The Agricultural Note-Book

Primrose McConnell, B.Sc.

FERTILISERS: PRICE AND CONSTITUENTS.

The Agricultural College conducted by the County Councils of Staffordshire and Shropshire rather suffers from being situated at one of the 200 Newports of Great Britain, and that a minor one. It will be best, perhaps, to call it the Shropshire College, not forgetting the equal share of Staffordshire, which, indeed, acts with special generosity, voting equal money for an establishment situated in the other county. The report for 1907, which is before us, gives the following most useful comparison of the price paid for fertilisers, with the fertilising material actually found in them. This is just what farmers want to have set out:—

ANALYSIS AND PRICES OF FERTILISERS.

Manure.	Price per ton. £ s.	Nitrogen. p.c.	Phosphates. p.c.	Potash. p.c.
Special mangel	6 0	3.64	12.77	—
Special turnip	6 6	3.74	14.11	.8
Special potato	6 15	4.10	12.45	2.42
Calcium cyanimide	13 5	20.60	—	—
Nitrate of soda	11 7	15.65	—	—
Sulphate of ammonia	13 5	19.48	—	—
Superphosphate	2 8	—	27.32	—
Dissolved bones	5 10	2.77	36.93	—
Sulphate of potash	10 15	—	—	48.8
Kainit	2 15	—	—	12.0
Bone meal	5 10	3.29	26.50	—
Steamed bones	4 0	.82	58.0	—
Basic slag	2 0	—	42.55	—

Incidentally we have to thank Mr. Hedworth Foulkes, of the college, for enabling us to give the first published market quotation of the new fertiliser, calcium cyanimide, or, as it is less correctly called, nitrate of lime. Basic slag comes out very well indeed, as, at half the price of steamed bones, it gave 4255 points of fertilising value against 5800. Two pounds a ton was very cheap, however. We fancy the cost is £2 7s. 6d. delivered at nearest station. Of course, if all the other prices are *ex* wharf, the comparisons will not be vitiated.

~~P. E. Moncpton~~

James Seely

THE AGRICULTURAL NOTE-BOOK.

NOTE-BOOK

OF

Agricultural Facts and Figures

FOR

FARMERS AND FARM STUDENTS.

BY

PRIMROSE McCONNELL, B.Sc.,

Fellow of the Highland and Agricultural Society of Scotland;
First-Class Certificate of the Royal Agricultural Society of England;
Author of "Elements of Farming," &c.

TENANT-FARMER, ONGARPARK HALL, ONGAR, ESSEX.

SIXTH EDITION.

LONDON:
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1897.

London:

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Cardington Street, N.W.

TO

ARCHIBALD M^C^CONNELL,

A SCOTTISH TENANT-FARMER,

This Note-Book

IS AFFECTIONATELY DEDICATED

BY HIS SON,

THE AUTHOR.

PREFACE TO THE FIRST EDITION.

THIS Note-Book makes no pretence of originality, either in the style or matter. When an agricultural student under Prof. Wilson at Edinburgh, the author oftentimes felt the great want of a book containing all the data connected with the subject he was studying. The various facts, which even those with the best of memories are continually forgetting, are scattered through numberless books and papers, necessitating in some cases a troublesome search, especially annoying to anyone preparing for an examination. The great value of Molesworth's "Pocket-Book of Engineering Formulæ" to engineers, and of similar books to those engaged in other professions, was so apparent to the author, that it occurred to him that a book compiled in the same style, and devoted to farming matters, could not fail to be useful as a ready means of reference for refreshing the memory.

With this end in view, the collecting of notes from all the standard text-books on Agriculture within reach was commenced, and carried on for several years, and the result, arranged as methodically as possible, is now given to the public.

Among the works to which the author has pleasure in here acknowledging his indebtedness are those of Mr. R. Scott Burn, Messrs. Johnston and Cameron, Professor Wrightson, Mr. Clements, Mr. Ewart, Mr. Stephens (the author of "The Book of the Farm"), and Professor Wilson. Besides these, a large number of other books, journals, papers, lectures, &c., have been consulted, for which it is hoped this general acknowledgment is sufficient. The whole has been supplemented and modified from the author's own practical knowledge gained on the farm and elsewhere.

He must also acknowledge the great assistance received from his friend Mr. John Speir, of Newton Farm, near Glasgow, who kindly revised the manuscript, and suggested many improvements.

AYR, *July*, 1883.

PREFACE TO THE SIXTH EDITION.

The first edition of this work was issued fourteen years ago, and now the *sixth* is submitted to the public. The immense progress made in agricultural practice and science within that time is astonishing to anyone who has tried to keep abreast of it, and much of our knowledge has had to be modified within the last few years. There is little pretence made of explanation or elucidation in the following pages, but the figures and other data of farming matters are stated in tabular form as far as it is possible to do so. The "Note-Book" has met with so much success—no doubt largely owing to the great advances made in agricultural education—that I am encouraged to make it as full as possible, while taking the greatest pains to have the information thoroughly reliable in the minutest detail. The whole has had to be largely re-written, as the amount of matter contained in this edition is three times that of the first one. On account of this increase in size, it has been found necessary to abandon the "note-book" form and adopt the ordinary style of paging and binding—an alteration which it is hoped will make the volume more convenient to use.

As on previous occasions, my friend Mr. Speir has revised the manuscript, and to him I am indebted for many valuable notes.

P. McC.

ONGAR, *July*, 1897.

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"I have a baylife as skilful as may be; yet, remembering the old saying that the best doung for the field is the master's foot and the best provender for the horse the master's eye, I play the overseer myself."—*Gervase Markham* (1620).

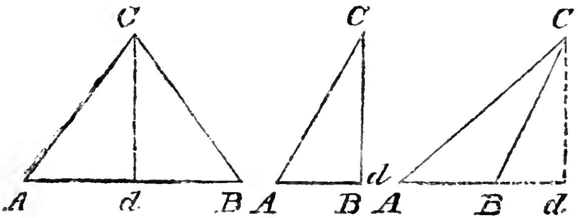
THE AGRICULTURAL NOTE-BOOK.

