantage, consult some specialist work, such as Mr Worthington G. Smith's admirable volume, entitled *Diseases of Field and Garden Crops*, published by Macmillan & Co.

CORN MILDEW.

This is a prevalent and very destructive disease, arising in different forms and from various causes. The "spring rust and mildew" is one form, known early in the season as rust, when it is seen in the form of reddish spots on the stems and leaves, and later in the season as "mildew," when it shows itself in black spots. It is, however, practically one disease, due to the attacks of the same parasitic fungus, *Puccinia rubigo-vera*, D.C.

This fungus appears very early in April or May, or even in March, and absorbs the substance which should go to the production of the ears of grain. The growth of the corn is thus impaired, and a deficient crop is the result. The straw as well as the grain is injured, and in the former the disease is carried on from the one season to the other.

Summer rust and mildew is another and more destructive form. It is caused by the fungus known as *Puccinia graminis*, Pers. It is usually first seen in June and July, and often reduces the crop by from 30 to 50 per cent or even more.

Corn Mildew and Barberry Blight.

—As to the life-course of this destructive fungus there is a sharp division amongst botanists. Many leading botanists and others believe and contend that the germs of the fungus must pass through, or, as Mr W. G. Smith puts it, be "nursed by a barberry bush" in spring before they can successfully attack the corn crop. Mr W. G. Smith is a vigorous exponent of the other school, which maintains that there is no necessary connection between the *corn mildew* and the *barberry blight*; that the fungi are perennial; and that both can live on from year to year for an indefinite period without aid from each other. Mr Smith assuredly seems to have won the battle, and the practical significance of this conclusion is that the destruction of the "barberry bush" will not contribute to the prevention of corn mildew.

Corn Mildew Hereditary.—There would seem to be no doubt that the mildew is hereditary in corn—that, as Mr W. G. Smith puts it, "it exists in a finely attenuated state in seeds taken

from diseased plants, and can be transmitted in a long interminable line from generation to generation."

Means of Prevention.

In discussing the means of preventing attacks of corn mildew, Mr W. G. Smith says:¹—

"All low-lying lands suffer most from mildew, and it is said that elevated lands are next most seriously affected, the intermediate positions being generally most free. This fact is generally explained by the presence of mists in the low lands, and clouds on the hill-tops, the mists and clouds being especially favourable to the development of *Puccinia*. Mildew is commonly seen at its worst in places where bushes and trees abound, as these objects impede free currents of air and aid fungus growth.

"We have ourselves observed corn mildew to develop with great rapidity after rain in August, and we have sometimes noticed the late sown wheat to be most affected. When the ears are badly attacked the grain is not only greatly impoverished and reduced to "skeleton grain," but it is hardly possible to separate the seed from the husks.

"Mildew is said to be more frequent after crops of clover than after other crops. We think the fact of straw from stables being so frequently thrown over old clover fields a sufficient explanation of this fact. Wheat after clover is certainly a favourable alternation of crops with many farmers, — perhaps because the old decaying clover roots act as good manure for the corn. When clover precedes corn it should be heavily folded with sheep, and straw from stables should not be used as manure.

"It is now generally accepted as a fact amongst practical men that after dressing the land with farmyard manure and nitrate of soda, mildew often puts in a strong appearance; but after mineral manures, bone superphosphate, and bone-meal drilled with the seed, rust and mildew are much less apparent. There can be no doubt that farmyard manure has a tendency to produce a gross soft growth in corn which is suitable for fungi, and that mineral manures, on the contrary,

have a tendency to produce a firm stiff growth unsuited for rust and mildew. As corn generally does so well in dry limestone and chalky districts, a hint might be derived from this fact as to the desirability, where possible, of manuring land with chalk. We have seen this done with success in North Herts and South Bedfordshire, where chalk is easily obtainable.

"It is probable that the resting-spores of the fungus of corn mildew seldom hibernate through two seasons; therefore, in instances where stable manure must be used, it should if possible be used in the crop preceding the corn or the crop following it rather than for the corn itself.

"An alteration of crops is in every way desirable. Beans, peas, turnips, potatoes, clover, and other farm produce should be taken alternately with corn.

"There is but one way of *getting rid* of corn mildew, and that is certainly not by cutting down barberry bushes and pulling up borage plants. Corn mildew is a *hereditary disease*, and therefore no seed corn should be gathered from mildewed plants. If the hereditary nature of the disease is disputed, it cannot be disputed that certain examples of corn have a strong and inherited predisposition for mildew; therefore predisposed examples should be struck out and no seed gathered from them. Especial care should be taken in the rigorous selection of seed from white wheats, which are notoriously more subject to mildew than red, probably because the latter are naturally more robust. If seed merchants would guarantee that the seed corn they sell is taken solely from corn free from mildew, in the course of years the attacks and consequent losses from this pest would be considerably lessened. Mildew is every year so common in our fields simply, as we think, because the disease is planted with the grain.

"Old corn stubble should not be left too long in the fields. Some corn-growers say that a top-dressing of salt has a tendency to lessen or prevent mildew.

"*Mildewed straw* is bad when used as food for stock in chaff, and the inferior grain is hardly fit for pigs. The straw is more commonly used as litter in stables.

¹ *Dis. of Field and Garden Crops*, 199.

In this position the spores of the *Puccinia* remain uninjured, for neither warmth, frost, wet, or dryness materially affect the vitality of the resting-spores of the fungus of corn mildew. They are so small that no amount of treading from horses, herds, or flocks injures them. The warmth and dampness of the stable floor in every way suits them, and they are frequently taken from this position, full of life, and at once thrown on to the fields in the saturated straw. If the spores are consumed with food by animals, their passage through the alimentary canal does not injure them. The disease is probably, as we think, propagated by the mildewed straw being used as manure, and by the germinating resting-spores of the fungus of corn mildew infecting the first young leaves of the corn.

"Mildewed straw should be destroyed, because the *Puccinia*, with its myriads of resting-spores, is in this material. We have shown that these resting-spores germinate in the spring and early summer at the exact time when rust, which is the early state of mildew, first appears. Whether the resting-spores attack barberry bushes, or whether they do not, is of no great importance, for there are generally no barberry bushes to attack. The mildewed straw should, as far as practicable, be destroyed, and the hedges kept clear of rusted and mildewed grasses."

BUNT OF WHEAT.

This disease is caused by the fungus, *Tilletia caries*, Tul. The diseased grains may not be readily observed, but, when examined closely, they are seen to be unusually short and thick, and are found to contain a black powder with an offensive odour.

Prevention.—The spores of the fungus causing bunt are sown with the seed, and germinate after they have been lodged in the damp ground. The best method of prevention, then, is to treat the seed before sowing, so as to kill the germs of the fungus. This should be done without fail, if there has been bunt in the crop from which the seed is selected.

Disinfecting Seed.—As to the means

of disinfecting wheat seed, Mr W. G. Smith says: ¹—

"When bunt is known to be amongst seed grain it should be washed or steeped in some weak poisonous solution, as the minute spores from bunted grains adhere to the healthy seeds. Water, salt, quicklime slacked with boiling water, sulphate of copper, a quarter of a pound to a bushel of corn, and sulphate of soda, have all been recommended. Sulphate of soda in solution and the seeds afterwards dried with dusted quicklime is said to be one of the best preventive solutions. The lime combines with the soda and forms sulphate of lime or gypsum, whilst caustic alkali is set free. As the spores are lighter than water, mere steeping in brine or even pure water is often effectual, as the spores float, and are easily washed away. It is probable that the presence of a few scattered greasy spores are quite as, if not more, damaging than the whole bunted grains with unbroken seed-coats. Some alkaline ley should be added if water is used, as the oil on the surface of the spores combines with the alkali and forms a soapy substance which is fatal to effectual spore germination. Sufficient permanganate of potassium may be added to the water until it becomes rose-coloured, or one per cent of carbolic acid may be mixed with the water. It is not proper for the seed to remain long in these solutions; they should be washed quickly and then allowed to dry.

"When millers see bunted grains amongst the wheat they generally pass it through a dresser with a strong exhaust, and this draws away the foetid spores."

SMUT OF CORN.

This is a fungoid disease, too well known to need description. It is caused by the fungus, *Ustilago carbo*, Tul. When attacked, the grain is entirely destroyed, crumbling away in the form of a fine black or dark-brown powder. It attacks wheat and barley, as well as oats, but is most destructive in oats, not unfrequently blasting one-third or more of the crop.

¹ *Dis. of Field and Garden Crops*, 252.

Propagation of Smut.—Mr W. G. Smith states that the disease is doubtlessly propagated by the spores of the fungus being blown over the fields and absorbed by the earth, and by the fungus spores which adhere to the seed at the time of sowing. He considers the evidence complete that the infection comes from the ground, and travels upwards.

Prevention.—As to the prevention of smut, Mr W. G. Smith says:—

“It is obvious, therefore, that smut can only be prevented by dressing the seed, as in the case of bunt, and the directions for one apply to the other.

“A remedy against smut, much in favour in the north of England, and one which is said never to fail, is the preparation of the seed, immediately before sowing, with a sprinkling of stale urine, the seeds being afterwards raked in powdered quicklime till the seed is white. Sometimes the seed is prepared with vitriol or sulphate of copper solution, or ‘bluestone’ dissolved in boiling water. One pound of ‘bluestone’ dissolved in 5 quarts of water is sufficient for a sack of 4 imperial bushels. The seed is soaked for ten minutes, or the 10 pints of solution may be poured over till all is absorbed.”¹

FUNGOID ATTACKS ON CLOVER.

It is well known that clover is attacked and injured by mildew caused by fungi, notably two forms of *Peronospora*—namely, *trifoliorum*, D.By. and *exigua*, W.Sm. The part which these fungi may play in the so-called “clover sickness” is uncertain, but there can be no doubt that they often cause considerable damage to clover.

These fungi are favoured by bad drainage and the absence of free ventilation, such as is sometimes caused by over-thick sowing. The germs pass the winter in the stems of clover, and a useful method of prevention is to cut and burn all dead and decaying clover material.

Clover Dodder.—The clover dodder, *Cuscuta trifolii*, Bab., is a troublesome parasitic plant, which, with its thread-like stems, entwines itself around the

clover plants, absorbing the substance therefrom.

The dodder seed is imported with clover seed. It is therefore necessary that great care should be exercised on the part of the seedsman to sift out any dodder seed before supplying the farmer. The seed of the dodder rarely ripens in the British Isles, but it is recommended that dodder plants should be carefully pulled up and destroyed, and not allowed to rot on the ground—this, because it is believed the thread-like stems are sometimes perennial.

Mr W. G. Smith mentions that some farmers, on first seeing the yellow patches of dodder in the clover fields, remove all the clover from the outer edges of the invaded patch for a width of about 18 inches. This leaves nothing for the dodder to prey upon, as the thread-like stems cannot stretch across the 18 inches of vacant ground. The clover is removed because it is extremely difficult to entirely remove dodder.

POTATO DISEASE.

The potato crop gives little trouble early in summer. As the season advances, however, the extensive grower of potatoes watches his potato-break with uncomfortable anxiety. He is looking for that unwelcome visitor, *Peronospora infestans*, by whose depredations British farmers have sustained enormous losses.

Cause.—The particular “potato disease” which we are now considering, and which has proved so serious as to throw minor ailments into the shade, is the work of a fungus, now generally recognised as *Peronospora infestans*, Mont.

This fungus makes its appearance on the potato-leaves towards the end of July, and during the months of August and September. It is seldom observed in this country before the end of the third week in July.

Weather and the Disease.—The fungus generally appears during close weather, with a humid atmosphere, especially when mists hang over the fields in the evenings and mornings, and the days are hot and damp. These are conditions well known to favour fungoid growth, and never fail to increase the seasonable anxiety of the potato-grower.

¹ *Dis. of Field and Garden Crops*, 261.

Recognising the Fungus.—The fungus, as a rule, first attacks the leaves, and any measures taken to prevent it from reaching the tubers will be more effective if promptly adopted. It is therefore important that farmers should be able to at once recognise the fungus when it makes its appearance. "The fungus," says Mr Worthington G. Smith, "generally manifests itself to the less experienced observer as a fine white bloom on the leaves, accompanied by dark putrid spots. The bloom is sometimes more profuse on the lowermost leaves of potato plants, not because the fungus has travelled up the stem from the seed tuber, but because the air is more moist and stagnant near the ground. The bloom, with its accompanying black disease blotches, soon travels to the stems, and when at length the tubers are reached, the exhausted seed tuber (the weakest part of the plant) is commonly traversed in every part by the spawn of the fungus. During warm, humid conditions of the weather, the black decomposed spots are sometimes present for several days on the leaves before the fungus is seen. These blotches indicate that the putrefactive spawn of the fungus is within the leaves, awaiting favourable conditions for its complete development as a white bloom outside. The phenomena just mentioned are accompanied by a peculiar and very offensive odour well known to every person who has walked through a field of potatoes suffering from disease. The odour is caused by the putrescence set up in the tissues of the host plant by the contact of the mycelium of the potato fungus. Although the attack of disease in potato plants is apparently sudden, and made on apparently sound plants, yet all known facts point to the probability of the existence of the fungus in a nascent state during at least several weeks prior to its general recognition. The belief in the extreme suddenness of fungoid growths is, in many instances, a mere popular delusion."¹

The Fungus in its Active State.

As to the structure and mode of growth of this remarkable fungus, it will be interesting and useful for farmers to

peruse the following extracts from Mr Worthington G. Smith's admirable little volume on the *Diseases of Field and Garden Crops* (Macmillan & Co.):—

"For an exact examination of *Peronospora infestans*, Mont., a very minute and extremely thin and transparent slice must be cut from a diseased leaf at a spot where the white bloom caused by the presence of the fungus is visible underneath. A good plan is to cut a diseased leaf in two through a disease spot, and then with a sharp lancet cut an extremely thin slice off from one of the exposed cut surfaces. If the slice last cut is somewhat longitudinally wedge-shaped, it will often best show the structure of the leaf and the contained fungus at the thinner end of the section. Such slicing requires great care and experience, and the art is only acquired after many failures. The atom to be examined should be placed on a glass slide in a drop of glycerine (this is preferable to water, as the latter often dries too quickly), and then covered with a clean thin cover-glass.

"The magnification given by an ordinary lens is useless for the observation of the minute fungus now before us, so we must at once place it under the higher powers of the microscope. If the slicing through a disease spot is successful, we shall probably see the atom when magnified 100 diameters, as at fig. 397. The thickness of the lamina of the leaf is shown at A, B; the under side of the leaf is represented at A, from which surface the fungus almost invariably springs. The fungus, therefore, really grows downwards. The true upper surface is shown at B. This reversal of the leaf in the illustration is merely, as in other instances in this book, to show more clearly the tree-like branching growth of the fungus. If we confine our attention for the present to the section of the leaf, we shall note that it is made up of minute bladder-like cells, loosely packed together; and that the cells at top and bottom, representing the lower and upper cuticle of the leaf, are devoid of the shading, which is meant to indicate the green colouring matter or chlorophyll within. An opening into the interior of the leaf will be seen at c; this is one of the stomata or organs of transpiration,

¹ *Dis. of Field and Garden Crops*, 279.

sometimes referred to as 'breathing pores.' The stomata are like the gates to a camp or to an intrenched position; they are the weak points through which an enemy may enter, and when once these gates are passed, the whole interior of the plant is at the mercy of the invader. At D may be seen a hair built

of the potato fungus is capable of growth, and of ultimately reproducing the parent fungus. The cells immediately under the true upper cuticle of the leaf at F are termed palisade cells; and their disposition in the manner illustrated serves to give the necessary firmness to the exposed upper surface of the leaf.

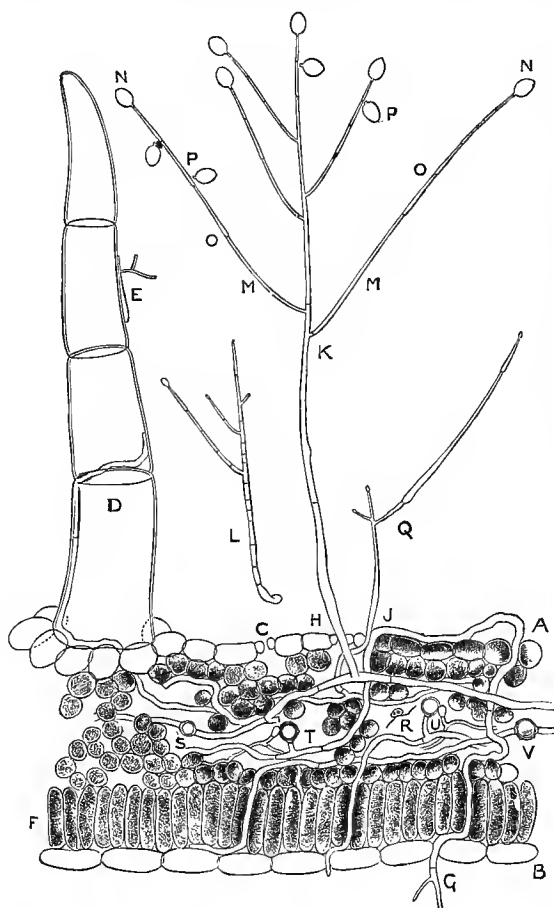


Fig. 397.—Section through a fragment of a potato-leaf, with the potato fungus, *Peronospora infestans*, growing within its substance, and emerging through the epidermis. Enlarged 100 diameters.

up of four transparent cells, the two lower being traversed by a mycelial thread of the potato fungus. On the upper part of this hair, attached to the outside at E, may be seen one of the small branches of the fungus; this branch has burst and thrown out a mycelial thread from its side. Every fragment

"If we now look within the fragment of the leaf we see transparent threads running between the small spherical leaf-cells; these are the spawn-threads or mycelium of the fungus. It should be especially noticed that wherever the spawn touches the cells it discolours them (as indicated by the darker shading), and causes putrescence by contact. If we again look at the palisade cells near G, we observe that a spawn-thread has pushed itself between them and between the cells of the upper cuticle, and is emerging into the air. If we trace the spawn-threads to the organ of transpiration at H, we notice that a thread in its passage from the body of the leaf has blocked up a so-called mouth. This choking prevents the transpiration of vapour, and hastens putrescence. Two other threads have pushed themselves between the leaf-cells at G and A. When the larger of the emerged threads is traced upwards to K, a tree-like growth is noticed; and this branching form is the fruiting condition of the fungus of

the potato disease called *Peronospora infestans*, Mont. The whole fungus is perfectly transparent, like colourless glass, and extremely fine, thin, and attenuated in all its parts. If we now look at the branches, M M, we observe that each is surmounted by a transparent spore, technically termed (as in other species

of *Peronospora*) a conidium, as at *NN*; and to these bodies we shall more specially refer further on. It must also be noticed that all the branches are more or less constricted or jointed in a peculiar manner, as at *OO*; and that each joint has at one time carried a conidium, the lower conidia having been pushed off as the branches have continued their growth, as at *PP*. Sometimes a weakly impoverished thread, if grown in dry air, will quickly become strong and robust in growth if transferred to warm moist air, as in the thread illustrated at *Q*.

"If ripe conidia [*NN*] are placed in water, it will be noted that a differentiation of the contained protoplasm takes place; and that the interior mass of each conidium becomes divided into from five to nine or more portions, each contained portion being furnished with one or two lustrous vacuoles. These differentiated portions speedily emerge from the top of the conidium when placed on any moist surface; and each portion now free, becomes quickly furnished with two extremely fine hairlike cilia, tails, or vibrating hairs. These secondary spores or zoospores are able to sail about in the slightest film of moisture. After a brief time the little motile zoospores or animal-like spores rest and take a globular form, and the vibrating hairs dissolve away or drop into the finest dust. After a short rest the now quiescent zoospores burst and produce a thread of spawn; this germinal thread is capable of carrying on the existence of the potato fungus.

"Sometimes the conidium, which, when it bears zoospores, is really a sort of spore-case, sporangium or zoosporangium, does not differentiate within, but bursts and protrudes a small mass of protoplasm or vital material. This mass speedily elongates into a mycelial thread capable (like the thread from the zoospore) of carrying on the life of the potato fungus. It must be specially noted that water or moist air is essential for the existence of the fungus, for nearly every part speedily perishes in dry air, heat, or frost. When the conidia burst and set free the minute zoospores, the latter sail over the damp surfaces of leaves, and even float into the organs of transpiration. A zoospore swimming in an intercellular space is shown at *R*, fig. 397.

"One has only to imagine a large field of potatoes, with all the leaves moist and swaying backwards and forwards with the wind, to perceive that such a field, say on a warm misty morning or evening, would form a sort of continuous lake of moisture on which the zoospores could float from one plant to another. The conidia, with the contained zoospores, are also carried through the air in millions by the wind; they are so lightly attached to their supporting stems and so extremely small and light, that the faintest breath of air wafts them away. Insects and other creatures also carry the conidia from place to place. The flies which alight on potato plants carry off hundreds of conidia on their bodies. If a bird drops in a field of diseased potatoes, the fluttering of its wings will disperse millions of the conidia of the fungus of the potato murrain into the air. The same phenomenon occurs when a dog or other animal runs amongst diseased potato plants. When the conidia or zoospores burst and germinate, the threads which emerge are corrosive or putrefactive. To such an extent is this the case that the spawn is said to be capable of piercing or boring through the cuticle of the leaf from within or without, regardless of the natural openings or stomata, and even of piercing the bark of the stem or the tuber itself.

"The fungus of the potato disease generally attacks the leaves first, and, as the leaves produce successive crops of fungus growth, the disease quickly spreads to the leaf-stalks, from the leaf-stalks to the chief stems, and from the stems to the tuber. Sometimes a week or two elapses before the tubers are reached by the putrefactive spawn of the fungus; but in other instances the attack is so sudden and so highly destructive, that the whole of the potato plants above ground in a large field will be destroyed in a day or two. The disease doubtlessly starts at first from a few centres only; there it remains for a brief time more or less unobserved. The fungus, however, possesses such wonderful powers of spore production and rapid growth, especially when the air is moist and the temperature ranges from 60° to 70° Fahr., that in a few days one fungus growth will become ten thousand. This growth goes

on in a constantly increasing *ratio* until at length the great flood of disease seems to almost suddenly cover the potato fields.

"When the fungus spawn reaches the tuber it decomposes the cells and corrodes the starch. In bad cases the tubers are soon reduced to a mass of putrefaction."

How the Fungus passes the Winter.

Perhaps the most formidable hindrance to a successful warfare against the potato disease is the peculiar provision which enables the fungus to pass through the winter in minute resting-spores, ready to pounce upon the crop in the following year, should the weather and other circumstances favour the development and attack of these mysterious germs of fungoid life.

The fungus having attacked the leaves of the potato, and found its way down the stem to the tubers there, runs through the course which Mr W. G. Smith has so graphically described. Having finished that course, it produces myriads of resting-spores which lie dormant during the winter, and carry on the disease to the crop of the succeeding year, which in its turn passes the fungus through another round of its destructive life, to be handed on again to a succeeding crop as before.

Mr Worthington G. Smith describes the course of these resting-spores very minutely; and we have to thank him for his permission to reproduce here, besides the illustration already given on page 419, a drawing made by himself of a section of an old potato leaf showing the resting-spores. In referring to the resting-spores Mr Smith says:—

"We will now leave the potato fungus as seen in a living potato-leaf and take a fragment of a dead leaf, one that has been destroyed by the *Peronospora*, such as may be seen in fields and gardens in September, or, if preserved with care, such as may be kept on a garden-bed till the following June. A fragment of such a potato-leaf is illustrated in fig. 398, enlarged, like fig. 397, to 100 diameters. The upper surface of the leaf is shown at A, the lower surface with two stomata at B B, and a small hair belonging to the leaf is seen at C. Nearly all the mycelium of the potato fungus has vanished; fragment only, in a hibernating, septate

state, is seen at D. The transparent oogonia of the summer have now become brownish ripe oospores or winter resting-spores of a larger size. Six resting-spores are shown in the illustration,—two in the transparent leaf hair, three in the intercellular spaces of the leaf, and one inside a spiral vessel, in which position it is extremely common to find them.

"The perfectly mature resting-spores are best seen in the remains of old rotten tubers left in the fields from the previous year, and commonly seen on the ground and about dung-heaps and hedge-sides in March and April.

"On an examination of a large number of resting-spores it will be found that

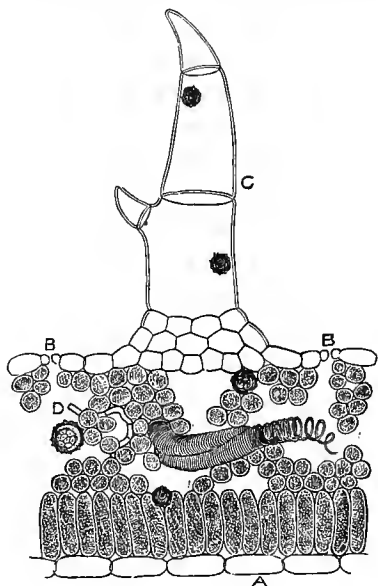


Fig. 398.—Section through a fragment of old potato-leaf, with resting-spores or oospores of *Peronospora infestans*, in situ. Enlarged 100 diameters.

the convolute mass of protoplasm within, though generally in one coil, may at times be in two or even three distinct portions, which, on germination, will produce one, two, or three germ-tubes; in other instances the interior mass becomes differentiated into zoospores, which escape, and speedily come to rest and germinate; the germinal threads from oospores and zoospores alike, when placed either on the foliage or tubers of potatoes

and kept uniformly moist and warm, soon give rise to the fungus of the potato disease, and cause discoloured patches of decomposition as the growth proceeds.

"Every part of the fungus, except the oospores, generally perishes with the supporting plant; the oospores or resting-spores are left alive upon or in the ground where potato material has decayed, and in this position the oospores germinate in June and produce the first conidia of the season. Such of the conidia as are blown from the ground or from decaying potato refuse on to potato plants, or certain allied plants, produce disease; such as fall in unsuitable positions perish. The progress of the disease is, therefore, necessarily at first extremely slow: it only progresses with rapidity after the living potato plants are thoroughly invaded.

"We have secured potato oospores direct from the ground by observing water filtered through earth on which diseased potato material has been allowed to decay.

"The fungus has attacked the leaves and proceeded downwards by the stems into the seed tuber from which the plant originally arose, and there, having run its course, it has produced resting-spores for the invasion of the following year's crop of potatoes. It is much less common to find resting-spores in the hard new tubers even when discoloured by disease; still it is quite possible to find them even in new potatoes. Ripe resting-spores of the potato fungus may be found with great ease in the spring and early summer, in the fragments of diseased and decayed potatoes picked up in the fields or about manure and refuse heaps by hedge-sides.

"A germinating resting-spore may be compared with a germinating seed of dodder. The dodder has enough nourishing material stored up within its outer integument to support an infant dodder plant for a short time. If no suitable host plant is near, the young dodder perishes. The first fruiting branch from a germinating resting-spore of the potato fungus is in an exactly similar condition, for, unless the spores or conidia are aided by the wind to reach a potato or some other suitable plant, the first-produced conidia perish at once.

The resting-spores of the potato fungus germinate in and upon the ground at the precise time of the year when the potato plant is in the best condition for infection. Habits of this nature are extremely common and well known amongst parasitic fungi."

REMEDIAL MEASURES.

Cure.—There is practically no cure. An attack of the fungus may be partially or entirely averted or checked, but an injury once inflicted cannot be repaired.

Preventive Measures.—The measures which have been found most useful in preventing or mitigating the onslaught of the fungus are—(1) earthing up the potato-drills with a deep covering of earth, with the view of preventing the fungus from passing down the stem or through the soil to the tubers; (2) cutting off the diseased potato-tops before the fungus reaches the tubers; (3) removing and destroying (burning) all dead and decaying potato-stems, leaves, and tubers, especially after a crop which has been attacked by the disease; (4) planting varieties which have been known to be exceptionally successful in resisting the disease; (5) growing the potato crop under such general sanitary and manurial conditions as will ensure to the fullest extent possible the healthy and vigorous development of the crop; and (6) careful storing of potatoes to be used as seed.

None of these measures could be regarded as an absolute remedy, but in certain cases each and all have been carried out with manifest advantage.

Protective Moulding.

This method is known generally as the Jensen system, from the fact that Mr J. L. Jensen of Copenhagen was, with the aid of Mr C. B. Plowright, M.R.C.V.S., King's Lynn, mainly instrumental in bringing it into public notice. It consists in earthing up the potato-drills with a deep furrow, so as to have about 5 inches of earth over the uppermost tubers, and thus tend to prevent the mycelium of the fungus from reaching the tubers from the leaves through the soil—the stems and leaves of the potatoes being bent to one side, so that the spores

of the fungus may fall from the leaves into the hollow rather than on the top of the drills.

The fungus has in a few instances been found to begin in the tuber and work upwards, but the rule is exactly the reverse. Development in the leaves of the potatoes would seem to be an important condition in the life of the fungus. The object of the Jensen system is therefore to prevent its getting beyond the leaves and stems.

Mr Jensen gives the following as the "principal points" in the protective-moulding system:—

"1. The ground must be thoroughly worked, so that the potatoes may be bedded in well-crumbled earth. Such earth affords a better means of protection than a lumpy soil.

"2. The potatoes should be planted (pretty early) in a distance between the rows of at least 28 or 30 inches. A greater distance is not required by the system, but a smaller distance would impede the protective moulding.

"3. The first moulding must be flat, so that the formed ridge be broad on top and only about 4 inches high. This moulding may be repeated if it is thought serviceable.

"4. The protective moulding must be applied as soon as the disease blotches make their appearance on the leaves of the potato plants. If this has not occurred before wheat-harvest time, the moulding ought to be executed then, without awaiting the appearance of the disease blotches.

"The protective moulding is performed by throwing up from one side of the row of plants a high ridge with a broad base, and running to as sharp a point at the top as possible. The covering of earth thereby produced over the upper surface of the uppermost tubers must be about 5 inches to begin with; later, by the settling of the earth and by sliding down, it will, as a rule, preserve a thickness of about 4 inches. At the time of this moulding the potato-tops are gently bent over towards the opposite side of the row, so as to give the top at least a half-erect position.

"6. The flat and the protective moulding, where potatoes are only grown on a small scale, may be done with a hand-hoe; on a larger scale these operations

ought to be performed with the moulding-plough, the "Protector," which is constructed to meet the necessities of the described system.

"7. In order to prevent after-sickness, which may often be exceedingly great, the potatoes must not be lifted ere about three weeks after the last leaves in the potato-field are withered.

"8. If the potato-tops are cut off and carried away, which, for the sake of the quantity and quality of the crop, ought not to be done before the leaves in the main are withered, the lifting may, as it seems, without danger of after-sickness, take place about six days after such removal."

Merits of the System.—This system has been extensively experimented upon in this country, and the results have been somewhat variable. The majority of the experimenters have come to the conclusion that if carried out carefully and at the proper time, immediately the first signs of the disease are observed, it will most likely have the effect of greatly mitigating a serious attack of the disease—reducing the loss by disease in extreme cases, perhaps from 30 to 10 per cent of the entire crop. In other cases again, it has been much less effective. Then in most instances it has been found to have a marked tendency to lessen the yield of fully grown tubers—increasing the percentage of small unmarketable potatoes, so much in many cases as to make the crop unprofitable.

Mr Speir's Experiments.—Mr John Speir, Newton Farm, Glasgow, put the system to a thorough trial, and the results led him to the opinion that by it the disease may be kept within very narrow limits.

His first series of experiments with the system resulted as follows:—

High Moulded.	Percentage of diseased tubers.
15th June	16.04
1st July	12.88
15th July	8.06
1st August	7.25
15th August	9.70
1st September	5.37
6th September (just after disease appeared)	6.55
Moulded in the usual way	24.20
" very flat	31.00
Bent tops, with the high moulding at various times	7.68
Tops not bent	10.54

These results were obtained in drills 30 inches wide. But he also experimented with the system in drills of various widths, from 24 to 30 inches wide, finding that by far the best crop with least disease was obtained from high moulding on 30-inch drills. Upon 24-inch drills, the results of the high moulding were unsatisfactory. This corresponds with the experience of others, who have found that in a narrow drill with a sharp apex, numerous potatoes are liable to be "greened" by coming so near to the surface.

Other Experiments.—Results quite as favourable to high moulding as in the trials made by Mr Speir were obtained in the south-east of Scotland by Mr S. D. Shirreff, North Berwick, Mr H. Elder, East Bearford, and others. On the other hand, at Barney mains, near Edinburgh, Mr John Durie found that while the high moulding lessened the disease by a small percentage, it incurred an actual loss on the crop by reducing the yield of marketable potatoes.¹

Bending the Tops.—The bending of the potato-tops to one side of the drill no doubt tends to lessen the disease, but it is also liable to reduce the yield of the crop. If done roughly, so as to break or bruise the stem, the development of the tubers will be seriously interfered with. If done at all, the bending of the tops must be performed with great care and very tenderly. It is almost impracticable where large areas of potatoes are grown.

The System little Practised.—Although there would seem to be certain merits in the protective moulding—although it would seem to be the most effective method yet known of repelling or lessening a threatened serious attack of the disease—the fact remains that the system has never come into general use throughout the country. A few, but only a few, persevere with it, and while there are a good many farmers who speak well of it, it does not seem to be gaining ground. It is probably most effective in repelling an attack of the disease which occurs late in the season—that is, after the crop has approached its full growth. In this case, of course, injury to the tops would not tell so seriously upon the yield as if it occurred earlier in the season.

The Main Difficulty.—The main difficulty in late moulding is the rankness of the potato-tops. These are often so rank that it would be almost impossible to have the earthing up accomplished without great injury to them. On this account alone many who have tried the system and acknowledge its efficiency have abandoned it as impracticable.

As a means of obviating this difficulty of injuring the tops in late earthing up it has been recommended—(1) that the potato-drills should be unusually wide, not under 30 inches; or (2) that between every two drills of potatoes there should be two, four, or more drills of roots, mangels or turnips. The latter method would be most advantageous to the potatoes, but in working it would rarely be practicable—that is, where potatoes are grown to any great extent.

Upon the whole, we have no hesitation in recommending that where it can be done without serious injury to the potato-tops, the protective moulding should be resorted to whenever an attack of the disease is observed.

High Moulding Plough.—The Jensen or "Protector" plough is designed specially for the high moulding. The work may be done, however, by an ordinary drill or single-furrow plough, provided with an unusually deep mould for throwing the earth on to the top of the drill.

Antiquity of the System.—The system of high moulding was not "invented" by Mr Jensen, as has been sometimes stated. It was practised by a few English potato-growers about 1850, and was described by Dr Jeffrey Lang in the *Journal of the Royal Agricultural Society of England* for 1858. Dr Lang remarks that "it was observed that no potato covered with more than 3 inches of soil was ever diseased. . . . It will at once be seen—and too much stress cannot be laid on the fact—that the disease is in exact ratio to the proximity of the tubers to the surface."

Then, as now, the practical difficulty of carrying out the work successfully would seem to have prevented its extensive adoption.

Cutting off the Tops.

Since it is generally the case that the disease begins on the leaves and passes

¹ *N. B. Agriculturist*, 1882 and 1883.

down the stems to the tubers, it follows that the tubers might be protected from it by the leaves and stems being cut off and removed as soon as the fungus is observed upon them.

This, indeed, is a speedy and effective method of combating the fungus. But the remedy may be worse than the disease. The removal of the stems and leaves at once stops the development of the tubers. The starch of which the potato is so largely composed is first formed in the leaves. If, therefore, the leaves are removed before the tubers are ripe, the result must be a deficient crop.

It is thus only as a last resort—where an immature, deficient crop would be better than the crop likely to be left by the disease, if allowed to take its course—that this drastic measure should be adopted.

As a further precaution, when the leaves and stems are cut off, it has been recommended that the cut ends of the stems should be sprinkled with dry lime.

Disease-resisting Varieties.

It is known that certain varieties are, for the time being, exceptionally successful in resisting the attacks of the fungus. This valuable property is most generally found in some comparatively new variety—a variety recently raised from the seed, perhaps by cross-fertilisation, as described in pp. 276-280 of this volume—whose constitution and vitality of growth are unusually robust.

It is obviously advantageous therefore, as a means of guarding against loss from the disease, to plant for the main crop such varieties as are at the time known to be the most successful in resisting the onslaught of the fungus.

Unfortunately there is a tendency in all the cultivated varieties of potatoes to lose vitality with long-continued culture. The "Champion," for instance, which for many years was almost disease-proof, at last fell an easy prey to the fungus. It is therefore desirable that the propagating of new and robust varieties should be liberally encouraged by potato-growers. See pp. 276-280 of this volume.

Conditions of Culture.

The liability (or the opposite) of the potato to injury from an attack of the

fungus may be powerfully influenced by the conditions under which the crop is cultivated. It may be accepted as a general rule, that whatever tends to retard the healthy growth or weaken the vitality of the plant assists the fungus in its onslaught.

Humidity necessary for the Fungus.—As with most forms of fungi, it is necessary for the preservation and propagation of the potato fungus, *Peronospora infestans*, that a considerable amount of moisture should be present. Indeed, we have it on the highest authority that nearly every part of the fungus in the active state (that is, apart from the condition of the resting-spore in which it lives through the winter) speedily perishes in dry air, heat, or frost. In the form of the zoospores, or resting-spores as they are aptly termed, the germ of the fungus will survive through the hazards of the winter. But for its fructification and free propagation on the potato plants in the following season, a considerable amount of moisture on and around the potato plants would seem to be quite essential.

Dry Elevated Land for Potatoes.—The practical lesson to be drawn from this is, that potatoes should, as far as possible, be grown upon well-drained land, in a dry, elevated, bracing position. Low-lying swampy ground, subject to mists, is, on this account, particularly ill suited for potatoes. It is well known that the disease is most liable to break out and do serious mischief during close humid weather when mists envelop the fields morning and evening.

It will often be beyond the power of the farmer to avert these conditions. He can, however, do a good deal in this direction—mainly by avoiding low-lying ill-drained land with his potatoes, and planting them on dry exposed land.

Sunshine and Dry Winds.—Bright sunshine and dry hot winds are destructive to the fungus. It is therefore useful to have the potato-drills wide apart, and set so that the noonday sun may have full play amongst the tops.

Manure.—In manuring, as in other matters connected with the culture of potatoes, it is important that the crops should be treated so as to secure as robust and steady growth as possible. Imper-

fectly balanced manure will tend to produce plants which are constitutionally weak. See therefore that the crop has all that it requires of the various elements of plant-food.

The decaying of rank dung in the soil is favourable to fungoid life. Well-rotted dung is for this reason preferable to fresh dung for potatoes. And artificial manure affords less encouragement to the fungus than dung, with its bulk of putrefying vegetable matter.

As with the human family, so with plants—the best safeguard from disease is healthy food and healthy sanitary surroundings.

Destroying Potato Refuse.

One of the most essential and effective precautions against future outbreaks of the disease is to gather and destroy all potato refuse—leaves, stems, and rotten tubers—that may be left on the field when the crop has been harvested. In all probability, if disease had attacked the crop, this refuse will be swarming with the germs of the disease.

To gather this infested rubbish to the dung-heap is absolutely nursing the enemy—keeping it warm and vigorous for future attacks. Burn the potato refuse, if convenient; if not convenient, bury it beneath the reach of the tillage implements. “No more fatal mistake,” says Mr W. G. Smith, “can be made by potato-growers than leaving dead stems, leaves, and tubers about in their fields, especially after a potato crop has suffered from disease.”

Care of Potato Seed.

The seed to be planted should not only be selected from disease-resisting varieties, but have been stored in conditions antagonistic to the life of the germs of the fungus. Upon this point Mr W. G. Smith writes: “Sometimes growers keep their potatoes in enormous underground heaps, called ‘pies’ [or pits]; in these positions the tubers frequently heat and rot. In other instances diseased potatoes are interbedded in dunghills, or dug into the ground. In all such cases the best means have been taken for successfully propagating the disease. From all such positions many millions of conidia of the potato fungus

are dispersed each June, whose special mission is to devastate potato crops. The warmth or moisture of the ‘pies’ [or pits] and manure-heaps are the exact conditions required by resting-spores for their maturation.

“As darkness, heat, and humidity are highly favourable to the growth of the *Peronospora*, all potatoes should be stored in perfectly dry, airy places, in positions where light is not entirely excluded. Potatoes should never on any account be stored in heaps in the damp holes in the ground termed ‘pies.’”¹

It is the general plan to store potatoes in long narrow clamps or pits; sunk perhaps 8 or 10 inches in the soil, and covered with earth and other material. It would no doubt be an additional precaution against the disease to store in a specially dry, airy position (as in the “boxing” system, see p. 274), such potatoes as are to be used as seed.

Mr Jensen has described and recommended a system of disinfecting potatoes by heating them in a sort of oven up to a temperature of 104° Fahr. The scheme, however, is scarcely practicable.

OTHER POTATO DISEASES.

Potatoes are also sometimes attacked and injured by other fungi, notably the *Fusisporium solani*, Mart., and the *Peziza postuma*, Berk. and Wils. The former often does serious damage to the crop in the southern and midland counties of England, but has not invaded Wales or Scotland. The latter has incurred heavy losses, chiefly in Ireland, by destroying the leaves before the crop has matured.

The best method of prevention against these fungoid attacks is to burn or bury deeply all potato refuse, dead stems, leaves, and rotting tubers.

Smut in potatoes (producing a form of scab) is caused by the fungus *Tuber-cinia scabres*, B. It grows beneath the skin of the tuber, forming there a thin dark stratum, and showing itself by discoloured blotches on the skin. Tubers showing traces of smut should not be used as seed.

Other forms of scab may be due to

¹ *Dis. of Field and Garden Crops*, 314, 315.

some irritating influence in the soil, which, when detected, should be avoided.

TURNIPS.

"Finger-and-Toe" or *Sporting*.

This is a condition of the turnip plant characterised by a non-development of bulb, and a division of the tap-root into more than one branch. Sometimes the divisions resemble human fingers or toes, and hence the name.

Cause.—Professor Buckland has demonstrated that the disease is due to "a degeneration of the plant from cultivation to wildness," to which there is always a tendency in root crops exposed to adverse conditions,—such as poor exhausted soil; continuous bad cultivation; rearing of the seed without transplanting, from small or late-sown bulbs; or in a dull, dark, warm climate.

Sporting.—One form of the disease is called *sporting*. In this case the stem gets tall, strong, and branched; and the roots, more strongly divided fangs or forks, taking such a hold of the soil as to render the plant difficult to pull up. This *sporting* is frequently seen in the south and west of Ireland, where the common turnip often runs to shaw, and even swedes frequently produce sports, which do not happen with the same seed sown in a different climate.

Remedies.—The indicated remedies are, to raise the seed from fair-sized transplanted bulbs, and good cultivation both before and after the seed is sown.