MATHEMATICAL AND OTHER SIGNS USED.

$=$ signifies "equal to."
$+$,, "added to" (*plus*).
$-$,, "subtracted from" (*minus*).
$\times$,, "multiplied by."
$\div$,, "divided by."
a^2, b^2, &c., signifies a or b "squared" ($\times$ itself).
$\sqrt{}$ signifies "square root of."
°F. or °C. signifies degrees Fahrenheit or Centigrade.
$\angle$ signifies angle.
″ ,, inches.
′ ,, feet.
% ,, per cent.

MENSURATION AND LEVELLING.

Computation of Acreage.—Divide the enclosure into convenient triangles; multiply the base (in links) of each triangle by its perpendicular height, and divide by two; this gives area in square links: point off five figures to the right (= dividing by 100,000 the number of square links in an acre), which gives acres and decimal fraction. Repeat the process for each triangle, and add together. Multiply decimal fraction by 4, point off 5 figures leaves roods; multiply fraction left by 40, point off 5 figures leaves poles with decimal fraction.



Area of each of these triangles is =

$$\frac{\text{base} \times \text{perpendicular}}{2} = \frac{A\,B \times C\,d}{2}.$$

Area of square = any side × itself.
,, rectangle = length × breadth.
,, parallelogram = base × perp. height.
,, circle = diameter^2 × ·7854.
,, sector of circle = length of arc × ½ radius.

Let S = ½ sum of sides of any triangle:

$$= \frac{A\,C + C\,B + A\,B}{2}; \text{ then}$$

$$\text{Area} = \sqrt{S\,(S - A\,C)\,(S - C\,B)\,(S - A\,B)}.$$

In right-angled triangles:—

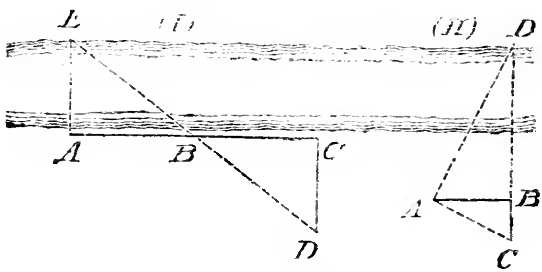
Hypothenuse $= \sqrt{\text{base}^2 + \text{perp.}^2}$;
Base ... ... $= \sqrt{\text{hypoth.}^2 - \text{perp.}^2}$;
Perpendicular $= \sqrt{\text{hypoth.}^2 - \text{base}^2}$.

Surface of cylinder = area of both ends + length × circumference.
,, cone = area of base + circumference × ½ slant height.
,, sphere = diameter^2 × 3·14159.

Solid content of cylinder = area of one end × length.
,, ,, sphere = diameter^3 × ·5236.
,, ,, cone or pyramid = area of base × ⅓ perpendicular height.
,, ,, wedge = area of base × ½ perpendicular height.

To Set Off a Right Angle with the Chain Only.—Measure off 40 links on the ground along the base-line; then take 30 for the perpendicular, and 50 for the hypothenuse; by fastening the extremities of these last 80 links at the ends of the base, and pulling the chain tight, we have a right-angled triangle.

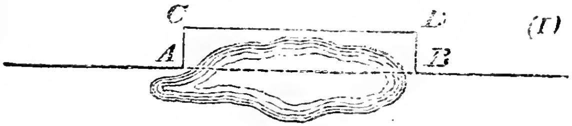
Inaccessible Points.



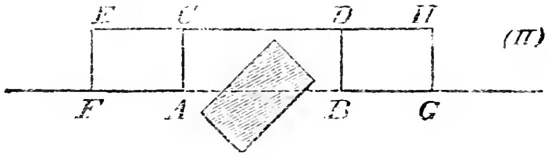
1. Start from A (exactly opposite to E) and go to B; continue to C, making B C = A B; erect C D perpendicular to A C, and find D in a line with B and E; C D = A E.

2. Take B A at right angles to C D; draw A C perpendicular to A D; then A B : B D :: C B : B A.

OBSTACLES IN CHAINING LINES.

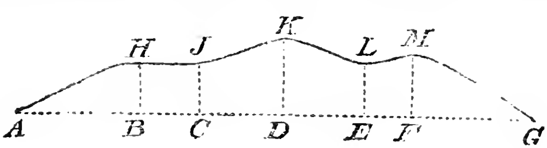


1. If the obstacle can be seen over:—Erect two perpendiculars (A C and B D) of equal length at A and B; then C D = A B.



2. If the obstacle cannot be seen over:—Lay off A C and E F, equal to one another, and at right angles to A F; range the points D and H in line with E C, and set off D B and H G at right angles to E H, and each = E F or C A; then C D = A B, and B and G are points for ranging the continuation of F A.

TO MEASURE THE AREA WHERE BOUNDARY IRREGULAR.



Lay off a base line, A G, and measure offsets to the various bends and angles of the boundary line, and at right angles to the base: this divides the enclosed space into approximate triangles and trapezoids. The area of the triangles is calculated in the usual way; for the trapezoids the average of the two sides is taken and multiplied by the base: thus, area $B C J H = \frac{B H + C J}{2} \times B C$; and similarly for the rest; the sum of the whole = area of A G M K H.

AREA in Acres for one Statute Chain in length of a given breadth in feet :—

Breadth in Feet.			Acres per Chain in Length.	Breadth in Feet.			Acres per Chain in Length.
1	...	...	·001515	6	...	...	·00909
2	...	...	·00303	7	...	...	·010606
3	...	...	·004545	8	...	...	·012121
4	...	...	·00606	9	...	...	·013636
5	...	...	·007575	10	...	...	·015151

An acre laid out as an exact square must have its side made 316·25 links = 208·71 feet = 69·37 yards: it may be taken at 70 paces.

TABLE FOR CONVERTING FEET INTO LINKS AND LINKS INTO FEET.

Links.		Feet.	Feet.		Links.
1	=	·66	1	=	1·5151
2	=	1·32	2	=	3·0303
3	=	1·98	3	=	4·5454
4	=	2·64	4	=	6·0606
5	=	3 30	5	=	7·5757
6	=	3·96	6	=	9·0909
7	=	4·62	7	=	10·6060
8	=	5·28	8	=	12·1212
9	=	5 94	9	=	13·6363
10	=	6·60	10	=	15·1515

DECIMAL PARTS OF AN ACRE CONVERTED INTO ROODS AND PERCHES.

Dec.	R.	P.	Dec.	R.	P.	Dec.	R.	P.	Dec.	R.	P.
·975	3	36	·725	2	36	·475	1	36	·225	0	36
·950	3	32	·700	2	32	·450	1	32	·200	0	32
·925	3	28	·675	2	28	·425	1	28	·175	0	28
·900	3	24	·650	2	24	·400	1	24	·150	0	24
·875	3	20	·625	2	20	·375	1	20	·125	0	20
·850	3	16	·600	2	16	·350	1	16	·100	0	16
·825	3	12	·575	2	12	·325	1	12	075	0	12
·800	3	8	·550	2	8	·300	1	8	·050	0	8
·775	3	4	·525	2	4	·275	1	4	·025	0	4
·750	3	0	·500	2	0	·250	1	0	.000	0	0

SCALES OF THE ORDNANCE SURVEY.

$\frac{1}{63360}$ = 1 in. to mile for the kingdom.
$\frac{1}{10560}$ = 6 ,, ... counties.
$\frac{1}{2500}$ = 25 ,, ... parishes.
$\frac{1}{500}$ = 10·56 ft. .. .. towns.

CONTENTS OF STACKS, ETC.

For Circular Stacks.—Square the average girt, multiply by ·07958 (the area of a circle whose circumference is 1): multiply this by the perpendicular height—all in feet—gives the contents of the stack in cubic feet. For the conical top, take the area of eaves (girt at eaves^2 × ·07958) and multiply by one-third the perpendicular height.

For Oblong Stacks with perpendicular ends.—Multiply the length by the average width (between bottom and eaves), and the product by the height from the ground to the eaves. For the top, multiply the area at the eaves by half the height to the ridge.

For Oblong Stacks with prismoidal bodies and sloped ends on the top.—To the area at bottom add area at eaves; to this add the product obtained by multiplying the sum of the lengths by the sum of the breadths; multiply this by $\frac{1}{6}$ of the perpendicular height to eaves—gives contents of body. For the top, take twice the length at the eaves and add the length of the top; multiply this sum by the breadth at the eaves, and again by the perpendicular height from the eaves to the top, and $\frac{1}{6}$ of this product will be the contents.

The weight of hay per cubic yard in the stack varies from 112 lbs. to 300 lbs., depending on the nature of the hay, its age, the size of the stack, and the part of the stack taken. 196 lbs. is the conventional average adopted in East Lothian. In the South of England, where the hay is well "sweated," 224 lbs. to the cubic yard is a good average—that is, 9 cubic yards to a "load," or 10 cubic yards to a ton. The weight may be ascertained very accurately by actually measuring the cubic contents of a truss, and from this calculating the weight of a cubic foot. The following table shows the number of cubic yards in a ton at different weights per foot:—

Wt. per Ft. in Lbs.		Yds. to a Ton.	Wt. per Ft. in Lbs.		Yds. to a Ton.
5·18	=	16	7·50	=	11
5·53	=	15	8·25	=	10
6·00	=	14	9·18	=	9
6·37	=	13	10·31	=	8
6·87	=	12	11·85	=	7

Cubic weights will usually run as follows:—

1 cubic foot Hay	... ...	8	lbs.
1 ,, ,, pressed	... ...	12	,,
1 ,, Straw	... ...	5	,,
1 ,, ,, pressed	... ...	8	,,

For different conditions of hay and stacks the number of cubic yards to a ton will approximately vary as follows:—

	Square Stacks. Cubic Yards.	Round Stacks. Cubic Yards.
If not well settled	12	13
If fairly well settled	10	11
If very compact	8	9

Second-cut clover hay will require 13 or 14 cubic yards to a ton.

Stacks of straw are estimated at from 18 to 20 cubic yards to a ton.

Carts.—For measuring the contents of Carts or Dung-hills the same rule is used as that for the prismoidal body of a stack.

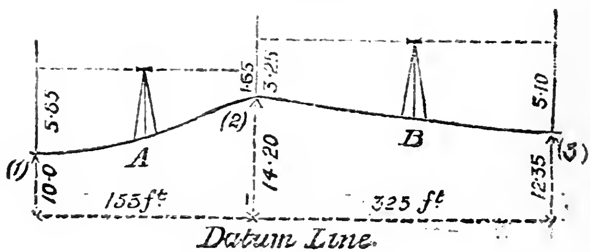
Grain.—For measuring Grain in the heap, take the cubic contents in feet, and multiply by ·8 to give bushels. A cubic foot is 1,728 cubic inches, and a bushel 2,219·7 cubic inches, or as 1 to 1·285: that is, as ·778 (say ·8) to 1. In practice 4 bushels equal 5 cubic feet.

3·64 cubic feet	New Oats	= 1 cwt.
2·38	Barley	= 1 ,,
2·20 ,, ,,	Wheat	= 1 ,,

Roots.—For measuring Roots in clamp, take the cubic contents in feet, and multiply by one of the following factors, according to the kind of root: the figures represent the weight in pounds of a cubic foot of each:—

Turnips	33	Potatoes	41
Swedes	35	Carrots	31
Mangolds	35	Parsnips	31

LEVELLING.