Finger-and-toe distinct from Anbury.—The name of this disease is often popularly applied to anbury or club-root, a totally different ailment having no character in common with finger-and-toe or sporting.

Anbury or Club-root.

Features and Symptoms.—This disease is characterised by warts or excrescences on the bulbs, or tap-root, as shown in fig. 399. When attacked at an early stage, club-like swellings may be seen on the minute roots before the plant is three weeks old. At other times the crop is in a more advanced stage before the disease is manifest.

The first outward symptoms of the disease often appear in a shrivelling of the

leaves on a few plants, first noticed in a dry warm day. When pulled up, the tap-root is found to be more or less diseased, and the smaller rootlets may have altogether disappeared, and the bulb will be more or less affected. The excrescences rapidly increase in size, are irregular in form, sometimes like races of ginger. In

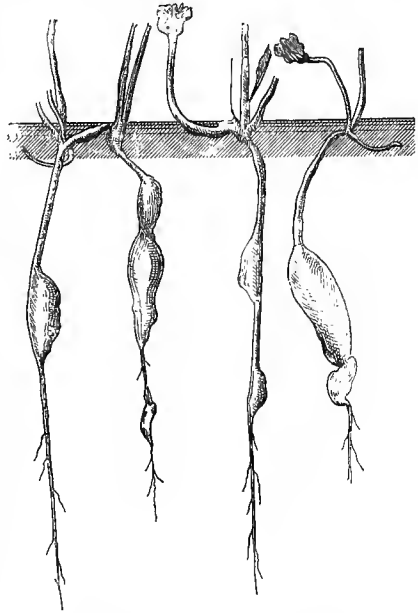


Fig. 399.—*Anbury or club-root—early stage.*

bad cases the roots decay, and, being unfit to absorb moisture or nutriment, the plant fades and dies altogether. Or the diseased roots may get amputated, and the plant throw out new roots, and recover so far as to form a fair-sized bulb.

If there is even a little of this disease in a crop, its keeping qualities will be impaired. A slight frost will cause many of the bulbs to decay; and the feeding qualities will be much deteriorated, the roots being spongy and sapless.

Cause.—The real cause of this disease has long been a puzzle. By the late Rev. James Duncan¹ it was erroneously ascribed to the attacks of the maggot of the *Anthomyia brassicae*, the cabbage-fly, whose bite he believed produced the excres-

¹ *Trans. High. and Agric. Soc.*

cences, as that of the gall-insect produces galls.

Mr Barclay, M.P. for Forfarshire, in a prize essay written in 1863, says: "I have come to the conclusion that the 'finger-and-toe' [anbury] disease is caused by a superfluity of the combustible as compared with the incombustible elements assimilated by the plant—that is, the diseased plant has abstracted from the soil, and more particularly from the atmosphere, a quantity of combustible constituents too large in proportion to the incombustible elements which it has taken up from the soil, its only source of mineral food. This superfluous quantity of combustible elements has to be disposed of, and hence result those excrescences and abnormal growths which destroy the plant. In short, the disease is the result of the inability of the roots to extract from the soil, as fast as the growth of the plant demands, that certain quantity of minerals indispensable for the production of healthy turnip fibre."

M. Woronin's Discoveries.—In 1878 M. Woronin, a Russian fungologist, published a paper on the club-root in cabbage,¹ which throws new light upon the allied disease in the turnip. From a translation of that paper the following extracts are taken:—

"The hernia disease attacks all varieties of cabbage, . . . turnip, rape, and so forth. In England cabbage hernia is called clubbing, club-root, anbury, or also finger-and-toes. . . . The real cause of this cabbage hernia has thus remained hitherto unknown, and now I have succeeded in finding it out. On examining the protuberances of the roots, I discovered a new organism, which I have termed *Plasmodiophora brassicæ*. . . . If we make two cross sections, the one of a quite healthy cabbage root, and the other of a root of the same age, but which already has been attacked by hernia, and compare these two sections together, we shall see that the difference between them consists solely in this—that in the diseased root some cells of the bark parenchyma are filled with an opaque, colourless, fine-grained, plasmodic substance, and moreover, that the

cells are mostly, in comparison with the neighbouring cells, somewhat enlarged. . . . In sections of cabbage roots that are more severely attacked, other cells are densely filled with very minute, likewise colourless globular bodies. . . . This fine-grained plasma is the plasmodium, and the small round bodies are the spores of that organism, to which I give the name of *Plasmodiophora brassicæ*.

"In all parenchyma cells, which contain the plasmodium of the *Plasmodiophora*, the formation of spores gradually comes into play, and almost simultaneously the whole mass of the hernia protuberances begins to putrefy. . . . When they remain long in moist ground, the hernia protuberances soon become quite rotten, and by this means the spores find their way, first into the earth, and then into the young roots of the still quite healthy cabbages, which in their turn get quite infected with the disease. The farther development of the spore lying loose in the earth consists in the escape of a myxamœba from every spore. . . . The myxamœba do not remain long in the ground; they contrive to penetrate the healthy young cabbage roots. Unfortunately I have altogether failed to see this process of penetration actually going on under the microscope; I nevertheless assume it as an indisputable fact that the myxamœba do penetrate into the cabbage roots, right through the hairs and epiblem cells."

Mr A. S. Wilson's Experiments.—The discovery of M. Woronin has been verified by Mr A. Stephen Wilson of North Kinmundy, Aberdeenshire, who satisfied himself² that the fungus in the turnip club is the same fungus as M. Woronin found in the cabbage. He found turnip seeds sown in "water mixed with the pulverised clubs of the previous year to have their roots attacked." He also mixed a quantity of rotten clubs of crop 1878, containing these spores, with garden mould in which no disease existed, "and all the resulting plants became at an early stage excessively and fatally clubbed."

There thus seems a strong probability

¹ *Jahrbucher für wissenschaftliche Botanik*. Pringsheim, 1878.

² Papers read to Cryptogamic Society of Scotland in 1879 and 1880.

that this fungus is the cause of clubbing, and that its spores exist both in diseased roots and in the soil, and attack healthy cruciferous plants.

Contributing Influences.—While M. Woronin has probably discovered the true cause of the disease, its virulence is greatly controlled by surrounding conditions, which affect the constitution of the crop, and alter its powers of withstanding attacks. Wet districts and soils containing much humus are more subject to the disease than soils in a dry climate, which accumulate less organic matter. The frequent repetition of the turnip crop upon the same soil, as in the four or five course rotation, is notorious as causing an aggravation of the disease, while the disease seldom causes much loss under a six or seven years' course. Working the land wet, either in autumn or spring, distinctly increases it, and ought to be avoided as much as possible. The treading of horses upon wet soil is most injurious to succeeding crops.

Manure and Anbury.—Farmyard manure, made from cattle consuming diseased turnips, and turnip-shed refuse, will infect sound land and cause the disease.

Professor Jamieson found that soluble phosphatic manures always increased the number of diseased bulbs, and, after many careful trials, he holds the opinion that sulphur in any form aggravates the disease. Dung that has lain some time in water, and urine applied with a water-cart direct to the drills, have been known to produce it.

Varieties of Turnips and the Disease.—The seed seems to influence the disease; but whether the spores can attach themselves in any way, or whether some seeds produce more vigorous plants than other seeds, and thus escape the attacks of this fungus, is unsettled. Many instances are on record where the plants from one kind of seed succumbed to the disease, while those from another variety escaped uninjured. When disease exists in a field sown with several varieties of turnip seed, it is always more virulent in some of the kinds than in others.

Its virulence may be further influenced by the weather during the working of the land, sowing, hoeing, or at a particular stage of growth.

Preventive Measures.—There seems to be no cure for the disease. The following measures of prevention, however, have been found useful: To have as many years between turnip crops as convenient; avoid taking infected dung to the farm, or, if made on the farm, use it for some other crop than turnips; secure seeds from healthy plants; avoid working land when wet; drain wet land. If a field is infected—that is, has shown the disease in the previous crop—exposing the drills to dry weather before the dung is put on has a beneficial influence. If a field get infected, the substitution of potatoes or other crop for turnips will sometimes eradicate the disease. Lime or marl, applied some years before the crop is sown, is found to have a favourable effect in lessening the disease, but when not required to benefit crops it is a rather costly remedy. A dressing of gaslime and salt, mixed a month or two before application, has been tried with good results.

Mildew.

Turnips, like most other plants, are occasionally attacked with mildew, or meal-dew, a species of *oidium*.

It is usually most injurious in dry seasons, but even very dry weather does not always lead to attacks of mildew. In some seasons the atmosphere seems to be in a state highly favourable to the development of the *oidium*.

In Scotland, in 1852, most of the turnip fields assumed a white appearance in September, the leaves rotted off, the bulbs, in most cases a fair size, ceased to grow, and after a time put out new leaves. In that season the growth of turnips was rapid and the weather dry, hazy, and dull. In 1865 turnips in many parts were badly mildewed in August, during a period of dry, hazy weather. Wherever a plant had much extra space, it was not affected, but kept green the whole season.

There does not seem to be any practical method of checking the *oidium*, once it has fairly set in, as the crop is not usually of sufficient value to admit of the application of sulphur, which is so effective in the vine disease. Fortunately the disease is only now and then injurious.

HOPS.

Mildew.—The hop mildew, *Sporotheca castagnei*, is the most destructive of several kinds of fungi which attack hop plants. It is commonly known as "mould," and is in many respects similar to the much-dreaded potato fungus, the *Peronospora infestans*. The mould first appears as whitish, mouldy blotches on the leaves, soon becoming discoloured and developing the black receptacles on the surfaces of the leaf. These mouldy patches appear on the plants where they have formed burrs or cones, and soon after they will blacken and decay.

As means of prevention, Mr Whitehead says that it is most important to destroy every particle of bine by burning, and to remove all rubbish and refuse from the proximity of the hop grounds.

Sulphur is the most effectual remedy

known for mould. Finely powdered sulphur is blown on to the plants by means of a machine called a hop-sulphur-ator, drawn by a horse between the rows of hops. A fan revolves quickly in a trough containing the powdered sulphur, throwing it up in clouds all over the plants. From 50 to 80 lb. of sulphur are applied per acre at one operation. It is found that the best time to sulphur hops is on a calm, sunshiny day. Sulphuring hops is now a regular process upon many farms whether mould appears or not, and then if the mould should happen to appear, the sulphuring is repeated. Experienced hands must be employed in sulphuring or syringing hops.

Another fungus which attacks the hop plant is an imperfect fungus belonging to the group of parasitic fungi known as *Uredineæ*. Sulphuring is equally effective in combating this enemy.

LIVE STOCK IN SUMMER.

During the months of summer the farmer bestows a large share of his attention upon live stock. Animals on pasture usually give comparatively little trouble, yet it is desirable that they should be carefully observed and promptly attended to in any matter affecting their health and progress.

It is the rule in this country for all kinds of farm live stock, excepting horses in daily employment, to find their subsistence on the arable pasture fields and natural grazing lands. In many instances, however, cattle, such as dairy cows and fattening cattle, are housed and fed under cover in summer as well as in winter. This latter method of summer management will be noticed later on. We will first deal with the animals on the pastures.

PREPARING PASTURE FOR STOCK.

Before giving the stock possession of the pasture fields, it is advisable to attend to some preliminaries, such as stone-gathering, rolling; and in particular to

inspect the state of the fences, in order to put them into such repair as to prevent the stock scrambling through gaps, to the injury of the fence and themselves.

Removing Surface Stones.—On every kind of soil, any stones inconveniently large which are lying upon pasture should be gathered by the field-workers, and carted away for use on the farm-roads. It may happen that the pressure of other field-work may prevent horses and carts being given for this purpose. In that case the stones should be gathered in small heaps upon the furrow-brow of every other single ridge.

But it should be remembered that heaps of stones occupy much ground, and prevent the growth of as much grass; so that they should be carted away as soon as possible. When carts are used, the stones are thrown directly into them, whereas heaps require to be carefully piled up, which wastes time, and they have to be removed after all. Some farmers are regardless of gathering stones from pasture fields, while all acknowledge that stones ought to be cleared from grass intended to be cut for hay. In wet

weather no cart should be allowed to go upon, or stones be gathered from, new grass on any soil.

Rolling Grass Land.—Every field of grass that is new, or that is loose and spongy on the surface, should be rolled with the smooth roller some time before the stock enter upon it; and unless the ground be cleared of stones, it cannot receive the full benefits of rolling. The best time for rolling is when the surface is *dry*, and not *hard*; for when young grass is rolled with the land in a hard state, it is bruised and blackened; and when the grass is wet, it is too much pressed and flattened; and when simply dry, its elasticity causes it to spring up after the pressure of the roller. Light land bears rolling at any time when the surface is dry, the clods being easily crumbled down; but grass is bruised between the roller and hard clods on clay land, and rolling causes soft clay to become encrusted on drying. Rolling clay land thus requires consideration; and the only criterion of its being in a fit state for the roller, is when clods crumble down with pressure of the foot, not merely become flat on account of their toughness, or enter whole into the soil. Rolling is done across the ridges. After rolling, grass grows rapidly if the weather be favourable; but if frosty, it assumes a brown tint.

Repairing Fences.

While the surface of the field is thus being prepared for stock, the fences should be repaired.

Hedges.—The hedger repairs the thorn fences. In this he is often assisted by the shepherd; and where there is no hedger, the shepherd or cattle-man undertakes the duty. The repairing of hedges consists in filling up gaps. Gaps occur in hedges by death of plants, or by trespassers. Gaps are made fencible by drawing a strong thorn branch across the hedge *roots*, or by driving 2 stakes in the face of the hedge-bank behind the gap, and nailing 2 or 3 short rails on them, or 1 or 2 pieces of plain or barbed wire, or by wattling the stakes with branches of trees or thorn, or by setting a dead hedge upon the hedge-bank.

Nothing should be placed *in* the gap, as it prevents the lateral shoots of the

thorn plants filling it up. A wide gap should be filled up at once with living plants, or with young stems from the hedge on both sides.

Stone Fences.—Stone fences should be repaired by a dry-stone mason, by replacing copestones, or rebuilding part of the wall where it has crumbled down. It is seldom that the stones driven or fallen down can repair a wall, so that fresh ones have to be provided. The stones left on making repairs should be immediately removed. In making repairs in all sorts of fences, a means should be provided for allowing the cattle-man or shepherd to go from field to field when looking after his flock. This may be in the form of a passage through the fence, or of steps leading over the top of it.

Repairing Gates.

Besides the fences, the gates of grass fields require inspection and repairs. A broken post or bar should be replaced by the carpenter, and the iron-work repaired by the smith. The most convenient position for a gate, for easy entrance into and egress from a field, is at the end of one or both head-ridges. Field-gates should fold back upon the fence, and should not shut of themselves. When they shut of themselves, they are apt to catch the wheel of the passing cart, and be broken, or the post snapped asunder. People pass through self-shutting gates without fastening them, and young horses take delight to loiter about gates, and escape through such.

Young horses rub against gates; a thorn or whin-branch, wattled through the bars, prevents them. So does barbed wire, but it is liable to inflict serious injury on both man and beast in exposed situations.

Fixing Gate-post.—We have found a good plan of fixing a hanging post for a gate to dig a narrow hole, 3 feet deep, and lay a flat stone of about 15 inches square, and 7 or 8 inches thick on the bottom, at the centre of which is cut a hollow 8 or 9 inches in diameter, and 3 or 4 inches deep, to take in the lower end of the post, dressed with the axe to fit the hollow. On setting in the post perpendicularly, earth alone is put in spadefuls in the hole around the post,

and rammed hard up to the surface of the ground. Fig. 400 shows the hole into which the post is sunk, as also at the bottom the stone in which the end of the post is inserted. The lower end of the post has the bark on and smeared with coal-tar, and the upper part is planed and painted. Earth, hard rammed,

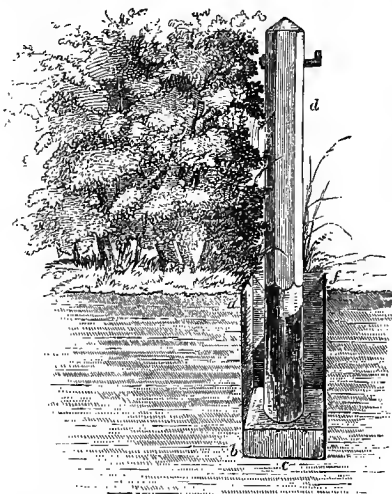


Fig. 400.—Secure mode of fixing the hanging-post of a field-gate.

- a b Hole for the post.
- c Stone at the bottom of the hole.
- e Insertion of the post in the stone.
- f Stone for heel-post of gate.
- d Crook for gate.

holds a wooden gate-post more permanently firm than the small stones commonly used, however compactly jammed in round it. Part of the hedge-fence of the field is also shown, and the crook on which the gate is hung.

Water on Pastures.

The importance of having pasture fields well supplied with fresh, pure water for stock can hardly be overestimated. This has more to do with the progress of grazing stock than is generally imagined. It is indeed one of the conditions which are absolutely essential to the profitable grazing of stock.

Assuredly in every field in which horses, cattle, or sheep are grazed day and night, or even for a whole day, there should be a supply of water.

Quantity of Water for Stock.—The quantity of water which the different

classes of farm animals require for their daily wants on pasture varies greatly, according to such influences as the succulence of the pasture, the heat of the sun, and the amount of exercise. It has been estimated that on pastures in dry weather horses and cattle require about five gallons of water each per day, and sheep about half a gallon. The aim of the owner should be to let the animals have access to pure water when they feel in want of it, and there will be little danger of the animals drinking more than is good for them. That is, if they have had no undue exercise or other stimulus to excessive drinking.

Running Water.—Running water is the best of all, for with ordinary care it is most likely to be pure and fresh. If there is no open stream which can be diverted into the field, it may be possible to draw in a supply by a pipe from some adjacent stream.

Pump Water.—Failing this, a pump may be sunk and worked either by hand or windmill. When a trough is employed to hold the field supply of water, the trough should be thoroughly cleaned out at least every week. This will cause little trouble if the trough is made with a plug in the bottom, so that it may be washed out.

Rain-water Ponds.—If this, again, should not be practicable or sufficient, then means may be employed for collecting and preserving for drinking purposes the water of the rainfall. For this purpose ponds are formed. These ponds are generally circular in shape, 4 or 5 feet deep in the centre, rising towards the edges, and from 30 to 60 feet in diameter, according to the number of stock to be supplied. The bottom of the pond is lined with about a foot of moist clay, trodden firm, and it is a good plan to prevent damage from worms to lay on the top of this a layer of quicklime, fully an inch thick, and then follow with another layer of clay, perhaps not quite so thick as the first layer, but pounded tolerably firm. This should form a pond which will be sufficiently water-tight. In some cases ponds are made with one layer of clay and mixed with lime to prevent the depredations of worms, with a layer of straw on the top to prevent the sun from cracking the

clay, and then over all a coating of small stones.

Reliability of Ponds.—It is really surprising how faithfully ponds so made retain a supply of water. It is perhaps still more surprising how, in some circumstances, they collect the water which they constantly contain. High up on the downs in the southern counties of England there are artificial ponds which are so situated that they cannot possibly be fed from springs in the soil, and which have nevertheless for many years maintained a constant supply of drinking water for the flocks that feed around them. The old idea that the supply was kept up by the condensation of dew upon the cool surface of the water (hence the name *dew ponds*) has been shown to be erroneous. The source of supply is unquestionably rainfall, and this is so abundant in all parts of the United Kingdom, that if proper ponds were formed for the conservation of rain-water, there is no farm or field in the country which could not thereby be well supplied with drinking water for animals.

Care of Ponds.—When these ponds have to be depended upon for drinking water for animals, the farmer must take care to see that they are kept clean and in good order. As a rule, it will be sufficient to have the pond cleaned out once a year for a couple of yards or so round the edges where the animals may leave droppings. The pond should be carefully examined now and again, to ensure that its water may not be contaminated by any animal matter decaying in it. It is by no means rare to see the body of a dog or cat decaying in drinking-ponds. Can it be healthful for animals to drink water so tainted? It must indeed be positively injurious to their health.

These ponds should be placed at corners where each pond might supply two, three, or more fields, and where they would also be out of the way of tillage operations.

Carting Water.—Carting water to pasture fields is a serious affair, yet in many cases it has to be done daily during the entire grazing season.

Rubbing-post.

Every pasture field should be provided with two or three good rubbing-posts.

These should stand about 6 feet in height. The surface should neither be so rough as to injure the skins of the animals, nor so smooth as not to afford a satisfactory scratching. Perhaps the best material for a rubbing-post is the trunk of a spruce-tree, with the branches sawn off, not too close to the trunk.

Salt on Pastures.

A little salt is relished by stock on pastures and is beneficial to them, especially in the case of cattle and sheep. A convenient way of giving this is in the form of lumps of rock-salt placed here and there over the pastures, either upon a close piece of grass or in a shallow wooden box.

A very useful contrivance for holding rock-salt within reach of stock, and yet preserving it from becoming filthy by rolling on the ground is shown in fig. 401 (Spratt's patent). It is attached to a post at a height to suit the class of stock in the field.

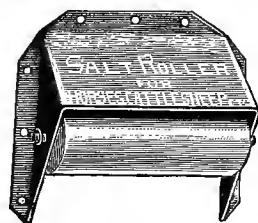


Fig. 401.—Salt-roller.

Weeds on Pastures.

Sufficient attention is not given to clearing weeds off pastures. Upon arable farms all obnoxious weeds in the pasture fields should be most carefully cut down or pulled up by the root, according to the nature of the weed. As a rule, one timely cutting will suffice. This should take place early in the grazing season, so that the weeds may not be allowed to run to seed. With some weeds, such as thistles, a second cutting later in the season may be necessary.

There is usually a plethora of weeds by the sides of roadways, hedges, and other divisions, and these should also be ruthlessly cut down.

Permanent pastures should likewise have attention in this matter; while on pastoral farms there may be green patches on the lower parts which would repay the trouble of clearing them of weeds. "Weeds," wherever they appear, are

enemies to the farmer, and should have no harbour.

SHEEP IN SUMMER.

The important question as to what sheep should be disposed of for slaughter and what retained for grazing when the supply of turnips has been exhausted, will depend upon circumstances which are liable to almost infinite variation; such, for instance, as the price of mutton at the time, and the prospects of a rise or fall in the near future, the condition of the sheep—whether well prepared for killing or not; the class of sheep—whether of a kind likely to be in demand later in the season, or to be useful and required for breeding on the farm; as also the general plan of management on the farm, and the probable supply of pasture. All these and other circumstances tending to regulate the actions of the flock-owner are subject to so many variations that each farmer must be left to decide for himself at the time. Only this general advice will be ventured upon—it is prudent to sell fat stock when prices are fairly satisfactory; better a fair price in hand than the prospect of a big price in the uncertain future!

Pasturing Sheep on Arable Farms.

The method of pasturing sheep on arable land will be regulated according to the class of stock kept and the nature and management of the farm. The stock may be a breeding or flying (hogging) one, or a certain modification of either, or both these recognised classes. A ewe stock is generally found where the farm is largely under rotation grasses or permanent pasture. The hogging system, on the other hand, prevails where the farm is worked in rotation, and the soil adapted for turnip culture.

Ewes and Lambs.—In the spring division of this work we left the ewes and lambs on the new grass. To lighten the demand on the young grass the earlier lambed ewes with their lambs may be drafted away to the more distant and perhaps less sheltered fields of older grass. Gradually they may be followed by the single lambs and the stronger doubles, thus leaving only the weaker

doubles or any weakly single lambs (with their mothers of course) on the new grass.

This gradual transference not only prolongs the supply of young grass to the animals most in need of it, but also allows time for the permanent pasture to obtain a satisfactory start. After this, in average seasons, there will likely be little difficulty as to food. Let the new grass be moderately cropped, but not too closely eaten. See p. 78, Divisional vol. iii.

Scarcity of Grass.—It may often happen that in a backward season the grass, old and new, but especially the old, comes up so slowly as to make it difficult for farmers to carry their flocks successfully through the earlier weeks of the grazing period. In this event it will probably be the better plan to keep the ewes (with their lambs) for a time on artificial feeding with a run on the new grass, turning them out to the old pasture in the evening. Linseed-cake and bran mixed— $\frac{1}{2}$ to $\frac{3}{4}$ lb. each daily, according to the supply of grass—will be found good food for ewes in milk.

On hogging farms the difficulty is more easily overcome, but with them also it of course involves additional outlay. Until the grass has become plentiful the hogs or non-breeding sheep may be kept on winter fare, minus the turnips, which may have been exhausted long ago. Upon cake, bran, bruised oats, and chaffed hay, with access to water and rock-salt, these sheep will thrive admirably.

Attention to Ewes and Lambs.—The duties of the shepherd, after he has placed his flock on the pasture, are comparatively light. Still there are a few matters which require attention from him. He must carefully observe the ewes, to see that the lambs are sucking properly. Many ewes, owing usually to sore teats, refuse to allow their lambs to continue sucking; and, if neglected, garget or udder-clap may set in. The ewe must be held till sucked, and the teats anointed with some healing lotion.

If a lamb does not seem to care for its mother, it will generally be found that the ewe has little or no milk. In this case the lamb, now likely able to forage for itself, should be put on some extra food, and the ewe turned out to the poorest pasture on the farm.

Summer Treatment and Disposal.

—The kind of treatment as to food which the various classes of sheep will receive during the summer will be regulated to suit the end for which they are intended —when and for what purpose they are to be disposed of. Sheep intended to be fattened and sold for slaughter during the summer and autumn, or early in winter, will of course be treated differently from those to be carried on in store condition.

Summer Fattening.—Sheep intended to be fattened on the pastures during summer are usually graded in lots, according to the conveniences on the farm in the way of separate fields. And it is a matter of great importance on grazing farms to have a good many fields of small or moderate size, rather than fewer fields of greater area. Of the sheep to be fattened a draw of the best is made, and these are put into the best piece of pasture. With plenty of good sweet pasture, and perhaps a little cake and grain, they will now fatten rapidly. Bruised oats are much in favour for fattening sheep on pasture.

The remainder of the sheep for fattening may be still further graded or kept together as will best suit the arrangements of the farm and the objects in view. It is usually advantageous to have the fattening sheep coming into a fit state for slaughter at different times instead of all at once. In this way they can be sold in small lots, as the condition of the market may dictate. The plan of grading in the feeding is therefore a good one, and should be carried out as far as possible.

When the first lot has been disposed of, the second is taken in hand and similarly pushed on till ready for the market; and so on till the entire stock of feeding sheep has been disposed of.

Store Sheep in Summer.—The sheep to be kept simply in good store condition during summer are of course treated less sumptuously than the fattening sheep. A common plan with a flock of hogs is to select the leanest and smallest, and assign these to the best of the pasture available for the store sheep, so that upon this (and perhaps a little extra food in the shape of oats) they may so develop as to “match” more

evenly with the “tops” at the time of selling.

The wether hogs will most probably be disposed of after clipping, and then the ewe hogs, which may hitherto have had the poorest of the pasture, can be promoted to better grazing.

Shifting Sheep on Pastures.—When sheep are enclosed on fields, it is very desirable that they should be frequently shifted on to fresh pasture. The change will be beneficial both for the sheep and the pasture. It will be all the better for the sheep if the changes can be arranged from poorer to richer food. Where the fields are large they should be divided, perhaps by a temporary fence of wire or iron hurdles—iron hurdles on wheels being specially suitable for this purpose, although rather expensive. Certain fields, or portions of fields, should be allowed to grow up well for a short time, and when the sheep are removed to these preserved portions, the pastures they have left will make headway, and afford another fresh change when it becomes desirable.

Animals are fond of changes in this way; and by being thus cropped and allowed to grow alternately, pastures produce more food than if cropped continuously throughout the season. Many flock-owners change the stock from field to field every three weeks, taking care never to allow the grass on any one field either to grow too rank or be too closely eaten.

Water for Sheep.—There is a prevailing idea amongst many farmers that there is little or no necessity to provide water for sheep on pasture. This is a serious mistake, which is responsible for greater losses to flock-owners than would be readily imagined.

Much of course depends upon the pasture and the weather. On succulent pasture with heavy dews sheep may require no further supply of water; but in dry weather and on dry pasture they cannot thrive and maintain good health without access to water.

For ewes and lambs in particular water should invariably be provided. It is especially necessary if artificial food is given. For sheep as well as other animals running water is best; and if it is supplied in ponds, see that these are kept clean. Many diseases are traceable to

the drinking of impure water. It is a fertile source of blood-poisoning and dysentery.

Salt for Sheep.—This is especially necessary for sheep. It gives tone to the system, and should always be within their reach. Common salt may be given to them in partially covered boxes on the fields, or rock-salt may be put within their reach.

Maggot-fly.—During warm weather, the shepherd should have his eye upon every sheep on the farm at least twice a-day. At this time they are liable to be attacked by the "maggot-fly." If any animal is seen to be restless, twisting its body, shaking its tail, and running forwards with its head bent down, the shepherd should catch it, and most likely on close examination he will find a colony of maggots located about the hind parts. In hot weather the shepherd should never go to the fields without having in his pocket a bottle of dip-mixture or fly-oil. With this he anoints the part attacked, and shakes out the maggots from the wool. This simple treatment will be quite sufficient.

After lambs have been weaned, and the summer dipping having taken place, there will be little further trouble from this pest.

Unclipped Sheep Falling.—Long-woolled sheep, hogs especially, before being clipped, are so loaded with wool that, when annoyed by the ked, they are apt to roll upon their backs; and when that happens in the hollow of a furrow, they cannot get up again. They then lie *awkward* or *awald*. Should they lie for some time with their head down the hill, with the stomach full of food, they may die of apoplexy. A careful shepherd will not allow any sheep to die thus. He cannot prevent them falling awkward, but as long as sheep are rough, he should visit them frequently. Sheep are not easily discovered lying awkward in a furrow, so he should cross the ridges and view the furrows in length. An accustomed eye can detect the hind-hoofs in the air at a considerable distance.

Many collie dogs are quick in observing sheep in this state, and some will run and take hold of the wool near the ground, and pull the sheep over on its

feet. Shepherds cannot be too alert in visiting sheep on pasture at this season.

Ravens Injuring Lambs.—Lambs are subject to serious and even fatal injury on farms situate on the rocky cliffs of the ocean, from the raven, *Corvus corax*. This formidable bird comes upon lambs asleep, pecks a hole in the abdomen, and draws out the entrails. Should the lambs be awake, it dabs out their eyes. Even hogs, when fallen awkward, have had their eyes picked and their entrails pulled out by these birds.

Pasturing Sheep on Hill-farms.

We will now describe briefly the system of management pursued on hill-farms in carrying on the flocks from spring until weaning-time.

Stocking on Hill-farms.—The classes of sheep kept on hill-farms are arranged to suit the character of the land, the nature of the pasture, the altitude and exposure of the farm. A common plan is to maintain a stock of ewes on the low ground attached to hill-farms, or where the heath is well mixed with green ground, or interspersed by streamlets with green banks. Young sheep are placed on ground similar in character, but with a less admixture of green pasture. Older sheep and wethers generally occupy the higher grounds, where the exposure and cold would be too great for ewes and lambs and young sheep.

Ewes and Lambs.—The handling of a typical hill-flock of breeding sheep in the lambing season is described on page 73, Divisional vol. iii. We have seen that the large "hirsle" there, 500 head in charge of two shepherds, has passed through the lambing ordeal, and been turned on to the usual run of pasture. There is less work here in the changing of pastures than on arable farms with small enclosures. The shepherd, however, must be daily amongst the flock, and see that, by now and again moving them from one part of the ground to another, the ewes and their produce are kept in good thriving condition.

The ewes and lambs are turned on the higher and blacker ground for a change towards evening, and admitted again for a run of the green pasture during the earlier part of the day. A careful and intelligent shepherd soon learns when to

give his flock a turn from one part of the ground to another.

Pasture Plants on Hilly Ground.—The intelligent shepherd observes carefully the different kinds and succession of pasture plants suitable for the feeding of sheep, and as these attain sufficient growth he gives his flock a turn upon them. For instance, in most parts during January and February, "mossing" is usually plentiful; in April and May, "deerhair" becomes a standard plant; in June, July, and August, green banks, "haugs," and old pasture land are at their best; in September and October, "prie" and "stool bent" come up; and in November and December, "moss leek" and coarse bent and heath come in for use.

There is thus upon hill-farms, embracing high and low ground, a wonderfully complete succession of pasture plants. It is the object of the careful shepherd to take advantage of these as they come up in turn; and the flock-owner's balance-sheet may be largely influenced by the manner in which these successional growths are observed and utilised.

Heather-burning.

As heath constitutes a large ingredient in the food of mountain sheep, it is important that heath-burning should be carried out systematically, so as to have at all times a succession of young and old heath. Sheep-farmers have long been in the habit of burning a portion of the heath on their farms every year, with the view of allowing it to grow again, that its young shoots may support sheep in those parts of the grazing where there is little grass. Burning causes an abundant growth of young shoots; it is therefore the interest of both landlord and tenant that the heath should be so burned as to produce the greatest growth of young shoots.

Method in Burning.—The question of burning being thus established on principle, the difficulty at first was to discover a mode which would produce the best results. At length a good plan was discovered, and it is this: Let that part of a hill-farm which bears heath be divided into eight equal parts, because beyond that number of years the heath plant grows so rigid as not to afford many new shoots, and

it has then reached 1 foot in height, which is tall enough for grouse. The first portion is burned in the first year, the second portion in the second year, and so one portion every year, until the eight years have gone round. Every year the plants which were first burned will be putting forth fewer shoots as the expiry of the eight years approaches; by which time the first portion is burned again, as the commencement of a new series of years. In winter the snow covers the youngest shoots and protects them under it, while the older plants being above the snow, both grouse and sheep feed upon them; and in spring, on the melting of the snow, the young shoots, tender and nourishing, are ready for use. It is remarkable that the young plants of heath bear the frost better than the old.

Old Method of Burning.—The old mode of burning was to set fire to the heath on the *windy* side, when the blaze soon towered to a great height, and was seen at a great distance, and the plants crackled amidst the scorching heat; but the heat which produced the crackling destroyed the plants by the roots, and the flame, fanned by the gale, ran along the ground, catching every bush that presented itself, until a much larger space of ground was set on fire than was desired. The conflagration, indeed, often became so extensive that the shepherd and all his family could not extinguish it. The flame went wherever the wind listed, till there was no more heath to consume, or until the wind lulled, or the rain fell.

Modern Method.—The burning of heather nowadays, being controlled by the regulations of the property, is done at the sight of and with the assistance of the gamekeeper and his gillie; the shepherd helping and pointing out the most suitable parts. On large hill-farms, heather-burning must be done on the ground of the separate hirsels. Where streams run through the hill ground strips of heather are burned from 120 to 200 yards in breadth, running from the bank of the stream through the hill, often a mile in distance, when suitable ground exists. Heather takes at least three years before it sprouts after burning, but often on the burned ground other plants come up soon which are useful to sheep.

SHEEP-WASHING.

There has from time to time, and more particularly in recent years, been much discussion as to the utility of washing sheep before clipping them.

Objects in Washing.—There is a two-fold object in washing sheep—to free the wool from earthy material and improve its lustre, and cleanse the skin of the sheep from incrustated matter.

Opposition to Washing.—It is maintained by many flockmasters that any depreciation in the price per pound for unwashed wool is fully compensated by the greater weight of the fleece. It is better, the opponents of washing contend, that the cleaning of the wool should be left to the manufacturer who has appliances which enable him to do the work in a more thorough and satisfactory manner than could be done on the live sheep on the farm. Then, again, it is argued that the advantage to be derived from having the skin of the sheep cleaned by washing may be more than counterbalanced by the risk and trouble arising after washing; and that after clipping the skin of the sheep will be sufficiently cleaned by the natural rainfall.

The opposition to washing has probably been gaining strength, yet the practice is still largely pursued in this country.

Study the Market.—Perhaps the best guide as to the expediency of washing sheep will be the tendency of the wool trade—whether washed or unwashed wool finds the greater favour, or brings relatively the higher price. Farmers must consider these points carefully from time to time—such matters, indeed, should be their constant study—and it will be their object to arrange their method of management to suit the spirit of the age.

Methods of Washing.—There are different methods of washing sheep. Plans often adopted are here described. A pool of about 3 feet deep of water is made across a natural rivulet having a slope on each side, and both margins clad with grass, the slope for the egress of the sheep being the easiest, so that there be no struggling to get upon the bank when the wool is loaded with water.

When a rivulet is wanting, a pool

should be constructed in a large ditch having a command of water, and both banks lined with a clean sward of grass. A damming should be made across a rivulet even if it have a pool of sufficient depth of water, as the water will flow quicker and be cleaner in an artificial dam. The bottom of the river or ditch should be hard and gravelly, and the water pure, or it will not answer the purpose. A soft and muddy bottom and dirty water will soil instead of cleanse wool.

A damming is best made with an old door or two, or other boarding, supported by stobs driven in the rivulet, and the chinks at bottom and sides stopped with turf in the inside. When the water accumulates, it falls over the boarding at the centre with such a current as to carry off quickly every impurity—as earthy and greasy matter, small locks of wool, and scum. A damming in a ditch is made of the same construction, and with the same materials and depth of water.

One side of the pool is occupied by the unwashed, and the opposite by the washed sheep. They are confined in their respective places by hurdles or nets. To prevent the sheep leaping into the water of themselves, which they are apt to do when they see others in before them, the fence should be returned along the sides of the pool as far as the men who wash the sheep take up their stations. Fig. 402 shows a damming with doors and stobs, and the overflow of water in the centre. The net on each side of the pool is returned far enough on both sides. The water is at the proper depth for the men.

Everything is now ready at the pool, the sheep having been separated for the washing. The tups are washed first, then the hogs and wethers, and lastly the ewes. Hogs and wethers are generally shorn in May, while ewes are left unclipped until about the middle of June, the exact time being dependent on the character of the season. Cold weather after the ewes are clipped will make the milk supply very scanty, if it does not stop the supply altogether. It is thus advisable that the hogs and wethers should be washed 2 or 3 weeks earlier than the ewes. Lambs are not

washed, and are kept apart when their mothers are being washed.

Force Required.—The men who wash cast their coats, roll up the sleeves of their shirts to the shoulders, and have old trousers and shoes in which to stand in the water. Long fishermen's boots, or india-rubber leggings, would provide good protection to the men.

The shepherd and two ploughmen are usually sufficient to wash a large number of sheep thoroughly; but should the stream be broad, a third may be required, to save time in handing the sheep from man to man. The three men in fig.

402 are the shepherd (who is the last man to handle the sheep, and is farthest up the pool) and two assistants. Two men are required to catch the sheep for the washers.

On this occasion the men receive bread and cheese and ale, and also a dram of spirits, as a safeguard against a chill while standing for hours in the water. The collie keeps watch, and is ready in case of an outbreak.

Process.—The washing is performed in this way: While the three washers are taking up their respective positions in the water, the two catchers are captur-



Fig. 402.—*Washing-pool and sheep-washing*

- a* A Damming with doors and stobs, the surplus water pouring down in the centre.
b Man catching an unwashed sheep for the first washer.
c First washer, who stands lowest down the pool.

- d* Second washer, mid-way in the pool.
e Shepherd, farthest up the pool and last washer.
f Washed sheep going out of the water.
g Washed sheep within the enclosure.
h Collie beside the provisions.

ing a sheep. The catching is fatiguing work, and, to make it easier, the enclosure should be small, to contain the sheep closely. A sheep, being caught, is presented to the first washer, who, on taking it into the water, allows the wool to be saturated, then turns the sheep over on its back, holding up the head by seizing the wool of the near cheek with his left hand, and grasping the arm of the off fore-leg with the right. With this hold he dips the sheep up and down—pushes it to and from him—turning it from one side to the other slowly, and causing the wool to wave backwards and forwards, as if rubbing it against the water. These motions are easily effected,

even a heavy sheep feeling light in the water. During the operation the water becomes turbid about the sheep, and he continues the agitation till the water clears itself, when he, hands the sheep to the next washer in the middle and higher up the stream. Whenever he gets quit of one sheep, another should be ready by the catchers for him to receive into the water.

The second washer, on receiving the sheep from the first washer, holds it and treats it in the same manner, and then hands it to the shepherd a little higher up the stream, and is ready to take another sheep from the first man.

Duty of the Shepherd.—It is the

duty of the shepherd to see that the skin of the sheep is cleansed, and every impurity removed from the wool. The sheep on its back is in a favourable position for the rapid descent of earthy matter from the longer part of the wool. Wherever he feels a roughness upon the skin, whether on the back or belly, groin, breast, or round the neck, he scrubs it off with the hand. Being satisfied that the sheep is clean, he dips it over the head while turning it into its natural position, when it swims ashore, and gains the bank. On coming out of the water it walks feebly, its legs staggering under the weight of the dripping fleece; and in a little it frees itself from the remaining water by twirling the fleece like a mop.

In the echelon position in which the men stand in the water, the sheep in its dirtiest state is in the hands of the man farthest down the stream, where the impurities flow away, and come not near the other men. The sheep being in a comparatively clean state when it reaches the second man, the water cannot much dirty that which runs past the first man, and still less the water from the shepherd soils that near the other two men.

Hours for Washing.—The afternoon is generally chosen by shepherds for washing sheep, but the morning is a better time, inasmuch as the fleece will have become much drier during the day than in the night when the sheep are washed in the evening, when they must feel uncomfortable with a wet fleece.

Effect on the Sheep.—Sheep are differently affected in the time of washing. Some disregard the plunges, and seem to enjoy them, giving themselves up entirely to the will of the washers; whilst others are in a state of great terror, struggling against every new motion, and groaning in anticipation of greater danger. Some are very expert in turning their backs upwards should the washer be off his guard and dip them too perpendicularly down; and when turning themselves quickly, they are apt to injure the bare arms of the washer with the hoofs of the fore-feet.

Speed.—In this way from two to three scores of sheep may be washed in an hour, according to the size of the sheep, the activity of the washers, and the supply of water.

After Washing.—After washing, sheep should be driven along a clean route, and be put into a grass field having no bare earthy banks, against which they might rub themselves. They should be kept perfectly clean until their fleeces are taken off.

Interval before Clipping.—How long the fleece remains on after the washing depends on the state of the weather. The wool must not only be thoroughly *dry*, but the *yolk*, the natural oil of the wool, must return into it again; and further, the new wool should have risen from the skin before the old is taken off. Disregard of this particular renders clipping difficult, and certainly deteriorates the appearance of the fleece. Perhaps eight or ten days may suffice for these effects.

No apprehension need be entertained of the fleece falling off when the new growth commences, for wool will remain for years upon the sheep's back if not clipped off, and the sheep be free of disease.