Required to find the difference of level between stations 1 and 3. Erect the spirit level at A and take the "back-sight" observation on the staff at 1, and the "fore-sight" on the staff at 2; repeat the same at B for 2 and 3; the distance between the stations to be also measured. These are entered in columns as follows:—

Stations.	Distance.	Staff Readings.		Rise.	Fall.	Reduced Levels.	Remarks.
		Back-Sight.	Fore-Sight.				
1	...	...	...	...	...	10	Datum Line below Station 1.
2	153	5·85	1·65	4·20	...	14·20	
3	325	3·25	5·10	...	1·85	12·35	
	478	9·10	6·75	4·20	1·85	12·35	
		6·75		1·85		10	
		2·35		2·35		2·35	

Thus there is a fall of 2·35 ft. from 3 to 1 (distance = 478 ft.), or 5·9 in. nearly in 100 ft. Station 1 is 10 ft. above the Datum Line, 2 is 14·2 ft., and 3 is 12·35 ft.

USEFUL NUMBERS.

For Converting		Multiply by	Converse.
LENGTH.			
Feet...	into links	1·575	·66
Yards	..	4·545	·22
Feet...	miles	·000189	5280
Yards	..	·00057	1760
Chains	..	·0125	80
Feet...	metres	·3048	3·2809
Yards	,,	·9144	1·0936
Chains	,,	20·117	·049
Prussian feet ...	Impl. ft.	1·030	·971
Kilometres	miles	·6214	1·6093
Scottish mile ...	..	1·123	·89
Irish miles	..	1·272	·785
Prussian miles	..	·2137	4·6807
Austrian miles	..	4·714	·212
Russian versts	..	·6629	1·508

Useful Numbers—*continued.*

For Converting	Multiply by	Converse.
Square.		
Square ft. ... into sq. inches ...	144	·00694
Square yds. ... ,, sq. metres...	·8361	1·196
Square ins. ... ,, acres... ...	·000000159	6272640
Square ft. ... ,, ,, ...	·0000229	43560
Square yds. ... ,, ,, ...	·0002066	4840
Square ft. ... ,, Pruss. sq. ft.	·943	1·060
Square ft. ... ,, Aust. ,,	·929	1·0756
Square ft. ... ,, Russ. ,,	·761	1·3129
Solid.		
Cubic ins. ... into cub. feet ...	·000579	1728
Cubic ft. ... ,, ,, yards	·03704	27
Cubic yds. ... ,, ,, metres	·7645	1·308
Cubic ft. ... ,, Pruss. cub. ft.	·915	1·092
Cubic ft. ... ,, Aust. ,,	·896	1·115
Cubic ft. ... ,, Russ. ,,	·664	1·5043
Capacity.		
Cubic ins. ... into bushels ...	·00045	2219·7
Cubic ft. ... ,, ,, ...	·778	1·285
Cubic ins. ... ,, gallons ...	·003604	277·463*
Cubic ft. ... ,, ,, ...	6·228	·1605
Bushels ... ,, ,, ...	8·00	·125
Gallons ... ,, litres ...	4·543	·220
Pints ... ... ,, ,, ...	·568	1·76
Litres ... ... ,, cubic feet	·03532	28·33
Weights.		
Lbs. ... into cub. ins. water	27·74	·036
Lbs. ... ,, ,, ft. ,,	·01605	62·2786†
Cubic ft. water ... into tons...	·0278	35·9
Lbs. ... ... ,, cwts.	·00893	112
Lbs. ... ... ,, kilogs.	·454	2·2
Cwts. ... ... ,, ,,	50·8	·01968
Money.		
Dollars ... ... into £	·2083	4·8
Francs ... ... ,, £	·03911	25·57
Thalers ... ... ,, £	·1448	6·91
Roubles... ... ... ,, £	·1562	6·4
Rupees ... ... ,, £	·926	10·78

* Board of Trade, 1890; formerly 277·274.
† Board of Trade, 1890; formerly 62·425.

WEIGHTS AND MEASURES.

Imperial Troy Weight.

·003961 cub. in. of water	= 1 grain (gr.)
3·17 grains	= 1 carat.
24 grains	= 1 pennyweight (dwt.)
20 pennyweights	= 1 ounce (oz.)
12 ounces	= 1 pound (lb.)
1 ounce	= 480 grains.
1 pound	= 5,760 grains.

The weight of a grain of wheat taken from the middle of the ear, well dried, is = "1 grain."

Imperial Avoirdupois Weight.

27·34 grains (grs.)	= 1 drachm (dr.)
16 drachms	= 1 ounce (oz.)
16 ounces	= 1 pound (lb.)
14 pounds	= 1 stone (st.)
28 pounds	= 1 quarter (qr.)
4 quarters	= 1 hundredwght.(cwt.)
112 pounds	= 1 cwt.
20 hundredweight	= 1 ton.
1 ounce	= $437\frac{1}{2}$ grains.
1 pound	= 7,000 grains.

Foreign Measures of Weight.

	Name of Weight.	No. equal to 1 cwt. Impl.
Britain	Lb. Avoir.	112·0
America	Pound	112·0
Austria	.. ..	90·68
Denmark	.. ..	101·55
France	Kilogramme	50·8
Holland	Pound	50·8
India—		
Northern	Maund, 82·42 lbs. ...	1·35
Southern	,, 25 ,, ...	4·48
Madras Government	,, 24·68 ,, ...	4·53
Portugal	Pound	110·68
Prussia	,, ...	108·60
Russia	,, ...	124·08
Spain	,, ...	110·4
Sweden	,, ...	149·33

Imperial Measures of Capacity.

5 ounces of water	= 1 gill.
4 gills	= 1 pint (pt.)
2 pints	= 1 quart (qt.)
4 quarts	= 1 gallon (gal.)
2 gallons	= 1 peck (pk.)
4 pecks...	= 1 bushel (bus.)
8 bushels	= 1 quarter (qr.)

These measures are used up to the gallon for liquids, and from the peck upwards for dry goods.

4 qrs. = 1 chaldron ; 10 qrs. = 1 last. In London a chaldron of coals = 36 bushels, or $25\frac{1}{2}$ cwt.

Imperial Wine Measure.

(For all Wines and Liquids.)

4 gills	= 1 pint (pt.)
2 pints	= 1 quart (qt.)
4 quarts	= 1 gallon (gal.)
10 gallons	= 1 anker (ank.)
18 gallons	= 1 runlet (run.)
$31\frac{1}{2}$ gallons	= 1 barrel (bar.)
42 gallons	= 1 tierce (tier.)
2 tierces	= 1 puncheon (pun.)
63 gallons	= 1 hogshead (hhd.)
2 hogsheads	= 1 pipe (pipe).
2 pipes	= 1 tun (tun).

Imperial Ale and Beer Measure.

(For Malt Liquors and Water.)

2 pints	= 1 quart (qt.)
4 quarts	= 1 gallon (gal.)
8 gallons	= 1 firkin (fir.) (ale).
9 gallons	= 1 firkin (fir.) (beer).
18 gallons	= 1 kilderkin (kil.)
36 gallons	= 1 barrel (bar.)
$1\frac{1}{2}$ barrels (54 gals.)	= 1 hogshead (hhd.)
72 gallons	= 1 puncheon (pun.)
2 hogsheads	= 1 butt (butt).
2 butts	= 1 tun (tun).

Imperial Corn Measure.

2 quarts	= 1 pottle (pot.)
2 pottles	= 1 gallon (gal.)
2 gallons	= 1 peck (pk.)
4 pecks	= 1 bushel (bus.)
2 bushels	= 1 strike (str.)
4 bushels	= 1 coomb (coomb).
4 bushels	= 1 sack.
2 coombs or 8 bushels	= 1 quarter (qr.)
4 quarters...	= 1 chaldron.
5 quarters...	= 1 load (load).
2 loads or 10 qrs.	= 1 last (last).

The gallon has the same capacity in all Imperial measures, and was fixed by the Board of Trade in 1890 at 277·463 cubic inches, or = 10 lbs. of distilled water at 62° F. and barometer at 30 inches. The old capacity was 277·274 cubic inches. The bushel is 1·28 cubic feet: 19½ inches diameter, and 8¼ inches deep. The U.S. bushel is 2150·4 cubic inches = ·9688 of an Imperial bushel.

Foreign Liquid Measures.

	Name of Measure.	Contents in Gallons.
Britain	Gallon	1·0
America	,, ...	0·833
Austria	Eimer	12·449
Denmark	Anker	8·493
France	Litre	0·22
Holland...	Anker	8·406
Portugal	Almude	3·750
Prussia	Eimer	15·147
Russia	Veddras	2·712
Spain	Arroba	3·527
Sweden	Eimer	17·289

Measures Used in the Sale of Wheat.

Per qr. of 8 Imp. bus. (or 480 lbs.)	at Mark Lane and throughout the country.
,, coomb of 4 Imp. bus.	at Beccles and other places.
,, load of 3 ,, ,,	at Sheffield, Doncaster, and other places.
,, ,, 5 qrs.	at Oxford, Cirencester, and other places.
,, ,, 144 qts. ...	at Ulverston.
,, ,, 5 Imp. bus.	at Bedford and other places.
,, boll of 3 ,, ,,	at Newcastle, Carlisle, and Darlington.
,, ,, 6 ,, ,,	at Berwick, Duns, and Kelso.
,, ,, 4 ,, ,,	at Glasgow and throughout Scotland.
,, bushel of 62 lbs. ...	at Birmingham, Gloucester, and other places.
,, ,, 65 ,, ...	at Aberystwith.
,, ,, 70 ,, ...	at Liverpool and Manchester.
,, ,, 72 ,, ...	at Wolverhampton.
,, ,, 75 ,, ...	at Chester, Shrewsbury, Market Drayton, Nantwich, and other places.
,, ,, 80 ,, ...	at Monmouth, Abergavenny, and other places.
,, boll of 264 lbs. ...	at Glasgow and other places.
,, ,, 240 ,, ...	at Hamilton.
,, barrel of 280 lbs. ...	at Dublin, Cork, and other places.
,, cwt. of 112 ,, ...	at Bedford, Newry, and other places.
,, cental of 100 ,, ...	at Liverpool and Manchester.
,, windle of 220 ,, ...	at Preston.
,, hobbet of 168 ,, ...	at Denbigh.
,, 540 lbs.	at Leeds.
,, 186 ,, ...	at Coventry.
,, 126 ,, ...	at Darlington.

1 boll of oats = 8 bus. : 1 boll of oatmeal = 140 lbs. = ½ sackful ; in Galloway, 280 lbs. = boll of oatmeal : 1 boll of ryegrass seed = 4 bus. of 24 lbs. = 96 lbs.

Imperial Lineal Measure.

72 points	= 1 inch (in.)
3 barleycorns (in length)	= 1 inch (in.)
12 lines	= 1 inch (in.)
12 inches	= 1 foot (ft.)
3 feet	= 1 yard (yd.)
6 feet	= 1 fathom (fth.)

IMPERIAL LINEAL MEASURE—*continued.*

$5\frac{1}{2}$ yards	= 1 rod, perch, or pole (po.)
40 poles	= 1 furlong (fur.)
8 furlongs	= 1 mile (m.)
3 miles	= 1 league (lea.)
$69\frac{1}{2}$ miles	= 1 degree (deg. or °).

For measuring digging, ditching, draining, &c., the Imp. pole of $5\frac{1}{2}$ yds. is used. In some districts the Cheshire rod of 8 yds., in others the Woodland pole of 6 yds., is used; in Ireland the Plantation pole of 7 yds., and in Scotland the "fall" of 6 Scotch "ells"—a fall being nearly equal to $18\frac{1}{2}$ feet.

The chain used for measuring land is 4 poles, or 22 yds. long, and consists of 100 links, each link being $\frac{22}{100}$ yd., or 7·92 in. long. 10,000 sq. lks. = a square chain: 25,000 sq. lks. = sq. rood: 100,000 sq. lks. or 10 sq. chains = 1 acre.

FOREIGN LINEAL MEASURES.