Another Method.—Another method of washing sheep, often pursued on pastoral farms, is as follows: A deep pool in a river is selected, or, failing this, a damming is made in the gully of a rivulet; and where no river exists, a suitable part of a lake is selected. A small space is enclosed with hurdles near the edge of the water; a narrow passage, fit to contain two sheep and two men in breadth, is made from the hurdles to a rising-ground or rock, which projects into and is 5 or 6 feet above the water; and from this the sheep are made to leap into the water one by one. On leaping from that height, the sheep go over the head, and on swimming reach the dry land, where another enclosure of hurdles is ready to receive them. They are thus treated several times till they are clean.

Bath Washing.—Where there is no stream or suitable pool at hand, and where the flock is small, a large bath or tub may be made for the purpose. Many contrivances are in use, some very primitive, yet efficient enough, if not very speedy.

Hungarian Method.—In some parts of Germany great pains are taken with the washing of sheep. At Alcarth, in Hungary, the washing is done under roof

in the following manner: The first operation is to dissolve and loosen the dirt in the fleece. For this purpose a soaking vat has to be put up, which is covered and tightly put together of strong planks or boards. It is filled with hot water, equal to 84° Fahr.; the sheep are then placed in two lines, and constantly handled until the yolk and dirt are dissolved, which ordinarily takes from fifteen to twenty minutes. The solvent effect of the water is increased by adding a few pounds of *potash*, and also by the *lye* arising from the natural oily matter of the wool. The sheep, after being well soaked, are placed under shelter, where they have to wait their turn of the shower-bath, in order that the animal, now too much heated, may not pass immediately from the hot *soaking-vat* into the *shower-bath*, this being from 61° to 63° Fahr. The water is let upon the sheep through a hose with a strainer at the end. It falls with considerable velocity, and is brought to bear upon all parts of the sheep until the wool is of a snowy whiteness. The sheep are then driven to a warm dry shed, and shorn as soon as the wool is dry, generally about the sixth day. On an average forty sheep are thus washed in an hour.

Australian Methods.—To suit the enormous flocks in the Australian colonies, elaborate washing appliances have to be provided. There, from £1000 to £2000 has been spent by some sheep-farmers for steam-engine and washing-gear. In Scott's *Practice of Sheep-Farming* there is the following description of the very complete arrangements for sheep-washing on an Australian farm (Mount Fyans): "The plan adopted is to pass the sheep through a cold-water tank over night, which washes a good deal of the loose dirt off the bellies and legs, and thoroughly saturates the fleece. They are then packed pretty closely in a sweating-house, with numerous subdivisions in it to prevent the sheep from being smothered. By this means the points of the wool are softened, and the work of cleansing the fleece is rendered very much easier than it would be if the sheep were taken into the wash without this preparation. The hot-water tank into which the sheep are put next morning has three divisions, in each of which

they are well crutched. At the end of this tank there is a movable floor, which is raised by a lever, so that the sheep leave the tank without having to struggle up a steep incline. The water is heated to about 108° or 116° Fahr., and bar soap is used to soften it, and render the process of cleansing the wool more easy. After draining for a short time, they are passed down shoots to the men at the spouts, where, on Sharp's patent sheep rollers, they are well spouted; and when the hot water has been fairly driven out of the wool, they go on to the landing-stage, where they drain for a time, and are then allowed to walk on the grass by a long battened stage. The water for the wash is drawn from a large dam, which is kept constantly full by a stream from the spring in front of the house. Centrifugal pumps are used to throw up the water to a height of 12 feet, and one spout will wash about 500 sheep a-day."¹

Lambs.—The lambs are restored to the ewes immediately after the washing. Some advocate washing lambs as well as the older sheep, but this is not advisable. When still on milk they are susceptible of changes, and a chill then arising from a wet state of their body might engender serious disturbance throughout their system. No possible good can accrue to them from washing.

SHEARING OF SHEEP.

This is an interesting event on sheep-farms. In most parts the sheep-shearing is regarded as a joyous occasion—a sort of harvest—in which a liberal allowance of beef and broth and ale is dispensed to the clippers engaged in the laborious work. It is a point of great importance to have dry settled weather for this operation; and as the time approaches, flock-owners watch the weather indications with some anxiety.

Time of Shearing.—The exact time of shearing varies with the locality, the class of sheep, and the season. The clipping season may be said to extend from the middle of May till the end of July. The new growth of wool should

¹ *Prac. of Sheep-Farming*, 134.

be well started before the clipping begins.

If the sheep have been washed, they may be clipped about eight or ten days thereafter.

The tups are first shorn, then the hogs and wethers, and lastly the ewes.

Clipping-place.—On Lowland and mixed husbandry farms a covered place is generally selected for clipping. The straw-barn may be used for the purpose. The end next the chaff-house, between the two doors, is a good site for the clipping-floor, while the rest of the barn contains the sheep cool under cover.

Clipping-floor.—A clipping-floor is sometimes prepared in this way: Let clean straw be spread equally two or three inches thick, and then spread the large canvas barn-sheet over it, with its edges nailed to the floor. Thus a soft cushion is made for clippers and sheep. A broom sweeps the barn-sheet clean.

The barn-floor and walls, as high as the sheep, should be swept of dust, and straw strewn upon the floor for them to lie upon.

Upon large sheep-farms facilities are provided for clipping at the sorting-pens, where there is usually considerable shed accommodation.

In case of dew or rain in the morning, as many dry sheep are brought into the barn on the previous evening as the number of clippers will shear on the ensuing day.

Force at Clipping.—It is customary for neighbouring shepherds to assist each other. The emulation amongst a number of men clipping together not only expedites the shearing of the individual flock, but makes the work cheerful, and calls forth the best and quickest specimens of workmanship from each clipper. Many additional hands have to be hired or transferred from other farm-work for the occasion, the number required varying with the size of the flock.

The steward has no time to clip sheep, but the art is known by the hedger; and if the cattle-man has been a herd, he lends a hand. Clipping being dirty and heating work, the coat is stripped, and the oldest trousers put on, whilst some throw aside the hat, vest, and cravat. In some parts of the country women assist at the clipping.

Wool-shears.—The implement with which the wool is clipped off sheep is made of steel, in the form of *shears*, whose broad blades are connected by an elastic ring, as in fig. 403. The elasticity of the ring acts as a spring to keep the blades separate, and the pressure of

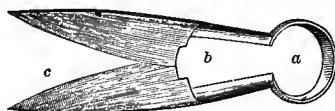


Fig. 403.—Wool-shears.

- a Spring-bowl of shears.
- b Rounded handles of shears.
- c Flat broad blades of shears.

the hand upon the handles overcomes the spring and brings the blades together.

Some wool-shears have additional springs between the handles to separate the blades more forcibly, but are oppressive to the hand, which requires relief from a piece of cord wound loosely round the handles. Strong-sprung shears are most easily worked if held at the blades; but the sharp backs of these soon hurt the hand. When not in use, and when carried, the blades are held together at their points by a ring of leather.

Sharpening Wool-shears.—The best method of sharpening is by the use of an oilstone, such as joiners commonly use.

The operator springs open the shears until the blades will pass each other back to back; then, gripping them firmly, he places the edge on the stone, holding the blade at a slight angle, and proceeds by a curving or circling motion to rub up the cutting edge. Simple as this operation seems, it demands considerable care and practice to do it really well. A good sharpener will not on any account allow another person to sharpen his shears.

A shepherd requires two or three pairs of small shears for trimming, and uses only large shears for shearing.

Avoiding Injury to the Sheep.—The shears are used in a manner not to injure the fleece or the skin of the animal. The particular to be attended to in clipping is to keep the *points clear of the skin* by gently pressing the blades upon the skin; for whenever the points are allowed to touch the skin, they will either run into

or make a large gash in it before the clipper is aware of the mischief he is doing. This is an error committed by new clippers, and it is done by holding the hand too high above the skin, and depressing the points of the shears into it. The sure way of avoiding this serious injury is to keep the hand low, and to rest the *broad* part of the blades upon the skin; and on drawing the skin a little tight by the other hand, the shears slide, as it were, upon it, while their

points thread themselves through the wool and never come quite close together, the blades at their centre in the meantime shearing the wool with moderately long and frequent clips.

The round form of the sheep's body favours the action of the blades, in not admitting the shears to make long clips, and in keeping their points asunder, which, if not so kept, would clip the wool at an elevation in advance of the blades clipping the wool next the skin.



Fig. 404.—First stage of clipping a sheep.

a Left leg of the clipper.
b Fore-feet of the sheep under the left arm of the clipper.
c Left arm of the clipper holding down the fore-legs of the sheep.

d Points of the small shears clipping the short wool off the belly.
e Left hand of the clipper keeping the skin of the sheep tight for the action of the shears.

f Scrotum of the sheep.
g g Inside of the thighs of the sheep.
h Tail of the sheep.

The wool would thus be clipped at two parts at the same time. *Very* short clips make slow work, but slow work safely done is preferable to hasty slashing, with injury both to the animal and the fleece. Experience makes longer clips effective, but at all times short clips are the safest mode of using the shears.

Shear-cuts.—Careless or inexperienced shearers are very liable to make cuts in the skin of the sheep with the shears. Every cut, however small, should be at once dressed with tar, which, for

marking purposes, is always at hand at the clipping process.

The object of washing sheep becomes apparent at shearing; for if the skin and wool are not clean, the shears grate upon the dirt and make bad work.

Method of Clipping.—A common method of clipping is described as follows: On catching a sheep, twigs on the wool and dirt on the hoofs are picked off by the clipper or shearer, as he is variously called. The first stage of the process is shown in fig. 404. After set-

ting the sheep on its rump, the clipper stands and leans its back against himself. Taking the shears in his right hand, and holding up the sheep's mouth with his left, he clips the short wool on the front and each side of the throat, round the neck and across the breast to between the fore-legs. Then resting on his right knee, placing the fore-legs under his left arm, he shears the belly across from side to side down to the groin. In passing

down where the skin is naturally loose, the palm of the left hand pulls the skin tight. The scrotum is then bared, then the inside of the thighs, and, lastly, the sides of the tail. These are all the parts that can be reached in this position.

For the clipping of these parts, small shears suffice; and as the wool is short, and of a detached character, it is best clipped by short clips of the *points* of the shears. The sheep is somewhat un-



Fig. 405.—Second stage of clipping a sheep.

a Bared neck of the sheep.

b Left hand of the clipper keeping the skin of the sheep tight.

c Fore-legs of the sheep.

d Tail of the sheep.

e Right or clipping hand of the

clipper with the large shears.

f Right arm of the clipper.

g Left arm of the clipper.

easy in this position, and many attempt to struggle.

The second stage in the clipping is shown in fig. 405. Its position for the sheep is gained by relieving its fore-legs from the first position in fig. 404, and, resting on both knees, the clipper firmly turns the sheep upon its *far side*, supporting its far shoulder upon his lap. The sheep now feels at ease, and will lie quiet to be clipped.

It should be borne in mind that, in shifting from one position of a sheep for another in clipping, a *firm* hold of the animal should be retained, else, on finding itself half released from constraint, it will attempt to start to its feet and be off. In such a burst, before the sheep can be caught and laid down again in its position, the clipped part of the fleece may be very much broken and ravelled.

Confining its head with his left arm,

the clipper first removes the wool from below the neck, and around the back of the neck to the shoulder-top, with the large shears. He then slips its head and neck under his left arm, and thus having the left hand at liberty, he keeps the skin tight with it, while he clips the wool with the right, from where he had just left off to the backbone, all the way down the near side to the tail. In the figure, the fleece is removed about half down the carcass; the left hand lying

flat, keeping the skin tight; while the right hand holds the shears at the right part, and in the right position. The clipper thus proceeds over the thigh and the rump to the tail, which he entirely bares at this time.

The third stage—according to this method—is shown in fig. 406. It is attained by clearing the sheet of the loose parts of the fleece: the clipper, holding by the head, lays over the sheep on its clipped or *near side*, while still on



Fig. 406.—Third stage of clipping a sheep.

a Right ankle and foot of the clipper keeping down the head of the sheep.

b Right arm of the clipper clipping.

c Left arm of the clipper

keeping the skin of the sheep tight with the left hand.
d Freed fleece.

his knees, and puts his right ankle over its neck, the ankle and foot keeping the sheep's head down upon the ground, the sheep lying quietly. The wool having been bared to the shoulder in the second position, the clipper has now nothing to do but to commence where the clipping was then left off, and clear the fleece off the far side from the backbone to the belly, the left hand still keeping the skin tight. The wool has to be taken off the far hind-leg onwards to the tail. The fleece is now freed from the sheep. In

assisting the sheep to rise, care should be taken that its feet do not get entangled with the fleece, otherwise, in its eagerness to escape from the unusual treatment it has just received, it may tear the fleece to pieces.

Clipping with the Left Hand.—Others proceed quite differently in this last stage of the process. They would hold the shears in the left hand, and clip from the belly towards the backbone. Expert clippers can clip with either hand, and this plan makes neater work.

Another Method.—Another method, which is common in some parts, is more irksome both to the clipper and the animal than the system illustrated. In this other method the practice, in the first stage, is to place the sheep upright on its rump, while the clipper stands on his feet, supporting its back against his legs, and clips around the cheeks, neck, breast, belly, scrotum, to the lowest part of the animal, the tail. Standing all the time and bowing low, he puts himself as well as the sheep in an uncomfortable position. In the second stage, the clipper still stands on his feet, and the sheep

upon its rump, while he secures its head between his legs, and tightens the skin of the near side by bending it over his knees. The skin is tightened at the expense of the ease of the animal, whilst bowing down low and long cannot fail to pain the back of the clipper. In the third position he keeps the left leg bent, resting on its foot—a more irksome position than kneeling on both knees.

Differences in Fleeces.—Some fleeces are much more easily clipped than others. Thin watery wool is not fit to be clipped in broad courses—the shears easily passing through it induces the clipper to

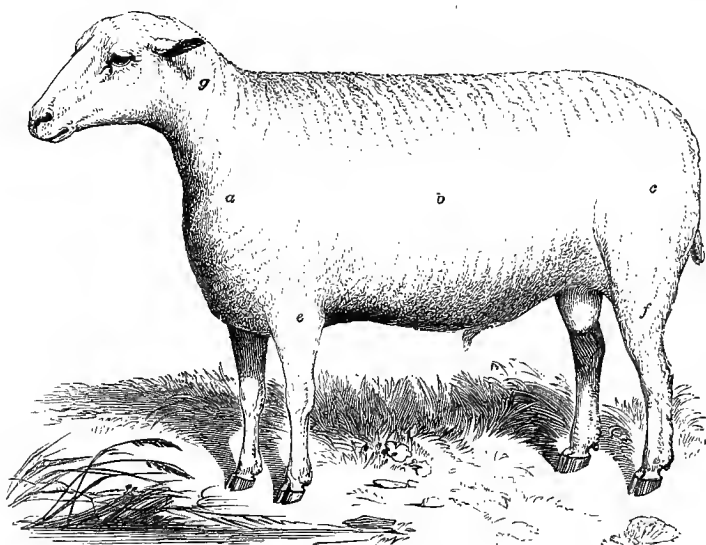


Fig. 407.—*New-clipped sheep.*

a Shoulder-point of sheep.
b Round rib of sheep.
c Hind-quarter of sheep.

e Fore-leg of sheep.
g Neck of sheep.
a to e Shoulder to fore-leg.

a to g Shoulder-point to top of shoulder.
c to f Hind-quarter to hind-leg.

take too broad a clip. Thick wool requires the shears to be employed mostly at the points, as these cannot penetrate it so far in advance of the blades as with wool in the ordinary state. Certain fleeces are so thick as to be *coated*—that is, felted on the sheep's back. These can be taken off only with the points of the shears in minute clips. Such fleeces are most easily clipped after a fresh growth of wool has taken place.

Number Clipped per Day.—To shear 25 to 30 sheep is a good day's work for any clipper, though there are

shepherds who can do more. A fat sheep is more easily clipped than a lean one. As soon as one lot of sheep is clipped, another is brought to be ready to commence on the following morning.

New-clipped Sheep.—A new-clipped sheep usually looks like fig. 407. The shear-marks, it will be seen, run in parallel bands round the body, from the neck and counter along the ribs to the rump, and down the hind-leg.

When pains are taken to round the shear-marks on the back of the neck, connecting the space between the counter

and the top of the shoulder; to continue the marks from the shoulder down the fore-legs; to continue them from the hind-quarters, in the shape of the hind-leg, as far as the wool reaches; to make them run straight down the tail; to cause them to coincide from each side across the back,—a newly clipped sheep in good condition is a beautiful object, artistically treated.

A sheep clipped in a state of *perfection* should have no shear-marks at all—these marks being small ridglets of wool left between each course taken by the shears. But such a nicety of clipping is scarcely attainable, and not worth the sacrifice of time in doing it. It should be borne in mind that the closer wool is clipped to the skin the better it is for the next fleece, while a larger and heavier fleece with a longer staple of wool is obtained from each sheep.

Clipping on Hill-farms.—In most purely pastoral districts where the flocks are large, the method of clipping is slightly different. There the old-fashioned practice of tying the legs of the animal together, on the greensward in the open air, is still extensively practised. After the sheep is thus placed in a helpless state between the legs of the clipper, who sits on the grass with the head of the sheep towards him, the shears are made to ply, from the neck to the tail, in long slashes, so that the fleece may be snatched off in the shortest time. The legs are then loosened and the sheep set at liberty. Women are frequently employed at this work, to which there is no objection, provided they do it well; but it must be said that in this method the work is sometimes rather imperfectly done.

In some cases, where there are no sheds or other houses available, tents of canvas are erected. In average seasons, however, there will be little need for this. Than a thoroughly close, dry greensward there can be no better place for sheep-shearing.

Few pastoral farms are without a steading or sheds of some kind, and in wet weather these are available for the sheep-shearing.

Early Shearing Risky.—When cold weather follows clipping there is considerable risk of injury to the newly

shorn sheep. Too early shearing is therefore undesirable; and when any sheep, such as rams, are shorn unusually early, they are kept in the house or where they have access to shelter till the weather becomes warmer. When cold wet nights follow immediately upon the clipping of the general flock, it is a good plan to place them under a roof or in some other dry and well-sheltered spot overnight.

Shearing Lambs.—In the extreme south of England, notably in Cornwall, the practice of clipping lambs has long been pursued. It is by degrees spreading northwards, and is considered by many flock-owners to be decidedly beneficial to the progress of the lambs. In the case of lambs which are to be fattened off in the course of their first winter or following spring, it is specially advantageous to clip them as lambs. Lambs' wool is usually in request at a comparatively high price. It is generally past midsummer before lambs are shorn. The practice, however, is still quite the exception in this country.

Sheep-shearing Machine.—A machine for shearing sheep, which promises to be of service where large flocks are kept, has been brought out in Australia by Mr Wolseley. It consists of a cutting-wheel geared to the shaft of a small steam-turbine, which is worked by a current of steam conveyed from the boiler in an india-rubber tube. A comb moves in front of the cutter, effectually preventing injury to the sheep. The shearing apparatus, which is made of brass, and is in shape similar to a small trowel, is held in the hand, and directed over the body of the sheep just as is the wool-shears. The clipping, however, is done much more rapidly, more cleanly and evenly, and with perfect safety to the sheep.

Tar-brand.—As the sheep are clipped, they receive the distinguishing brand, "bust," or tar-mark—noticed more fully under the heading of "Marking Sheep."

Mothering Lambs after Clipping.—There may occasionally be difficulty in getting lambs to take to their mothers after clipping, especially if the two have been kept apart longer than one day. This occurrence will be referred to in dealing with the weaning of lambs.

ROLLING AND WEIGHING FLEECES.

Wherever sheep are shorn—in the straw-barn, in a shed, or on the green-sward—a board is erected for rolling the fleeces upon as they are shorn.

Method of Rolling.—In many cases a smooth plain deal door is used for winding fleeces upon, and it should stand on tressels 2 feet above the ground, and 3 or 4 feet from a side-wall, near the clippers. A chaff-sheet should be spread on the floor close to the wall to pile the rolled fleeces upon until they are taken to the wool-room, at the end of the day's work. The person appointed to roll the fleeces must be accustomed to the work, for it has to be done carefully and neatly. Whenever a fleece is separated from the sheep, he or she lifts it carefully and unbroken from the shearing-cloth, and spreads it upon the board upon its clipped side, with the neck end farthest off. The folder then examines the fleece carefully, and removes any extraneous substances such as straws, thorns, whins, burs, or lumps of dung. Fig. 408 shows the mode of rolling a fleece, where a board



Fig. 408.—Rolling a fleece of wool.

- a. Board.
- b. C Tressels supporting the board.
- d. Field-worker rolling a fleece of wool.
- e. A fleece of wool placed on the board.

is supported upon the tressels, and a field-worker is in the act of winding a fleece.

Folding Rack.—Preferable to the close door for folding fleeces upon is a door or rack, made of narrow strips of wood attached on cross spars, and having an opening of about one inch between every two. This allows any dust or

other similar substance adhering to the fleece to fall through in the process of rolling and folding. This rack-like folding door is placed upon tressels, as shown in fig. 408.

Keep Fleeces Clean.—The farmer should be particular in giving instructions to have every fleece as clean as possible. The purchaser cannot unloose every fleece he buys; and should he find as much filth in the fleeces, after purchasing them, as to warrant the belief that it had been purposely made foul, he may either relinquish his bargain, or make a large deduction from the price—in the former case implying fraud on the part of the farmer, and in the latter diminishing his profits.

Details of Folding.—The winder being satisfied of the purity of the fleece, folds in both its sides, putting any loose locks into the middle, and making the breadth of the folded fleece from 24 to 30 inches, according to its size. She then rolls the fleece from the tail towards the neck, tightly and neatly; and when arrived at the neck, puts a knee upon the fleece, while she draws out and twists the neck-wool in the form of a rope with both hands, of such length as will go round the fleece; and then holding the fleece tight at the lower end of the rope with one hand, removes the knee, still holding the end of the rope in the other, winds the rope tight round the fleece, making its end fast under the rope. The fleece, as a bundle, is easily carried about, having the clipped surface outside, which, being white wool saturated with yolk, has a silvery lustre. It is laid aside next the wall. Fig. 409 is a fleece of wool rolled up in the proper manner.

Where there are eight or ten clippers, with one person to catch the sheep, two women will be required to roll up the fleeces; one rolling and the other twisting the band, and keeping the floor tidy and clean.

Assorting Fleeces.—All fleeces are not alike, either in structure or colour. Those of ewes are thin and open in the locks, of pale colour, and feel light in the hand. Hoggs' fleeces are close, long in the pile, of a rich colour, bulky, and feel heavy in the hand. Fleeces in all parts have not the same completeness; one part may have been shed off in the field;

another coated, having the appearance of thick cloth; whilst several parts may have a dusky hue. Whenever such differences are observed, fleeces should be assorted and each class or grade sold separately.

Coarse stray locks, clotted with dirt, which are known as foot-locks, are thrown

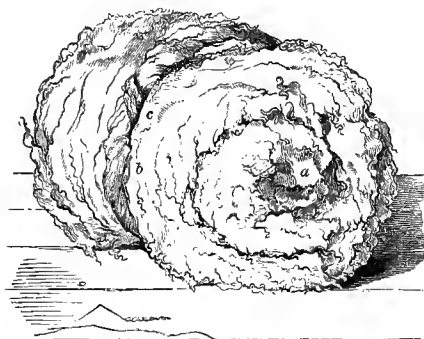


Fig. 409.—Fleece of wool rolled up.

- a Centre of fleece, consisting of the wool from the breech of the sheep.
- c Rope of wool from the neck of the sheep twisted round the body of the fleece.
- b Body of fleece of wool.

under the rolling rack, and afterwards sold to one of the farm hands, who will wash and clean them for the wool.

Wool-room.—Each day's clipping is carried into the wool-room. Previous to being occupied, the room should be swept clean of dust from its plastered walls, and its wooden floor washed and dried. The fleeces are piled upon the floor at a distance from the walls, the hogg and ewe and other distinctive fleeces being kept apart, as assorted.

Each sort is covered with a cloth, and the shutters of the window closed. The reason for these precautions, which are not always attended to by farmers, is, that the cloths serve the double purpose of keeping off dust and preventing too quick evaporation of the yolk of the wool and the consequent diminishing of its weight, while the exclusion of light preserves the bright lustre of the wool. A damp wool-room causes the wool to clasp together and to mould. A hot dry room scorches the wool.

Coated fleeces and locks of wool should not be brought into the wool-room at all. The coated fleeces should be sold at once, and the locks cleaned for use.

Wool-moth.—In spite of every precaution, the white-shouldered wool-moth, *Tinea sarcitella*, fig. 410, may come into the wool-room in a short time. This, as observed by Curtis, "has long been recorded as a most mischievous little moth in our dwelling-houses, where it is common the greater portion of the spring, summer, and autumn. . . . The female deposits her eggs upon cloths, blankets, curtains, carpets, or any woollen articles, on which the larvæ feed, living in cylindrical cases which they form of the materials on which they subsist covered with their excrement, and in which they change to pupæ. The caterpillar is a lively wriggling animal, about $\frac{1}{2}$ an inch long when full fed; it is soft and white, with a yellowish tint, and sparingly clothed with fine longish hairs, sometimes having a slate-coloured stripe down the back, arising from the food; the head is horny, of a chestnut brown, and furnished with little strong jaws and minute horns."¹

Wool is an unsafe article for a farmer to keep long. For a short time it becomes heavier in the room, absorbing moisture from the walls, floor, and air, which it probably does as long as it retains its vitality; for, being a living body

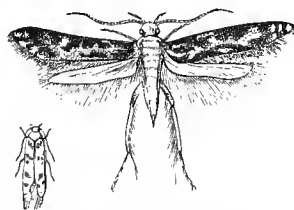


Fig. 410.—White-shouldered wool-moth (*Tinea sarcitella*).

when shorn, some time must elapse before it loses life. After life is gone, wool soon loses its natural moisture in a dry room, and the staples become curled and harsh; and in a damp room, after loss of vitality, the fleeces compress and feel clammy. The wool-moth then appears, and breeds numerous larvæ, which subsist on the staples, and cut them in pieces.

Many farmers have no wool-room, but keep their wool in a granary or outhouse, where these evils are aggravated.

Preserving Wool.—The best way of

¹ Jour. Eng. Agric. Soc., vii. 429.

preserving wool for a length of time is to have it in a cool dry room with a wooden floor, and packed in sheets, in which it will be out of the reach of dust, light, and moths.

Disposing of Wool.—The safest plan for the wool-grower is to sell it every year at the current prices, which are determined at the great wool fairs in summer in every part of the country, either to wool-dealers at home; or to consign the entire clip to the wool-brokers (whose name is legion), to dispose of to the best advantage, at the proper time. When a wool merchant purchases wool from a farmer, he sends his own people to pack it in his own pack-sheets.

Weighing Wool.—Wool is weighed in this way: It is sold in Scotland by the

wool-stone of 24 lb. avoirdupois, and is weighed out in double stones of 48 lb., each being called a *weigh*. In England wool is sold by the lb., and weighed out by the *tod* of 2 stones of 14 lb. each, or 28 lb. In weighing out, fleeces may not exactly weigh the double stone; and as fleeces are never broken to equalise the scales, a few small weights are in use to balance the scale on the side of the wool or weights at each weighing. In this way the weight of the number of weighs required to fill each pack is correctly noted.

In fig. 411 are shown the large scales and beam weighing wool. A man takes the fleeces from the pile, and, after weighing a double stone, places the fleeces in a heap on the floor. If the wool-room

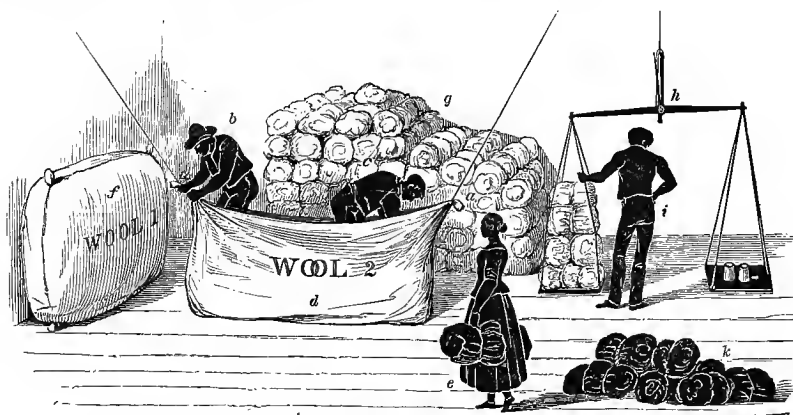


Fig. 411.—Weighing and packing wool.

a Pack-sheet suspended by the corners.

b Man tramping fleeces in the corner of the sheet.

c Man placing a fleece in the

corner of the sheet.

d Pack-sheet.

e Worker carrying weighed fleeces to be packed.

f Completed pack-sheet.

g Unweighed fleeces.

h Beam-scale for weighing fleeces.

i Man weighing fleeces.

k Weighed fleeces.

has a ceiling high enough to suspend the beam and scales from a hook, and large enough to pack the wool in the sheets, so much the better; but if not, the wool must be removed to a spacious enough place to be weighed and packed, and placed on clean barn-sheets.

Packing Wool.—Wool is packed in this way: Pack-sheets are made of thin canvas, doubled, of the shape of an oblong rectangle, about 8 feet long when empty, and open along one side. A small stone is placed in each end of the opening of the sheet, and a rope for each end being

suspended from the ceiling, the stones form knobs which prevent the ends of the sheet slipping through the tyings of the ropes. The sheet just swims above the floor. Two men get into the sheet, one at each end, place the fleeces, handed to them by a worker from the heap, lengthways across its bottom, as the man on the right is doing; and they trample them down with force, especially at the ends, with both feet together; while both hands hold firmly by the end of the sheet under the tying, as the man on the left is doing. The second layer of fleeces is laid con-

trary to the first, along the sheet, two or three fleeces being placed parallel in the breadth of the sheet; but the ends of the sheet are filled with fleeces placed across as at first.

The sheet is thus filled with alternate layers of fleeces till it is full, when the packers come out, loosen the ropes, and, reserving the small stones for the next sheet, at once close the mouth of the pack.

Sewing Packs.—If the mouth of the pack were left open for a time, the elasticity of the wool would cause the fleeces to rise up above it and render the closing impracticable, unless a few of the fleeces were taken out. With the aid of hand-cramps, the two men at opposite sides bring the mouth of the pack-sheet together, and hold it closed with iron skewers. When a farmer is packing wool on his own account, common iron kitchen table-forks answer for bringing the mouth of a pack-sheet together, and keeping them close. Thus closed, the mouth is sewed up with packing-needle and strong twine, the skewers being removed as the sewing proceeds.

Contents of a Wool-pack.—A pack of wool contains 10 stones—that is, 240 lb.

Wool, as it is sometimes packed, is not placed regularly in the sheet—the fleeces being crammed in and trampled down as they happened to come into the hands of the packer. This is an objectionable method, for the staple of the wool may be broken by the treatment.

Peculiarities of the Fleece.

The wool on a sheep will, on close inspection, be seen to consist of different qualities. The coarser is found on the under, and the finer on the upper part of the body. The finest wool is upon the shoulder and along the top of the back to the tail-head; the next finest below the shoulders, along the ribs to the rump; the coarsest on the haunches and breast; and below the belly it is often so short and detached that it cannot be classed with the rest.

Subdivisions of the Fleece.—Each of these parts is divided into different qualities, which wool-staplers classify. These subdivisions of the fleece by wool-staplers are technical—such as prime-

lock; choice-lock; picked-lock; super-head; head; downrights; second abb; livery; short-coarse or breech-wool. It would be well for wool-growers to have lessons from wool-staplers on the quality of the wool on different parts of the fleece, in order to be able to estimate the value of the fleece. According to present practice, wool-growers grow wool without knowing what it is fit for, and must take such prices as are offered.

Properties of Wool.—Good wool has these properties: The *fibre* is of uniform thickness from root to point, when it is said to be *true*; the finer the wool, the smaller the diameter of the fibre; the fibre is elastic on being stretched lengthways; tough, not easily broken; of great density, having a shining silvery lustre.

As to *staple*—the staple being any lock that naturally sheds itself from the rest—all the fibres should be of the same length, otherwise the staple will be *pointed*; the end of the staple is as bright as the bottom, and not composed of dead wool; the entire staple is strong. The strength of the staple is tested in this manner: Take the bottom of the staple between the finger and thumb of the left hand, and its top between those of the right, and, on holding the wool tight between the hands, make the third finger of the right hand play firmly across the fibres, as in staccato across the strings of a violin, and if the sound be firm and sharp, and somewhat musical, the wool is sound; if the fibres do not break on repeatedly jerking the hands asunder with considerable force, the staple is sound; if they break, the wool is unsound. It will most likely break at the place which issued from the skin of the sheep when the animal was stinted of food or had an ailment; and the greater the illness, the easier the staple gives way. Pliability is a good property in the staple; inflexibility and brittleness bad qualities.

Good Fleeces.—A good fleece has the points of all its staples of equal length, otherwise it will be pointy. The staples are set close together, and the fleece *clean*.

A pointy, watery, or dirty fleece creates much waste to the manufacturer, in bringing the wool to a proper state.

A good fleece has great *softness* to the feel, which does not depend upon *fineness* of fibre, but upon a delicate elasticity which yields to the touch at once, and quickly recovers its form.

Hair in Fleeces.—There should be no *hairs* in wool—the long ones are easily distinguished, and give the name of *bearded* to the fleece; short ones, soft and fine, are not easily distinguished, and are named *kemps*. Long hairs are of a different colour from the wool, but kemps are of the same colour; and of the two, the kemps are the more objectionable, as being less easily detected.

Injuring the Clip.—With all these properties in view, it would follow that the farmer who breeds sheep having fleeces with pointy staples, thinly set on, and of unequal lengths—who stints his sheep of food at times, producing wool of unequal size and strength—and (as many contend) who does not wash his sheep clean—or, having washed them clean, allows their wool to be dirtied before being clipped, and clipped before the yolk has returned to it—injures his clip of wool to a serious extent.

Composition of Wool.—The composition of wool, analysed by Way, is as follows:—

Organic matters		63.1
Ash		36.9
		100.0
Nitrogen		4.3
Ammonia		5.2
Soluble.	Potash	0.3
	Soda	
	Chloride of potassium	
	Chloride of sodium	
	Sulphuric acid with salts	
	Lime	15.4
Carbonic acid		12.1
Total inorganic matter.	Sand and silica	61.8
	Salts of potash and soda	0.3
	Lime	17.3
	Alumina and oxide of iron	6.1
	Chloride of potassium, } with salts	
	Chloride of sodium, }	
	Phosphoric acid	2.4
	Sulphuric acid, with salts	12.1
Carbonic acid		100.0 ¹

Woollen Rags.—The composition of

woollen rags, analysed by Nesbit, is as follows:—

Organic matter	89.9
Ash	10.1
	100.0
Nitrogen	11.4
Ammonia	13.8
Sand and silica	16.9
Potash	4.1
Soda	2.0
Lime	15.1
Magnesia	1.5
Oxide of iron	20.0
Chloride of sodium . . .	11.9
Phosphoric acid	15.6
Sulphuric acid	12.9
	100.0 ²

Weaning Lambs.

The time of the year for the weaning of lambs, like that of the lambing itself, is subject to great variation throughout the country. June, July, and August are the weaning months, southern arable farms coming first, and northern hill farms last. The most general time would be from the 10th of June till the 1st of August.

Voluntary Weaning.—As mentioned in speaking of wool-shearing, it sometimes happens that the older lambs do not take readily to their mothers after the latter are shorn. The change in the garments of the mother must no doubt surprise the youngster, and not a few of the stronger lambs that have learned to forage for themselves may absolutely decline to have anything more to do with their maternal parents. The tendency to this estrangement will be lessened by keeping the ewes and lambs apart only as short a time as possible. In stubborn cases the weaning may be regarded as finished, yet both the ewe and the lamb will require attention. Good pasture is all the lamb will require, with access to pure water and a lump of rock-salt.

Treatment of the Ewes.—When ewes are forsaken in this way—indeed, at weaning-time, at whatever date that may occur—the shepherd should observe the ewes carefully, lest any of them should suffer from a persistent supply of milk. If they are removed to close-eaten dry pasture, there will, as a rule, be little

¹ Jour. Eng. Agric. Soc., xiii. 498.

² Ibid

danger; but in extreme cases it may be advisable to relieve the udder by drawing away a little milk by hand, taking care not to empty, but merely to slacken the udder.

Weaning on Arable Farms.—A common practice is to take the ewes away from the lambs, leaving the latter on their own pasture, and removing the ewes to the barest and driest pasture on the farm, where they remain until the supply of milk has disappeared. When the lambs are left on their old pasture they do not fret so much or so long as when put to strange quarters. Still it is desirable, for the sake of pasture, to shift both ewes and lambs, placing the youngsters on some piece of fresh succulent pasture specially preserved for weaning-time—neither new nor rank, but fresh, sweet, and succulent. This prevents the lambs from falling off in condition, and lessens the first great wrench their little hearts have met with.

Hill-pasture for Weaning Lambs.—Some flock-owners think it a good plan to send their lambs at weaning-time on to some rough hill-pasture for a week or two, their idea being that the astringent properties of this pasture acts as a useful tonic. Rough hill-pasture is often hired for the purpose, and the youngsters may be all the better of the change if it is of short duration.

Milking Ewes.—In former times it was customary in many places to milk the ewes in order to make ewe-milk cheese, which, when well made, is very nutritive (*vide* Roquefort cheese, p. 517). Then, when smearing was common, milk was sometimes drawn from the ewes to make a low-class butter to mix with the tar for smearing. The practice of milking ewes, however, has been discontinued in this country. It was injurious to the ewes. It hindered them from storing up the fat in the system, so very essential for ewes that have to face the storms of winter in upland situations.

After-treatment of Lambs.—The treatment in the way of feeding given to the lambs after weaning, will depend mainly upon the purpose for which the youngsters are designed. If they are to be fattened off early on the farm, or sold to others for this purpose, they are fed highly all along. Most likely they have been learned to eat all kinds of the com-

mon artificial food before being weaned. If not, they are taught this now—receiving a daily allowance of cake and grain on good pasture land.

Training Lambs to Artificial Food.—There is often great difficulty in getting newly weaned lambs to begin eating artificial food. A good plan is, when the “speaning brash” is off the lambs, to confine them, in lots of, say, fifty in a fold, where they will have access to water and artificial food, the latter being placed in boxes. After the first day they will begin to eat, and they then may have a run for some hours on pasture, and be again taken to the fold. In a few days every lamb will readily take to the boxes.

Fattening Lambs.—The rate at which the lambs are forced will, of course, be regulated to suit the time at which it is desired to have them ready for slaughter. In Hampshire and other parts in the south of England, where the fattening of lambs for slaughter at nine to eleven months old is extensively pursued, the system of feeding is most liberal and highly forcing. Until early turnips are ready, the youngsters have frequent changes—perhaps weekly—upon rich pasture, lucerne, and clover aftermath, with all they can well consume of cake and grain. Then on turnips they have artificial food and hay.

Store Lambs.—The lambs to be kept for breeding purposes or for fattening at a later time, are treated more moderately. When they have been weaned, and had a week or two on good pasture to get thoroughly on their own feet, as it were, they may be turned on to some poorer pasture, where they will have sufficient food to keep them growing at a full pace, yet not such feeding as will tend to fatten them. In feeding of store lambs a medium course should be steered. Forcing, as with the fattening lambs, would be injurious to the afterthrif of lambs intended for breeding purposes. Pinched feeding, on the other hand, would be equally mischievous, for it would lead to stunted growth and to slow maturity in the produce. There is need for good judgment at every turn in the management of live stock—at no point more so than in deciding as to the methods of treatment for the various classes of stock

to be used for the widely different purposes of fattening at an early age, and breeding with fattening at an older age.

Weaning on Hill-farms.—At weaning-time on hill-farms the ewes are removed to higher ground and barer pasture, where for a week or ten days they are watched constantly. In many cases the lambs are also put to the heath or high ground, where they can have access to water, for a week or so—care being taken not to leave them longer there than seems necessary to break them into their new order of life. Many farmers, on the other hand, disapprove of putting newly weaned lambs on to heath, moory, or high ground, for the reason that, if left for any considerable time there, they may sustain a check to their progress which may tell upon them for long after.

On many farms a specially good part of the pasture, green or well mixed, well sheltered, with access to running water, but free from dangerous "holes," is preserved for a few weeks to be used as a "weaning-ground." Here the youngsters are kept for two or three weeks—most probably until they can be replaced upon the ordinary run of the flock.

The usual plan where there are two "hirsels" of ewes on the farm, is to place the lambs of "hirsle" No. 1 on the ground of "hirsle" No. 2, and those of No. 2 on the ground of No. 1; so that when the ewes come back to their old ground, in the course of perhaps about a month, the ewes of the one lot run with the lambs of the other.

Drafting Lambs.—After weaning the lambs are drafted, so that the various classes may be assigned to the intended purposes. Most probably the stronger of the wether lambs and the greater number (the best) of the ewe lambs will be retained to run on the farm along with the old sheep until later in the season. The others may be sent to arable farms to be wintered on grass and turnips. Those kept behind are drafted to the low country, as the pasture becomes scarce on the high ground, and as the winter approaches.

Dipping Lambs.

As soon as practicable after weaning, the lambs should be dipped. This keeps

them from keds, and also prevents the maggot-fly from injuring them.

The dip used is almost always arsenic in one form or other, diluted with certain proportions of water. As the water evaporates, the skin and fleece become impregnated with the crystals of arsenic, so that even if the lambs should be attacked by the maggot-fly the maggots may develop, but will be poisoned by the arsenic in the skin and wool before they have been able to do any appreciable harm. The dipping of sheep will be treated of more fully in a later section.

Care should be taken that lambs (or sheep either) should not be heated or fatigued immediately before being dipped. Many deaths have occurred from summer dipping in a heated condition. A good plan is to allow the lambs, after being brought down for dipping, to lie on their pasture undisturbed for a fortnight or so, and then take them up in lots and run them through the dipping-bath.

MARKING SHEEP.

Sheep are marked for the purposes of identification and classification, in various ways and at different times. There are the farm or flock mark, the age mark, and the pedigree or breeding mark. To provide these, four distinct systems of marking are in use—ear-mark, tar-mark, keel-mark, and horn-brand. By different ways of impressing one or more of these marks, all the distinctions required may be easily secured.

Ear-marks.—These consist of small pieces punched out of the fore or back margin of the ear, a slit in the tip with a sharp knife, holes made with punching-nippers, or a combination of these marks, or studs fixed in the ear after the manner of cuff-studs.

One form of the punching-nippers is shown in fig. 412. An inverted hollow cone, having its small end sharpened to an edge, is employed to cut the hole—of any form, round, square, or triangular—out of the ear; and, to save bruising the ears in punching, a pad of horn is inserted into the straight under-arm, the pieces nipped out rising out of the orifice

of the hollow cone. Some prefer a clipping-tool to the punching-nippers for ear-marking.