	Name	Number = 100 Feet Impl.	Length in Inches Impl.
Britain	Foot	100·0	12·0
America	,, ...	100·0	12·0
Austria...	,, ...	96·4	12·45
Denmark	,, ...	97·2	12·35
France	Metre ...	30·47	39·37
Holland	Foot	107·7	11·14
Portugal	,, ...	92·7	12·96
Prussia	,, ...	97·1	12·36
Russia	,, ...	87·2	13·75
Spain	,, ...	108·0	11·03
Sweden...	,, ...	102·7	11·69

IMPERIAL SQUARE MEASURE.

144 sq. inches	= 1 sq. foot (sq. ft.)
9 sq. feet	= 1 sq. yard (sq. yd.)
$30\frac{1}{4}$ sq. yards	= 1 sq. pole (sq. po.)
40 sq. poles	= 1 rood (ro.)
4 roods	= 1 acre (ac.)
640 acres	= 1 sq. mile (sq. m.)
6,272,640 sq. inches	= 1 acre.
43,560 sq. feet	= 1 acre.
4,840 sq. yards	= 1 acre.
160 sq. rods	= 1 acre.
10 sq. chains	= 1 acre.

Solid Measure.

1,728 cubic in.	=	1 cubic foot (cub. ft.)
27 cubic ft.	=	1 cubic yard (cub. yd.)
A barrel bulk	=	5 cubic feet.
A load of rough timber	=	40 ,,
,, squared ,, ...	=	50 ,,
A ton of timber, shipping... ...	=	42 ,,
,, freight, ,, ...	=	40 ,,
A stack of wood	=	108 ,,
A cord ,, ...	=	128 ,,

Fluid Measure.

60 minims (♏)...	=	1 fluid drachm (f ʒ).
8 drachms	=	1 ounce (f ℥).
20 ounces	=	1 pint (O).
8 pints	=	1 gallon (C or gal.)

Old Apothecaries' Weight.

20 grains	=	1 scruple (sc. or ℈).
3 scruples	=	1 drachm (dr. or ʒ).
8 drachms	=	1 ounce (oz. or ℥).
12 ounces	=	1 pound (lb. Troy).

Superseded in 1864.

New Apothecaries' Weight.

Ounce	=	$437\frac{1}{2}$ grains.
Pound (16 oz.)	=	7,000 ,,

Same as Avoirdupois.

Symbols Used in Prescriptions.

j or i	=	one.
ij	=	two.
iij, etc.	=	three, &c.
s. s.	=	one-half.
gtt.	=	drop.
a.a.	=	of each.
F. ft.	=	mix.
ft.	=	make.
℞	=	take of.
Q.S.	=	sufficient quantity.

And also the symbols used in Fluid Measure and Apothecaries' Weight.

Cloth Measure.

$2\frac{1}{4}$ inches	=	1 nail.
4 nails	=	1 quarter (qr.)
4 quarters	=	1 yard (yd.)
3 quarters	=	1 Flemish ell

Cloth Measure—*continued.*

5 quarters	= 1 English ell.
6 quarters	= 1 French ell.
37·0598 inches...	= 1 Scots' ell.

Bread and Flour Weight.

4 lbs. $5\frac{1}{2}$ oz. Imp.	= 1 quarter loaf.
8 ,, 11 ,, ...	= 1 half-peck loaf.
17 ,, 6 ,, ...	= 1 peck loaf.

A peck or stone of flour is 14 lbs.: a bushel of flour is 56 lbs.; a boll is 140 lbs.: and a sack of 5 bushels is 280 lbs., or $2\frac{1}{2}$ cwt.

Hay and Straw Weight.

36 lbs. Imp. of straw...	= 1 truss.
56 lbs. of old hay	= 1 ,,
60 lbs. of new hay	= 1 ,,
36 trusses	= 1 load.
A load of straw	=11 cwt. 64 lbs.
A load of old hay	=18 cwt.
A load of new hay	=19 cwt. 32 lbs.

Hay sold between 1st June and 31st August is reckoned new hay, and must weigh 60 lbs. per truss. Hay sold between 31st August and the succeeding 1st June is reckoned old, and must weigh 56 lbs. per truss.

Wool Weight.

7 lbs. Avoirdupois	= 1 clove
14 ,, or 2 cloves	= 1 stone.
28 ,, or 2 stones	= 1 tod.
182 ,, or $6\frac{1}{2}$ tods	= 1 wey.
364 ,, or 2 weys	= 1 sack.
4,368 ,, or 12 sacks	= 1 last.

20 lbs. = 1 score, and 240 lbs. or 12 scores = 1 pack. Wool is frequently sold in Scotland by the stone of 24 lbs. Imp. In practice, wool buyers frequently reckon 30 lbs. to the tod.

The Quarterly Terms.

In England and Ireland.

Lady Day, 25th March.
Midsummer, 24th June.
Michaelmas, 29th September.
Christmas, 25th December.

In Scotland.

Candlemas, 2nd February ...	Old Style—	13th February.
Whitsunday, 15th May... ...	,,	26th May.
Lammas, 1st August	,,	12th August.
Martinmas, 11th Nov	,,	22nd Nov.

Seasons.

Spring commences 21st March.
Summer ,, (longest day) 21st June.
Autumn ,, 23rd September.
Winter ,, (shortest day) 21st December.

Thirty days hath *September*,
April, *June*, and *November* :
February hath twenty-eight alone.
All the rest have thirty-one :
But Leap Year coming once in four,
February then has one day more.

Angular Measure.

60 seconds (″)	...	... =	1 minute (′).
60 minutes	...	... =	1 degree (° or deg.)
30 degrees	...	... =	1 sign (s.)
45 ,,	...	... =	1 octant.
60 ,,	...	... =	1 sextant.
90 ,,	...	... =	1 right angle or quadrant.
180 ,,	...	... =	1 semicircle.
360 ,, (12 signs)	...	... =	1 circumference.
3·1416 diameters nearly		... =	1 circumference.

Various Moneys.

Country.	Name of Coin.	No. in £1 Sterling.
Britain	Shilling...	20
America	Dollar	4·84
Austria	Florin	9·83
Buenos Ayres	Patacon	4·8
Denmark	Dollar	4·897
Egypt	Pound	0·979
France	Franc	25·57
Holland	Florin	11·97
India	Rupee	10·78
Italy	Lira	25·263
Portugal	Milreis	4·285
Prussia	Dollar	6·9
Russia	Rouble	6·4
Spain	Dollar	4·8
Sweden...	Ducat	2·182

A halfpenny is 1 inch diameter, and 1½d. is = 1 oz. in weight.

Old Measures now Abolished.

Old English Dry Measure.

				Imp. Gals.
2 pints	=	1 quart	=	0·24236
4 quarts	=	1 gallon	=	0·96944
2 gallons	=	1 peck	=	1·93889
4 pecks	=	1 Winchester bushel ...	=	7·75558
4 bushels	=	1 coom	=	31·02231
2 cooms	=	1 quarter	=	62·04462
5 quarters	=	1 wey or load ...	=	310·22313
2 weys	=	1 ton	=	620·44620

Heaped Measure.

(For Lime, Coals, Culm, Fish, Potatoes, Fruit, &c.)

2 gallons	=	1 peck.
4 pecks	=	1 bushel.
3 bushels	=	1 sack.
12 sacks	=	1 chaldron (ch.)

Old English Coins.

				Sterling.
Silver	Groat	=	4 pence.
,, ...	Tester...	=	6 pence.
Gold	Noble	=	6s. 8d.
,, ...	Angel	=	10s.
,, ...	Half-Guinea	=	10s. 6d.
,, ...	Mark or Merk ...	=	13s. 4d.
,, ...	Guinea	=	£1 1s.
,, ...	Carolus	=	£1 3s.
,, ...	Jacobus	=	£1 5s.
,, ...	Moidore	=	£1 7s.
,, ...	Joannes	=	£1 16s.

Scottish Lineal Measure.

1 ell ...	...	... ...	=	37·0598 Imp. ins.
6 ells	=	1 fall	=	18·5299 feet.
4 falls	=	1 chain ...	=	74·1196 ,,
10 chains	=	1 furlong ...	=	247·0653 yards.
8 furlongs	=	1 mile... ...	=	1,976·5226 ,,

The Scots' chain was 74·1196 feet long, divided into 100 links, each 8·894352 in.

Scottish Land Measure.

				Sq. Yds.
1 square ell	=	9·5377 sq. feet	=	1·05974
36 ,, ells	=	1 sq. fall ...	=	38·1508
16 ,, falls	=	1 sq. chain ...	=	610·4128
40 sq. falls or 2½ sq chains	=	1 sq. rood ...	=	1,526·03197
4 sq. roods or 10 sq. chains	=	1 acre	=	6,104·1279

Scottish acre = 1·261 Impl. acre.

Scottish Dry Measure.

				Imp. Measure.
1 lippie or forpat			=	½ gal.
4 lippies or forpats ...	=	1 peck	=	1 peck.
4 pecks	=	1 firlot	=	1 bushel.
4 firlots	=	1 boll	=	½ qr.
2 bolls	=	1 quarter	=	1 qr.
16 ,, ...	=	1 chalder	=	8 qrs.

The wheat firlot is nearly equal to the Imperial bushel, or as ·998256 : 1, or = 7·98605 Imp. gals. Barley and oat firlot larger, as 1·4562794 : 1, or = 11·65024 Imp. gals. Other measures in proportion.

Scottish Troyes or Dutch Weight.

				Imperial.
16 drops	=	1 oz.... ...	=	1·09375 oz.
16 oz.	=	1 lb.... ...	=	17½ oz.
16 lbs.	=	1 stone ...	=	17½ pounds.
1 peck	=	½ stone of meal	=	8¾ lbs. Imp.
16 pecks	=	1 boll ...	=	140 ,,
2 bolls	=	1 sack or load	=	280 ,,

Scottish Trone Weight.

(For Butter, Cheese, Hay, Butcher Meat, &c.)

				Imperial.
16 drops	=	1 oz.		
16 oz.	=	1 lb. ...	=	22½ oz.
16 lbs.	=	1 stone	=	22½ lbs.

The pound varied from 20 to 28 oz. in different parts of Scotland; 22½ oz. is the old Glasgow pound; 22 Imp. oz. was the number fixed by an Edinburgh Jury in 1826

Scottish Liquid Measure.

				Imp. Gals.
		1 gill	=	·0235
4 gills	=	1 mutchkin ...	=	·0939
2 mutchkins	=	1 chopin ...	=	·1879
2 chopins	=	1 pint	=	·3758
2 pints	=	1 quart	=	·7516
4 quarts	=	1 gallon ...	=	3·0065
8 gallons	=	1 barrel ...	=	24·0520

Scots' Money.

2 pennies	=	1 bodle	=	$\frac{1}{6}$d. stg.
4 ,,	=	1 plack or groat...	=	$\frac{1}{3}$d. ,,
6 ,,	=	1 bawbee... ...	=	$\frac{1}{2}$d. ,,
12 ,,	=	1 shilling ...	=	1d. ,,
20 shilllings	=	1 pound	=	20d. ,,

13 shillings and 4 pennies = 1 mark or merk = 13$\frac{1}{3}$d. stg.

The Irish pound was $\frac{12}{13}$ of a £, or 13 pence Irish were equal to 12 pence sterling.

METRICAL SYSTEM.

Long Measure.

	Metres.	Inches.	Feet.	Yards.	Miles.
Millimetre ...	·001	·03937	·00328	·00109	...
Centimetre ...	·01	·3937	·0328	·0109	...
Decimetre ...	·1	3·937	·328	·1093	·00006
Metre	1	39·37079	3·2809	1·0936	·00062
Decametre ...	10	...	32·809	10·9363	·0062
Hectometre ...	100	...	328·09	109·363	·06213
Kilometre ...	1,000	...	3,280·9	1,093·63	·62138
Myriametre ...	10,000	...	...	...	6·21382

Square Measure.