Tar-mark.—The tar-marking, or *buist*-

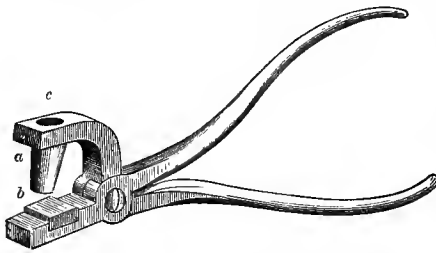


Fig. 412.—Punching-nippers for sheep.

a Hollow cone. b Horn pad.
c Orifice of hollow cone.

ing, consists simply of stamping a letter or letters, expressive of the initials of the name of the owner of the farm, or of both, on different parts of the body. The *buist* is made with a simple instrument such as that shown in fig. 413, made with a wooden handle, an iron shank, and a flat capital letter, as S, cut out of some kind of stiff metal, as copper or iron. The length of the implement is about two feet.

The liquid for *buisting* is tar, made viscid by an addition of a little pitch, the two being boiled together in a metal pot.

As a rule the tar-mark is made high on the rib, so as to be easily seen—perhaps on the *near side* for female sheep, and on the *far side* on male sheep. Sometimes, for purposes of classifying the stock of different ages, breeding, &c., on the farm, the tar-mark on one lot is on the shoulder, on another on the fore-rib, and on another lot on the hip or hind quarter.

Keel-mark.—The keel-mark is made by red ochre mixed with oil, and, as with the other marks, it is put on at various spots on the wool on different farms, and to distinguish the one class from the other. The keel-mark, if well put on, is more easily seen at a distance than any of the other marks, and is therefore often

very serviceable. Green keel is sometimes used for “hirsle” marks.

Horn-brand.—Horned sheep are marked on the horn with the owner's initials, or some other distinguishing letters, and perhaps also the year of birth and number in the flock register. A tool used for this purpose is shown in fig. 414. It is made wholly of iron, and on the upper face of the block is cut out as a die the capital letter to be used, as S. The length of the implement is about 18 inches. It is heated in the fire, and the letter burns its form on the horn. If heated high, it may brand several sheep before it cools, but the most uniform brand is made when the iron is heated for every sheep. To carry on the work expeditiously, two or three brands should be used—one to be in use while the other is heating in a fire hard by, to and from which a person carries the brands for the operator.

Branding is also sometimes done on the face of the sheep, but it is painful to the sheep, and may slightly disfigure the countenance.

Cattle are similarly branded on the horn and hide.

Marking Lambs.—As a rule, lambs receive the *buist* or tar-mark at the time of castration. In some cases they are then also ear-marked. In other cases the ear-marking may be delayed till a later time, perhaps till being sold, if they are to be sold as lambs, or until being sent away to the wintering ground. The wether lambs may not be ear-marked at all, but ewe lambs to be kept on the farm are always so marked. On some farms the female stock are marked on the *near* ear, and the male on the *far*. Thus, a single round hole is punched through the near ear of the ewe lambs, and a similar hole through the far ear of the wether lambs; and should any ewe lamb be considered fit for breeding-tups, it either receives an additional hole through the near ear, or a bit punched out of either margin, corresponding to a similar mark on its dam or sire, to dis-



Fig. 414.—Branding-iron for sheep and cattle.



Fig. 413.—*Buisting-iron for sheep.*

tinguish its descent in blood. Twin ewe lambs receive a hole through both ears.

Tup lambs in many cases receive no ear-marks of any kind. Individual tups are so easily identified, and their descent so well known by the shepherd, that they may require no marking; yet it is far the better plan to have the distinguishing mark in all cases.

At weaning-time ewe lambs for sale are often *keeled*, perhaps on the neck, to distinguish them from the others.

Marking Older Sheep.—These receive the tar-mark at the clipping-time, each animal being *buisted* as it is relieved of its fleece. Later in the year, when the wool has dried sufficiently after dipping, the hogs, wethers, and ewes may be *keeled*, the marks being differently placed so as to distinguish at a glance the different classes, such as draft ewes intended to be sold. Draft ewes are often also distinguished by a different tar-mark, perhaps merely a spot of tar put on with a round stick instead of the ordinary letter brand.

When a farmer purchases a lot of sheep it is the usual practice for him to stamp them with his own mark before placing them on the pastures.

Method of Tar-marking.—The following method of tar-marking or buisting sheep is often pursued: The sheep to be buisted are put into a convenient apartment of the steading, and handed out of a door, one by one, by a man, and held steady by another man holding the head and rump with his hands, and bulging out the side to be marked by pressing one knee against the side next him. The buisting-iron is dipped by a third person in the melted tar in the pot, lightly, to prevent dripping; and to make the buist vivid, he uses the buist with a considerable pressure equally upon the entire surface, flat upon the clipped wool, and withdraws it quickly. The wool must be quite dry, otherwise the tar will not adhere to it.

Registering Marks.—To facilitate the recovery of strayed sheep, the flock-masters in several counties and districts have introduced the system of registering their respective marks, and of publishing these in a book or pamphlet form. This is an excellent plan, especially useful in

large pastoral districts where there is little fencing.

DRAFTING SHEEP.

When the ewes are dry or the milk leaves the udder, the flock are taken to the folds and "drafted"; that is, all the ewes which have attained a certain age, or are deficient in form or fleece, or have sustained any of the mishaps incidental to a breeding flock, or which are for some other reason to be sold, are separated from those which are to be kept.

Breeding and Selection.—The manner in which this work is accomplished—the care and judgment exercised in deciding which animal to sell and which to keep—makes all the difference betwixt a breeding flock of high quality which give character and similarity to their progeny, and a flock composed of all sorts and sizes, with no family likeness. The maintaining a flock, or the raising of it to a high standard, require great perseverance, patience, and firmness. Although the flockmaster may be aware of the general principles which underlie successful stock-breeding, he will most likely have to face many disappointments. This he must do with courage and perseverance, remembering that eventually *like will produce like*, without much variance, when his flock, by hereditary influence, asserts its *fixity of type*. The *best to the best* is a safe rule, and the results arrived at from this cause may not only lead to fame, but are also the most likely to lead to fortune.

This cannot be attained in the early development of a flock. The owner may have to wait years for the attainment of his ideal; but by a judicious selection of gimmers (shearling ewes) to make up his stock, his flock will always be getting nearer to the desired excellence.

Another point which ought to be always kept in view is, that any deficiency in form or fleece will most likely assert itself with greater intensity in the offspring, so that the breeding flock must be as nearly faultless as it is possible to have it.

Principles of Breeding.—The general principles of stock-breeding, thus briefly hinted at here, will be more fully treated of in another portion of this work.

A careful study of these principles will repay every flockmaster. Here it will suffice to say further that each flockmaster keeps in view the perfect sheep of the particular breed he owns, and retains for breeding only such of his young stock as come near to this type, aiming always at a higher and higher standard.

It is not meant that no young ewe, unless perfect, should be admitted into the ewe-flock. The object of the flockmaster should be to get his shearling ewes as free from faults as possible, and no animal should be taken into the breeding flock which may have very marked defects. A faulty head or a weak neck may be corrected by placing the animal to a male having these points strongly developed. There can be no doubt that faults of form or constitution in the parents are liable to crop up in the offspring; if not the first, very often in the succeeding generation.

Treatment of Draft Ewes.—The draft ewes on many farms are placed on the best grass available, which, with artificial food, quickly fattens them, so that they are generally all cleared off before the autumn. But when ewes are regularly cast from hill-farms at four years old, they usually find their way to lower-lying farms, and another crop of lambs taken from them before they are fed off—generally from rams of some of the earlier maturing Lowland breeds, such as Border Leicester, Shropshire, or Half-bred, the half-bred rams so largely used in the south of Scotland being crosses between the Cheviot and Border Leicester breeds.

Breeding Ewes.—The keeping ewes, old and young, are put on fair pasture, so that they may retain their condition, and so remain until within a month of putting them to the ram, when they are changed to better pasture, with the object of flushing them before service. This flushing, if judiciously done, will ensure a larger crop of lambs.

Hill Flocks.—On pastoral or hill farms the flocks are treated in a similar manner, except that often the draft gimmers which are deficient in size, but have all the other qualities, may be kept for another year before they are put to the ram. By this method of treatment they usually attain to a satisfactory size, and

may become as good ewes as any on the farm, while they do not generally break down so quickly as those which are tuppued in their second year.

Tip-yield ewes, or those which have aborted, are all disposed of in early summer.

Age for Drafting Ewes.—The age at which ewes ought to be taken from the flock has been a subject of much controversy. No hard-and-fast line can be drawn. Much depends upon the character of the pasture on the farm, which influences the state of the teeth of the sheep. The difficulty or otherwise of obtaining young sheep to make up the place of the draft must also be considered, while the class and management of the farm are likewise leading factors. On most arable farms the flockmaster rears his own ewes, and consequently is so far independent of outside influences. In a flock of say 500 ewes, he would require to have 130 suitable shearling ewes to keep his flock always up to a fixed standard.

Keep the Flock Young.—It is better, as a rule, to keep the flock young. There can be no loss in this, as the owner can obtain as much money for his draft ewes as he could procure for shearling ewes; that is, when he regularly cast at a certain age. A customer is never awanting for stock of this kind or character.

General Hints.

Lodging for Sheep.—Where the green land is limited, it is advisable to turn the sheep off this during the night. Indeed of their own accord sheep—that is, the breeds accustomed to high land—will gravitate towards high and dry ground for their lodging, turning their heads down-hill again early in the morning. This prevents the low and green land from becoming so foul as would be the case if the sheep spent the night upon it.

Exhausting Green Land.—But the pasturing of sheep all day upon one portion of the ground and lodging them on another overnight, has also the effect of tending to seriously exhaust the fertility in the former. The greater and richer portions of the droppings of the sheep occur during night and early in the

morning. The low ground pastured during the day is thus being impoverished and the high ground enriched. Where this has occurred to a great extent, measures may have to be taken to replenish the fertility of the deteriorated ground.

Saving Hay for Hill-farms.—Care has to be taken during summer to provide sufficient hay for the requirements of the flock in snowstorms. A general practice is to save or hain the enclosed park which had been used early in spring for weak ewes and lambs. There is usually an enclosure of this kind, extending to perhaps 6 to 10 acres for every "hirsle" of ewes, and sufficient hay should be obtained here for a flock of 500 ewes during an average winter. It is the duty of the shepherds to cut and secure this hay, and it is important that the work should be properly and seasonably attended to. The shepherds also provide hay for their cows in winter; this they generally obtain by saving some "haughs" or green patches during summer.

"Pining" on Hill-farms.—In the pasturing of hill-farms, especially in a dry season, care should be taken not to keep the stock there too long without a change. Hill sheep in such circumstances are liable to acquire a very destructive disease known as "pining" or "vanquish." This malady, which is most prevalent on soils overlying the granite formation, and in seasons of drought when the vegetation becomes very dry, is supposed to be caused by alkaline poisoning arising from there being too great a proportion of potash and soda in the soil. The best remedy is an immediate change to soil and pasture of a different character—to low ground, if a sufficient change cannot be had on high ground.

Care against "Rot."—But in sending sheep from high ground to escape "pining," and in grazing all flocks on low ground, care must be taken to guard against the acquiring of that still more deadly disease known as "rot." This, with other ailments, will be dealt with subsequently in a special chapter. Here it will suffice to say that the flukes which cause the "rot" are most liable to be picked up on low, damp land, in wet or

moist weather; that there is little danger upon dry land; that salt is a useful remedy; and that after the first severe frost the whole of the farm, high and low, may be grazed with impunity in so far as the liver-fluke is concerned.

PASTURING CATTLE.

The cattle which have been fattening during winter will be gradually drafted away for slaughter, so that by the end of April there will be few animals of the cattle kind on the farm except those which are to be grazed at least for some part of the season. At this time—the time of transition from the winter to the grazing season—the farmer has to consider and decide as to the stocking of his farm during the coming summer—what stock he is to carry on to the grass, and what should be disposed of. The chief conditions to be considered are the probable supply of summer pasture, the present and prospective prices of lean and fat stock, and the probable prices of extra food, in case such should have to be procured to supplement the supply on the farm.

Study the Markets.—It is especially important that the farmer should carefully study the tendencies of the market at this time. If beef should happen to be cheap and store cattle dear, he may find it advantageous to hold on a number of his partially fattened cattle to be finished on the grass, and sold perhaps in the month of June—that is, instead of selling these when the winter food is exhausted, and buying lean or store cattle when the supply of pasture becomes plentiful.

It very often happens that beef is scarce and dear in the first five or six weeks of summer. The winter-fed beasts are pretty well cleared out by the end of April, and grass-fed animals are seldom ready for slaughter before the advent of July. It will therefore often pay a farmer to hold over a few of his partially fed cattle to be finished on the grass with cake and meal, and sold in the month of June.

But in this as in other farming matters, the ruling conditions vary with every season, and no prudent farmer would

follow hard-and-fast rules in a blindfold fashion.

Keep Stock Progressing.—There is one point which demands most careful attention about the end of spring and beginning of summer. It is this—to see that the animals are carried from the one season to the other in a steadily progressing condition. Do not on any account let the animals fall off towards the end of the house-feeding season. If the supply of turnips and other home-grown food becomes scarce, buy in food, or reduce the stock by selling. Then if the supply of grass should be deficient at the outset, supplement with other food—with purchased corn and cake, if need be. In the period of transition from one season to another, cattle are often allowed to fall back in condition. This is very detrimental to the interests of the stock-owner, and should be avoided by hook or by crook.

Give the Pasture a Good Start.—Do not be impatient to turn the cattle from the winter quarters to the summer grazing. Let cattle of all ages remain in the steading until the grass is quite ready to receive them, and able to maintain them in a satisfactory condition. In late seasons, when the turnips and other winter food are exhausted before the grass can afford them a bite, the animals should be partly supported upon extraneous food—as oilcake, beans, oats; or those in fairly good condition should be disposed of, to leave some turnips for the young cattle and cows until the grass grows up.

The cattle are let out in relays as the grass grows up. It is a good plan at the first of the grazing season to take up the cattle at night, and give them dry fodder. This tends to counteract the laxative influence of the fresh grass.

Cattle should not be let on to pasture while there is frost in the soil, as they are then liable to injure the grass with their feet.

Overgrowth of Pastures Injurious.—An important point in the successful grazing of land is to keep the pastures from growing too rank. In the earlier part of the season, in particular, they should be well eaten down, cropped frequently, but not so as to injure the plants. Pasture-grasses should never be

allowed to mature and produce seed, for both the land and the plants will be thereby impaired in their productive powers. Pastures do best when grazed for about two weeks, and rested for a similar period all through the season.

All kinds of stock thrive best on moderately short pasture. Rough bunches of grass should be regularly cut down by the scythe.

In some cases, in a good growing season, it may be advisable to buy in more stock to keep down the pasture. Others, especially when cattle are dear, save a portion for hay, and thus curtail the grazing area.

In some cases the droppings of the cattle are daily collected into heaps, and in the autumn spread upon the inferior parts of the field. Others merely scatter the droppings over the field, once or twice a-week.

Grass as Food for Cattle.—In confinement cattle thrive better on a variety of food; whereas on grass they require no further variety than nature supplies in good pasture, and they thrive the better the longer they live upon it, provided they are changed frequently to a fresh pasture. Grass is evidently the natural food of the ox, and his anatomical structure is peculiarly adapted for it. Whatever kind of food he receives in winter, partakes of an artificial character; and being only a substitute for grass, artificial food should be made as palatable as circumstances will allow, whether in variety or superior quality.

This consideration prompted Boussingault to adopt hay—grass deprived of its superfluous water—as the standard for comparing the nutritive properties of different sorts of food.

Changing Stock on Pastures.—Grass-land requires skilful management to make it most available as pasture in every sort of season. The circumstances under our own control which most injure grass are *overstocking* and *continual stocking*. To avoid overstocking, there should be no more stock upon the farm than its grass will maintain in good condition; and to avoid continual stocking, the stock should not be allowed to remain too long in the same field.

The safest way to treat each grazing-field is to stock it fully at once, in

order to eat it bare enough in a short time, and then to leave it unstocked for two weeks or so, that the grass may grow up to a fresh bite. One advantage of this plan is, that it provides new-grown grass; and another is, that the grass never becomes foul by being constantly trodden upon. Stock delight to have fresh-grown grass: and they loathe grass which has been trampled and dunged upon, times out of number.

To facilitate the frequent changing of stock to fresh grass, many farmers run a temporary wire-fence across a pasture field, letting the animals crop first one division and then the other.

Mixed Stock on Pastures.—Another principle affecting the treatment of pasture-land, is the different way in which different animals crop grass: cattle crop high, sheep nibble low, while horses bite both high and low. This is a wise distinction between the two classes of ruminants, sheep being suited to short mountain-pasture, which their mobile lips hold firmly while it is severed from the ground with the incisors of the lower jaw with a twitch of the head aside; whereas the ox is as well suited to the plains and valleys, where grass grows long, and which it crops with the scythe-like operation of its tongue and teeth.

From these different modes of cropping grass, it is inferred that the horse or sheep should follow the ox in grazing, or accompany him, but not precede him. On pasture eaten bare by horses or sheep, the ox cannot follow them; and when all are in company, the horse and sheep will eat where the ox has eaten before, or the horse will top the grass before the ox, the horse being fond of seizing the tops of plants by his mobile lips, and pinching them off between the upper and lower incisors. The accompaniment of them all in the early part of the season is a good arrangement, because all have the choice of long and short grass; but the horse should be separated from the sheep in the latter part of the season, as both bite close.

It is curious that horses, and work-horses in particular, have a great dislike to sheep and not to cattle.

Rules for proportional pasturing of stock are thus given by the Rev. Mr Beever: "The sheep-pastures should

have one young steer to twelve sheep; the bullock-pastures, one horse to every twelve beasts. The sheep-pastures should be kept comparatively bare; but the bullock-lands must have a good bite, so that the animals may quickly feed and soon lie down to rest and ruminate. An old grazing rule is, that grass should be twenty-four hours old for a sheep, and twelve days old for a bullock."¹

Stocking.—A disturbing element in reckoning the number of animals that may be kept during the summer is the uncertainty as to the suitability of the season for the continued growth of grass. The usual plan is to reckon upon an average, and to arrange the number of stock accordingly. In the event of a bad grazing year, the stock may either have to be reduced by sales, or hay and artificial food may have to be purchased. On the other hand, superabundance of grass does no harm; for besides maintaining the stock in high condition during the grazing season, it will afford rough aftermath for the sheep in winter. On farms where stock are purchased every year, the number may be regulated by the state of the grass; but even then the season may turn out better or worse than expected.

Seeing that no one can foretell the future supply of pasture-grass, the prudent plan is to keep the number of stock under the mark which the farm can well support. An obvious lesson is to have the land always in good heart, as it will be the less affected by an adverse season.

Water and Salt.—The importance of having pure water within the reach of stock on pastures has already been referred to (p. 432). The opportunity of licking rock-salt is also relished by stock (p. 433).

Shelter on Pastures.—The want of a *shed* in a pasture-field is a reflection upon the sagacity of our farmers. In summer, where a tree spreads its branches over the grass in a lawn, how gratefully cattle resort to the shade, where they know that the stirring breeze will cool their hides, and afford them a refuge from flies! In cold weather, cattle crowd to the wooded corner of a field, and in a rainy day take

shelter behind trees and hedges. Such indications by our animals should teach us how to treat them. We dislike hedge-row trees on account of the injury they do to the crops and fences near them; and still more dislike large trees in the middle of a cultivated field. There are many fields well sheltered on one side by trees, but this is not enough.

A shed should be erected at a suitable part to afford shade in the hot days, and shelter in a rainy or cold night. Such an erection would cost little where stone and wood are plentiful on an estate. It should be placed on either side of a fence when a field is in grass. No matter what it costs, it should be provided when the health and comfort of stock are concerned. Its cost would be repaid by the healthy state of the stock in the first or second year of its erection, and it would stand, with slight repairs, for many years. Let it be roomy, and its structure light, with a roof of corrugated iron or tiles.

It is troublesome to carry straw for litter from the steading to a shed situate at a distance. There is little need for litter in summer, however, and the rough grass from an adjoining wood or ditch is good enough for the purpose. The dung can be shovelled up and removed before it accumulates to the discomfort of the animals.

Apportioning Pasture.—The first point is the judicious distribution of the pasture amongst the various classes of stock to be grazed. In this matter there is scope for good judgment, for the returns from the grazing season may be largely affected by the manner in which the pasture of the different ages and qualities has been allocated to the various classes of stock.

Beginning Cattle on Pasture.—When cattle are first turned out to grass, they may so gorge or over-eat themselves as to become *blown* or *hoven*—an ailment which demands immediate treatment. To avoid this, the best plan is to begin the cattle gradually with the succulent pasture, which may be effected by giving the cattle a feed of some dry food daily for a few days before turning them on to the pasture, or by allowing them only a partial feed of the pasture for the first day or two.

Fattening on Pastures.

Animals to be fattened off early will, of course, have the best pasture—not perhaps the rankest, but pasture which is sufficiently well grown to afford a full bite, and which is known to possess the best fattening properties. Here the cattle will most probably also receive artificial food—the giving of extra food and the quantity being regulated by such conditions as the quality of the pasture, whether capable of fattening by itself, the condition of the cattle, and the time they are to be finished for slaughter.

There are few pastures capable of fattening cattle without the aid of cake or grain—only some of the choicest pastures of Ireland and the south of England. By the aid of cake and grain, however, cattle may be fattened upon all the average pastures of our good arable farming districts. Whether it will be more profitable to fatten on the pastures than to merely keep the grazing cattle in good progressive condition, to be finished by winter fattening, will depend upon conditions which must be considered in each individual case.

As a rule, fattening pays on the richest grazing land, known to possess high fattening properties. On the other hand, upon medium and poor land it is usually safer to simply graze the animals well, and not attempt the more expensive plan of finishing for the pole-axe.

For fattening cattle in particular, frequent changes to fresh pasture is highly beneficial.

Artificial Food on Pastures.—The artificial food given to cattle on pastures consists largely of linseed and decorticated cotton cake. It may often be found cheaper and better to use a mixture of cake and grain, the farmer taking care to buy whichever variety of food happens to be cheapest at the time.

For fattening stock on pasture, from 4 to 6 lb. per day of cake and corn are general quantities. Decorticated cotton-cake is largely used. It is difficult to feed meal to cattle on pasture without some portions of it being lost. The size of the cattle and the supply of pasture must be considered in deciding as to the quantity. It may be sufficient to begin with even

less than 4 lb., and increase as circumstances seem to indicate.

The artificial food should always be given in shallow boxes which cannot be easily turned over. It is a bad plan to scatter cake upon the grass, as is sometimes done. The boxes are shifted every day, so as to ensure, as far as possible, the even manuring of the land by the droppings of the cattle, and to prevent the grass from being spoiled by frequent treading on any one spot.

By the consumption of artificial food on land, the fertility of the soil is enriched; and in many cases this system of manuring land is extensively practised.

Most people give the artificial food in the morning, some early in the afternoon, and some in the evening.

It is a good plan, to prevent stock from falling off when put out to grass at the first of the season, to continue for a week or two, according to the supply of pasture, a portion of the artificial food they had been receiving in the house. Many farmers thus give their young store cattle a couple of pounds of cake, or cake and grain, daily for a fortnight or so after they are put on the pasture fields. When the supply of grass is plentiful, this, of course, is unnecessary.

Summering Cows.

Cows in milk must also have good pasture. Indeed, where no cattle are being fattened, the cows giving milk will probably have the best pasture on the farm.

Cows in summer are treated in an opposite manner by different people—one putting them into the byre at night, and milking them there in the day; another causing them to lie out all night, and milking them in the field. Which-ever mode is adopted, it should be borne in mind that cows are peculiarly susceptible of injury from sudden changes of temperature—their produce of milk being suddenly reduced by exposure even for a few hours to an outburst of cold, wet weather. On the approach of unfavourable changes in the weather, the cows should be brought under cover.

At any rate, for some time after they are put out to grass, they should be brought to the house at night, where they are then milked, as also in the

morning before being sent to the field. If they are milked at mid-day as well, this intermediate milking is done by some in the field and by others in the house. As a rule, in dairy districts cows are milked twice a-day—morning and evening; and in breeding districts three times a-day—morning, noon, and night.

Night and Day on the Field.—After the nights become warm, we have found it conducive to health in breeding cows to have them in the field all night—the shepherd or cattle-man bringing them to the most convenient part of the field to be milked. Milking in the field imposes more labour on the dairy-maid and her assistants, in carrying milk to the calves, and to the dairy; nevertheless, many consider it an excellent system for the health of the cows.

The cows rise from their lair at day-break, and feed while the dew is still on the grass; and by the time of milking arrives—6 o'clock—they have partially filled themselves with food, standing contentedly chewing the cud, while the milking proceeds. By 9 o'clock they lie down in a shady part of the field, and chew their cud until milking-time arrives at noon, when they are again brought to the same spot to be milked. Feeding again, they go in the heat of the afternoon to the coolest part of the field, whisking away the flies with their tails and ears. As the sun wanes, they walk about picking up a mouthful till the evening milking takes place about 6, after which they feed industriously, and take up their lair about sunset, chewing their cud, and at daybreak rise and resume the daily round.

Does Dew-laden Grass injure Cows?—Apprehension does exist that cows injure themselves by eating grass wet with dew. Yet it is a fact, which is not so well known as it should be, that bedewed grass before sunrise, and grass after it is dried by the sun, are alike good for cows. It is only when the dew is being evaporated, after sunrise, that grass proves injurious. Cows which lie out all night eat the grass while it is yet wet with dew; whereas those in the byre, after being milked, are let out just at the time the dew is being evaporated by the sun, when the grass is in the coldest state. Hence cows kept in the byre

at night are more liable to be injured by eating dewy grass than those lying out overnight. Being hungry when let out, the former eat the cold damp grass with avidity.

Consider the Climate and Weather.

—Locality, the character of the weather, and the local conditions as to shelter, should rule the custom of lying out or housing at night. In cold upland districts, or exposed situations devoid of shelter, so susceptible creatures as milk-cows should not lie out at night; and in the very few really warm nights in such situations, the byre might be ventilated. In favourable situations, this circumstance is worthy of attention in determining between lying out and housing, that housing causes the providing perhaps of supper, and certainly of litter, for the cows; and the provision implies cutting and carrying the forage, and rearing the plant in the field, and storing up straw for litter.

In warm weather, with strong sunshine, it is a good plan to keep dairy cows in the house during the day, feeding them on green food, and turning them out to the pastures overnight.

Excepting a change of pasture—and the change should be to a better one—the treatment of cows is the same throughout the summer, and until the advent of the cool evenings at the end of autumn. As the milk falls off, the noon milking, where such takes place, is dropped; and when the evenings become cool, the cows are brought into the byre at night, milked there evening and morning, and grazed during the day. Whenever housing takes place, supper must be provided for them after the evening milking is over, as also litter. Should the straw be exhausted, many light materials answer the purpose of litter—as coarse grass from plantations and bogs, ferns, sawdust, or peat-moss litter.

Serving Cows.—The cows of a breeding stock will mostly have been served by the bull before going out to grass. The cattle-man should attend to this matter, and enter the date of the service of each cow in his note-book.

Dairy Farms.—On farms where dairying is the chief or a leading feature, the whole system of cropping is arranged with the view of providing abundance

of food for the cows all the year round. The cows have the best of the pasture in summer, and will also most likely receive additional food in the shape of linseed-cake, bruised oats, and bean-meal, or green forage, such as vetches, clover, and grasses, grown for successional cutting. In some cases they get the cake and grain on the pastures, but more frequently when taken to the house to be milked.

Dairy cows are fed with great liberality, the foods known to encourage milk-production forming a large portion of the daily allowance.

Water for Dairy Cows.—Access to fresh pure water is a matter of great importance to dairy cows. Cold spring water is objected to by many for this purpose. Running water which has been mellowed by exposure to the air, just cool but not chilly, is considered best for cows giving milk.

Avoid over-exertion for Cows.—The milk-production of cows is liable to be seriously impaired by over-exertion, as well as by imperfect feeding or exposure to cold. They should be walked leisurely between the house and the pastures, and the shorter the distance they have to walk the better it will be for the cows. In warm weather insects greatly disturb cattle on pastures, and to avoid these, many farmers take their cows to the house for a few hours in the hottest part of the day.

Mr Gilbert Murray on Grazing Dairy Cows.—On this subject Mr Gilbert Murray, Elvaston Castle, Derby, writes: "There are few farms on which dairy cows are kept where artificial foods of one kind or another are not used. Meal and a mixture of cut hay or straw are fed in the stalls at milking-time morning and evening. This counteracts the watery character of the grass, and keeps up the quality of the milk. Dairy cows are especially susceptible of injury from sudden changes of temperature and over-exertion or ill-usage of any kind. For them an even temperature and quiet kindly treatment are of the utmost importance. An acre of good grass land will produce from 1500 to 2000 lb. of milk, and by the use of artificial food this may be considerably increased."

Town Dairies.—In and around towns

it is the common practice to keep dairy cows in the house all the year round. Their food in summer consists largely of fresh grass and other forage, which is cut daily and given to them in a green, succulent condition, along with cake, bean-meal, and brewers' grains and bran.

Many of these dairymen, however, knowing the benefits to cows of a turn on pasture, rent small fields, and put their cows on them for a few hours daily, or perhaps overnight in warm weather.

Carse and Suburban Farms.—Grazing cattle in the ordinary sense of the term rarely forms part of the system pursued on carse farms or farms near large towns. The grazing on these farms is confined mainly to the work-horses and the milk-cows of the farmer and the farm-servants. On carse farms the new grass is, as a rule, kept only one year, and is chiefly used for forage and hay. On farms near towns the grass is sold for forage to cowfeeders and stablers.

Pasturing Young Cattle and Calves.

Young store cattle require little tending while on grass. Nevertheless the cattle-man, on going his daily rounds, should see that the young beasts are in good health, have plenty of food, plenty of water, and are in security within the fences. Like the other stock, they should have frequent changes to fresh pasture—every three weeks if possible. After a change to fresh pasture, they will thrive much faster, while the grass itself “goes further” by being cropped and rested alternately for two or three weeks at a time.

The young cattle, mostly into their second year, usually get the poorer pastures; yet they should have abundance of food, to keep them at full and steady progress. Shelter (from sun and wind), rock-salt, and pure water must also be within their reach.

Artificial Food for Store Cattle.—In reference to the use of artificial food in the grazing of young store cattle, Mr Gilbert Murray says: “Store cattle are usually grazed on second-rate pastures, and in no case is artificial food more profitably employed than for these on the grass. This not only hastens the growth of the animal, but at the same time, by

the residue of the food in the droppings, enriches the soil. Without the assistance of artificial food, young growing stock impoverish the soil. This is well known to experienced graziers, who affirm that by storing the best fattening pastures for a few years they may be reduced to the level of ordinary store pastures; while, on the other hand, store pastures situated on suitable geological formations, may, by good management, be raised to the position of feeding pastures. It is needless to say how important it is to keep the young animal in a state of steady progression. When young growing animals are kept on food which is not sufficiently nutritious, or which is deficient in quantity, their organs of digestion and assimilation are liable to be so impaired that no after-treatment, however skilful and liberal, will fully repair the injury.

“A healthy animal of a good class should, at the age of from one to two years, on pasture increase in live weight at the rate of from $1\frac{1}{2}$ to 2 lb. per day. This rate of increase, however, will seldom be attained without the aid of artificial food. For growing stock we prefer a mixture of meals of the home-grown cereals, including a small proportion of linseed. The main difficulty is in feeding these meals on the pasture without losing any portion of them. The best plan is to give them mixed with cut hay or grass. The hay, although not always palatable to the animals on pasture, is nevertheless a valuable corrective to the laxative tendency of the succulent grass. The quantity of the meal may vary from $1\frac{1}{2}$ to 4 lb. per day. Decorticated cotton-cake may be used with less trouble, but with it there is a certain amount of danger, owing to the hard cake impeding the action of the digestive organs, and resulting in inflammation, not unfrequently in death.”

Calves on Pasture.—Calves are put on grass at the same time as the other cattle, whether weaned or not. By that time the oldest ones will be ready for weaning; but although ready, the herd of calves should be kept together at first, in a paddock of grass near the steading, where the younger ones are still served with milk or other liquid food, while the older eat the grass, and both are put into

the shedded court at night, until the weather becomes warm enough to permit them to lie out all night.

Calves are very susceptible of cold, especially when on milk, and receive more injury from exposure to it and to wet than most breeders seem to be aware of.

Weaning Calves.—This important work in breeding stocks has already been dealt with. See Divisional vol. iii. p. 45.

Pastoral Farms.—On *cattle-pastoral* farms, the calves go with their dams, and partake besides of grass. Calves thrive well in this way, and attain to a large size. But if the cow does nothing more than breed and rear the calf, the system is not likely to be profitable.

The young cattle on pastoral farms graze on the low and sheltered parts till the weather becomes less stormy and cold in the upper parts, when they stretch their walks by degrees until the highest points are attained.

Purchasing Young Cattle.—Young cattle are purchased from the pastoral and breeding farms for the arable districts where few are bred, just before the grass is ready to receive them. Not unfrequently arable farmers hire grass parks for the season, and stock them with young cattle on speculation.

Young cattle for grazing should have all the symptoms of health and constitution—a clear eye, dewy nose, large frame, glossy long hair, although low in condition. A low condition is likely to be a greater loss to the breeder who has half-starved them, than to the purchaser who puts them upon good pasture on sound feeding land. Many requisites are to be attended to in purchasing young cattle. To be a good thriver and attain condition, the hair should feel mossy, and the touch of the skin mellow. The skin should not be too thin, nor feel hard and tight, and it should be covered with abundance of hair. Each lot of young cattle should be of the same or similar size and appearance. This uniformity is an enticing property in every lot of cattle. It is a lesson to the seller, in preparing cattle for the market, to assort them in lots of equal levelness.

Treatment of Bulls.

The rearing of calves intended for bulls has been dealt with under the head-

ing of "Calf-Rearing," in Divisional vol. iii., and referred to more particularly on page 44.

When a number of bull-calves are brought up together (after weaning) they should be grazed by themselves on the best grass the farm affords, or with the ox-calves, while the heifer-calves go with the cows. Anyhow, they should never accompany the heifer-calves. A single bull-calf may go with the cows or with the young oxen.

Ring ing Bulls.—Bulls should have a ring put into their nose before they are a year old. This instrument is useful not only in leading them, but of keeping their temper in subjection, and affording a more complete command over the most ungovernable bull than any other contrivance. In case a bull becomes irritable and troublesome as he advances in years, which is often the case, the ring furnishes the means of curbing him at once. The ring also affords an easy means of suspending a light chain from it to the ground, upon which the bull tramps whenever he runs towards a person, and by thus suddenly jerking his nose he checks himself. A young bull may follow a person in sport, which he should not be allowed to do, as the following may terminate in a run in earnest. It is best not to go in the way of a bull in a field, especially when he is with cows. He does not mind the dairy-maids when they come to milk the cows, nor the cattle-man, or the shepherd and his collie, for he becomes familiar with them.

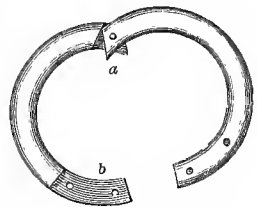


Fig. 415.—Opened bull's ring.

a Joint with rivet.

b Lapped joint for the screws.

Rings for

Bulls.—A common form of ring for a bull is shown in fig. 415. The opened ring is passed through the hole in the bull's nose, and then screwed close as a round ring. Fig. 416 shows the ring screwed together as it hangs in the bull's nose—the joint closed, and the lapped ends also closed, with the countersunk screws flush with the surface of the ring. The ring is of quarter-inch rod-iron or

brass, and its diameter over all is $2\frac{1}{2}$ inches. The surface is smoothly filed and polished.

Process of Ringing.—The ringing of bulls has to be carried out with great care, so as to excite the animal as little as possible. Formerly the hole for the ring was generally made by a

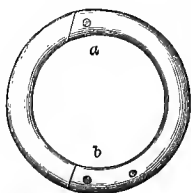


Fig. 416.—Closed bull's ring.

a Rivet joint.

b Lapped joint with 2 screws.

hot iron, and with that system the process was described as follows, in the former editions of this work :

—The operator is provided with an iron rod about a foot long, tapering to the point, and rather thicker than

the rod of the ring. Let a fire be near to heat the point of this rod. The operator should also be provided with a small screw-driver. Let a long strong cart-rope be provided with a noose hitched upon the middle, just large enough to take in the bull's neck, like a collar. Put the bull into any outhouse that has a window sufficiently low to allow his head to reach through it, though it is safer for his knees against the wall to press his counter against a strong bar of wood. Slip the top of the loop of the rope over his head down to the counter, bring his breast against the window, pass the rope from the lowest part of his neck along the ribs on each side round his buttocks, like a breeching, and bring an end through the window on each side of the bull, where a man or men hold on to each end of the rope, to prevent the bull retreating backwards from the window. A man stands on each side of the bull's buttock, to prevent him shifting to one side or the other. A man also stands on each side of the bull's head, holding on by a horn, or by an ear if he is hornless, with one hand, and keeping up the nose by supporting the lower jaw with the other. The operator having the iron rod given him by an assistant, heated in the fire just red enough to see the point in daylight, takes the bull by the nose with his left hand, and feeling inwardly with his fingers, past the soft part of the nostrils, until he reaches the cartilage, distends

the orifice of the nostrils, so that the hot iron may pierce clear through the cartilage without touching the skin of the nostrils or his own fingers, the operator taking care to pass the iron in a direction exactly parallel to the front of the nose, otherwise the hole will be pierced obliquely. Immediately after the tapering rod has been passed as far as to make the hole sufficiently large for the ring, and the wound seared enough, the operator removes the rod and takes the ring opened, still holding by the bull's nose, passes one end of it gently through the hole, and, on lapping the two ends together, lets go the nose with the left hand, and taking hold of the ring with the same, still to command the bull, puts one screw in, then the other, securing each in succession firmly with the screw-driver. He then turns the ring round in the hole, to feel that it moves easily, and to see that it hangs evenly, after which the bull is released.

The ringing may be done more quickly and simply without the use of a hot iron, while improved rings are now made to save trouble in screwing.

Substitute for the Ring.—Although it is prudent to have a ring fixed permanently in the nose, many now prefer an instrument such as is shown in fig. 241, Divisional vol. iii., which can be tightened to grip the nose, as a person would grip it with his two fingers, and can be slackened again and removed at will. This indeed may and often is entirely substituted for the ring fixed through a hole in the nose; yet the ring through the hole is an additional safeguard.

Leading by the Ring.—The ring should not be used until the wound of the nose has had time to heal, though it is not uncommon for the ringing of a bull to be delayed until the time he is led to a show, when, the nose being still tender and sensitive, the poor animal is unnecessarily tortured. So alarmed do bulls become by this operation, that they hang back at the first attempt to lead them, and sometimes the leader thoughtlessly holds on by the rein-rope until the ring is torn through the nose. He should slacken the rope whenever the bull hangs back, as often and until he

learns to yield to the slightest motion of the rope.

Care in Leading.—The cattle-man in charge, and in whom the animal has confidence, should lead the bull for the first time. He should never *pull* the animal along after himself, but allow him to walk on while he walks at his side, or goes behind, with the rope in hand. While so following, to relieve the animal of the weight of the rope upon the nose, the man should throw the rope over the bull's back, and retain a hold of its end. Should the bull offer to step *backwards*, a gentle tap on the shank with a stick will check him; and should he run *forward*, a gentle pull of the rope will make him slacken his pace. On no account should the man struggle with the bull on the first occasion; on the contrary, he should soothe and pacify, and convince the bull that he will receive no hurt if he will but walk quietly along. A bull soon learns what is intended for him when he is properly dealt with; but if tormented merely that the man may show his power over him, it will be a long time ere he will learn to behave quietly when led, and in the meantime may become vicious.

Spring-hook.—The leading-rein is best fastened to a ring or holder by means of a spring-hook swivel, such as is shown in fig. 417. A movable part is jointed, and kept in its place by the spring behind it. When the hook is desired to be attached to the ring, the thumb presses on the movable part which yields, and allows the ring to be taken into the circular void of the hook. The rein-rope is spliced on the ring of the hook, which, turning upon a swivel, prevents the rope twisting. Such a hook can be attached and released from a bull's ring in much less time than any sort of tying.

Leading-stick.—A leading-stick, as well as a leading-rein, should always be used in handling adult bulls. The leading-stick is a strong pole, similar to the shaft of a hay-fork, with links and hook attached to one end for fixing into the ring in the bull's nose, or into the nose itself. By this stick the attendant has much better control of the bull than by a leading-rein alone. When two men are required to lead a bull, one holds the stick and the other the rein.

Grazing Bulls and Cows together.

—A bull is never in a better position for serving cows than when grazing with them in the field. We believe it to be a fact, that a bull which is constantly amongst cows in a field rarely teases or abuses them, as would be done by one taken to them for the occasion out of his own house. But a bull can be left with the cows in the field only when he has to serve all the cows. When a bull is with cows, he is usually safe to approach, and quiet within the fence; but a bull is often troublesome by himself in a paddock or field, or even amongst oxen. He is constantly restless, often bellows, especially when he snuffs the wind from the direction of the cows. Hence he should either be confined to his hammel or byre, and supported on cut forage of some kind, or allowed to be with the cows he is to serve in a separate field from the rest.

Summering Bulls in the House.—When it is necessary to confine a bull to a byre or loose-box during summer, he should have exercise once every day, and receive a full allowance of green food, such as grass and clover, and perhaps a pound or two of bruised oats and linseed-cake. With plenty of fresh grass he will need little else, unless he is hard worked in the service season, or has become low in condition. He will most likely relish a little dry hay amongst or alternately with the green succulent food. He should have access to water at least once daily, and be groomed once or twice a-week.

Temper of Confined Bulls.—When confined, bulls, like watch-dogs on the chain, dislike the approach of any one but their keeper; and even a keeper has been known to fall a victim to their caprice. Some bulls become then so



Fig. 417.—Swivelled spring-hook.

- a Movable part of hook.
- d Joint of movable part.
- c Swivel-joint of ring of hook.
- b Spliced end of rope.

prone to mischief that they will attempt to run at every person when brought out of the house. Air and daylight together seem to have an intoxicating effect upon them.

Curbing a Savage Bull.—Several plans have been adopted for preventing a savage bull from doing harm, such as attaching a stick to his nose by a chain, or fixing a board in front of his eyes. A method which causes less inconvenience to the bull when not in the act of mischief, consists of an apparatus attached to the point of one of the horns, which, when the bull touches anything with this horn, pulls the string so tight in the nose, by means of a short chain, that he immediately desists.

The display of bad temper in bulls is more frequently occasioned by an improper upbringing in calf-hood than a natural propensity to vice. The training of young bulls should therefore be carefully attended to by the cattle-man, and not intrusted to boys or other inexperienced persons.

Number of Cows for a Bull.—Bulls can serve a large number of cows in a season, perhaps as many as 60, or even more. Where a bull is confined to the service of cows on the owner's farm, he has usually a smaller number; but it is a common practice to give the use of the bull to neighbours' cows at a certain charge per head.

SOILING.

The system of "soiling" might be humorously described as grazing cattle in the house! It consists of retaining the animals in the house,—the byre, hammel, or cattle-court,—and cutting and carting the green food to them, instead of allowing the animals to browse over the pastures and pick up the grasses for themselves.

Advantages of Soiling.—Several advantages are claimed for this system over the older and more simple and natural method of grazing. The chief of these are—(1) that a given extent of land will carry a heavier stocking of cattle; (2) that more actual food will be produced during the season; (3) that the quantity of food grown is more fully utilised; (4) that the animals

thrive better, because they are protected from extremes of temperature, from the teasing of insects, and from undue exercise; and (5) that a greater quantity of manure is made upon the farm.

More Food Better Used.—It has been asserted by the more enthusiastic advocates of "soiling" that one acre "soiled" is equal to three acres pastured. This, we think, is overstating the case; yet it is unquestionable that by the frequent and systematic cutting of the grasses as they grow up, a greater weight of food will be grown during the season than when the pasture is cropped irregularly by stock in the ordinary method of grazing. Then with careful cutting and carting, every particle of the food is placed before the stock in a palatable condition, so that the material grown is more fully utilised than when it is trodden upon and unevenly eaten by cattle.

Animals Thriving Better.—Provided the animals are kept in comfortable, well-ventilated compartments, with plenty of fresh air, they will most likely give a better return for the food, in yield of milk or in accumulation of fat, than they would on the pastures exposed to sun and wind and to the teasing of insects. That young animals would develop bone and muscle more rapidly is very doubtful; but it has been abundantly proved that adult animals will accumulate fat more quickly in this confinement than upon pasture fields.

More Dung made.—The gain in this point is not so very great as many have contended. The heap of dung at the farm-steadings will, of course, be largely augmented; but it has to be remembered that it has been augmented mainly at the expense of the pasture field, which would otherwise have been enriched by the droppings of the animals grazing upon it. The only gain in manure will arise from the treading down of the litter spread below the animals, and from the residue of any artificial food given in the house along with the cut grasses. It is doubtful, indeed, if any gain in the quantity and quality of the manure would be more than sufficient to repay the cost of returning the dung to the land.

By the earlier advocates of "soiling" it was argued that the droppings of the

cattle on pasture land were in great part lost to the soil by exposure. It is now known that this was a mistaken idea, and that there is perhaps no better way of utilising farmyard dung than spreading it upon grass land.

Disadvantages of "Soiling."—But while these important advantages may be urged in favour of "soiling," it has to be pointed out that there are certain disadvantages which must also be taken into account. "Soiling" is altogether a more artificial system than ordinary grazing. It necessitates the employment of more money per acre, not only in the larger head of stock, but also in providing the necessary house accommodation, and the considerably larger force of labour.

It will at once be obvious that the cost of labour is very much greater than with grazing. There is the cutting and carting of the grass, the tending of the cattle, the carting out and spreading of the dung, all of which must be regarded as extra work due to the system. The heavy labour bill is indeed the greatest disadvantage of the system as opposed to grazing.

Then, again, there is this further consideration, that substantial outlay may be incurred in providing food to the animals in the house before the grass is sufficiently grown to admit of being cut. Successional forage crops are grown for this purpose, as well as to supplement the grass at other times. All this involves additional outlay, employing more capital per acre.

Utility of the System.—Still there are many circumstances under which the system may—especially with fattening cattle and dairy cows—be pursued with excellent results. It is specially suitable for warm climates, where forage crops may be easily grown, and where cattle would be disturbed by the excessive heat in the open fields. Then, where the supply of water for fields is insufficient, house-feeding may be followed in preference to grazing.

It is not likely, however, that in the best grazing districts, or in the colder parts, it will ever displace the long-established system of summering stock on the open fields. Indeed, it has to be noted that with all the advantages claimed for

it, the system of "soiling" cattle is not gaining ground in the British Isles.

HORSES IN SUMMER.

From the beginning of the spring work until the sowing of turnip-seed has been completed, the farm-horses have enjoyed no rest; and in the long hours of labour during a period from 15 to 18 weeks, they require a liberal allowance of good food to maintain their strength and condition. A little green food may be obtained for them before the sowing of the root crops is finished; but with this exception, the farm-horses, until the completion of the hard work of root-sowing, are fed just as they were fed while working hard in winter and spring.

Summer Leisure.—With the conclusion of the root-sowing comes the summer holiday for the horses. In some parts they spend this time of leisure in the cattle-courts and in others on the pasture fields.

Pasturing Work-horses.—On many farms, especially in Scotland, the rule is still to graze the horses. As soon as the warm weather of summer has fully set in, the horses lie out in a pasture field all night, and get cut grass between the yokings in the stable. When the first yoking is over, they are put on pasture until taken up for the afternoon yoking at 1 o'clock, which saves the trouble of cutting grass. Work-horses are liable to suffer much from chilly nights, cold often laying the foundation of diseases—such as rheumatism, costiveness, stiffness of the limbs. The aftermath is good pasture in the interval of work at noon, and the second cutting of clover may last for suppers until the time to betake to the stable altogether.

Soiling Horses.—Many farmers disapprove of pasturing farm-horses, and support them at the steading upon forage. Where there are hammels or courts which could be easily divided, we would adopt this plan at once, but we are doubtful of its advantage in a stable. The heat of a stable in summer—and the doors cannot be left open—with the evaporation of the increased issue of urine from the green food, cannot fail to vitiate the air. The cattle-courts are

more open; and if they can be divided so that each pair of horses may have a compartment to themselves, they will thrive admirably here. In the tillage districts of England this system of summering horses in the cattle-courts is extensively pursued. Many farmers, indeed, maintain that there is no better or cheaper method of keeping draught-horses in summer than in the courts, fed with green vetches or other similar succulent food, and dry hay, with perhaps a little bruised oats. Very often the grain is omitted. Still it is a good plan to give the horses a week or two of the fresh air in an open pasture field.

Pasturing Young Horses.—Young horses are put to pasture during the day as soon as they can obtain a bite. They should be brought at night into their hammels until the grass has passed through them; after which they should lie out all night in a field which offers them the protection of a shed or other shelter. Work-horses do not care for a shed on pasture, being too much occupied with eating during night to mind it. In rainy weather young horses should be kept in the hammel on cut grass, and not exposed to rain in the field over-night.

The farmer's saddle-horse should have grass in summer, as the best course of physic it can have. But it is more convenient to give it cut grass in a court or hammel than to send it to pasture, in which it may be with considerable difficulty caught when wanted.

Peculiarities of the Horse in Graz-

ing.—It is surprising with what constancy a work-horse will eat at pasture. His stomach being small in proportion to the bulk of his body, the food requires to be well masticated before it is swallowed; and as long as that process is proceeded with while the grass is cropped, no large quantity can pass into the stomach at a time. The horse, like all herbivorous animals, grazes with a progressive motion onwards, and smells the grass before he crops it. His mobile lips seize and gather the stems and leaves of the grass, which the incisors in both jaws bite through with the assistance of a lateral twitch of the head. When grass is rank, he crops the upper part first; and when short, bites very close to the ground. Horses should not graze amongst sheep, as both bite close to the ground; and work-horses often injure sheep that come in their way, either by a sly kick or by seizing the wool with their teeth.

It is proverbial that horses do not graze well upon many of the very best bullock pastures. Horses often do better on rough pasture than on land which has been altered in its herbage by thorough drainage.

Horses Injured by Green Food.—Care must be exercised in beginning horses with green food every year. If allowed to gorge themselves too freely at the outset, serious illness may follow. Begin them sparingly with it, and if it should be wet or very succulent at any time during the season, it will be all the better to be accompanied or mixed with a little dry food such as hay.

DAIRY WORK.

The breeding, feeding, housing, and general management of cows and their live produce are fully discussed and described at convenient points in other sections of the work. Here we are to deal specially and at considerable length with the manipulation and utilisation of milk and its products.

The cow—the best friend to man of the entire animal creation—gives a bountiful yield of a delicious fluid,

which, although universally familiar to the eye and welcome to the palate, is neither so well understood nor so skillfully manipulated and utilised as might be reasonably expected in the enlightenment of the present day. What, then, is this fluid? and what shall we do with it?

The notes in the following pages, intended to elucidate these two comprehensive questions, are not addressed in

any exclusive sense to those who are usually described as "dairy farmers"—those who make dairying their sole object, or the one great, all-absorbing feature in their farming. Our notes are designed for all who have milk to manipulate, in large or in small quantities. Whether it happen to be the milk of the crofter's one cow, the stunted produce of the breeding herd, or the fuller flow of the heavy milkers on the large dairy farm, the object all through should be the same—to turn the milk to the best possible account. Whether this will be as food for the residents on the farm, for calf-rearing, for sale as whole-milk, skim-milk, cream, butter, or cheese, will depend upon circumstances too numerous, involved, and variable to be discussed here with advantage. Whatever the destiny of the milk may be, it is important, in order to ensure the best possible results in its utilisation, that the operator shall be acquainted with the characteristics, the inherent properties, the weak points and the strong, of the commodity which he or she is handling. It is thus desirable that all farmers who keep cows, whether few or many, should make themselves familiar, not only with the characteristics and properties of milk, but also with the best methods of preparing it for the various purposes for which it may be employed.

The milking of cows has already been dealt with, page 24, Divisional vol. iii. Here we take up the milk as it comes from the cow-house to the *Dairy*.

THE DAIRY.

The special apartment designed as the dairy will, of course, be regulated in its capacity and equipment in accordance with the extent and nature of the dairying operations carried on upon the farm.

Upon mixed husbandry farms, where dairying is quite a subsidiary interest, or where, indeed, only as many cows are kept as will supply the wants of the farm itself, the dairy or "milk-house" is often merely a small compartment opening out of the kitchen or from the passage between the kitchen and the main dwelling-house.

Upon holdings where dairying bulks largely, the manipulation of the milk and its products requires a distinct building of considerable dimensions.

Be the extent of the dairy what it may, there are some important conditions which should be common to all. Leaving individual farmers to provide the dairy capacity required for their respective holdings, and also allowing them the fullest freedom in what may be called the embellishment of their dairy buildings, we would press for general adoption only such conditions and arrangements as are known to be essential for the successful handling of milk, butter, and cheese.

Some further reference will be made to the dairy when we come to speak of the construction of farm-buildings.

Situation of the Dairy.—In the first place, the milk compartment or dairy should be so situated as to be free from strong or unpleasant odours. Unless it is kept perfectly sweet, airy, and wholesome, successful dairying is out of the question.

Milk-room in Dwelling-house.—The "milk-house" in the body of the dwelling-house is therefore not a desirable arrangement. Odours from the kitchen, scullery, and pantry are liable to find access into this compartment, and play havoc with the milk, cream, and butter. If the dairying interests of the farm are too small to justify the erection of a separate dairy, make a point of having the milk compartment as far removed from the kitchen, scullery, and pantry as possible. Let it be in a cool, airy position, on the north side of the house if possible. Keep nothing in the milk compartment except milk—above all, nothing that gives off a strong or unwholesome smell.

A Medley in the Milk-room.—An arrangement by no means uncommon upon farms where little attention is given to dairying, is to have the milk-house and pantry combined in one compartment. Here, in close proximity, perhaps on one shelf, are milk, butter, cheese, old and new; cold meat from the table, dripping, fish, fresh and cured, and such odorous, savoury and unsavoury articles. A worse arrangement for the milk and butter could

not be conceived. Those who desire to have first-class, good-keeping dairy produce, must protect it from all such contaminations.

Separate Dairy.—A convenient position for the separate dairy is right back from the kitchen on the north side of the house. It is a good plan to have the kitchen and dairy connected by a covered passage, leading through a yard perhaps from 5 to 10 yards wide. It is desirable, of course, that the dairy shall be within easy access from the cow-house, yet not so close as to endanger the tainting of the milk with smells from the farmery or piggery.

Compartments in the Dairy.—With a small number of cows one compartment, perhaps about 12 feet by 14, may be sufficient for all the dairy work. In other cases there may be three or more compartments, a milk-room, churning-room, cheese-making room, with a cheese-store above. Two compartments for active work, and one in which to ripen cheeses, are usually considered sufficient.

Verandah.—It is a good plan to have a covered way or verandah along the south front of the dairy. This provides a shade from the noonday sun, and permits the dairy utensils being dried and aerated in rainy weather.

Finishings of the Dairy.—There is no need for elaborate or costly buildings for dairy work. They should be fairly roomy, not less than 10 feet in height, well ventilated and thoroughly dry, with a subdued rather than bright light. The ceiling should be lathed and plastered, and the flooring formed of some material which will be hard, proof against damp, and easily cleaned. Encaustic or enamelled tiles and polished pavement are often used, but there is nothing better than well-formed concrete with a smooth surface. The concrete floor is rounded at the edges and corners, and declining towards the door or other exit, so that with a hose-pipe and a good supply of water it can, with little trouble, be thoroughly flushed.

Dampness to be avoided.—Dampness is very injurious in the dairy. If the situation is of a damp nature, special precautions must be taken in constructing the dairy to ensure that its floor and walls shall be proof against damp.

Dairy Sink and Wash-tank.—There should be no sink or fixed water-tank within the milk-room or churning-room. A water-tap is convenient in both, but there should be no sink underneath the tap—at most only a slight indentation in the floor, which will carry off any stray water from the tap, and which may be easily cleaned with a sweep of the brush.

The washing-tank and sink for the cleaning of the dairy utensils will be either in a compartment by themselves or in the kitchen scullery. All underground drains should be provided with bell-traps. Many think it desirable to avoid underground drains. Surface drains are more easily kept clean.

Milk Shelves.—Shelves for holding milk-pans are usually fixed round the walls. The shelves should be formed of some non-absorbent material such as slate or flag-stone. Some prefer movable shelves, such as shown in fig. 428, to fixed shelving.

Temperature of the Dairy.—It is a matter of great importance to have the dairy kept cool, sweet, and fresh. Many consider an equable temperature so essential that they employ artificial means of regulating it—by hot-water pipes or a fire in winter, and by shading from the sun and flushing with cold water in summer.

One of the most perfect dairies we have ever known of was one in the State of New Jersey. Right in the centre of it there is a strong spring of delightfully pure water bubbling up from the rock, keeping the compartment almost equal in temperature all the year round.

To secure, as far as possible, a cool, even temperature, the dairy is sometimes sunk partly into the ground on a hillside; great care being given to the drainage; while walls and roofs are made double, with an air-space between. In summer the windows and doors are well shaded from the sun, and it is considered that a subdued is preferable to a bright light in the dairy. Specky or streaky butter is sometimes attributed to exposure to strong rays of light.

Precise limits need hardly be laid down as to the temperature of the dairy. The object to be aimed at is to have the atmospheric temperature of the milk-room lower than the temperature of the

milk itself. The tendency of milk to become contaminated by offensive odours is much increased when the surrounding temperature is warmer than the milk. Hot air coming into contact with colder milk becomes condensed and deposited upon the milk with all its impurities, whatever they may be. On the other hand warm milk placed in a colder room with pure cool dry air coming into contact with it, is more likely to be purified than contaminated. The cold air coming within the influence of the warm milk is expanded, and rising, may carry with it volatile impurities from the milk.

Professor Sheldon remarks that "milk that has been cooled by water or ice should not be exposed to an atmosphere 10° or 20° warmer: for it then becomes a facile condenser and absorbent. While the air is seldom pure enough not to injure milk that is 10° colder, it is seldom so impure as to vitiate milk that is 10° warmer."¹

There is thus good reason for keeping the atmosphere of the milk-room cool, fresh, pure, and dry.

Importance of Temperature.—At every step in dairy work, no matter what branch of dairying may be pursued, the guidance of the thermometer must be constantly resorted to. Temperature is a controlling influence in all the operations of cream-raising, butter-making, milk-ripening, and cheese-making; and without due attention to this influence, success cannot be reckoned upon. Guess-work is quite unreliable, both as to the temperature of the room and of the commodities under manipulation. But there is a simple and efficient guide at hand—the common thermometer—which may be had specially adapted for dairy work at from 1s. to 3s. each. Glass or porcelain thermometers are required for inserting in and marking the temperature of milk, curd, &c. There should also be a wall-thermometer hanging in every compartment of the dairy, so that the temperature in each may be seen at a glance.

Dairy Utensils.

In regard to the kind of dairy appliances to use, it would be imprudent to

dogmatise. In recent years vast ingenuity and enterprise have been employed in the bringing out of "new and improved" dairy appliances. We heartily acknowledge the benefits which have thus been conferred upon the dairy interest, for it has been established beyond question that many of these modern contrivances for use in the dairy are possessed of merits of the highest order.

Still it is not necessary that in order to ensure first-class dairy produce the dairy farmer should discard all his old appliances and adopt new ones. He will do so only as far as his experience, observation, and means seem to dictate and justify. This is pre-eminently one of those points as to which the dairy farmer may, with ample justice to the produce of his dairy, give considerable scope to his purse and his fancy.

Three important points to look for in all dairy appliances are simplicity and economy in working, facility in cleaning, and durability. Cheapness is, of course, also to be kept in view; and the greatest consideration of all is efficiency.

In the course of our detailed notes upon the various operations in the dairy, numerous appliances which are well thought of will be mentioned and illustrated.

Power for the Dairy.

In tolerably large dairies, where hand-power would be insufficient, a small steam-engine is very often employed. A vertical boiler and engine similar to that shown in fig. 49, page 135, vol. i., is well suited for this purpose. It should be so placed as to be useful for other farm-work as well, such as preparing cattle-foods. Horse and water power are also utilised for dairy work. A useful form of horse-gear for working dairy appliances is illustrated in fig. 132, Divisional vol. ii.

The steam-engine is best adapted for working the centrifugal separator.

MILK.

Milk, the most perfect of all foods, possesses characteristics which should be carefully studied by those who have to handle it and manufacture its products.

¹ *The Farm and Dairy*, 62.

Composition.

The composition of cows' milk varies greatly. The following may be taken as fairly representing (1) the analysis of an average sample of milk; and (2) the extremes in milk-analyses:—

	Average Analyses.	Extremes of Ingredients.
Water	87.40	81.00 to 91.00
Casein	3.30	3.00 " 4.10
Butter-fat	3.40	1.85 " 9.50
Milk-sugar	4.55	3.00 " 5.00
Albumen	0.60	0.30 " 1.20
Ash	0.75	0.70 " 0.80

The range of solid matter in milk is as great as from 9 to over 19 per cent. A good sample should contain at least 12 per cent. Different breeds vary greatly in the standard percentage of solids in their milk. Dutch cows would rank lowest, and Jersey cows highest, shorthorn cows being about the average. Even with the same cows there will be marked variations under good and bad treatment.

Butter-fat.—It will be observed from the figures given above that the greatest variation occurs in the butter-fat. In many samples of milk from Jersey cows, analysed at the London Dairy Show by Mr F. J. Lloyd, the percentage of total solids ranged from 13 to over 19 per cent, and this variation arose almost entirely in the butter-fat. The percentage of butter-fat ranged from about 4.10 to about 9.50 per cent, while total "solids other than fat" showed only very slight variation, at most considerably under 1 per cent. With the milk of shorthorn cows analysed on the same occasion, exactly similar results were obtained—that is, in regard to the variableness in the percentage of butter-fat, and the comparative fixity in that of the other solids. The total solids in the shorthorn milk ranged from 11 to 15 per cent, while the solids *other than butter-fat* did not vary more than about one-half per cent.

Composition of Milk from Different Breeds.—The following table, arranged by Professor M'Connell, gives the average daily yield of milk in pounds, with the fat and total solids in the milk, calculated out for each breed from the results of the trials with 432 cows at the London Dairy Shows in the ten years of 1880-89:—

Breed.	Lb. of Milk.	Total Solids.	Fats.
119 Shorthorns . .	{ 43.13	12.87	3.73
31 "	{ 44.80	12.89	3.81
118 Jerseys	{ 27.87	14.36	4.56
43 "	{ 28.41	14.94	5.47
49 Guernseys . . .	{ 28.30	14.00	4.77
14 "	{ 31.15	14.46	5.03
26 Crosses	{ 39.12	12.91	3.69
3 "	{ 51.86	12.28	3.23
7 Dutch	{ 43.31	12.11	3.26
13 Ayrshires	{ 34.26	13.43	4.15
2 Devons	{ 30.12	14.34	4.90
3 Red Polls	{ 43.10	12.72	3.60
1 Welsh	{ 46.00	12.74	4.16
3 Kerries	{ 23.50	14.22	4.40

432

A comparison of the figures corroborates many points with which we are already familiar. Thus Shorthorn milk is not very rich in total solids or fat; Jerseys and Guernseys are very high in fat and total solids; Dutch very poor in fat and solids; and others medium. If the solids other than fat are worked out, it will be found that they vary only within a half per cent, not only within the limits of the breed, but between the averages of all; that is, they exist in the proportion of from 9 to 9½ per cent, no matter how much the "total" solids may differ, though, of course, the highest in one is also highest in the other. The exceptions to this only occur with the Dutch and Welsh in the above table, which fall below 9 per cent, where, however, the total solids are fair. Under the headings of Shorthorns, Jerseys, Guernseys, and Crosses, the averages of the last two years are given by themselves, showing that the general quality of all kinds as dairy animals is improving. There is an increase in every item right through, with the exception of the quality alone of the "Cross" milk—apparently due to an extra number of Dutch half-breeds.¹

It is thus established beyond question that by far the most variable ingredient in milk is fat. It is the commodity which is most within the control of the farmer, and which will be chiefly influenced by the feeding and general treatment of the cow. The fat, of course, is the ingredient from which the butter is derived.

Testing Percentage of Cream.—

¹ *Ag. Gazette*, 1889, 493.

This is not easily done with absolute accuracy. The ordinary *test-tube*—a glass tube with graduated lines at the top to mark the percentage of cream as it rises—is useful, but not quite reliable. The milk is put into this tube as it is drawn from the cow, and when the cream has risen, it shows on the graduated scale the percentage of the bulk of the cream. But the cream of different cows varies so much in the size of the butter-fat globules and therefore in specific gravity, that this test will not always show the entire and exact comparative quantities of butter-fat in samples of different milk. For mixed samples of milk from a number of cows it is fairly reliable, and is a ready means of testing much used in the new-milk trade. Every farmer should, for his own information, test the percentage of cream from his cows.

The *Lactocribe* is a most useful invention for ascertaining the exact amount of butter-fat in milk. It is worked similarly to the De Laval separator, and tests the milk by centrifugal force—making as many as twelve tests at one time. This is a very useful appliance in dairy factories or creameries, where cream is purchased from the farmers.

Fat-globules.—The butter-fat may be seen by the microscope to be in suspension in the milk in tiny globules. These globules vary in diameter in the milk of different breeds and different cows from $\frac{1}{2000}$ to $\frac{1}{800}$ of an inch, and it has been estimated that there are over forty thousand millions of these fat-globules in a pint of milk containing 4 per cent of cream.

Casein.—This useful ingredient of milk, so important in the manufacture of cheese, is described by Professor Sheldon as existing in the milk in the form of an extremely attenuated jelly, owing to lavish absorption of water. There has been much discussion as to how far the percentage of casein can be influenced by the food given to the cow. Mr F. J. Lloyd says he is sure every chemist who has analysed milk will confirm his statement, that “we cannot by feeding perceptibly increase the casein contents of milk;” and he adds, that therefore the object in cheese-making should be to feed so as to increase the flow of milk

and keep down the fat—that is unless a rich cheese is desired, when more albuminoids are given in the food to increase the fat. Some practical dairy farmers, however, contend that, by changes in feeding, they have been able to alter the casein contents of the milk.

Milk-sugar.—This is usually present in a larger quantity than any of the other solid ingredients. It is the most active agent in the decay of milk, as by the action of germs, *Bacterium lactis*, it is transformed into lactic acid, producing sour coagulated milk.

Albumen.—This nitrogenous substance is very similar to casein. Yet the two are so different that, while the rennet precipitates casein in the form of curd, the albumen passes off with the whey. It is this albumen and the sugar of milk that give to whey the feeding value it has been shown to possess (page 41, Divisional vol. iii.) This albumen coagulates on boiling the whey *after* the removal of the casein. It forms the skin which appears on boiled milk.

Weight and Specific Gravity.—A gallon of whole-milk weighs as near as might be from 10.25 to 10.35 lb. For simple calculation, it is a common practice to reckon 10 lb. of milk to the gallon. The specific gravity of whole-milk would vary from about 1.025 to 1.032, as compared with 1.000 for water as the standard. The higher the percentage of cream, the lower the specific gravity of the whole-milk. The specific gravity of cream itself is about .90.

Milk Statistics.—Taking the stock of cows in this country as a whole, the average yield of milk would probably be somewhere between 430 and 450 gallons of milk each per annum. Good average dairy cows of the heavier milking breeds—shorthorn, cross-bred, Ayrshire, Dutch, and red polled—should give from 700 to 900, some of them even 1000 gallons each in the twelve months. The produce of butter for a given quantity of milk varies greatly. The choicest butter cows, such as Channel Island cows, often give 1 lb. of butter from rather less than 2 gallons of milk, and average dairy cows in a butter dairy should give a pound of butter from 25 to 30 lb. of milk. Cheese-makers expect to get about 1 lb. of hard cheese, such as Cheddar, from

each gallon of milk; and a little less in Stiltons.

Weighing Milk.—It is very desirable that the product per day of every

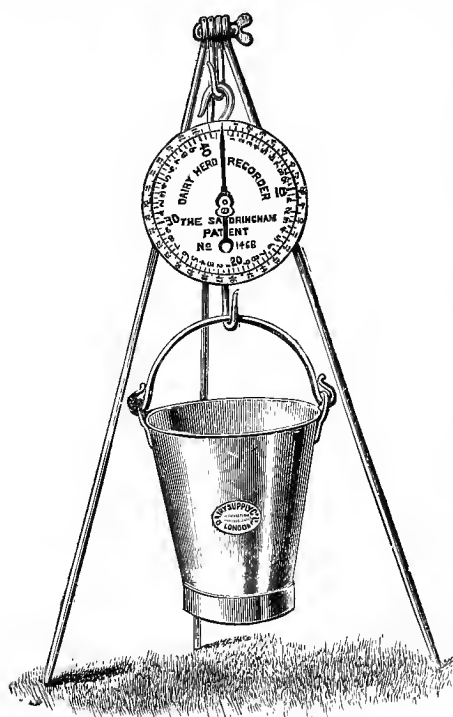


Fig. 418.—Sandringham dairy herd recorder.

cow in milk should be tested by weight at least once or twice every week. Useful information will thus be obtained as to the return each individual cow is giving for the food she consumes. In the absence of precise facts as to the yield, unprofitable cows may be occasionally kept on longer than would otherwise be the case. A convenient appliance for weighing and measuring milk is represented in fig. 418 (Dairy Supply Co.) The dial shows the weight of the milk in pounds and ounces, and the measure or quantity in gallons and pints.

Purifying and Preserving Milk.

There are several processes by which milk may be to some extent purified and preserved sweet and wholesome for a time. As soon as milk is exposed to the atmosphere it is liable to absorb not

only bad odours, but also living organisms (minute vegetable growths), which are continually floating about, and which accelerate the souring and decaying of milk. The action of these organisms is very much impaired by cooling the milk to about 50° or 55° Fahr., and this is frequently done as soon as the milk is taken to the dairy. It is also believed that by heating the milk to at least 170° the most if not all of these living germs are killed. In hot weather, therefore, when it is difficult, mainly on account of the activity of these organisms, to keep the milk sweet for any length of time, it is the custom in some dairies to heat the milk up to 170°, and then rapidly cool it to below 50°.

Heating and Cooling Milk.—

There are numerous methods of heating and cooling milk. Where there are small quantities to deal with, it may be done by filling a tin can (such as shown in fig. 419) with hot or cold water as the case may be, and dipping it into the milk. Where there are large quantities to manipulate, other methods have to be adopted.

In fig. 420 (Lawrence's patent refrigerator, for the illustration of which we have to thank Messrs Bradford & Co.) is shown a very efficient appliance for this purpose. A is the milk-receiver on top, and B the refrigerating part. This latter is formed of two thin corrugated sheets of tinned copper, placed side by side, with the flutings of the one sheet fitting into those of the other, the whole soldered to ends and made watertight. A thin stream of milk is allowed to trickle down over B and collected at C again, while cold water is led in between the sheets from D, and up and out at

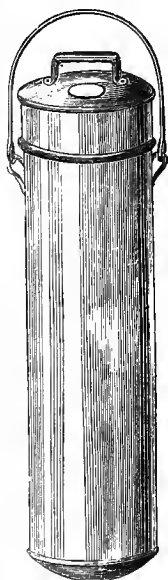


Fig. 419.—Temperature can.

exit E. By this means the milk is *suddenly* reduced from a temperature of about 90° Fahr. to nearly 50° Fahr., being *thoroughly aerated* at the same time. This cooling is the more efficacious, because it is sudden, in nullifying the action of the souring germs, so that the milk remains sweet longer, while

the medium of milk.¹ Some indeed go the length of saying that all milk should be boiled before using.

Preserving Milk.—In Norway a system of preserving milk by sterilising it, and enclosing it in sealed tins, has been introduced with apparently some measure of success. The milk is taken direct from the cow, and, in the first place, is cooled down to ordinary temperature, about 50° or 60° Fahr., and then hermetically sealed up in tins. In this state it is exposed to a temperature of about 160°, and kept at this for one hour and three-quarters or thereabout, after which it is allowed to cool down to 100°, at which it remains for some time. It is then quickly heated up again to the former temperature of 160°. This alternate heating and cooling is repeated in the same manner several times, and then finally the temperature is raised to the boiling-point of water, or about 212°, after which it is cooled again to ordinary temperature, when it is found to be completely sterilised, not a trace of any organism or germ being left. It is therefore in a state in which it is said that it can be kept for an indefinite length of time without undergoing any change.

Boracic Acid as a Preservative.—It is well known that milk may be kept sweet for a longer time than usual by adding to it a little boracic acid or borax, which is in itself quite harmless in the milk.

Saltpetre in Milk.—Many farmers add to milk a little saltpetre dissolved in water. Professor Sheldon regards the use of saltpetre in moderation as a good thing. "In summer," he says, "it will help to preserve the milk, and in winter neutralise the bitter taste which is too commonly found in butter."

Condensed Milk.—The preparation of condensed milk is now quite an important industry. The process consists of evaporating the water of the milk and preserving the solids (mixed with sugar) in sealed tins. The nourishing elements in the milk may be thus preserved for any length of time, but the natural flavour has been to a large extent dissipated.

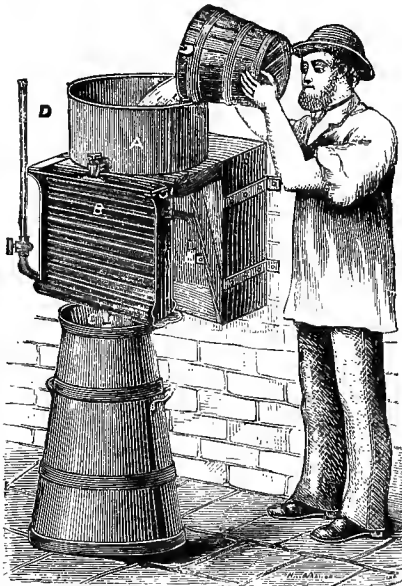


Fig. 420.—Lawrence's refrigerator.

noxious gases and flavours are removed by the aeration. By hot water (instead of cold) being run through between the sheets the milk may be raised in temperature.

A more elaborate arrangement of the same apparatus, designed to at the same operation scald and cool the milk, is represented in fig. 421 (Dairy Supply Co.) The milk from C runs over A, which is fitted with an arrangement for circulating boiling water internally, then flows over the refrigerator B, and becomes cooled and ready for use.

Milk in Sealed Bottles.—As a simple plan for keeping small quantities of milk sweet, Professor Long recommends that it should be sealed in bottles, and these submerged in boiling water for a few minutes. He adds that if this plan were universally adopted there would be no danger of attack from disease through

¹ *The Dairy Farm*, 7.

Destination of the Milk.

The treatment of the milk, from the very moment it leaves the cow-house, will to some extent vary in accordance with the purposes for which the milk is to be employed—whether (1) for con-

sumption as milk upon the farm—as human food, and for calves, (2) for selling as whole-milk, (3) selling as cream and skim-milk, (4) butter-making, or (5) for cheese-making.

We do not intend to discuss here the relative advantages or disadvantages of

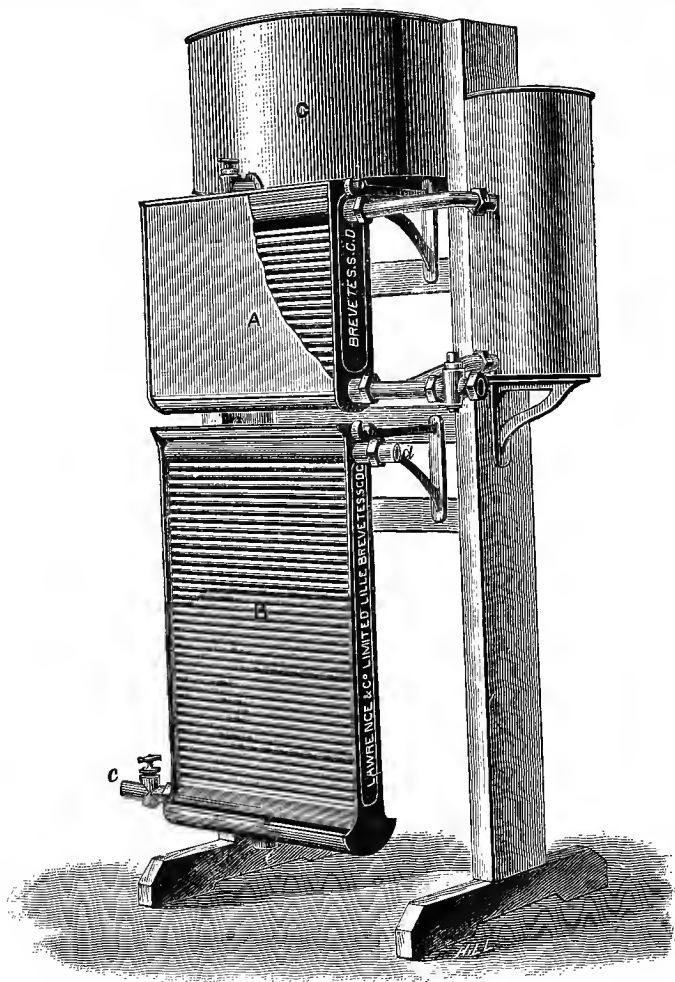


Fig. 421.—Scalding and cooler.

these various methods of utilising milk and its products. Circumstances as to supply and demand, and other conditions, may so vary in a comparatively short space of time as to completely upset former reasoning, and warrant farmers in altering their plans. Leaving farmers

to decide for themselves, after due consideration of the circumstances of the particular time and locality, as to the method of utilisation that will afford them the best return for the milk, we devote our attention here solely to describing the details to be gone through

in each of the methods of utilisation pursued.

Consumption and Selling of Whole-milk.

When the milk is to be consumed on the farm, or sold as new milk, very little manipulation in the dairy is required. In the former case it may be measured out to the consumer just as it leaves the cow-house.

In the latter case, the milk should be run through the refrigerator as soon as it is taken to the dairy. In view of a journey by road or rail, the immediate cooling process, down to 50° or 55°, is very desirable. In fig. 420, the refrigerator is shown standing upon a railway milk-can, into which the milk runs as it leaves the refrigerator, and in which it is then removed to its destination.

Milk-selling Trade.—The selling of whole-milk for consumption in towns and villages has grown into a business of very large proportions. And as the taste for milk-food grows amongst townspeople—it is growing fast, and will surely enough continue to do so for many years—the milk-selling trade will go on increasing. In some cases the milk is conveyed from house to house by the farmer. The general custom, however, is to consign the milk and deliver it by road or rail to extensive milk-sellers, who contract with farmers for a certain supply during the year or season.

Cleaning Dairy Utensils.—With this system of disposal no other dairy work is involved, excepting, of course, the cleaning of the vessels used in conveying the milk. This latter is a most important matter, which should be attended to with the greatest care. Wash and scald the utensils thoroughly as soon as they come into the dairy empty. Upon no account leave any dairy utensil dirty over-night.

Milk for Calves.—The system of feeding whole and skim milk to calves is so fully dealt with in the chapter on calf-rearing, pp. 30-46, Divisional vol. iii., that no further reference need be made to the subject here.

CREAM-RAISING.

An important piece of dairy work is the separating of the cream from the milk. The manner in which this process

is carried out has much to do with the success of dairying, more perhaps than is generally recognised.

Principles of Cream-raising.—The term *cream-raising*, which is extensively used, affords in itself an indication of the theory of the process of separating cream from milk. The factors involved are specific gravity and temperature. Cream is the lightest ingredient of milk, and therefore rises to the surface. The period of time which the cream requires to make its way to the surface depends largely upon the influence of temperature. Water is the largest element in milk, fat the chief ingredient of cream. Water is a better conductor of heat than fat—the former expanding with heat and contracting with cold rather more quickly than fat. Thus it happens that with a falling temperature, and the water in the milk cooling and contracting—increasing in specific gravity—more rapidly than the fat in the cream, the latter is more quickly forced to the surface. On the other hand, when the temperature of the mass is rising, the difference in specific gravity between the milk and cream becomes less, and collecting of the cream on the surface therefore slower.

The discovery of these facts has been of great service to dairy farmers, for it has enabled them to so manipulate the forces of nature as to raise the cream much more speedily than was attainable in former times.

In practice it is found that the sudden cooling of milk, as soon as it is drawn from the cow, retards the rising of the cream, while the setting of the milk, while it is warm, hastens the process.

Methods of Raising Cream.—At one time the setting of milk in shallow pans was almost universal in this country. Now, however, several other methods of raising cream are in use, and some of them have unquestionable advantages in their favour. The deep-pan system has many advocates, and so likewise have the centrifugal separator, the “Jersey creamer,” the “Speedwell” cream-raiser, the “Dorset” system, and the Devonshire scalding system.

Shallow-pan System.

This system, the oldest of all, is still pursued by many successful farmers.

The theory of this plan is that by setting the warm milk in pans from 2 to 4 inches deep in a cool milk-room, the temperature of the milk will rapidly fall, and thus accelerate the rising of the cream. With a steady temperature of about 58° to 60° in the milk-room, this shallow setting gives satisfactory results, raising almost the whole of the cream within from 24 to 30 hours.

Airing Cream.—It is believed that the butter made from cream raised on these shallow pans is rendered superior to what it would otherwise be by the cream being brought freely into contact with a pure cool atmosphere in the process of rising. This was confirmed by the late Professor Arnold, who stated that "cream makes better butter if raised in cold air than in cold water. . . . The deeper milk is set, the less airing the cream gets while rising."

Disadvantages of the Shallow-pan System.—The chief disadvantages of this system are—(1) that it is liable to be rendered unsatisfactory by changes of temperature in the milk-room, (2) that it requires a great deal of shelving space for the setting of the milk, and (3) that it also involves much time and labour.

Temperature and Shallow Pans.—In the first place, if the temperature of the milk-room rise to unusual height, to anything over 60°, the milk is liable to become sour very rapidly, perhaps before all the cream has risen. Then by exposure to a temperature warmer than itself the cream is liable to absorb impurities. The importance of this latter point was enforced by the late Professor Arnold, who wrote: "While milk is standing for cream to rise, the purity of the cream, and consequently the fine flavour and keeping of the butter, will be injured if the surface of the cream is exposed freely to air much warmer than the cream. When the cream is colder than the surrounding air, it takes up moisture and impurities from the air. When the air is colder than the cream, it takes up moisture and whatever escapes from the cream. In the former case the cream purifies the surrounding air; in the latter the air helps to purify the cream."

The depth of setting, Professor Arnold added, "should vary with the tempera-

ture: the lower it is the deeper the milk may be set; the higher, the shallower it should be. Milk should never be set shallow in a low temperature nor deep in a high one."

Then if it should happen that the milk-room is unusually cold, under 50°, the milk may have to stand for 48 hours, and even then the whole of the cream may not have risen. The loss of a certain percentage of cream is not the only result of this slow rising of the cream. A great deal of shelving space must be provided for the milk, and this on a large dairy farm might involve considerable expense. Then the skim-milk will not keep so long sweet as if it had been separated sooner, while the labour in skimming and cleaning so many pans is also an item worthy of consideration.

Shallow Pans.—The pans in which milk is set in the shallow system consist of either stoneware, tinned iron, or wood. Common stoneware is the least durable

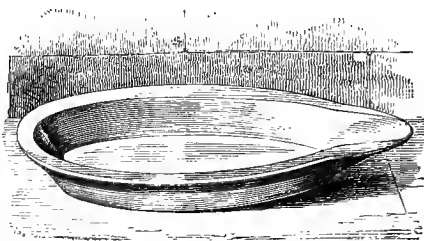


Fig. 422.—White Wedgwood-ware milk-dish.

of the materials employed, and is not now so extensively used as in former times. The harder and better finished varieties of stoneware are preferable.

Fig. 422 represents an excellent milk-pan made of white Wedgwood ware, oval in shape, 16 inches long and 3 inches

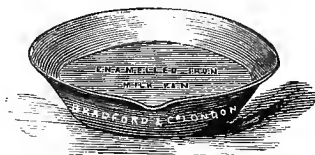


Fig. 423.—Enamelled iron milk-pan

deep inside measure. Milk-dishes of this material are wonderfully durable, nice-looking, and easily kept clean.

The form of milk-pan now most

common, and perhaps on the whole the best, is shown in figs. 423 and 424. The former has a mouth to facilitate pouring.

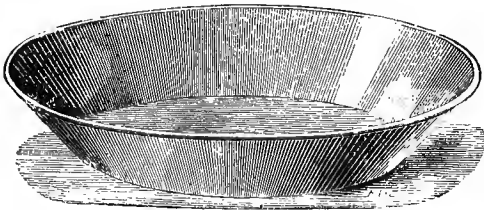


Fig. 424.—Iron milk-pan.

This pan is made of tinned iron, and similar tins are made of block tin stamped in one piece, or of iron with enamelled interior, and with or without a lip to pour out the milk by. This material admits of perfect cleanliness, while it is practically unbreakable.

Zinc Unsuitable.—Zinc or galvanising should never be used on dairy utensils, except perhaps on outside parts, where the milk or its products do not come into contact with the metal. Milk always tends to sour, the souring being due, as we have seen, to the formation of lactic acid from the milk-sugar by the fermentive action of a particular germ—the *Bacterium lactis*—which is always present. The acid so formed has a great affinity for zinc, forming zinc lactate, a substance which is highly poisonous, giving rise to nausea and vomiting.

Milk-sieve.—Another utensil required in a dairy is a milk-sieve, fig. 425, which consists of a bowl of tin-

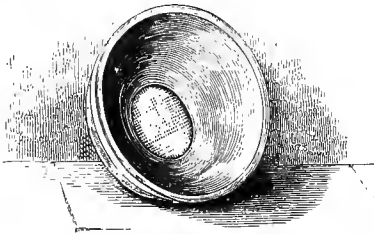


Fig. 425.—Milk-sieve.

ware, 9 inches in diameter, having an orifice covered with wire gauze in the bottom for the milk to pass through, and to detain the hairs that may have

fallen into the milking-pails from the cows in the act of milking. The gauze is of brass wire, and, when kept bright, is safe enough; but silver wire is less likely to become corroded.

The straining of the milk through a sieve such as this, should in all cases be the very first operation after the milk is drawn from the cow. A very useful strainer is made for attaching to the side of the milk-pail.

Skimmer.—The creaming-dish, fig. 426 (Dairy Supply Co.), also of tin-ware, skims the cream off the milk. It is thin, circular, broad, and shallow, having on the near side a sharp edge to pass easily between the cream and milk, and a mouth is formed

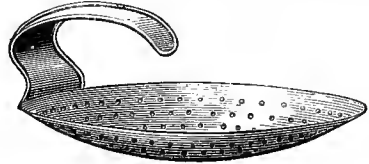


Fig. 426.—Cream-skimmer.

for pouring the cream into any vessel. At the bottom are a number of small holes for milk to pass through.

Cream-jar.—In small dairies the cream, until churned, is usually kept in a jar of stoneware, such as is shown in fig. 427, which is about 18 inches in height and 10 inches in diameter, with a movable top, having an opening in its centre, covered with muslin to keep out dust and let in air.

Shelves.—The shelves in dairies should be made of materials easily and quickly cleaned.

Wooden shelves are easily cleaned, but are too porous and warm in summer.

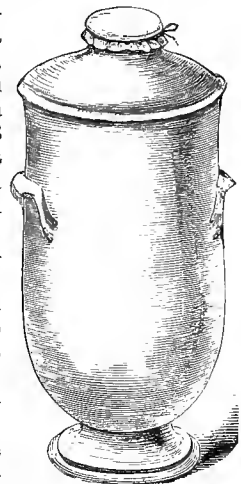


Fig. 427.—Cream-jar.

Stone ones are better, but must be *polished*, otherwise they cannot be cleaned

Movable Milk-stands.—In many dairies movable milk-stands have taken the place of fixed shelving. These stands are made of iron, and are in various shapes. Fig. 428 represents a very convenient stand, in which the discs revolve, so as to facilitate the turning of the pans for skimming.



Fig. 428.—Movable milk-stand.

without being rubbed with sandstone. Marble or slate shelving is the best for

warmed up higher, is rapidly reduced in temperature, and, as already explained (page 479), this falling temperature hastens the rising of the cream to the surface.

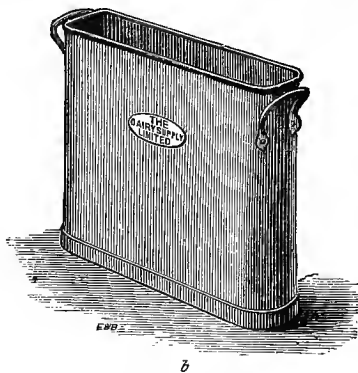
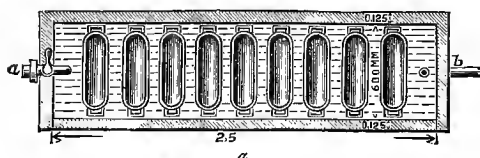


Fig. 429.—Swartz system.

a Trough with pans immersed in water. *b* Empty pan.

coolness and cleanliness combined, and now neither is expensive.

The Cooley System.—In the Cooley system, somewhat similar to, but in most respects an improvement upon the Swartz plan, a lid is fitted to each can on the principle of the diving-bell, so that the cold water is allowed to rise over the top. Slips of glass are fixed into the sides of the cans to show the depth of the cream, and taps are provided to run off the milk. Fig. 430 (for which we have to thank the Dairy Supply Co.) indicates the arrangement of the Cooley system.

Swartz and Cooley Systems Compared.—The main principle in the working of these two systems is the same—the accelerating of cream-raising by a falling temperature in the milk. The pans are about 20 inches deep, and in both the cream will have risen in about 12 hours. The main difference is in regard to the exposure and

enclosing of the cream and milk, as to which there is some difference of opinion.

Atmospheric Influence on Cream.—In the Swartz system, as we have seen, the pans are open at the top.

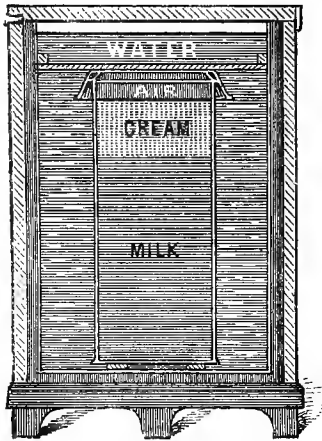


Fig. 430.—Cooley system.

Some regard this as an advantage, holding that the exposing of the cream to the air has an influence which improves the butter. Others, again, prefer the Cooley system, mainly for the very reason that in it the pans are closed and submerged, so that atmospheric impurities and changes are entirely prevented from coming into contact with the milk and cream. The condition of the atmosphere immediately around is the regulating influence. Exposure to a *pure*, cool atmosphere is beneficial to cream; contact with impure, hot air is distinctly the opposite. It is therefore claimed that the Cooley system is more to be relied upon in securing uniformly good results, in spite of impurities and changes in the atmosphere.

Ice used in Summer.—For these two systems, especially in the open Swartz trough, ice has to be employed in summer unless cold spring water is available.

Advantages of Deep Setting.—The setting of warm milk in deep pans in cold water economises time, labour, and space, and lessens the risk of injury to

the cream from impurities and changes in the atmosphere.

Disadvantages of Deep Setting.—The appliances are more costly than for shallow setting, and the providing of the necessary supplies of water (and ice in summer) may be troublesome and costly. The improvement imparted to butter by the free exposure of the cream, when rising to a pure, cool atmosphere, cannot be so fully obtained in the deep as in the shallow pans.

Devonshire Scalding System.

The Devonshire system of raising cream by scalding is of long standing. Fig. 431 (Dairy Supply Co.) represents the appliances employed in this system.

Method of Working.—The milk is first set in the ordinary way in pans in a cool dairy (temperature about 60°), and at the end of about twelve hours the pans are placed on a stove, as shown in the figure, and the milk scalded to a temperature of about 180°—until the surface of the cream becomes wrinkled—when the pans are removed. The milk and cream are allowed to cool, when the cream is removed and put into crocks or jars, in which it becomes thick and clotted.

Merits of the Scalding System.—

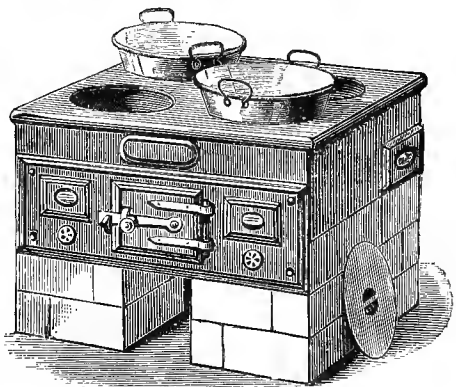


Fig. 431.—Devonshire cream stove.

This method of scalding raises more cream than would be obtained in the ordinary setting system. The butter is very easily made, and the scalding has the effect of purifying the cream and making it keep longer sweet.

Jersey Creamer.

One of the best known and most useful of modern contrivances for the speedy and effective separation of cream from milk is the Jersey creamer, shown in fig. 432. This provides an ingenious and admirable combination of the old shallow-

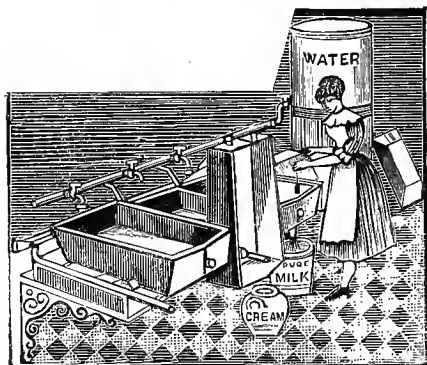


Fig. 432.—*Jersey creamer.*

pan system and the modern idea of exposing the milk to a cooling current of water. The pans have double sides, ends, and bottoms, with intervening spaces to permit the circulation of hot or cold water.

Method of Working.—The milk is put into the pans as soon as drawn from the cow. If it is not below 90° Fahr., it may be at once submitted to the cold current; but it is a speedier method to first run boiling water through the spaces around the pans, and thus raise the milk to about 110°. The hot water is then drawn off, and cold water run through until it is found that the milk has fallen to about the temperature of the water. The water should not be higher than 58° or 60°, nor lower than about 45°.

By this method of first heating the milk, the cream will rise in from 12 to 15 hours. Each pan is fitted with a tube, having at its lower end a very fine sieve, through which the skim-milk passes, leaving the cream in the pan, from which it is taken by removing the tube and stopper, or by simply tilting the pan forward on its hinges.

The lids are constructed to act as ventilators, and greatly assist the raising of

the cream. They will allow all gases to escape; but at the same time prevent dust, flies, and every animal coming into contact with the milk.

Merits of the Jersey Creamer.—The Jersey creamer is admirably suited for average dairies, on a small or moderate scale. It is inexpensive, simple, and thoroughly efficient. The whole of the cream is obtained by this plan—perhaps from 10 to over 20 per cent more than by the ordinary method of setting and hand-skimming.

Speedwell Cream-raiser.

This is an ingenious and most valuable invention, which raises cream in a remarkably short time—in from 2 to 3 hours. Its construction is shown in fig. 433.

Method of Working.—The warm milk is put in to cover the series of cells, marked c in fig. 433. The whole pan is then set into a bath of water as cold as can be got, and milk is poured in till the surface of milk rises to the upper line of the slip of glass at A.

Method of Skimming.—When the cream has risen, it is removed by a skim-

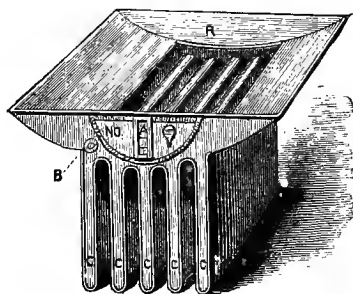


Fig. 433.—*Speedwell cream-raiser.*

mer, as shown in fig. 434. A careful hand will remove the whole of the cream at one course of the skimmer. When it is desired to leave some portion of the cream in the skim-milk, a little of the skim-milk is drawn off through the pipe at B before the skimming takes place.

Merits of the "Speedwell" System.—The rapid falling of the temperature of the milk is the stimulating influence in raising the cream here also. This ingenious dairy appliance is both simple and efficient, and is a wonderful econo-

miser of time in the raising process. It is made in different sizes, a small one of 1 gallon capacity being provided to suit the single-cow dairy. By the use of this appliance and the "Speedwell" crystal

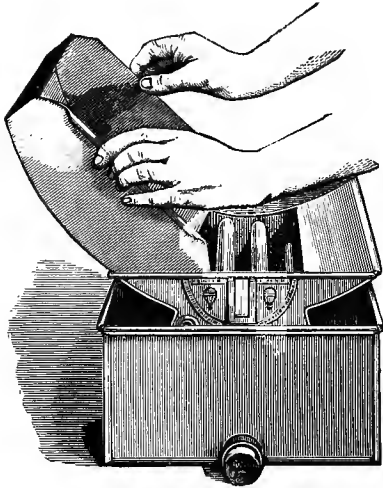


Fig. 434.—Speedwell method of skimming.

churn (fig. 444), cream may be consumed as butter from 3 to 4 or 5 hours after it leaves the cow.

Similar other Methods.

There are some other useful appliances for raising cream rapidly, all working on principles similar to those already described. The "Dorset" and the "Richmond" cream-raisers are both well spoken of, the former, in particular, being very largely used with excellent results.

Centrifugal Separator.

But the most remarkable and most useful of all the modern contrivances for separating cream from milk is unquestionably the "centrifugal separator." By the use of this admirable invention the cream and milk can be separated immediately upon leaving the cow.

Method of Working.—There are several patterns of this machine, all working upon similar principles. They were first manufactured on the Continent, but they are now made in this country by Mr John Gray, Stranraer, N.B., Messrs Freeth & Pocock, London, and others.

VOL. II.

In fig. 435 the De Laval separator is shown at work. The new milk fresh from the cow is fed in at the top in a regulated quantity by the tube shown, and falling into a chamber which revolves with great velocity—from perhaps 2000 to 4000 revolutions per minute—the cream, because of its lighter weight than that of the rest of the milk, is thrown to the inner surface, and escapes by the higher of the two exit-tubes shown. The skim-milk, thrown to the outer part of the drum, passes out through the other tube. The separation of the

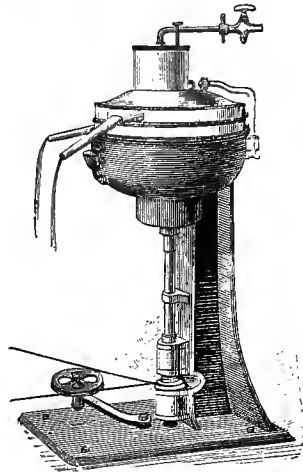


Fig. 435.—De Laval separator.

cream from the milk is practically perfect, and is performed with remarkable rapidity. The machine illustrated in fig. 435 will separate 150 gallons of milk per hour. By a form of the Danish separator made for very large dairies, over 200 gallons may be separated within an hour of the time the milk has been drawn from the cows.

The cream and milk coming from the separator are usually quite pure, dirt and other impurities being found adhering to the side of the bowl when the separator stops.

Power for Separators.—For the working of these larger separators, horse, water, or steam power is necessary. Regularity in speed is essential for perfect separation, and with horse-power this is difficult to obtain. A water tur-

bine-wheel is fairly suitable, but steam-power is most largely used. The De Laval separator is made with a steam turbine arrangement, with which only a steam-boiler is required to complete the means of separating.

The "Baby" Separator.—An ingenious form of the De Laval machine is the "Baby" separator, which was introduced into this country by the

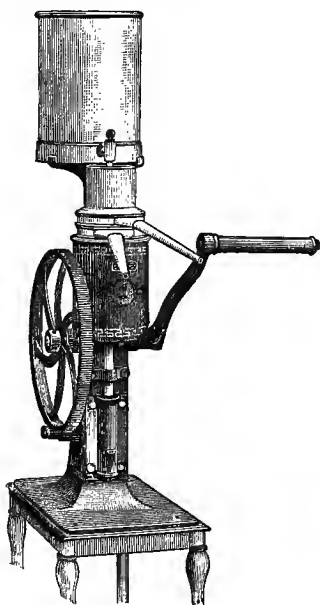


Fig. 436.—"Baby" separator.

Dairy Supply Co. This most useful little machine, which is shown in fig. 436, is adapted for hand-power. Driven steadily, by a strong girl or lad, it will separate from 12 to 20 gallons of milk in an hour. It is a valuable acquisition for small dairies.

Advantages of the Separator.—The advantages which may be derived from the use of the centrifugal separator are of great importance. In the first place the work of the dairy is facilitated and simplified, for the setting and skimming are done away with. The cream and skim-milk are obtained separately in a perfectly sweet and fresh condition, and therefore more suitable for marketing than if the slower system of setting and skimming had been followed. Then—

and this is assuredly a consideration of great importance—the separation is so thorough, that, while practically no cream is left in the skim-milk, only the smallest percentage of casein is thrown off with the cream. The latter point is one of especial value, for it is well known that the presence of casein in butter tends to impair its quality and keeping properties.

One of the chief merits of the centrifugal separator therefore is, that by its use the maximum quantity and highest quality of butter may be obtained.

Selling Cream and Skim-milk.

Since the introduction of the centrifugal separator a large and growing trade has arisen in the selling of sweet cream and sweet skim-milk.

Separated Cream.—The inhabitants of towns and villages have a keen relish for sweet cream for tea, fruit, and puddings, and the separated cream is admirably fitted to supply this demand. The cream removed by the centrifugal separator is of course thinner—as indeed is the cream in all the rapid systems, whether by centrifugal force, or a falling temperature—than is the thick cream, which is obtained in the old method of setting and skimming, but it is much fresher, more wholesome, and will keep longer sweet.

"Speedwell" Cream.—The "Speedwell" cream-raiser is also likely to increase the use of fresh cream, as by it the cream can be obtained in a perfectly sweet and most palatable condition. Fig. 437 shows an excellent contrivance for cooling and aerating the cream, provi-

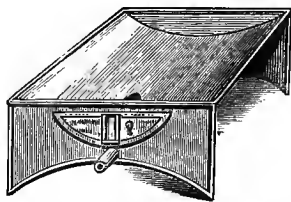


Fig. 437.—Speedwell cream-cooler.

sion being made in the bottom for drawing off skim-milk.

Preserving Cream.—One difficulty in the sweet cream trade is that of prevent-

ing the cream from getting sour. Various methods are tried with the view of overcoming this difficulty. The introduction of a little boracic acid into the cream has the effect of keeping it fresh longer than would otherwise be the case. Others adopt the more troublesome expedient of enclosing the cream in hermetically sealed tins of various sizes, containing quantities suitable for family and hotel use.

Devonshire Clotted Cream.—The system of scalding the whole-milk, which has been so long associated with the county of Devonshire, tends to strengthen the keeping properties of cream. The scalding destroys or impairs ferments in the whole-milk, and this followed by the cooling of the cream to a low temperature, perhaps 40° to 50° , tends to preserve the cream. This scalded cream becomes unusually thick and clotted, and is largely sold for family use in London and elsewhere. It is retailed in sealed tins, or small or large jars, which should be kept, in the shops, in suitable refrigerators. The system of scalding cream in Devonshire is described on page 483 of this volume.

Separated Milk.—The milk which is deprived of its cream by the centrifugal separator is no doubt poorer in a sense than milk skimmed in the old way, for, as a rule, by the latter system, less or more of the butter-fat is left in the milk. But if the separated milk loses in fat it gains in freshness. It is in a better condition for selling, and for consumption both by man and beast, than if it had sat perhaps till acidity had begun. And if it is desired to have the separated milk enriched with a little of the butter-fat, the separator can be set to provide for this.

But it should be remembered that, after all, the most nourishing and strength-giving ingredients of the milk, as it leaves the cow, remains in the milk after the cream has been removed. What it has lost in the butter-fat can be easily made up by other articles of food, and assuredly there is no more healthy or muscle-making food than plenty of fresh skim-milk. Happily its consumption amongst townspeople, to drink by itself, and for use in puddings and other food, is decidedly on the increase.

BUTTER-MAKING.

The next steps to the separating of the cream and milk are the ripening of the cream and the making of butter. In some parts of the country, as will be afterwards mentioned, the whole mass of milk and cream is churned, but the prevailing custom is to churn the cream only.

Ripening Cream.—No matter how the cream may be raised and removed from the milk, it should be “ripe” before being churned. This condition of “ripeness” in cream is rather indefinite. Widely prevailing opinions among high authorities are to the effect that the proper ripeness consists merely in the mellowing of the cream by exposing it for a few days to the oxygen of the air; that the cream should be churned before it becomes decidedly sour; that after it has become sour, further ripening deteriorates the cream; that butter from sour cream is not usually of the highest quality, because of the acidity in the cream injuring the delicate and volatile flavouring oils; that churning should take place the moment the slightest indication of acidity becomes apparent, indeed *just before* that, if this fine point—the approach of acidity—could be determined.

In practice it is very common to find the cream quite sour before being churned. The fact that sour cream needs less churning than sweet no doubt favours the practice of letting the cream become sour. At any rate, it is true that the main bulk of the butter of commerce, even those Continental brands most highly esteemed in the London market, is made from cream which is allowed to become less or more sour before being churned. The ripening is, indeed, the first stage in the souring process. As to the exact point in this process at which the cream should be transferred to the churn, experience will be one's best guide. Keeping in view the consideration as to the effect of over-ripening here mentioned, one should watch the results carefully, and regulate the practice so as to obtain the maximum production of the choicest butter.

Period of Ripening.—Cream ripens more quickly in summer than winter—a

high temperature exciting the activity of the organisms ("bacteria") in the cream, which give rise to fermentation. In a temperature at about 60° Fahr., cream ripens quickly, and may be ready for churning in from 12 to 20 hours. In a temperature as low as 45°, double that time may not be sufficient without assistance to the souring.

Cream which has been raised slowly in the open-pan system needs very little after ripening, and yet many leading dairymen consider that even this cream gives better butter and more of it by being kept mellowing in a cool temperature for a few days.

Cream which has been removed from the milk by the centrifugal separator or some of the other speedy systems, necessarily requires longer to ripen, unless some artificial souring is introduced. This fresh separated cream is usually exposed in a temperature of from 55° to 60°, with a muslin rag thrown over the mouth of the jar or vessel holding the cream, to keep out impurities and secure ventilation. Cream set to ripen should be stirred frequently, perhaps three times a-day.

Uniform Ripening of Cream.—It is very important that the mass of cream to be churned at any time should be as uniformly ripened as possible. This is most easily secured of course where the churning takes place daily or frequently. It can be fairly well obtained however by care in the mixing of the cream as it is removed from the milk. Each "creaming" should not have a separate vessel to itself unless it is to be churned by itself. The better plan is to have a cream-holder sufficiently large to hold all the cream to be churned at one time, and as each quantity of fresh cream is added, the whole should be thoroughly stirred, the stirring being perhaps repeated once or twice between the times of creaming.

In large dairies, where there is more cream to handle than could be conveniently kept in one vessel for each churning, the cream may at each creaming be evenly divided over any number of vessels.

This uniform ripening of all the cream in one churning is essential to obtain

both the greatest quantity and the choicest quality of butter. The reason is not far to seek. Ripe cream passes into butter more quickly than fresh cream. Then with a quantity of ripe and a quantity of fresh cream in one churning the former would be over-churned before the whole of the butter-fat in the other would be transformed into butter. The result is usually a compromise, a little over-churning of the ripe cream and a slight under-churning of the fresh cream. Avoid the evils of this compromise by attending to the proper mixing and uniform ripening of the cream.

Artificial Ripening.—When it is desired to hasten the ripening of cream, this may be done by the addition of a small quantity of sour cream or buttermilk. The precise quantity of this sour matter to be added cannot be stated with safety for all cases, the lower the temperature the fresher the cream, and the milder the sour cream or buttermilk to be added the more will be required to make the ripening process go on rapidly. In Danish and Swedish dairies, where large quantities of excellent butter are made with admirable uniformity, a general practice is to add about 3 per cent of buttermilk to the cream, raise the cream to a temperature of about 63° Fahr., and churn after an interval of about 19 hours.

Salt in Cream.—In some instances salt is put into the cream before churning. Mr Thomas Nuttall, Beeby, Leicestershire (Lecturer on Dairying at the Royal College of Agriculture at Cirencester), puts in 1 lb. of salt to every 10 lb. of cream, and he considers that when the cream is ripened and treated in this way he gets better butter and a bigger yield—10 lb., where only 9 lb. would have been made in the usual way. The salt passes out in the buttermilk, which has to be sacrificed, as it is found useless even for pig-feeding. This practice, however, is quite exceptional, and is contrary to the experience of others.

Sweet-cream Butter.—For immediate consumption, butter made from sweet, imperfectly ripened cream, is by many preferred to butter from sour or well-ripened cream. But it does not keep so well as the latter, and the weight

of butter from a given quantity of sweet cream will be less by from 3 to 6 (perhaps even more) per cent than from the same quantity of sour cream.

Keeping Cream Sweet.—It has been stated that cream, which has been carefully ripened or mellowed for churning, is still sweet to the ordinary palate. That is, it is not appreciably sour. To preserve this sweetness in the cream while it is ripening, the cream should be kept in a cool place, and some add a little saltpetre or other preservative prepared for the purpose.

Times of Churning.—It is a common practice to churn only once a week. Others think it preferable to churn twice, and many do so three or four times a week, or even daily. In the majority of cases of churning once or twice a week, the whole of the cream then in the dairy, excepting that taken off on the previous day and day of churning is well mixed together and churned. The fresh cream is usually held over till the next churning. The times of churning must of course be regulated by local circumstances, such as the quantity of cream to be handled and the demand for butter.

Temperature of Cream for Churning.—There is not a little difference of opinion, amongst both theoretical and practical butter-makers, as to what should be the temperature of cream when put into the churn. Fortunately, it would seem that upon this point some latitude may be allowed without seriously injuring the produce. Much, of course, depends upon the temperature of the churning-room. From 55° to 58° in summer, and from 58° to 63° in winter, are common ranges of temperature for the cream just on being put into the churn—56° to 58° in summer, and 60° to 62° in winter, are perhaps most general. Some prefer to keep the dairy at the same temperature—about 58° to 60°—in summer and winter, and so churn the cream at the same temperature all the year round.

A high temperature hastens churning—the “coming” of the butter—but it tends to make the butter soft. A low temperature prolongs churning, with no appreciable benefit to the butter. Therefore seek for the “happy medium,” which

all teachers of dairying invest with much importance.

In Denmark the cream is usually churned at a slightly lower temperature than in this country—from 50° to 56°.

Churning Whole-milk.

The old-fashioned system of churning the entire milk as it comes from the cow, still holds a strong footing in several parts of the country, notably in the north of Ireland and south-west of Scotland.

Advantages.—The chief advantages claimed for the churning of the whole-milk are, that less dairy space and milk-setting appliances are required, that in certain districts more money can be obtained for the buttermilk than for skim-milk, and that more butter is obtained than where the milk and cream are separated, and only the latter churned. There is, no doubt, a saving in outlay for buildings and utensils, but the last advantage claimed is not now of universal or even general application.

In all probability a little more butter may be obtained by churning the whole-milk than when the cream is skimmed off by hand, as by this latter system some small portion of the butter-fat may be left in the skim-milk, and thus escape the action of the churn. But with the more effective methods of raising and removing cream, such as the “Jersey creamer” and the “centrifugal separator” (which practically separate the entire quantity of butter-fat in the milk), the churning of the whole-milk will not compare favourably, even in regard to weight of butter, while as to quality, it is as a rule inferior.

The improved contrivances for more speedily and effectually separating the cream from the milk have removed the strongest argument in favour of the churning of the whole-milk.

Disadvantages.—Amongst the reasons urged against the churning of the whole-milk are, that it involves a great deal of labour in churning such a large quantity of fluid, that the skim-milk is all in the form of very sour buttermilk, for which in many parts there is a poor demand, and that the butter is liable to be injured in quality by containing too much water. The butter made in this

way is more difficult to work, so as to effectually remove the water and the casein of the milk, with which it has been in close contact in the churn. Indeed, it is undeniable that it is more difficult to make first-class keeping butter in this way, than where only properly ripened cream is churned.

The buttermilk finds a ready sale in large towns for human food, but in the country districts the demand for this purpose is of course very limited. It is useful for feeding pigs, but not suitable for calves. There is this difficulty in profitably utilising large quantities of buttermilk.

Method.—In preparing the whole-milk for churning it is necessary that it should be well soured. If churned while sweet a good deal of the butter-fat may remain in the buttermilk. A little buttermilk is often poured in amongst the fresh whole-milk to hasten its souring, but this is not a good plan, as the buttermilk is liable to contain organisms that would be detrimental to the butter. If any artificial aid to ripening is necessary, it should be introduced in the form of a little whole-milk, which had been set aside to ripen for the purpose.

Continental Method.—By carefully regulating the temperature of the dairy and the depth of the milk in the butts, Continental dairymen, who churn the whole-milk, secure the proper degree of ripeness without introducing any ferment. For this purpose they keep the temperature of the milk-room somewhere between 45° and 59° Fahr. If the temperature is low, say between 45° and 50° Fahr., the milk should be filled into the butt to a depth of about 24 to 28 inches. If the temperature is higher the milk should be set shallower, so that when the maximum temperature of 59° Fahr. occurs the depth of the milk should not be more than from 12 to 16 inches.

The milk should be put into the butt just as it comes from the cow. No previous cooling is necessary, nor is it advantageous, as it retards the ripening too much. Should the butt not be big enough to hold an entire milking, the milk should be divided between two butts, but quite equally, so that the ripening may go on at the same pace in both, for unequally ripened milk

makes bad butter. If the temperature of the room rises higher than 59° Fahr. the milk should be cooled, and if it should be too cool the milk must be heated, otherwise there will be imperfect ripening and consequent loss of butter. In about thirty-six hours the milk will likely have attained the proper degree of ripeness, and then, before being put into the churn, it is thoroughly mixed, so as to be rendered quite homogeneous.¹

CHURNS.

It has been facetiously remarked that the dairy farmer may now have almost as much scope and freedom in selecting a churn as in choosing a wife! By this of course is meant, that, as with those who would be helpmates to the dairy farmer in all his affairs of life, there are very many patterns of churns, the majority of which are almost all equally well qualified to perform the important and delicate duties devolving upon them.

How many first-class churns there are in the market at the present day we do not venture to say; and to carry the above comparison a little further, it would perhaps be almost as unsafe and invidious in the one case as in the other to attempt to place in order of merit the claimants to the favour of the dairy farmer. With this additional remark we let the simile drop—that it is well for the dairy farmer that his wants are thus so admirably provided for.

But while we should not presume to draw up a list of the first-class churns in order of merit, we think it may be useful and interesting to illustrate and indicate the working of two or three of the well-known churns.

Types of Churns.—In general use throughout the country there are three types of churns less or more distinct: (1) those in which the fluid and the containing vessel with its agitators (if it has any) are in rotative motion; (2) those in which the containing vessel is at rest, and the agitators in rotative motion horizontally; and (3) those in which the containing vessel is at rest, and the agitators in rotative motion vertically.

¹ Dr A. P. Aitken on "Butter-making."

The old-fashioned *plunge-churn*, in which the agitator is worked by hand upwards and downwards in a stationary cylinder of cooper-work, is never seen now in a well-equipped dairy. It is still employed on some farms where dairying receives little attention, and where few dairy improvements have been introduced. It is heavier to work, and altogether inferior to the modern barrel

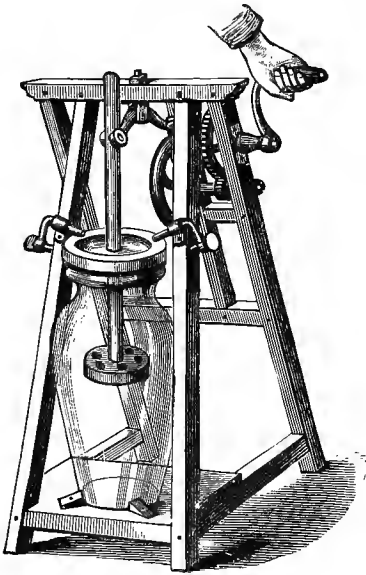


Fig. 438.—The "ladies' "plunge-churn.

churns. A modification of the plunge-churn, designed for easy working, is shown in fig. 438 (Dairy Supply Co.)

Barrel Churns.

The barrel churn in one form or other is now the most largely used. It may be formed in the actual shape of a barrel, hooped with iron, as shown in figs. 439 and 440, or in an octagonal box shape, as in fig. 441.

Ordinary Barrel with Beaters.—This popular churn, fig. 439 (Dairy Supply Co.), has fixed beaters, secured in an oblique direction and perforated, so as to produce the maximum amount of butter, and also be easily driven.

One drawback to this pattern is that the opening to admit of the removal of the butter and the cleaning of the churn is usually too small to be quite convenient.

End-over-end Churn.—This very efficient churn, shown in fig. 440 (John Gray, Stranraer), provides the great convenience of easy access into its interior.



Fig. 439.—Barrel churn.

One of the ends of the churn is made so that it may be entirely removed, and the freedom which is thus afforded the worker is of great importance, not only in the cleaning of the churn, but also in

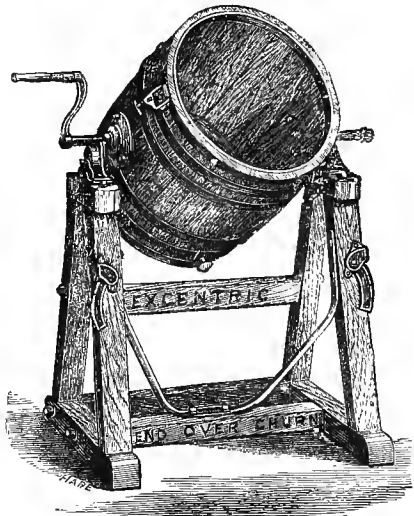


Fig. 440 — End-over-end churn.

removing the butter. The axles are fixed so as to give the barrel an eccentric end-over-end motion.

Churns of this pattern have usually

been made to work without any agitators inside. In this case it is found that while the working is almost perfect when the churn is not more than about one-third to half full of cream, it is difficult with a larger quantity of cream to obtain sufficient agitation throughout the entire mass to transform the whole of the butter-fat into butter.

Dashers or no Dashers.—Upon this particular point as to the advantages or disadvantages of internal "dashers," "beaters," or "agitators," there has been a good deal of discussion. It was argued, on the one hand, that the dashers injured the grain of the butter, and, on the other, that without agitators the full produce of butter could not be obtained. There is still difference of opinion, but, while it is conceded that the end-over-end eccentric churn without agitators makes excellent work when under half-full of cream, yet in general practice the dashers are more than holding their own. In the improved churns the dashers are designed so as to minimise or avoid injury to the butter.

Mr Somerville of Sorn states that he has found that any danger of having the butter-grains injured by the dashers is averted by using in the Holstein—an upright stationary barrel—a dasher which does not extend quite to the top of the churn. He mentions that the butter particles rise to the surface as they form, and thus do not come into contact with the dasher as it works below in the buttermilk, driving up any butter-fat not yet granulated. With dashers of this form he prefers a stationary to a revolving churn.

Diaphragm Churn.—The introduction of Bradford's "Diaphragm" into barrel churns has been attended with very satisfactory results. The "Diaphragm," which is seen hanging upon the churn, A in fig. 441, forms a sort of central division in the churn, removable for convenience, but stationary in the churn. This central division neutralises the centrifugal force, and ensures the equal and thorough agitation of the entire mass of fluid. Professor Sheldon speaks highly of the action of the "Diaphragm," remarking that, "I do not ex-

pect that any system of beaters or dashers or mixers will ever be invented to supersede the 'Diaphragm.'"

In this churn, also, the opening is not so large as could be desired. A better form of churn, in so far as concerns the opening (for convenience of manipulating the butter and cleaning the churn), is that shown in fig. 442—Bradford's improved "Victoria" end-over-end churn, known as the "Charlemont Diaphragm churn," to which a one-hand butter-worker is conveniently attached. The "Charlemont" churn is made so as to work with or without the Diaphragm;

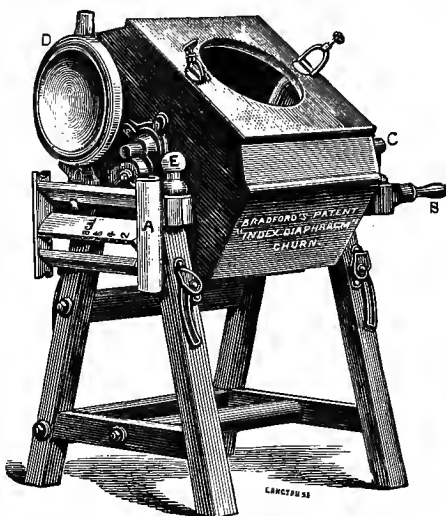


Fig. 441.—The "Index Diaphragm" churn.

- A "Diaphragm" dash as placed when not in use. When slid into the churn groove, it indicates the quantity of cream in the churn.
- B New patent spring handle.
- C Rest for left hand while churning with the right hand.
- D Lid, which is turned hollow to receive the butter from the churn.
- E Ring (when not in use) in socket rest.

but the makers remark that the experience of a week or two always shows conclusively that it makes a better quality of butter with the Diaphragm.

Other Forms.

Box Churn.—Box churns, such as that shown in fig. 443 (Bradford & Co.), represent the second class referred to. They are provided with agitators, and are well suited for small dairies.

Holstein Churn.—The Holstein churn is an example of the third class of churn

mentioned. It is an upright barrel, with agitators which revolve horizontally while the churn is at rest. The Holstein churn is extensively employed in large

churn, shown in fig. 444, consists of one or more glass jars or cells, mounted in a revolving frame—a frame adapted for sitting upon a table, or a wooden frame as in the figure—which is easily transformed into a butter-working table. This churn is very convenient for churning small quantities of cream in private dairies. A form of this ingenious churn is made in which the glass jars have a double casing, so that the temperature of the cream may be raised, lowered, or kept stationary in the process of churning by the vacant space between the two casings being filled with hot or

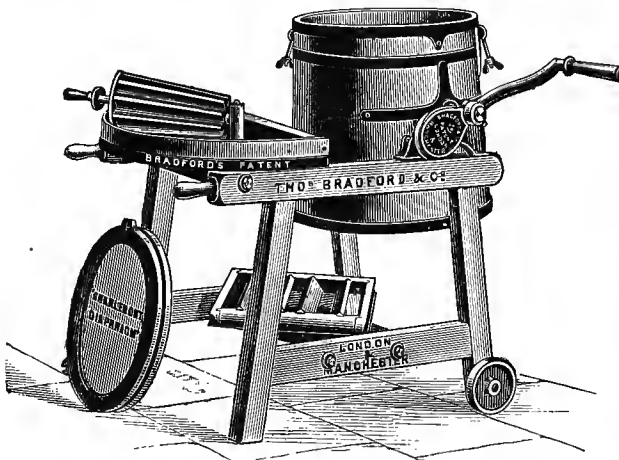


Fig. 442.—Charlemont churn and butter-worker.

factories and creameries, where a number of churns require to be driven separately from one shaft.

Streamlet Churn.—This churn, made of fire-clay enamelled, is extensively used for churning the whole-milk in the south-west of Scotland. It is usually made in large sizes, with dashers. It is rather

cold water. This is a valuable provision for churning in a high temperature.

Swing Churn.—There is still another sort of churn. It is in the form of a box or child's cot, and effects the churning by oscillation. It is used in a good many small dairies.

Important Features in a Churn.—While the farmer may exercise abundant freedom in the choice of the pattern of churn, there are a few important features which he should look for and insist upon. Amongst these are, that the churn should be easily cleaned, with no crevices wherein dirt may lodge and escape observation; that it should afford ample facility for removing the butter; that the churn may be easily ventilated; and that means should be provided for seeing the cream and ascertaining its temperature during churning. Light working as well as efficiency, should, of course, also have due consideration.

It is a good plan to have a small pane of glass in the churn through which to note the progress of the churning. And to permit the escape of gases evolved in the process of churning, there should be a ventilation valve in the lid of all churns.

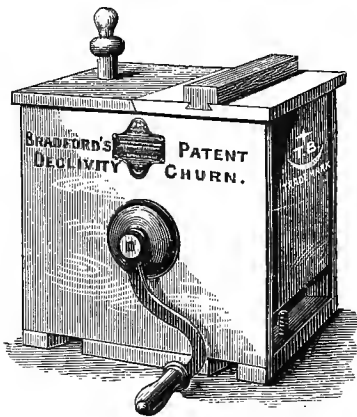


Fig. 443.—Box churn.

difficult to clean out, and for this purpose steaming is most effective.

"Speedwell" Crystal Churn.—This

Churning.

We now come to the details of churning. These require little explanation.

Preparing the Churn.—The preparation of the churn for the reception of the cream requires careful attention. It may be assumed that, after the previous churning, it had been thoroughly cleaned—first rinsed with cold water, then well scrubbed with boiling water, and again rinsed with cold. If it has not been in use for a few days, the churn may be scalded with hot water the day before churning. Some heat the churn with

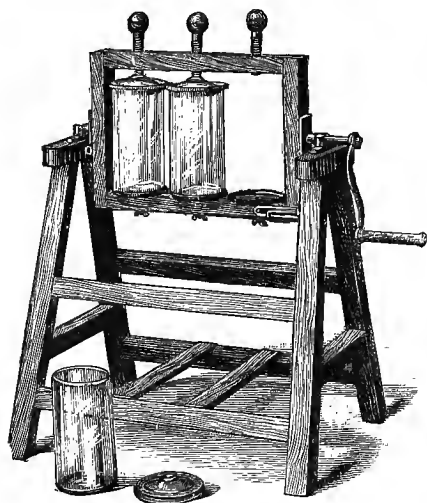


Fig. 444.—Speedwell crystal churn.

hot water just before putting in the cream. Others consider this a bad plan, and prefer to rinse out with water about the same temperature as the cream, or perhaps even two or three degrees lower than the cream. In cold weather the churn is frequently heated, and in hot weather cooled.

Upon the whole, perhaps the safest plan is to have the temperature of the churn just about the same as that of the cream to be churned, or a trifle below it, as the temperature of the cream rises a little, about 3° or 4°, with the friction in churning.

Some sprinkle a little salt in the churn before the cream is put into it, and others put salt into the water used in rinsing.

The object of this is to counteract any taint that may possibly be present.

Accelerating Churning.—“It is a good practice,” writes Professor Sheldon, “to pour acid buttermilk, say a pint to a gallon, into the churn along with the cream—buttermilk kept over from a previous churning. It has the effect of making the cream churn sooner, of producing more butter, and of hardening the butter, and clearing the colour of it. The finest sample of butter I have ever seen was produced in this way, in Ireland.”¹ Others maintain that this admixture of buttermilk would be liable to injure the butter.

Straining Cream.—To prevent, as far as possible, impurities getting into the milk, the cream is run into the churn through a strainer, perhaps a coarse linen cloth, well known as cheese-cloth. This cloth is dipped in clean water, and held over the mouth of the churn while the cream is poured into it. The thickest of the clotted cream will be held back, and impurities, such as dust and flies, will be prevented from getting into the churn.

The straining-cloth is washed without soap, and kept sweet by exposure to air.

Speed of the Churn.—The churning has now begun. The speed at which the churn should be driven has been the subject of much difference of opinion. In practice there is also considerable variation. The rate should vary with different churns, but should begin slowly and end slowly. From 40 to 60 revolutions per minute are common after the first few minutes, until the butter appears in granules. Mr Thomas Nuttall, using Llewellyn’s three-cornered churn without dashers, does not go beyond 35 revolutions per minute, driving even lower than that for a few minutes at the outset until the gas has evolved and escaped through the ventilator. Professor Sheldon considers that from 45 to 50 revolutions per minute should be the top speed with the ordinary barrel churn containing dashers; and that in hot weather seldom above 40, as the faster the speed the more the temperature of the cream will rise in churning, and in summer this should be avoided. With the Holstein vertical churn the rate

¹ *The Farm and the Dairy*, 76.

is often as high as 150 revolutions per minute after the first few minutes, and until the granules appear.

With very slow churning the butter is long in coming. With rapid churning the butter is liable to be soft and oily. With every individual churn, and in the varying circumstances of temperature and condition of the cream, the operator must exercise careful judgment as to the rate of speed in the churning.

Variation in Speed.—It is very important that for a few minutes at the outset, until the cream is broken and well mixed, the churning should be done slowly. After the first five minutes, until the butter-fat appears in the tiniest granules, there will be little danger, with a proper churn, of the fat-globules being injured by bruising, even although the rate of speed should be high. But the moment small granules are observed on the window of the churn, the rate should be slackened, and the churning completed at any easy speed.

With hand-worked churns it is easy to regulate the speed. Where horse or other power is employed to drive the churn, a difficulty has been encountered in varying the speed while the churning goes on. This difficulty has been overcome by the De Laval steam-turbine, and cone and friction pulleys are now arranged to give different rates of speed to the one churn.

Ventilation.—This must be carefully attended to in the first 8 or 10 minutes' churning. In the stirring of the cream at the outset, some gas is evolved, and the ventilator in the churn should be opened frequently during the first 10 minutes, to provide the desired ventilation.

Stop Churning.—The speed is lessened, we have seen, as soon as the butter-fat appears in tiny granules. This is a critical moment in butter-making. The old-fashioned method of plunging or grinding away with little variation, until the butter has collected in large lumps, is very injurious to the butter. The more tenderly it is manipulated while it is gathering, the better the butter.

As soon as the butter-granules attain the size of pin-heads—in no case larger than the grains of wheat—the churning

should be stopped. The butter, indeed, is already formed. It has now to be separated from the buttermilk and collected into a solid mass of pure butter—a process quite distinct from churning.

Time Churning.—The churning will probably have occupied from 30 to 40 minutes. With less time, there is a liability to softness in the butter; with much more the flavour is apt to be injured. During the time of churning, the agitation will raise the temperature by perhaps 3° or 4°.

Sleepy Cream.—Occasionally the complaint is heard from the dairy that the "butter won't come," "the cream is sleeping." Most probably the cause will be that the cream is too cold. Test the temperature with the thermometer, and if it is below 55° in summer, or 58° in winter, raise it to slightly over these points by immersing a vessel filled with hot water (fig. 419).

But the temperature may be high enough and still the butter, or a portion of it, may refuse to come. In this case also, scalding the cream may be effective. If not, the use of a little churning powder, which it is well to have at hand, will most likely make the sleepy, frothy cream give up its butter. Dr Aitken considers a little bicarbonate of soda (baking soda) as efficacious as any butter-powder.

This difficulty is most liable to occur in the cold months of the year, and may be due to various causes besides cold cream, such as the feeding of the cows on unwholesome or over-dry food, a sickly cow, dirty milk-vessels, or to cream from cows that have been long constantly giving milk.

Butter-working.

The working of the butter is an important part of the operation.

Object of Working.—The object of working is the complete removal of the superfluous water or buttermilk, as the case may be, the working-in of the salt, and the consolidation of the butter into a solid mass. This should be done by pressure, not by rubbing, in order to avoid injuring the "grain" of the butter. If any portion of casein is left in the butter, it will speedily ferment and spoil the butter. Good keeping butter must

be free from casein; and, to obtain this, butter-makers cannot be too careful.

Process of Washing.—It is only while the butter-grains are small that the buttermilk can be entirely separated. When the churning is stopped, the plug-hole is opened, and nearly all the buttermilk allowed to run out through a sieve or piece of muslin cloth, which holds back the grains of butter. Clean cold water—in quantity about equal to the buttermilk withdrawn—is then poured into the churn, which is oscillated or turned gently a few times. The liquid is again strained out, and this process is repeated several times—just until the water comes away from the churn almost as clear as it went in. By this system every small grain of butter is separately exposed to the washing, and by no other method can the removal of the buttermilk be so thoroughly or simply effected. No more washing should be given than is really necessary to separate the buttermilk, for over-washing may injure the butter.

Salting.—There are three methods of salting—(1) putting the salt into the cream before churning; (2) by using brine, instead of pure water, to wash out the buttermilk; and (3) by mixing dry salt with the butter after it is washed. The first is a good plan for the butter, but it renders the buttermilk useless. Many eminent butter-makers continually use dry fine salt, as pure as can be obtained, worked into the butter after it has been washed. The brine system is perhaps most generally commended. It facilitates the thorough incorporation of the salt into the butter, and by it the degree of saltiness in the butter may be easily controlled—added to or decreased. The brine is prepared by dissolving about 1 or 2 lb. of pure salt in a gallon of water, this being poured into the churn amongst

the butter when the buttermilk has been removed. In other cases, the dry salt and cold water are put separately into the churn, which is then turned a few times to mix the commodities and dissolve the salt. With the mouth uncovered, the churn is then allowed to lie untouched from 10 minutes to 3 hours or even longer, according to degree of saltiness required. Ten minutes will give very slight salting. If it is found that the salting has been too heavy, it may be lessened by gently washing the butter in pure cold water. By adding the dry salt when the butter is in the worker, the exact quantity is most easily given.

Professor Long points out that the same brine may be used over again three or four times, care being taken to add sufficient salt each time to balance the water which fresh-made butter always contains. There would probably be about half a gallon of water in every 10 lb. of butter, just after the buttermilk has been strained from it; and accordingly, for 50 lb. of butter he would use 6 gallons of cold water and 17 lb. of salt.¹



Fig. 445.—Butter-worker.

The quantity of dry salt used for incorporating with the butter is rarely more

¹ *The Dairy Farm*, 22.

than 1 oz. per pound. This, indeed, is heavy salting, and should preserve the butter for many months. Even when it is to be used as fresh butter, a very little salt will improve the flavour of the butter.

Details of Working.—When the washing, and perhaps the salting, in the churn have been completed, the butter is removed to the butter-worker. In fig. 445 (Bradford & Co.) is represented a convenient form of butter-worker. The function of this article is to consolidate the butter, press out the water, and, if dry salt is to be introduced, incorporate this with the butter. The fluted roller alternately flattens and rolls up the butter, the backward and forward movement being continued until the objects of the working have been thoroughly attained. Yet the butter may be easily enough spoiled by over-working, so that good judgment and careful attention are necessary on the part of the operator. Fig. 442 represents a novel and useful combination — Bradford's Charlemont Dia-

Centrifugal Butter-drier.—This is an ingenious and most serviceable invention, in which centrifugal force is employed to remove superfluous moisture from the butter. It is named the "Nor-

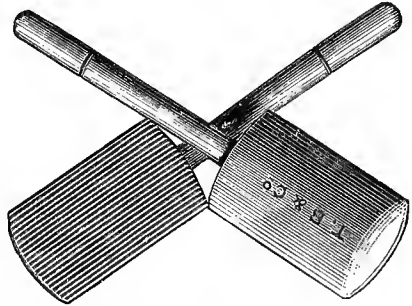


Fig. 447.—Butter-beaters or boards.

mandy Délaiteuse" and is represented in fig. 446 (Dairy Supply Co.) The butter, after leaving the churn, is, while still in a granular state, placed—about 16 lb. at a time—in a canvas bag. This bag is then placed in a metal cylinder, perforated with holes, like a colander, which, from motion communicated by the horizontal spindle, is made to revolve rapidly—700 to 800 turns per minute. The buttermilk, and any other moisture the butter may contain, is driven off to the circumference, and thence through the holes into the outer case, whence it passes out by the pipe into a receptacle underneath, the butter remaining in a perfectly dry condition, in immediate readiness for being worked up into pats of whatever shape may be required. The whole operation only takes four minutes, and directly one lot of butter is dealt with another may be put in.

Butter Rolls and Pats.—When the butter is removed from the "Délaiteuse" it may be kneaded and compressed in the butter-worker, fig. 445, or by "Scotch hands"—very useful

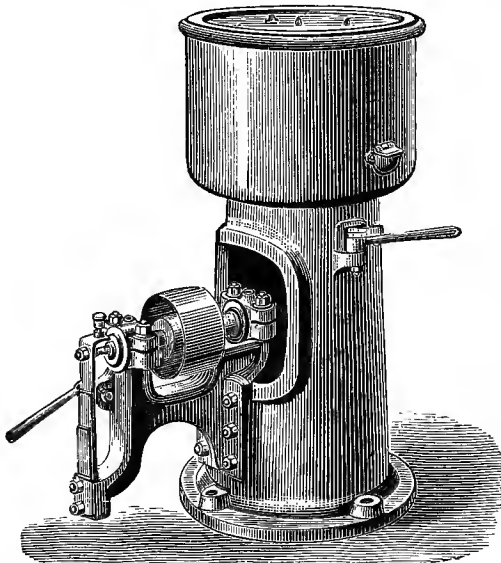


Fig. 446.—"Délaiteuse" centrifugal butter-drier.

phragm churn and a one-hand semicircular butter-worker. This combination is so arranged that by slanting the churn the butter will roll into the butter-worker.

dairy appliances similar to the beaters, shown in fig. 447. These are usually made of box-wood, and are much used throughout the country in working butter into

rolls or pats for home use or sale. These rolls and pats should be made with care and good taste, not only for the sake of ornament on the table, but also for good effect in the market. Butter-boxes suitable for the conveyance of butter-rolls are shown in fig. 448. The rolls are wrapped into thin damp muslin cloths, and the boxes may be lined with white

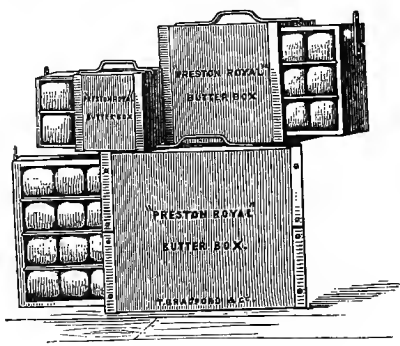


Fig. 448.—Butter-boxes.

paper. The boxes should be kept in a cool place until despatched to market, in which there should be as little delay as possible.

Hand - working Objectionable.—Many eminent authorities state emphatically that in all the process of working, butter should never once be touched by the bare hand. The temperature of the hand is usually so high as to have a tendency to make the butter soft, while there is also some risk of the flavour of the butter being slightly injured by contact with the hand. It is no doubt true that a great deal of first-class butter is worked by the bare hands of the operator, yet the safest plan, unquestionably, is to avoid this practice, and use some of the modern butter-workers which we have referred to and illustrated. With one of these and the deft use of the "Scotch hands" there is no need to let the bare hands touch the butter.

If in any case the bare hands are to come into contact with the butter, they should be first washed with warm water and oatmeal, and then rinsed in cold water, and this rinsing should be done frequently while the hand - working

proceeds. A person with hot clammy hands is not suited for dairy work.

Packing into Crocks.—If the butter is to be kept for a considerable time, it is packed into crocks. And the packing process requires both skill and care. The object is to thoroughly exclude the air, and this will be effectually secured by packing the butter in shallow layers, not much over an inch in thickness. It is a good plan, after placing the first layer in the bottom of the crock, to line the sides with a similar layer as high up as it is intended to fill the vessel. Then proceed to press in one layer after another. Over the butter place a muslin cloth, and cover this with fine salt to the depth of about 1 inch.

To this covering some prefer to have about an inch deep or more of brine floating on the top of the butter. By this method, always taking care to keep the surface of the butter covered with brine, the writer has kept butter, which had been given merely a trace of salt in the working, quite fresh, from the beginning of October in the one year till into May of the following. Even at the very last the butter was perfectly free from any rancid or undesirable flavour, and was so slightly salt to taste as to almost pass for fresh recently made butter. But this butter was made by a skilled hand, who was careful to leave in it the least possible traces of casein, which is so destructive to the keeping properties of butter.

Prepared Preservatives.—Some useful preparations are now sold for preserving butter. But care should be taken to use only such as have been proved to be harmless and effective.

Fresh Butter.—If butter is properly made from well-ripened cream, well washed in the churn, and worked so as to have the surplus moisture removed, it may be kept sweet and fresh for several weeks without any salt whatever. Care should be taken to keep fresh butter in a cool temperature. In warm weather the farmer should have the butter made and conveyed to market at night or early in the morning; and in retail shops, refrigerators should be provided for holding the fresh butter in summer.

If the housekeeper find that her supply of fresh butter is likely to become rancid before being used, she will find it a good plan to pack the butter firmly into some fine glazed stoneware vessel and pour some strong brine over it.

Colouring Butter.—A rich golden colour is most esteemed in butter. When it is naturally pale or not sufficiently "gilt-edged" it is a common practice to colour it artificially. This may be done by introducing a little liquid annatto into the cream just before churning is commenced. Experience is the best guide as to the quantity required to give the required tint to the particular make of butter.

But artificial colouring is an objectionable practice, and where high-coloured butter is desired, the better plan is to have on the farm one or two cows known to produce high-coloured butter. Jersey and Guernsey cows are noted for this property, and one of these will most likely give sufficient "colouring" to the butter of ten or twelve other cows.

Butter Extractor.

At the Royal Show at Windsor, 1889, the Aylesbury Dairy Company exhibited the Swedish Cream Separator and Butter Extractor, "which constitutes a completely new departure in butter-making—and may, if it should prove successful in prolonged practice, possibly abolish both the churn and the dairymaid." So says the reporting judge in the *Journal of the Royal Agricultural Society* (Part ii., 1889), where he thus further refers to this very ingenious appliance:—

"The operation of churning, as is well known, consists in agitating cream, which is itself only a mass of separate fat-globules interfused with milk, until such globules cohere, and the freed fluid originally entangled among them passes away as 'buttermilk.'

"It recently occurred to Mr C. A. Johansson, a Swedish inventor, that the agitation necessary to bring about this result might be given in the centrifuge itself, and while the separation of milk and cream was going on. With this end in view, he furnished the milk-drum with a cover, from the centre of which there hangs a vertical axle, which becomes concentric with, or slightly eccentric to, the

centrifuge, by turning a graduated handle this way or that.

"A circular cage, composed of half-a-dozen thin vertical wires, is supported from, and free to turn around, the axle in question: while the milk-drum is provided with a second and smaller annular chamber, which, as the spinning proceeds, becomes entirely filled with the cream-ring, whose internal diameter, determined by the position of escape-ducts in the floor of this chamber, is very slightly greater than that of the 'agitating cage.'

"The latter is made to touch the cream-ring at one point in its circumference by turning the handle governing the eccentric spindle, and can thus be more or less deeply immersed in the cream. The cage is set revolving by contact with the cream-ring, just as a pinion is turned by a wheel; but it fails to attain quite the same speed as its driver, on account of its own inertia. Its wires, which pass vertically down from top to bottom of the cream-ring, thus create a considerable agitation among the superficial layer of fat-globules, and, it is claimed, convert them into butter, which, as milk flows into the centrifuge, passes away continuously through ducts provided for that purpose in the floor of the inner cream-chamber.

"A greater or less agitation follows on setting the cage more or less eccentrically with the milk-drum, and creams of different character or density are dealt with in this way.

"It was arranged that this machine should be tried on Wednesday, June 26. Two hundred pounds of milk were weighed out and all put together, and carefully mixed in a can and samples taken. I should state that the inventor wished to reduce the milk to 60°, but time would not permit, and the milk used for the trial was 65°.

	h.	m.
The machine was started at . . .	5	23
Skim-milk came at . . .	5	30
Commenced churning at . . .	5	32½
Butter came at . . .	5	33½
Finished at . . .	5	47

On completion—

	lb.
Weight of skim-milk was . . .	183¾
" butter and buttermilk was . . .	16¼
" butter made up . . .	7

Dr Voelcker certified as follows:—

Original milk	{ Total solids	. 12.41	per cent
	{ " fat.	. 3.45	"
Skim-milk	{ Butter-fat	. 0.30	"
	{ Solids (total)	. 10.11	"

"The butter was lumpy rather than granular, somewhat soft and pale-coloured, and would not have passed muster with the butter made by Miss Maidment [winner of the Queen's gold medal for butter-making] in the dairy, though it tasted better than a great deal of the butter sold throughout the country."

The judges awarded a silver medal for the Extractor, although they were not prepared to say that its complete practical success had yet been demonstrated.

CHEESE-MAKING.

The systems of cheese-making pursued in this country are numerous. It is a more intricate process than butter-making, affording scope for the exercise of greater skill in manipulation, and of more ingenuity in producing differences in the manufactured article.

In making the hard cheeses of this country the entire milk as it comes from the cow is dealt with. In making Stilton cheeses a little extra cream is usually, and ought always to be added. The cheese-maker has thus a bulky article to handle, and one which requires to be treated with the utmost skill and care

if uniformly good results are to be obtained.

Apartments for Cheese-making.—In well-equipped dairies there are at least three separate compartments for cheese-making—(1) the milk-room, (2) the curd and pressing room, and (3) the drying-room. In Stilton dairies there are generally three but sometimes four compartments. A convenient arrangement is to have the store over the other compartments, or perhaps over the curd or cheese-making room only. Some prefer to have the store in a cool dimly lighted ground-floor room.

An important point is to have the compartments as much as possible protected from variations in temperature,—so arranged that the temperature may be artificially controlled independently of the season of the year.

And, as in butter-making, the apartments and vessels must be kept perfectly clean, sweet, and fresh. Bad smells and impurities in the milk are fatal to successful cheese-making.

Utensils.—The utensils required in cheese-making are numerous, but they need not be costly. They usually consist of a milk vat or tub, strainers, curd-knives, curd-mill, curd-shovel, curd-rake, cheese moulds or hoops, cheese racks or shelves, cheese-presses, pails, and pans, &c.

Vat.—The vessel in which the milk is collected to be coagulated by rennet is

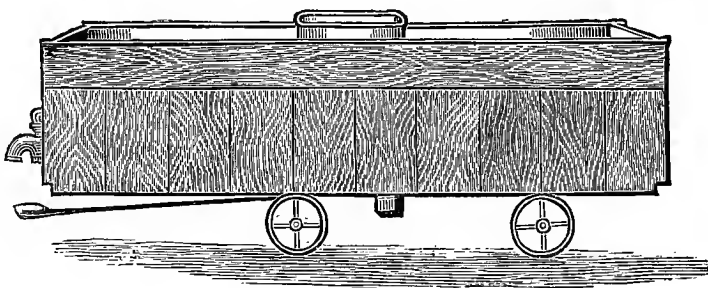


Fig. 449.—Milk-vat.

commonly called a vat or tub. It may be oblong, as shown in fig. 449, about 20 inches deep, and 30 to 32 inches wide, and mounted on 3 or 4 wheels so as to be easily moved about, and from one apartment to another. The vat is

made of many sizes to suit different dairies. This is the most modern vat. It has a double casing, so as to admit between the two cases cold water for cooling and hot water for heating the milk and curd. The inner case should be made

of the best tiuned steel; and the vat is provided, as shown, with brass taps, as well as with draining cylinder, siphons, covers, and draining racks, on which last the curd is placed to strain.

Circular Cheese-tub.—Formerly the milk-vat was in the form of a circular tub. In very small dairies these tubs may still be convenient for the handling of small quantities of curd. Indeed



Fig. 450.—Curd-mill.

there are not a few noted cheese-makers who still prefer the circular tub. With either the round or oblong vat first-class cheese may be made; but the modern oblong vat, with the double casing for heating or cooling the contents, is unquestionably the most convenient.

Heating Curd.—In the modern vat with double casing the curd may be heated as desired by circulating steam or hot water between the two cases, which are usually about 2 inches apart. The perfect control which this gives over the temperature of the contents of the vat is regarded by most modern cheese-makers as of the very first importance. There are some who contend that this system is liable to injure the cheese by over-cooking the portions of curd which come into contact with the hot sides of the vat. This risk may be avoided by raising the heat slowly. In the round tubs the curd is heated by withdrawing

a quantity of the whey, scalding it to a high temperature, and pouring it over the curd. This has to be frequently repeated, and is a troublesome process.

Curd-mill.—The frame of the curd-mill, fig. 450 (Dairy Supply Co.), is usually made of wood, consisting of two bars supported on four legs. On the top is fastened the hopper with movable pins and hinges, and at the bottom of this runs an iron axle armed with pins or teeth fixed on it spirally, and below this again a metal grating. A handle drives the toothed axle, and the teeth pass through the bars of the grating, so that slices of "green" curd when put into the hopper are cut and broken through the grating, and fall into a receiver below. The metal working parts are tinned over; and the wood must be

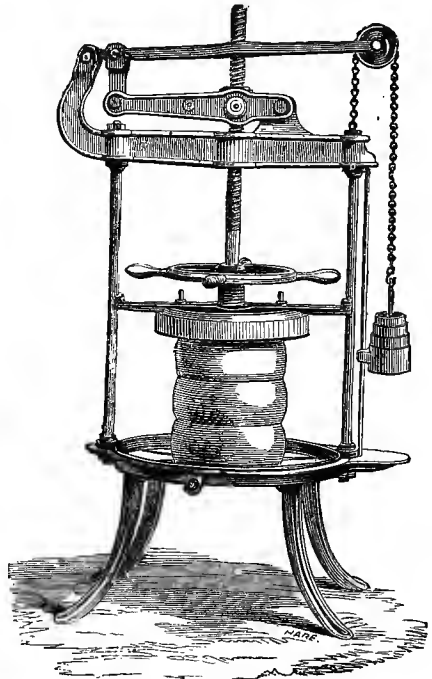


Fig. 451.—Single cheese-press.

of some close-grained variety, and well seasoned, while the framework is sometimes made of iron.

Presses.—Of the cheese-press the varieties are numerous. Those most in use may be classed under two kinds,

with and without levers. Of the lever-press the varieties are most numerous, passing from the single lever, through the various combinations of simple levers, to the more elaborate one of the rack and levers. An essential characteristic of each is that the load, when left to itself, has the power to descend after the cheese which is pressed, and which sinks as the whey from the curd is expelled. None but such should be used in any dairy.

Convenient lever-presses are shown in

fig. 451 (Dairy Supply Co.) and fig. 452 (John Gray).

Shelves.—These are arranged in various forms. The most convenient are the self-turning shelves, those made so that two or three shelves turn round on an axle with their contents of cheese.

Rennet.—Rennet, the agent employed to coagulate milk, is an extract from the mucous membrane of the fourth stomach of the calf. It is indeed the agent which digests the food of the calf, and it is remarkable that no perfect

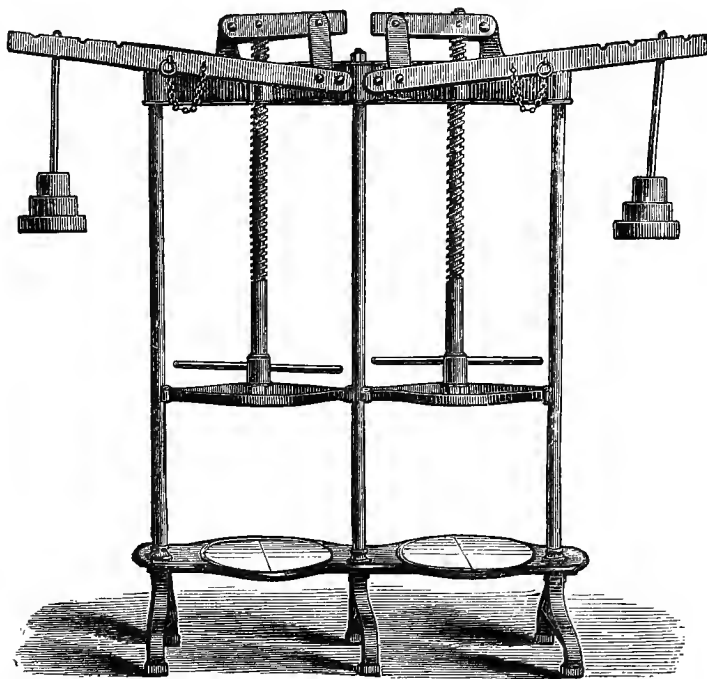


Fig. 452.—Double cheese-press.

substitute has yet been found for the natural calf-rennet in cheese-making. The rennet is prepared in the following manner: Good clean *vells* or stomachs are selected and put into salt brine—which has been made strong enough to float an egg—at the rate of four to every gallon. To this is added half an ounce of saltpetre and half a lemon sliced. The whole is put into a covered jar, and allowed to soak for a month, when it will be ready for use. Half a pint of this will, with the help of a little sour

whey, coagulate 100 gallons in an hour. Where cheese are intended to ripen quickly, however, more must be used, and it is customary to put in nearly double this quantity.

In some cases the hard dried skin or *vell* of the calf's stomach prepared in brine is cut in small pieces, macerated in water, and the liquid put into the milk. This, however, is not a good plan, for it is difficult in this way to regulate the amount of rennet applied.

Testing Rennet.—The proper use

of rennet is a critical point in cheese-making. Mr Joseph Rigby says—"It is most important to have it of uniform strength, to know what that strength is, and to use the right quantity. The most practical and reliable way of ascertaining the strength is to take a drachm of the liquid, or a fixed portion of the powder, and mix it with five gallons of milk at the temperature it is usual to make the whole of the milk when putting together for cheese, and to notice how long it is before it begins to thicken, as the curdling power of the milk often differs. If this occurs in twenty or twenty-five minutes, the right proportions will have been found. If it takes a longer time, more rennet is required; if a shorter time, a less quantity should be fixed upon. The exact quantity can only be fixed upon by repeated careful tests in individual dairies. Too much rennet causes the curd to become dry and brittle; too little leaves it soft and spongy."¹

The more general plan now is to use some of the prepared extracts of rennet, which are sold at moderate prices, of uniform strength, and with useful directions as to application.

Action of Rennet.—The rennet acts on the milk by coagulating the casein, in which the butter-fat thereby becomes imprisoned. Both are thus preserved for use as food. Rennet also co-operates with acidity in softening the fibre of the curd, assimilating moisture, and in ripening the cheese, but its entire action is still imperfectly understood.

Acidity.—A much-disputed question in cheese-making is the amount of acidity which should be developed in the milk and curd during the various stages of the process. In the Cheddar system a certain amount of acidity is regarded as absolutely essential to bring out the full nutty flavour which is so much desired in Cheddar cheese; and unless the milk were allowed to ripen sufficiently before the rennet is added to develop in the curd the necessary degree of acidity in from five to seven hours, the curd would be liable to be injured by having to lie too long in the whey—engendering, perhaps, a bitter flavour instead of the rich

flavour characteristic of the well-made article.

Mr Nuttall, Leicestershire, the well-known Stilton maker, condemns the ripening of the milk before the addition of the rennet, maintaining that it should be coagulated while it is still warm with the animal heat. But while this system may be advisable for Stilton making, it is not approved of in making Cheddar and other hard cheeses.

No doubt too much acidity is injurious to the cheese. It will spoil the texture and make the flavour too sharp. But without a certain amount of acidity developed at one stage or other the cheese will be weak-flavoured, perhaps even insipid. In poor milk less acidity should be developed than in rich milk. For this reason the acidity is kept more moderate in spring than in summer and early autumn.

Acidity, Ripening, and Keeping.—Acidity has much to do with both the rate of ripening and the keeping properties of cheese. If a considerable amount of acidity has been developed, the cheese will ripen quickly, but will not keep long. With little acidity the cheese ripens slowly, but has good keeping properties. Too much acidity will make the cheese dry and "crummy," and prevent mellow ripening.

Artificial Souring of Milk.—The plan, once common, of souring milk by mixing with it a little sour whey before putting in the rennet, has lost favour with many cheese-makers. Mr Drummond, instructor at the Kilmarnock Dairy Institute (one of the specialists brought from Canada to teach the improved methods of Cheddar cheese-making in the south-west of Scotland), says he has no doubt that in the old system whey was often added to the milk when the latter was already acid enough, thus resulting in a spoiled cheese. He considers a certain degree of acidity or ripeness in the milk as quite essential before adding the rennet, but this acidity he prefers to develop naturally in the milk by controlling its temperature—by having the evening's milk cooled so that enough heat will be left in it to develop by morning the slight acidity required. The warmer the milk the more rapidly it becomes sour. He generally found that

¹ *Jour. Royal Agric. Soc. Eng.*, 1889.

sufficient acidity had been developed when the evening's milk had a temperature of from 64° to 68° Fahr. next morning.

Professor Primrose M'Connell favours the use of whey, if it is employed with proper skill and care. He says: "The use of sour whey is one of the points which requires experience such as cannot be taught by books. It greatly aids the action of the rennet, and improves the quality of the curd if a little is used. One pint to every 30 gallons of milk is the average: more must be used in cold weather, or where the milk was previously cooled, and less in a hot season. Some of the best cheese-makers condemn the use of sour whey, on the ground that the milk will ripen itself if given time, but nevertheless it appears to be sound both in practice and theory. It certainly expedites matters by hastening the development of acidity; and as this acidity is due to the presence of the lactic or other ferments which we find in it, it appears good practice from a scientific point of view. Of course the practice must be carried out in a cleanly fashion, so as to prevent the introduction of any taint."

Mr George Gibbons, Tunley Farm, Bath, says that in the earlier and later months of the year a little sour whey may be added, but its regular use cannot be commended.

Artificial Souring Curd.—Some dairy authorities consider that, in the event of deficient acidity, it is a better plan to introduce the artificial souring into the curd than into the milk. This is done by keeping a portion of curd of the previous day's making, and mixing it with the new curd while it is being manipulated—before it is put through the curd-mill.

Professor J. P. Sheldon mentions a curious and interesting instance of the influence of acidity upon the character and quality of cheese. His father's farm, although made rich enough by improvements, somehow would produce only a second-rate cheese from the sweet-curd system pursued. "One day it happened that a few pounds of curd were mislaid until too late to include them in the cheeses of the day, and it was decided to put them into one cheese on the follow-

ing day, mark that cheese, and watch the result. In this way a most valuable secret was discovered, for the truant bit of curd, which had become acid in the night, kept as it was without salt, communicated acidity to the cheese with which it was mixed, and that particular cheese was the best in the whole dairy! Afterwards all the cheese was made with a portion of old curd, and became a first-class dairy, the entire make of one year, about seven tons, realising 87s. per cwt. ! Acidity, therefore, accidentally hit upon in this case, improves the character of cheese, making it firmer, and improving the flavour, as well as regulating the ripening. In point of fact, most of the mischief incidental to cheese-making is fairly attributable to the want of acidity as a feature in the process, though it does not necessarily follow that sour curd is the best way of introducing it.

"It is generally found that late autumn and winter cheese is inferior in warmth and mellowness of flavour and texture, and this may be said to be owing to the evening's milk becoming too cold through the night, and therefore not ripening as it ought to do. The most intelligent cheese-maker I have talked with, told me that he overcame this difficulty by warming the evening's milk, the following morning, up to 80°, and letting it ripen for several hours before making it into cheese. In this way the autumn cheese acquired the mellowness of the summer cheese, and sold for as much money. The milk of autumn is richer than that of summer in solids, though less in quantity, and this may be an additional reason why it needs the ripening artificially that summer milk obtains naturally. It is, in fact, a question of temperature, which is all-important in cheese-making."¹

Measuring Acidity.—The controlling of the acidity is unquestionably one of the most important as it is one of the most difficult points in the entire process of cheese-making. There is need for more exact knowledge not only of the part which acidity plays in the making and maturing of cheese, but also of the means by which it may be developed and controlled. The chief hindrance to the

¹ *The Farm and the Dairy*, 101, 102.

proper elucidation of these matters is the want of some ready, precise, and reliable means of measuring the exact progress and strength of the acidity as it is being developed. Gray's Acidometer, a new invention, promises to be of much use for this purpose.

We will now notice in detail the methods pursued in making the different varieties of cheese.

CHEDDAR CHEESE.

The Cheddar variety of cheese, which takes its name from the village of Cheddar in the county of Somerset, has been famed for centuries. It was introduced into the south-west of Scotland by the late Mr Joseph Harding, Marksbury, Bristol, who is said to have been the first to establish the practice of Cheddar making upon a regular system. It is now extensively made in that part of Scotland, as well as in Somersetshire and other districts in England. It is also manufactured in very large quantities in Canada and the United States.

The making of Cheddar cheese has received very special study in Canada, and it is remarkable that by the employment of Canadian specialists as teachers, the system of Cheddar cheese-making in the south-west of Scotland has since 1885 been radically altered and vastly improved—a result proved by the high position which Scotch Cheddars have taken in recent London Dairy Shows, and by the higher price obtained for the cheese made upon the new methods.

One of the Canadian experts employed as a dairy instructor in the south-west of Scotland was Mr John Robertson, a Scotsman whose family have settled in Canada. To him we are indebted for the following account of "How to make first-class Cheddar cheese."

Character and Composition of Cheddar Cheese.—Mr Robertson says: Before giving the details of the operation of Cheddar cheese-making, I wish to define, as clearly as I can, what a Cheddar cheese should be, and in as few words as possible. Cows' milk, with which we have to deal in cheese-making, usually has 13 per cent of solids and 87 per cent of water. Cheese-making is the process of preserving the valuable food

solids of the milk in the best possible form for human food.

A perfect Cheddar cheese should have in its composition 32 per cent of water, 36 per cent of butter-fat, 27 per cent of casein, 2 per cent of carbohydrates, and 3 per cent ash. A cheese thus composed should have a sweet, nutty, pleasing flavour. In quality it should be rich and mellow, with consistency of body, of close silky texture, true and even colour, and of prepossessing appearance and finish. To convey a still clearer idea of what a fine Cheddar cheese should be, I will define the meaning of each of the aforementioned qualities when applied to cheese, taking them as they rate in importance.

Flavour in perfect cheese I would define as the particular quality that has the power of pleasing the taste or smell; and we speak of the flavour being good or bad, just as the cheese possesses or lacks the quality to please the taste or smell.

Quality in cheese I would define as the nature of the inherent properties, relatively considered; and we speak of a rich mellow cheese as having good quality, and of a hard dry one as lacking quality.

Texture is the arrangement or combination of the parts composing the cheese; and we speak of a cheese being either silky, raw, or open in texture, as the different component parts are combined to form a smooth or grainy body of cheese, and the texture as open when the pieces of curd when pressed together do not form a completely solid mass in the cheese.

Colour of cheese might be defined as the quality that affects our sensation with regard to its hue or tint. We speak of the colour of a cheese being true when the body of the cheese when cut appears of the same tint throughout, and of the colour being untrue when the body of the cheese has a mottled or streaky appearance.

The *appearance* and *finish* is seen on the outer surface. In a cheese this would be considered good or bad as it is symmetrical in shape with a smooth clear skin, or unshapely and with a surface dirty and cracked open like baked clay.

Scale of Points in Judging Cheese.—I would give the following scale of

points of merit to each particular quality in a perfect cheese :—

	Points.
Flavour, or particular power of pleasing the taste or smell	35
Quality, or properties as to richness with consistency of body	25
Texture, or combination of parts	15
Colour, or evenness of hue or tint	15
Appearance and finish, or impression produced at sight	10

Milk.—With this knowledge of the article we desire to produce borne in mind, we will now consider the milk from which it is produced. Besides its inherent tendency to decay, milk furnishes a favourable condition for the propagation of foreign ferments and parasitic fungi that are readily introduced where all of the surroundings and dairy utensils are not kept scrupulously clean; and as the introduction of impurities in this way is sure to affect the flavour and other valuable properties of the cheese, too much care cannot be given to keeping the milk free from all impurities.

Keeping and Treatment of the Milk.—In Cheddar cheese-making the evening's milk should be kept in the vat, fig. 449, to mix with the new milk in the morning. Besides keeping it where the surroundings are sweet and pure, it is important that it is not allowed to get too cold. When the milk is cold, the lactic acid or souring principle in the milk develops very slowly, and the development of that acid to a certain extent is considered essential in the making of fine cheese. When the milk can be kept at such a temperature and depth as to gradually cool down from its natural heat to 68° Fahr. in the morning, it should be in good condition to mix with the new milk; and when kept warmer than 68° or 70° Fahr., the lactic acid would, in most places, be too far developed to allow sufficient time for the proper working of the curd.

Testing Ripeness of Milk.—An idea of the ripeness or development of the lactic acid in the milk may be had by using 4 oz. of milk, or an ordinary teaspoonful of rennet extract, noting the number of seconds that it takes to thicken. This can readily be seen by allowing a short bit of straw or mote to

float on the milk. The motion given to it by stirring the rennet in the milk for a few seconds will be stopped as soon as the milk thickens. In spring months, from fifteen to twenty seconds is a very good time to have it thicken in; and in the summer months from twenty-five to thirty-five seconds. A standard tested rennet extract should be used. But a careful watching of the temperature of the evening's milk in the morning will give one quite as accurate an idea of the ripeness of the milk as any method known, provided the milk is always set nearly the same depth.

In testing the ripeness of the milk with rennet see to it that the milk used is always at the same temperature, as heat is a favourable condition for rapid rennet action, and cold an unfavourable condition. When the evening's milk is too cold in the morning, it is advantageous to heat it a few degrees warmer than usual, and allow it to cool again, the heat facilitating the development of the souring before the rennet is added.

Cream.—The thick cream should be removed from the evening's milk, and warmed by pouring a portion of new milk amongst it, and left to dissolve again, till fifteen minutes before the rennet is added. In this way it is more thoroughly incorporated into the body of the milk again, when poured through the strainer and thoroughly stirred in the milk.

Colouring.—When colouring is to be used, it should be added as soon as the whole quantity of milk is together in the vat, fig. 449. An ounce and a half of annatto per 100 gallons of milk gives a medium bright colour. From 1 to 2 oz. per 100 gallons are commonly used, according to brightness of colour desired. The colouring should be diluted in not less than five times its bulk of pure water, to facilitate its thorough incorporation into the milk. The practice of using artificial colouring is being very properly discouraged.

Adding the Rennet.—From 84° to 88° Fahr. are good temperatures at which to add the *rennet*; 88° in the early spring and autumn months, when the milk is likely to be very sweet; 84° in very warm summer days; and 86° in moderate weather.

Pure *rennet* of known strength should be used, and that also should be well diluted with pure water to ensure its rapid and even distribution throughout the milk.

Quantity of Rennet.—In spring months sufficient rennet should be used to thicken the curd ready for cutting in thirty minutes, and in the summer months in forty-five minutes. When the rennet is added, stirring of the milk should not exceed five minutes, as the milk should be quite still when coagulation begins. The surface may advantageously be slightly agitated by passing the bottom of the dipper lightly over it, to prevent the cream from separating till coagulation has commenced.

From 4 to 5 oz. of rennet extract per 100 gallons of milk is usually sufficient in the spring months, and from 3 to 4 oz. in the summer months.

The Curd.

Cutting.—The *curd* should be ready for cutting when it splits clean before the finger, when inserted at an angle of about 45°; or, if note is taken of the time at which the rennet was added, till coagulation is perceptible, and the curd is left as long again and a half. Coagulation should by that time be complete, and the curd ready for cutting. Horizontal and perpendicular curd-knives (fig. 453) should be used, and the

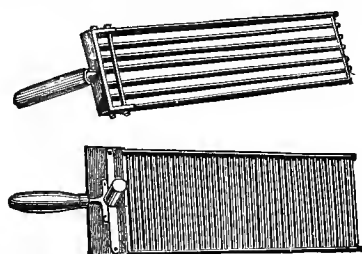


Fig. 453.—Curd-knives.

cutting should be done very gently and slowly, taking at least half an hour to reduce the curd to pieces as small as peas.

The cutting of the curd is done to facilitate the escape of the whey, and allowing the curd to settle for fifteen minutes when the cutting is completed, is another help to expel the surplus whey from the structure of the curd.

Heating.—Heat should then be applied very slowly, where steam is used for that purpose, the temperature being raised at the rate of one degree in from four to five minutes. Rapid application of the heat at this time forms a skin on the pieces of curd, and thus prevents the proper expulsion of the whey from the curd that the heating is intended to accomplish. The heat in the modern vat is applied, as we have seen, by circulating hot water or steam between the two casings of the vat; and in the old-style circular tub by heating whey and pouring over the curd.

In spring months the heat should be raised to from 98° to 100° Fahr., and in summer and autumn from 100° to 102°. Gentle stirring of the curd should be continued during the process of raising the heat, and from twenty minutes till a half-hour after the heat is raised.

Firmed or "Cooked."—The curd may then be allowed to settle, and if not firm enough to spring apart when slightly disturbed after having been squeezed firmly in the hand, it may with advantage be stirred up occasionally, until that degree of firmness has been attained. It is important in the making of a good-keeping, sweet-flavoured cheese, that the curd is properly firmed or "cooked," as it is commonly called, before there is any sourness or acid perceptible to the taste or smell. When the curd is properly "cooked," the whey should not be drained off till acid is quite perceptible.

Testing Acidity.—A good test of the *acidity* may be obtained by squeezing a handful of the curd as dry as you can, take a piece of it as large as a walnut, and apply it to a hot iron just warm enough to roast it without burning. When applied with light pressure, and when removed slowly from the iron, if a number of fine silky threads draw out a fourth of an inch, the whey should be removed at once, and unless the curd is firm and well cooked, the whey should be removed when the silky threads draw out an eighth of an inch. With the milk in good condition the time of cooking, from the time the heat is raised till the acid should show as above, varies at different places from one hour to two hours.

Draining.—As soon as the whey is

drained off, the curd should be removed from the tub or vat, and placed on racks or drainers covered with a cloth through which the whey may readily escape. Unless the curd is very firm and dry, it should be gently stirred for a few minutes to prevent it matting at once, thus facilitating the escape of the whey.

Packing.—The curd should then be packed to a depth of 5 or 6 inches, and well covered to maintain the heat. In twenty minutes after packing it should be cut into pieces about 6 inches wide, and 8 or 10 inches long, and turned, care being taken not to allow the curd to cool very much. After turning three times at intervals of twenty minutes or half an hour, the curd may be piled up deeper to maintain the heat throughout the whole alike, and thus develop the acid equally throughout the entire mass of curd. But in cases where the souring is developing rapidly, it is best not to pile the curd deep.

Milling.—When the acid has developed so that fine threads from $1\frac{1}{2}$ inch to 2 inches draw out on the curd when applied to the hot iron, the curd should be put through the curd-mill (fig. 450). That much of the butter-fat may not be bruised out in the milling process, it is advantageous to spread the curd to allow it to cool before milling. But the cooling should not be below 80° Fahr.

The curd at this stage of the process should have a smooth velvety feel, with a flavour like well-ripened cream to the smell. The length of time from placing the curd on the rack till milling varies from $1\frac{1}{2}$ to $2\frac{1}{2}$ hours.

Salting.—After stirring the curd well for a few minutes, salt at the rate of 2 lb. per 100 lb. of curd should be thoroughly stirred into the curd. This quantity is best suited for the early months, and after the month of May $2\frac{1}{4}$ lb. salt per 100 lb. of curd should be used. After salting, the curd should be left 15 or 20 minutes to allow the salt to thoroughly penetrate the curd before putting it in the chesset, mould, or hoop, as it is variously called (figs. 454 and 455, John Gray).

Pressing.—Unless the curd is very soft and buttery it should not be allowed to cool below 78° to 80° before packing into the chesset. Pressure should be

applied to the curd in the chesset very lightly at first, just sufficient to start the whey running being enough, and gradually increased to 2 or 3 tons weight, that the curd may be made a completely solid

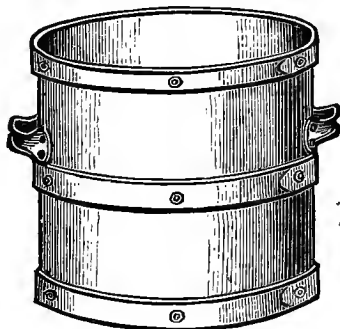


Fig. 454.—Metal chesset or cheese-mould.

mass. It should be kept in press for 8 days, and should be turned each day, and a dry cloth exchanged for the one it is pressed in.

Smooth Skin.—Turning the cheese the same day on which it was made helps to secure for it a smooth skin, and care should be taken that the cheese-

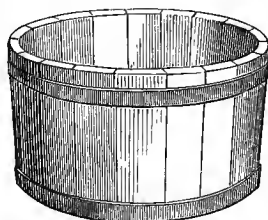


Fig. 455.—Wooden chesset or cheese-mould.

cloths are not greasy, thus preventing the pieces of curd from sealing closely together to form a skin that will not readily crack.

Hot Bath.—After pressing overnight, the cheese should be treated to a warm bath in water about 120° Fahr., to ensure giving it a smooth rind.

Curing.—The cheese, when taken out of the press, should be carefully banded, and the ends well rubbed with fresh fat before being put away in the curing-room. Allowing the surface to get exposed and dry tends to crack the cheese.

Curing-room.—The curing-room should be kept dry and well ventilated, and a steady temperature of about 65° Fahr. should be maintained. A warmer temperature than the above will ripen the cheese quicker, and a lower one slower. The cheese should be turned each day in the curing-room, and the apartment as well as the cheese should be kept bright and attractive. Carelessness in this particular very often gives a merchant a bad impression of the cheese, and makes him indifferent in buying.

Cheese carefully made and kept in this way should be ready for use in from 2 to 3 months, and it should keep well for months afterwards, if required.

Other Methods.

Professor Primrose M'Connell thus describes briefly a method of preparing the curd pursued very largely in this country in Cheddar making: Where there is a daily making of cheese, the evening's milk is set in the vat or in coolers, so as to ensure that it will fall to a temperature of 66° Fahr. by morning—or it may be passed over the aerator. In the morning the cream is taken off, the morning's milk mixed with the previous milking, and the cream warmed to 75° Fahr. and returned to the mass through a sieve, for the purpose of ensuring thorough mixing. The whole is then heated to 90° Fahr. in spring, or 84° to 86° in summer (according to temperature of the air—a lower temperature requiring the higher heating), when it is allowed to rest for some time to acquire a certain degree of acidity or "ripeness." After this the rennet is added, when it has cooled down to 82° to 84° Fahr., and well stirred in. About 1 pint to 400 gallons of the "artificial" varieties being required, or 1 pint to 100 gallons of the old home-made kind.

When the milk is sufficiently coagulated, which it ought to be in from 30 minutes to 1 hour, the curd is cut with the curd-knives (fig. 453), one of which should be for horizontal and the other for vertical cutting; or it may be cut by the curd-breaker (fig. 456). This latter is made with tinued steel blades, either vertical or horizontal, and with a long or short handle. The object is to cut, *not break*, the curd slowly into small pieces,

for the purpose of letting out the whey. When the curd has been cut by repeated stirring into pieces as big as beans or peas, and begins to become firm, the temperature (which should not be allowed to fall below 80° Fahr.) is gradually raised to 100° Fahr. (or 98° in hot weather), and the whole kept stirred with the curd-stirrer, a utensil similar to the cutter, but made with round wire, instead of thin steel blades. The stirring is continued until the curd attains a certain degree of firmness, which requires practical skill to know, but cannot be described. From beginning to end, the cutting and stirring occupies about 1½ to 2 hours. At the end of this time, the curd is allowed to settle and lie till it is sufficiently "cooked" in the whey.

A good judge knows by the feel when it is ready; others use a hot iron to which a piece is applied, and if it melts and draws out into threads, it is considered "ripe." The whey is then run off by a tap or siphon, the curd taken out, placed in an oblong trough with a sparred false bottom, on which a cloth has been spread, and then broken down by hand, turned, and allowed to lie in a heap to drain and develop acid.

The curd is then put into a large chesnet, known as the dripper or drainer, put into the press and subjected to a pressure of ½ ton to get rid of the whey. It is taken out of the press, sliced-up with a knife, put through the curd-mill, salted with refined dairy salt—usually at the rate of 1 lb. of salt to 50 lb. of curd—and it is then ready for packing in the chesnet for final pressing.

The system thus described by Professor M'Connell prevailed in Ayrshire prior to 1884, but it has now been largely superseded by the method detailed by Mr Robertson.

Mr Gibbons's System.—Mr George Gibbons, Tunley Farm, Bath, a well-

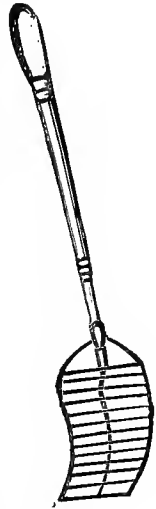


Fig. 456.—Curd-breaker.

known authority on dairying, describing the system of making Cheddar in small or medium dairies (where there is no arrangement for heating the curd in the vat by circulating hot water or steam between the casing of the vat as already described), says:—

“This done [the first cutting of the curd in the tub], it should be left to harden a few minutes and for the whey to separate, when, by the use of a shovel-breaker, the splitting of the curd in its own grain commences. This at first must be done with the greatest caution, or the whey will get white and loss of quality ensue; but the speed should increase as the curd hardens—always taking care that it is regularly broken, and not smashed, until it is the size of a pea, and the whey of a greenish hue; the time of this operation depends somewhat upon the quantity dealt with, but it should take from fifty to sixty minutes. The mass should now be allowed to settle for ten minutes, when with a siphon sufficient whey may be drawn off, which, when heated to not more than 130°, would raise the whole to 90°. During the application of this whey the curd should be well stirred and mixed. A further rest of ten minutes takes place, when enough whey should be drawn off for heating to 130°, and the whey in the tub lowered till it only covers the curd by about two inches. The heated whey should now be poured in a small stream over the curd, the operator taking the utmost care that the whole mass is thoroughly broken up and incorporated with it, the thermometer being frequently used, until it stands at 100°, the limit desired; but the stirring must be continued until the curd becomes shotty and is disposed to sink, the whey showing above it clear and green.

“This operation may take from ten to thirty minutes, but should the curd not harden sufficiently fast, and the temperature fall quickly, it would be well to add more hot whey, so as to retain the heat at 100°. The curd may now rest thirty minutes (or, if it is sufficiently acid, a shorter period will do), when all the whey may be let off, and the curd piled as high as possible in the centre of the tub. Carefully wash down all crumbs, strain, and place them on the top of the mound.

Cover and keep it warm with cloths until it has become sufficiently solid to cut into large pieces which can be turned over without breaking. When this has been done, the whole should be again piled and kept covered for thirty minutes longer, as before; after this it may be removed to the curd-cooler, cut into smaller pieces, and again piled and covered for thirty minutes. This cutting, changing, piling, and covering is continued until the curd presents a rich, dry, mellow, solid appearance, and a perceptible amount of acidity has been developed. This is easily ascertained by taste and smell. It is now ground, and should present a ragged solid curd, dry, but greasy; and if several pieces are pressed together by the hand, the fragments should easily fall apart. Fine clean dry salt should be used at the rate of $2\frac{1}{4}$ lb. per 112 lb. of curd, and thoroughly mixed with it. At this point the temperature of the curd should not be below 70°, and it should be put into the vat or mould, lined with a thin cloth large enough to cover the cheese, placed in the press, where it has a pressure of about 20 cwt., and allowed to remain there until the next morning, when the cloth should be changed, the position of the cheese inverted, and replaced in the press until the following morning. A little fat rubbed over it softens the surface, and is useful in preventing cracks, a square piece of muslin being placed on its top and bottom, and the sides also completely covered with the same material, of sufficient width to draw over the squares $1\frac{1}{2}$ inch, to which it should be neatly sewn. Replace the cheese in the press, where it should continue two days longer. It should then be stoutly bandaged and removed to the warm cheese-room, whence, after being turned daily for six weeks, it should be taken to the cooler room, and turned every other day until three months old, after which, turning once every four or five days is sufficient. Much trouble and damage to the cheese is saved by the use of vats which open with a key.

“Some successful makers scald at a lower temperature, only raising the first scald to 86° or 88° by whey heated to 120°, stirring the curd to assist the hardening fifteen or twenty minutes. The temperature of the second scald should

be 98°, by whey heated to 130°, and it should be stirred until the curd is shotty. It should then be left for twenty minutes, or less, if acidity develops fast. In this case no whey is removed from the curd previous to scalding, except what is required for heating. After the expiration of the time of rest, let all the whey run off; then the usual course is to place the curd in the centre, cutting, turning, covering, and keeping warm, putting it on a rack to drain, placing a board and heavy weights on it to facilitate separation of the whey, promote acidity, and produce a solid curd."¹

To obviate the laborious work entailed in lifting and carrying the whey to be heated, Mr Gibbons recommends for large dairies the use of improved appliances made by E. S. Hindley, Bourton, Dorset, whereby the quantity of milk or whey required for heating is raised by a small centrifugal pump to a tin or copper-tinned vessel called the heater, placed on a level with the top of the tub, and partly overhanging it. The heater has a double bottom to admit steam underneath to heat the whey or milk, which, when a tap is opened, runs back into the tub to heat the mass of milk or curd and whey to the desired temperature.

STILTON CHEESE.

Professor J. P. Sheldon gives us the following notes regarding this famous cheese: In appearance and character quite distinct from any other kind of British cheese, save the Yorkshire Cotherstone, which resembles it more in looks than anything else, Stilton cheese is at once one of the most modern and perhaps the most famous of all the many different kinds that are produced in the British Islands. A hundred years ago it had a local reputation in the district around Melton Mowbray, chiefly because the well-known Cooper Thornhill, who kept the Bell Inn at Stilton, on the Great North Road between London and Edinburgh, had it always at hand to regale travellers in the old coaching days. It was first made by Mrs Paulet of Wymondham, a relative of Thornhill's, whose customers were sometimes "gratified"

with it "at the expense of half-a-crown a pound,"—so we are told in Marshall's *Rural Economy*, which was published in 1790. It thus received the name of "Stilton cheese"; and the place where, as well as the method on which, it was made, was kept secret for some time. At length, however, the place and the method became known, and it was then made at various farms in the counties of Leicester and Rutland, while in modern days it has been produced in many parts of England, in the United States of America, in Canada, and elsewhere.

Characteristics.—The distinguishing feature in the old-time Stilton method of cheese-making was the presence in the milk of a double quantity of cream—that is, the cream of the evening's milk was added to the morning's milk, which was then made into cheese. Hence, indeed, its superior quality, and the price it used to command. True Stilton cheese is still a double-cream cheese, wherever it may be made; but in modern times its reputation has suffered, because a great deal of so-called Stilton has been made from milk without the added cream, in which event it has no higher quality than ordinary cheese made on other methods, though the Stilton method gives a different character to the product.

Climate and Soil.—It is said that no other county can produce Stilton cheese equal to that of Leicester and Rutland, soil and herbage having so much to do with the result. It is probable, however, that this claim cannot be sustained, and that the finest qualities of Stilton can be produced elsewhere, on the same method, with a double quantity of cream, and from rich old pasture-land. It is also said that really fine Stiltons can only be made in the five months beginning with May and ending with September. This is probably correct, but the statement is equally applicable to other kinds of cheese.

Method.—The Stilton method is as follows: The evening's milk is put into shallow "leads," or pans, and is skimmed next morning, the cream being mixed with the fresh milk of the morning. The rennet is added when the milk has been raised to a temperature of 83° Fahr., and coagulation is perfected in an hour afterwards. The coagulum is then broken a

¹ *Jour. Royal Agric. Soc. Eng.*, 1889.

little and very gently, after which it remains at rest for a quarter of an hour; it is then put into the "leads," over which cloth strainers have been spread to receive it, and the whey drains slowly out of the curd. As the draining proceeds, the corners of the cloth are tied closer and closer, until the curd becomes tolerably firm and dry. The curd is then put into a tin strainer and cut into squares, remaining so until it is ready for the hoops, at which stage it is carefully broken into small pieces. A layer of curd is then put into the hoop, and on it a sprinkling of salt, care being taken not to let the salt get too near the outside; then another layer of curd, and on it salt as before, and so on until the hoop is full, when the mass of curd is lightly pressed down in the hoop.

The hoop is a cylinder of perforated tin, but without bottom or top, and it is placed on a shelf over which a cloth has been spread, and where the whey may still drain away. The hoop is turned "other end down" two or three times a day, until the cheese is firm enough to be taken out of it, the time required being from five to ten days, or even longer, according to the temperature. The cheese is then bound tightly round with a cloth, which is repeatedly changed for a dry one, until the crust of the cheese has firmed, and the shape can be maintained without the aid of cloths. The cheese is then placed on a shelf in the cheese-room, where it ripens, and the blue mould so highly prized is developed—a process, as a rule, occupying a good many weeks.

No curd-mill is used in the Stilton method, and the cheese is not put into press. Grinding the curd, indeed, would liberate the cream, a portion of which would be lost in the draining, and pressure would cause more of it to escape. In a double-cream cheese, the danger is obvious; and even in single-cream cheese there is always a loss of butter-fat through grinding and pressing. In the Stilton method, the curd is a good deal exposed to the air. This oxidises it and causes a little acidity to develop, which facilitates the escape of the whey, the ripening of the cheese, and the development of the blue mould—*Penicillium crustaceum*—which has its influence not only on the consistency but also on the fla-

vour of the cheese. The measure of the operation is governed by temperature, in respect of which, as of the whole process of manufacture, the Stilton cheese-makers do not appear to have laid down any general or definite rules.

CHESHIRE CHEESE.

The system of cheese-making pursued in Cheshire corresponds pretty closely with the Cheddar method.

Four processes differing in minor details are here practised—an early ripening process, medium ripening process, late ripening process, and the Stilton-Cheshire process. The difference in the first three lies mainly in the amount of acidity developed, and the amount of pressure applied.

In the early ripening process about 50 per cent more than the usual quantity of rennet is added, while more acidity is developed and less pressure employed than in the other methods. In the medium ripening process a moderate amount of acidity is developed, to ensure the draining of the whey from the curd under pressure. In the late ripening system acidity is as far as possible prevented, the whey being drained by breaking down the curd more finely, and skewering under press, while the milk and curd are raised to a higher temperature in this method. In the Stilton-Cheshire system a large quantity of rennet is used, and little pressure is employed. An open flaky curd with little acidity is desired for this cheese.

OTHER ENGLISH VARIETIES.

Many other varieties of cheese are made in different parts of this country. In few instances, however, has a clearly defined or recognised system of manufacture been established, as in the case of Cheddar cheese.

The most widely known of these other English cheeses are the Leicestershire cheese, "single" and "double" Gloucestershire cheeses, Cotherstone cheese, Wensleydale cheese, and the cheeses of Derbyshire, Lancashire, Wilts, and Dorset. In Scotland the Dunlop cheese still maintains a local habitation, and a name more than local.

Cotterstone cheese is a copy of *Stilton*, little used outside Yorkshire, where it is made. The *Wensleydale* cheese, also a Yorkshire article of only local repute, is made at a high temperature, so that coagulation takes place in from thirty to forty minutes. The process is short and simple, but the cheese is not of a high class. After being pressed for twenty-four hours, the cheeses, which are usually under 15 lb., float in brine for three days, and are salted by that means. The *Gloster* "single" and "double" cheeses are flat and level, the latter being double the thickness of the former. They were at one time more widely esteemed than now.

Cream Cheese.—This is a fancy cheese, relished by many people. As indicated by the name, it is made from cream, and is of course the richest cheese made in butter-fat.

Professor Sheldon thus describes the making of cream cheese: "Cream cheese is easily made by pouring thick cream into a perforated box of wood, which is lined with muslin. The box may or may not have a bottom, and it should stand where the moisture from the cream can drain away. As the wet leaves it, the cream gradually hardens and becomes fairly solid, when it may be taken out of the mould and placed on straw exposed to the air. A blue fungus soon appears on the crust, and the cheese is ready for eating.

"It is made in a cool room, and should become slightly sour. Though there is less art and work in making cream cheese than in making any other sort, success is not always attained at the outset, and it must be remembered that cream cheese will not keep long.

"The cooler the room the slower the cheese will ripen, and indeed it should not ripen quickly. A room whose normal temperature in summer is 60° to 65° Fahr. will serve the purpose well enough, and in winter the temperature may be artificially raised if need be.

"The demand for cream cheese is limited and irregular, and the price at which the producers will find a profit is one which will not encourage a large circle of consumers."¹

Ordinary cream cheese is made with one part of cream to two parts of milk, rennet being added to curdle the mass in from six to eight hours.

Skim-milk Cheese.—Skim-milk cheeses are made in several parts of the country, chiefly in Scotland, but without the addition of some portion of cream the cheese is dry and rather tasteless.

An attempt has been made, chiefly in America, to replace the fat removed in the cream by the introduction of lard or other animal fat into the skim-milk. But the oleomargarine cheese thus produced is an inferior article, which has been very properly classed as a "dairy abomination."

Keeping Milk for Cheese-making.

The general plan, we have seen, is to make cheese every day. But on many small and mixed husbandry farms a sufficient quantity of milk is not available to make a cheese daily. In these cases the milk may be kept over one or two days, and a cheese made every second or third day. When it has to be kept for this purpose, the milk is cooled as soon as drawn from the cow, and kept in a cool place. When the cheese is to be made, the cream is taken off the stale milk, some fresh milk added, more fresh milk is heated up to perhaps 150° Fahr. (not to boiling-point), and added, and the cream which was taken off mixed with its own bulk of milk, and heated to 98° Fahr., and also added,—the whole being well stirred, and the rennet then put in.

If the milk has to be kept longer than one whole day and night, it is difficult to make really good cheese from it. Yet in many cases it has to be kept over two days in order to collect a sufficiency for cheese-making.

Different Makings of Curd.—Cheddar cheeses usually weigh from 80 to 90 lb. each. Mr Robertson, Dairy Instructor, Wigtownshire, gives the following directions for making an 80 lb. Cheddar cheese with 40 gallons of milk to make into curd at one time:—

"Let the curd of the first 40 gallons of milk be put into the chesset or mould, and pressed as if the cheese were finished, and then when the curd of the next 40 gallons is ready, scratch the surface of

¹ *The Farm and the Dairy*, 86.

the curd in the chesset with a dinner fork, or anything that will make the surface quite rough, gather the loose curd thus broken up towards the centre of the chesset, and pour a little warm water around the edge of the chesset on the inside, and pack in the fresh curd and press as usual. The splice thus made will most likely be complete, without any danger of cracking, or the cheese parting into halves. Of course this method should not be pursued except where there is not a sufficient quantity of milk to make enough curd at one time for an ordinary-sized Cheddar cheese.

"Where there are smaller quantities of milk to be handled daily, I would consider some method of making soft cheeses preferable to an attempt to make Cheddar."¹

It is a better plan to make small cheeses frequently from fresh curd, than larger cheeses more seldom from mixed stale and fresh milk or curd.

FOREIGN CHEESES SUITABLE FOR BRITAIN.

The following notes regarding foreign varieties of cheese capable of manufacture in this country, were prepared for this edition by Professor James Long:—

The varieties of cheese made upon the Continent of Europe is much greater than can be realised by those who have not examined the subject. Those cheeses which are suitable, however, to British trade and taste are not numerous, and are practically included in the list, details of the manufacture of which are given below. France claims the longest record, after which come Italy, Switzerland, and Germany. In Germany there is no specially leading variety, such as is universally recognised as a leading cheese, as in the case of the Gruyère for example. Nor do we find any important cheeses in such well-known dairy countries as Sweden, Norway, or Denmark.

Gruyère.

This cheese, which is made chiefly in Switzerland, and in those departments in France bordering upon that country, is well-known in England. It is of great

size, weighing from 100 to 150 lb., and often being more than 2 feet in diameter and 6 inches in thickness. It is a cheese which, at its best, is mellow, melting on the tongue, homogeneous, a light yellow in colour, without cracks on the crust, with a number of small holes which should not exceed three-eighths of an inch in diameter. The interior of these holes is moist, and the walls glazed, and they usually contain a little brine. The flavour is at once rich and nutty, somewhat resembling the very best Cheddars.

Gruyères are made in three qualities, —fat, half-fat, and lean,—or from full milk, half skim-milk, and skim-milk respectively. Most of the cheeses are made at factories or *fruitières*, to which the milk is delivered by the small producers.

It is warmed to 93°, and the curd brought by means of rennet in from 25 to 35 minutes. It is then cut with a long wooden knife, and subsequently stirred until the pieces of curd are no larger than peas.

The operation takes place in a handsomely made vat, or kettle of copper, frequently 5 feet in diameter. This kettle hangs upon a crane, and is swung over a wood-fire in the floor. Sometimes it is fixed, and the fire, made in a movable grate upon wheels, is run on a pair of rails from kettle to kettle.

The curd is next heated up to 135°, the stirring continuing until it has reached a proper consistence, which can only be ascertained by experience. The whole is then allowed to settle, and the cheesemaker skilfully passes a cloth beneath the curd, which has settled at the bottom of the vessel, brings up the ends on the other side, attaches the four corners to a hook hanging from a pulley, and in a few moments the curd is swung over a table and dropped into a mould waiting to receive it.

This mould is open at the side, and can be tightened at will. When once within it, the curd is carefully wrapped up with cloths, and after standing for a short time, it is put under a press for the removal of the whey.

It is salted the next day, the salting continuing from day to day for a considerable period, two men being required

¹ *Farming World Year-book*, 1890.

to move the cheeses, which are placed upon shelves in the ripening room.

Here three temperatures are, if possible, introduced, at the lowest, middle, and top shelves. These temperatures vary between 52° and 60° . Poor, or skim-milk, is set at a lower temperature than that given. What art there is in making Gruyère is chiefly displayed in the judgment in removing the curd from the vat at the right time, and in properly pressing, salting, and ripening it.

The other cheeses made in Switzerland, but all of which are unknown in the ordinary markets of this country, are the Spalen, the Bellelay, the Battelmatt, the Vacherin, the poor man's cheese, and the Schabzieger, in which the sugar of milk plays an important part. This cheese resembles the Myseost of the Scandinavian countries, and is not likely to become an important article of commerce.

Dutch Cheeses.

The two important cheeses made in Holland, both of which are sold in the English markets in very large quantities, are known as round or *Edam*, and flat or *Gouda* Cheese. We have seen these cheeses made in various districts in Holland, and have found that, although the systems adopted are similar, they vary in minute details, such as temperature.

Edam.—A round Dutch cheese weighs about 5 lb. The milk is sometimes partially skimmed, but the best makers remove no cream from it. The cows are milked in the meadows, and the milk—placed in round wooden tubs, which are taken to the cows by boat along the dykes which divide each farm—is renneted before starting for the dairy, at from 85° to 90° .

The curd usually forms in from 15 to 30 minutes, in accordance with the custom on the farm, and it is slowly cut with a wire cutter during 10 minutes, when the whey commences to separate.

The colouring is added with the rennet, if it is used.

After manipulation with the hands, the whey is baled out with a ladle, and the curd gathered together and again worked. As no mill is used, it is broken in the tub, and more whey removed, after which it is gathered together in a round mould

and pressed for a short time. This pressing continues until sufficient whey is removed, when the curd is placed in a trough in an egg-cup-like mould, with a lid which gives it its circular form. In this it is placed under a unique lever press, which is common in Dutch dairies.

Next day some salt is placed upon the top, but the cheese is reversed from time to time, while always being salted from the same point. This continues for from 8 to 10 days, when it is put into a vat of thick brine for from 12 to 24 hours, being subsequently washed and removed to the ripening room, where it stands upon a shelf, as near as possible at 70° . The cheese is turned daily until it is fit to sell.

It is well rubbed with linseed-oil and coloured yellow or red, in accordance with the market to which it is destined, the surface being scraped smooth and fine.

This cheese is made to an enormous extent in the provinces of North Holland, the chief markets being Hoorn, Edam, and Purmerend, all of which are within a convenient distance of Amsterdam.

Gouda.—The *Gouda*, or flat Dutch cheese, when at its best closely resembles the fine flavour of English Cheddar. It is much larger and heavier than the Edam, and although flat, has rounded sides. It is generally possible to purchase cheese of prime quality in Amsterdam, although its very high price prevents any considerable sale in this country. The milk is set at 92° , sufficient rennet being added to bring the curd in 25 minutes. It is then cut either with a knife or a lyre-like implement common among the Dutch.

As the whey exudes, it is removed from the tub, and the curd carefully and gradually broken up into fine pieces with the hands. It is subsequently pressed and squeezed in a large perforated basin-like mould, in which it is again pressed for the removal of the whey.

The cheese afterwards goes into the mould which gives it its shape, and in 24 hours is salted, salting continuing from day to day until it is fit for the brine-vat, where it sometimes happens that hot water is added to the curd after the withdrawal of the whey, in order to

harden it. This is a rougher plan of heating up than the operation as performed in England.

The Dutch cheeses are undoubtedly a boon to the working classes, who prefer them to inferior home-made cheese at similar prices.

Parmesan.

Parmesan cheese is manufactured in Italy, chiefly in Parma and Emilia. It is generally known as Grana, on account of the fine grain into which the curd is brought during manufacture. In size and shape it resembles Gruyère, but often weighs more than 150 lb.

Parmesan requires keeping for a considerable period, sometimes three years, until it is fit for the market, and for this reason the export trade is in few hands, the makers being obliged to sell to the dealers while the cheese is new, for they complete the process of ripening in the marvellous caves which are built beneath their premises.

The true Parmesan is full of minute holes, and when cut in halves emits a sticky sweet substance, which has caused the term "honeyed" to be applied to cheeses of the finest quality. The flesh of the cheese is a pale straw colour, but the crust is often almost black from its age and the colour which has been applied to it. Like the Gruyère, the Parmesan is made in factories, where the milk is carried by small farmers, as in Switzerland. In one of these establishments, where we were enabled to learn the process, as many as eighty persons brought in their milk, varying from 4 to 60 litres apiece. The work was done by two men.

The milk is put into a kettle of solid brass, and resembling in shape an inverted bell. This hangs from a crane over a fire in the floor. The milk is heated to 92°, when the cheese-maker takes a piece of solid rennet, the size of a walnut, which he places in a cloth, and dipping this into the milk, wrings it for some minutes, until its virtue has passed into the milk. The strong-smelling animal matter is then thrown away.

The curd is sometimes brought in fifteen minutes. It is then roughly cut, and subsequently broken up with two implements—one called the *rotilla*, a

long staff with wire-work bound around its head, and the other a rod with a disc at the end. Stirring is continued until the grain is almost as fine as large shot; some cold water is then sprinkled over the surface, the kettle is swung over the fire a second time, and the milk heated to from 104° to 110°, stirring being continued the while.

When the Grana, which is continually tested, is fit, the whey is dipped out, and the curd, which has been pressed into the bottom of the kettle, is removed into a cloth by two men, and placed in a large vessel for half an hour, after which it is removed into the mould. Here it is wetted with whey two or three times, in order to keep it sufficiently flexible; but it is also pressed by lying between two boards, and having weights placed upon the top.

The cloths are removed from time to time, when the cheese is covered with buckram, which gives an imprint to the skin. The buckram is subsequently cut, and the cheese is salted and again pressed. This process continues every other day for a fortnight, when the cheese is cleaned and scraped and taken to the ripening room, where it is greased and turned from time to time at suitable temperatures until it is ripe. In the ordinary way, however, it is sold to the dealer while it is yet young and green, very few of the makers venturing to complete the ripening process.

Gorgonzola.

This blue-moulded cheese, which somewhat resembles Stilton, is made chiefly in Lombardy, in moulds which are 12 inches in diameter by 12 inches high.

The curd is chiefly prepared by owners or drivers of cattle, and sold to the merchants when it has become solid, and formed into a cheese to ripen. The practice is to add the rennet to the evening's milk while it is from 85° to 95°, so as to bring the curd in fifteen minutes. It is then cut and broken up and ladled into cloths, which are hung up to drain in a cool apartment until the following morning.

The milk of the morning is served in a similar manner, except that the cloth holding the curd is placed into a bucket or vat to drain for some ten to fifteen

minutes. At the end of this time the curd of the evening, which is cold, and the warm curd of the morning are placed in the cheese-mould, care being taken that the top and bottom, as well as the sides, are composed of the warm curd. The middle of the cheese is built up of alternate layers of cold and warm, the maker plunging his fingers occasionally into the mass to amalgamate them.

When filled, the cloth which envelops the curd is folded over the surface, and the cheese is allowed to settle until it has sunk into the lower half of the mould—for it is divided into two pieces; the top portion is then removed and the lower one reversed, that the cheese may drain and face better.

At the end of twelve hours it is again turned, and the mould tightened. Next day the cloth is removed, and the cheese begins to take its form.

It is then removed into an apartment of 65°, where it remains for three or four days, at the end of which time the mould is removed altogether, and salting commences.

One-half of the cheese, and that always the top, is daily sprinkled and rubbed with salt, being reversed the following morning. This salting continues until, in the judgment of the maker, sufficient has been given; brining then goes on for a few days, and the cheese is next taken to the cave, which must be cool and moist, and is preferable if a damp draught is passed through it.

By this time a red mould has commenced to grow over the surface, and the cheese now requires great care in management and frequent turning. In from four to five months it will be ripe for the market, and will be veined throughout the interior with green mould.

The following analyses of Gorgonzolas, some of which, it may be mentioned, are made without any mould, for the higher Italian classes, many of whom prefer it, as the green fungus has been at times produced by artificial means, which are objectionable:—

German Analyses.

		Soxhlet.
Water . . .	36.72	43.56
Fat . . .	33.69	27.95
Casein . . .	25.67	24.17
Salt . . .	3.71	4.32

VOL. II.

Professor Kinch's Analysis.

	White.	Blue.
Water . . .	48.99	24.96
Fat . . .	26.50	26.10
Casein . . .	21.11	43.46
Salt . . .	3.40	5.22
Sugar . . .	...	.26

The analyses by Professor Kinch were of cheeses made under the direction of the writer, at the Royal Agricultural College, Cirencester—10 gallons of milk made from 14 to 15 lb. of cheese.

Roquefort.

This cheese, also somewhat popular in this country, is made in the Aveyron, in France, from the milk of the ewe, some half-million of these animals being kept in one district alone for the purpose.

The Roquefort is a small, round, flat cheese, weighing about 5 lb., and, like Gorgonzola and Stilton, it is veined with blue mould. This, however, is obtained in a different way, as will be seen.

The evening's and morning's milks are mixed together, and brought to a temperature of about 90°; the rennet, which is made from the stomach of the lamb, is added, and the curd brought in a short time.

It is then cut and broken down, and much of the whey removed. The curd is afterwards conveyed into the mould in three layers, between each of which a quantity of specially prepared mouldy bread crumbs are sprinkled, the bread being made from a mixture of wheat and barley flour.

After pressure, and when the cheese has attained a distinct form, it is removed to the drying-room for two or three days, when it is carried to the celebrated caves which have made the district so famous, and which are extremely humid, the temperature being about 46°. Here it is from time to time scraped, as mould grows upon it, salted, and ripened. Machines, however, are now used in some instances for brushing the rind instead of scraping it, and also for piercing the cheeses with needles, in order to encourage the growth of the fungus within.

Cantal.

The Cantal cheese, which is an extremely important one upon the Con-

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tinent, and which is probably destined to make its appearance in this country, is chiefly made in the Auvergne, and varies in weight from 40 to 100 lb. It is of piquant flavour, has a solid consistence, and may be termed a hard cheese.

Cantal is made from milk at a temperature of 75°; the curd is broken up in an hour, the whey removed, and the solid remnants gathered together in fifteen minutes, when they are kneaded and further drained. The curd is then put into a vessel pierced with holes, and again pressed with the hands, and indeed with the body, the maker frequently getting on to the top of the mould and pressing with his knees. The mass is then reversed, and left under heavy pressure for twelve hours, being kept warm the while. Each lot of curd manipulated in this manner is called a tome—a full-size cheese requiring from three to four tomes in its manufacture.

When the real cheese-mould is about to be filled, the masses of now solid curd which we have called tomes are broken up with the fingers into small pieces, the whole salted, and finally put into the moulds in cloths, and sent to the press. Here the cheese obtains its final form, and when sufficiently solid to be removed from the mould, it is taken to the cave to ripen.

The Cantal is ripened in about two months, and when made of full rich milk is of very fine quality.

Camembert.

This is the most popular of the small cheeses of the Continent which are sent to this country. It is made upon one principle, under various forms, in the department of Calvados and in the neighbouring districts of Normandy.

In a general way the evening's milk is skimmed and added to that of the morning, and heated to from 80° to 85°, sometimes higher. There are makers, however, who make three batches daily from three several milkings, thus preventing the necessity for heating the milk.

The curd is brought by the use of rennet in from one and a half to four hours, according to the custom on the farm. While still warm it is ladled into cylindrical moulds, placed upon mats

made of rush or reed, upon benches of cement or galvanised metal. Each mould is nearly filled with each batch of curd, and by the time the next curd is ready, the first will have sunk in the mould by reason of drainage, when it is again filled.

When the second curd is sufficiently low the mould is skilfully reversed, and kept upon the cheese until it is firm enough to handle; it is then salted upon one side, and left until the following day to be salted upon the other.

After salting it rests upon shelves for a few days, when it is carried to the *séchoir*, or drying-room, an apartment through which currents of air are induced to travel in all directions. Here a white mould appears; and when the pile is at its best the cheeses are conveyed to the cellar, which is usually dark, damp, and free from draught.

It is turned daily until covered with a green mould. During the growth of this fungus the flesh of the cheese will have gradually changed its condition, and in from five to six weeks it will be fit for market.

Brie.

This cheese, which is the most popular in France, is chiefly made in the department of Marne, not far from Paris, and sent to the Paris markets, where it obtains high prices. It varies from an inch to an inch and a half in thickness, and from 9 to 12 inches in diameter. Its character very much resembles that of Camembert, although it is differently made.

The new milk set at 83° is brought to a curd in from three to four hours, although details differ upon various farms. The mould is made in two parts, the top portion fitting into the bottom. This is placed upon a mat and a beech board, and the curd is laid within it in large, thin, unbroken slices until it is full. It remains to drain until the top portion of the mould can be removed; the cheese is then reversed by the aid of a clean mat and board, and in time becomes firm, when the mould is removed altogether.

It is then salted, as in the case of the Camembert, and finally taken, first to the drying-room, and subsequently to the cellar, an apartment which, as we found

in the Brie district, was not only extremely dirty, but positively reeked with fungoid growth upon the walls and shelves.

The cheese is speedily covered with white mould, with specks of blue here and there; it then goes to the cellar, and is soon covered with blue mould, upon which patches of a vermilion mould commence to grow. This blue mould is known as *Penicillium glaucum*, the red as *Oidium aurantiacum*, without which it is believed by French experts that the highest type of Brie cannot be obtained.

There is no more delicious cheese than the Brie, not even excepting the Camembert.

The Neufchatel.

This cheese, sometimes called the Bondon, is largely made in the department of Seine Inférieure. It is a small loaf-shaped cheese, about 3 inches high, and $1\frac{1}{2}$ to 2 inches in diameter, and is properly made from new milk, although the majority of makers, many of whom we have visited, in this department use milk which has been partially skimmed. For such cheeses the makers obtain only a penny apiece in the Paris markets.

The majority of the makers are farmers of the smallest class, who have not sufficient milk to make large cheeses.

The milk is set directly it comes from the cow, and sufficient rennet is added to bring the curd in twenty-four hours. It is then ladled into a cloth, stretched by the four corners over a draining-tub, and left to drain for twelve hours; the partially solid curd is then removed to a press, in which it remains for some hours, until in the judgment of the maker it is fit for moulding. At this moment it is worked up with the hand, and each cheese is moulded separately in a small brass cylinder, and placed upon a straw-covered shelf to dry. Here it becomes covered with white mould, which subsequently changes to blue, the apartment being maintained at 60°, or a little less.

The cheeses are turned daily; and when a second lot of white fungus has covered the blue it is ready for the market, and will keep a long time.

This cheese is salted after it has been dried upon the shelves for a day.

The Bondon is imitated in London by

East End purchasers of sour or stale milk; but it is sold to the public in a white or new state.

ASSOCIATED BUTTER AND CHEESE MAKING.

An important development of the dairy industry is the organising of establishments in which the milk produce of the cows on several different farms can be collected together for united manipulation. These establishments are of different kinds, with different yet similar aims and objects.

Creameries.—There is the "creamery," in which, as a rule, only the cream is received from the farmer. In some cases the farmer is paid for his cream by its weight or measure. In others, each farmer's cream is churned separately, and the payment made according to the produce in butter. The former is the more convenient to the creamery, the latter usually the more satisfactory to the farmer whose cream is of choice quality. A third plan, which has certain points to commend it, is for the farmer to bring the whole milk to the creamery twice a day—just after it is milked and run through a refrigerator to cool it and prevent it spoiling on the journey—get it at once separated by the centrifugal separator, and take back with him the fresh skim-milk, which he can usually turn to better account on his farm than could be done by the creamery.

In the creamery the cream is made into butter in large quantities at a time, thus securing a product of uniform character and appearance, which is so important in the sale of butter. In some cases creameries also do a considerable trade in selling fresh cream for table use in towns.

Butter-blending House.—This is a sort of modified butter factory, in which butter is collected in small quantities from farmers, graded according to quality, and submitted to a certain amount of re-making. The object here is to rectify the home defects in the "working" of the butter, to grade, blend, and remake it, so that it may be presented in the market in large quantities of uniform character and attractive appearance.

This system has been highly successful in France, especially in Normandy, and is being carried out at various centres in this country with results which seem to be fairly satisfactory.

Dairy Factory.—Then there is the dairy factory, which, known perhaps by different names, embraces all the branches of dairying (excepting, most likely, the keeping of cows)—buying in new milk from many farmers, selling some of it as fresh whole-milk, making cheese of various kinds, separating the cream from the milk by the centrifugal separator, making butter, selling fresh cream, selling the skim-milk back to the farmers or through towns and villages, and perhaps feeding part of it to cows, calves, and pigs.

These latter are generally establishments of considerable size, and, like the creameries and butter-blending houses, are conducted in some cases as distinct businesses, and in others in co-operation with the farmers who produce and supply the raw material.

Origin and Development of Dairy Factories.

The origin and development of this peculiar outcome of dairying in this country are explained in the following notes by Mr Gilbert Murray, Elvaston Castle, Derby:—

Since 1869 the dairy management of this country has undergone a complete revolution. In that year the landowners and farmers of Derbyshire originated a movement for the improvement of cheese-making. American cheese were then taking the lead in our markets (to the great injury of the home maker) and were realising higher prices than the average prices of our home dairies. The great advantage of the foreign article was the uniform quality which it derived by being made in a factory, while in no two dairies in this country was the produce alike in quality—there was scarcely one indeed in which the quality did not vary from day to day.

After much deliberation it was at last determined to introduce some skilful American makers, in order to give the factory system a fair trial on its merits.

Two factories were started; one in the town of Derby, and the other at

Longford, a purely rural district. At Derby a warehouse was improvised and fitted with the necessary machinery and plant. At Longford a new building was erected.

During the first two years, or what was then the experimental period, a fixed price was guaranteed to the suppliers of milk. After this the farmers undertook the management themselves, conducting the factories entirely on co-operative principles, and this system has since continued at the Longford Factory.

The object of the organisers of the new departure was to bring up the whole make of a district to a uniform point of excellence. This they attained, and continue to do, though meeting with considerable opposition from persons interested in the trade.

For several years the factory system made slow progress, but subsequently factories were planted in different counties. The reports and discussions to which the new departure gave rise and the authentic data as to the value of milk, were the means of enlisting public interest in dairy matters.

The cost of erecting and fitting up a cheese factory will run on an average to from 30s. to £2 per cow. The economy in working is very considerable.

Large dairy factories are now being established in different parts of the country on entirely new lines. These are manufactories on a large scale, skilfully carried out on strictly commercial principles. The output embraces every product of the dairy, from the raw material to the manufactured articles of all kinds. Some are carried on as limited liability companies, in which the farmers are shareholders.

The milk is delivered to the factory twice a-day from all distances up to four miles. As soon as the milk is drawn from the cow, it is passed over a refrigerator, figs. 420, 421, and the temperature reduced to about 60° Fahr.: in hot weather this prevents the milk from souring in transit. On arrival at the factory it is weighed and credited to the producer in the delivery book—the imperial gallon being reckoned at ten pounds.

The payments are monthly, with one month's money kept in hand to meet any case of emergency. Advances are

made to suppliers on payment of a discount at the rate of 5 per cent.

The great difficulty in the making of butter on an extensive scale is that of disposing of the bye-products — the separated milk and buttermilk. On these chiefly depend the financial success of the undertaking.

Much to their own disadvantage the farmers are chary of having anything to do with these establishments.

A butter dairy can only be successfully carried on near to a first-class station on a main line of railway.

There is much need for better organisation and more extended use of separated milk, and this must take place before dairy farming can be developed to its fullest extent in the British Isles.

Utility of the Factory System.

There is considerable difference of opinion as to the advisability of en-

couraging and extending the system of associated dairying. It is very properly contended that it is in itself an undesirable thing that the dairy farmer should employ others to perform work which should be done by himself and his family, or at any rate on his farm under his own eye. On the other hand, where the farms are small, or where few cows are kept, the small quantities of milk and cream may be turned to better account by being collected and manipulated in large quantities in associated dairies, than if each farmer were to prepare and market his dairy produce independently.

The factory system is assuredly very useful in its own way, and it has already done good service in this country. Yet it is by the extension and improvement of home-dairying that the lasting interests of the general body of farmers will be most effectually promoted.

END OF THE SECOND VOLUME.

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