	Square Metres.	Square Inches.	Square Feet.	Square Yards.	Acres.
Milliare	·1	155	1·076	·119	...
Centiare	1	1,550	10·764	1·19	·00025
Deciare	10	15,501	107·64	11·96	·0025
Are	100	...	1,076·4	119·6	·0247
Decare	1 000	...	...	1,196	·2471
Hectare	10,000	...	...	11.960	2·4711

Solid Measure.

	Cubic Metres.	Cubic Inches.	Cubic Feet.	Cubic Yards.
Millistere	·001	61·028	...	...
Centistere	·01	610·28	·353	...
Decistere	·1	6,102·8	3·531	·13
Stere, or cubic metre ...	1	61,028	35·317	1·308
Decastere	10	...	...	13·08
Hectostere	100	...	...	130·802

Weights.

	Grammes.	Avoir. Oz.	Avoir. Lbs.	Cwts.	Tons.	Grains Troy.
Milligramme ...	·001	...	...	...	...	·015
Centigramme ...	·01	...	...	...	...	·154
Decigramme ...	·1	...	...	...	...	1·543
Gramme	1	·035	·0022	...	...	15·432
Decagramme ...	10	·352	·022	...	...	...
Hectogramme ...	100	3·527	·2204	...	...	...
Kilogramme ...	1,000	35·274	2·2046	·019	·00098	...
Myriagramme ...	10,000	...	22·046	·196	·00984	...
Quintal	100,000	...	220·462	1·968	·0984	...
Millier or Bar ...	1,000,000	...	2204·62	19·684	·9842	...

Dry and Fluid Measure.

	Litres.	Inches.	Feet.	Gallons.	Bushels.
Millilitre	·001	·061	...	·00022	...
Centilitre ...	·01	·61	..	·0022	...
Decilitre	·1	6·1	...	·022	·0027
Litre	1	61·02	·0353	·22	·0275
Decalitre	10	610·28	·353	2·2	·275
Hectolitre ...	100	...	3·53	22	2·751
Kilolitre	1,000	...	35·317	220·09	27·512
Myrialitre ...	10,000	...	353·17	2,200·9	275·121

The Metrical System is based on the *metre* (39·3709 inches), which is the ten-millionth part of the quadrant of a terrestrial meridian. The *litre* is the cube of the tenth part of a metre; the weight of a litre of distilled water at its greatest density is a *kilogramme*, and one-thousandth of this is a *gramme*; the *are* is 100 square metres, and the *stere* one cubic metre.

Comparative Scales of Thermometers.

Centigrade or Celsius.	Fahrenheit.	Reaumur.	Centigrade or Celsius.	Fahrenheit.	Reaumur.
100	212·0	80·0	50	122·0	40·0
98	208·4	78·4	48	118·4	38·4
96	204·8	76·8	46	114·8	36·8
94	201·2	75·2	44	111·2	35·2
92	197·6	73·6	42	107·6	33·6
90	194·0	72·0	40	104·0	32·0
88	190·4	70·4	38	100·4	30·4
86	186·8	68·8	36	96·8	28·8
84	183·2	67·2	34	93·2	27·2
82	179·6	65·6	32	89·6	25·6
80	176·0	64·0	30	86·0	24·0
78	172·4	62·4	28	82·4	22·4
76	168·8	60·8	26	78·8	20·8
74	165·2	59·2	24	75·2	19·2
72	161·6	57·6	22	71·6	17·6
70	158·0	56·0	20	68·0	16·0
68	154·4	54·4	18	64·4	14·4
66	150·8	52·8	16	60·8	12·8
64	147·2	51·2	14	57·2	11·2
62	143·6	49·6	12	53·6	9·6
60	140·0	48·0	10	50·0	8·0
58	136·4	46·4	8	46·4	6·4
56	132·8	44·8	6	42·8	4·8
54	129·2	43·2	4	39·2	3·2
52	125·6	41·6	2	35·6	1·6
50	122·0	40·0	0	32·0	0·0

Formulæ for Converting Degrees.

$$F = \frac{9\,C}{5} + 32\,; \quad F = \frac{9\,R}{4} + 32\,; \quad F = C + R + 32.$$

$$C = \frac{5\,(F - 32)}{9}\,; \quad R = \frac{4\,(F - 32)}{9}.$$

MISCELLANEOUS WEIGHTS AND MEASURES.

Acre :—			
Imperial	4,840	sq.yds....	1·000 Imp.
Scottish Standard ...	6,104·128	,, ...	1·26118 ,,
Cunningham	6,250·0	,, ...	1·291 ,,
Dumbarton...	6,084·444	,, ...	1·257 ,,
Inverness	6,150·4	,, ...	1·270 ,,
Irish Plantation... ...	7,840·0	,, ...	1·61983 ,,
Northmbld. & Durham	5,926·58	,, ...	1·224552 ,,
Westmoreland	6,760·0	,, ...	1·396 ,,
West Derby	9,000·0	,, ...	1·859 ,,
Lancashire	7,865·968	,, ...	1·6252 ,,
Cheshire and Staffs ...	10,240·0	,, ...	2·1157 ,,
Leicestershire	2,308·75	,, ...	0·477 ,,
Herefordshire	3,226·66	,, ...	0·666 ,,
Wilts and Dorset ...	3,630·0	,, ...	0·749976 ,,
Devon and Somerset	4,000·0	,, ...	0·8264 ,,
Cornish	5,760·0	,, ...	1·1901 ,,
N. Wales (customary)	3,240·0	,, ...	0·669 ,,
,, (Erw)... ...	4,320·0	,, ...	0·892 ,,
Woodland	5,760·0	,, ...	1·1901 ,,
French "Hectare" ...	11,960·3326	,, ...	2·4711431,,
,, "Are"	119·6033	,, ...	0·0247 ,,
Belgian "Hectare" ...	11,960·3326	,, ...	2·4711 ,,
Prussian "Morgen"...	3,053·0	,, ...	0·630 ,,
Rhine ,, ...	10,185·0	,, ...	2·1043 ,,
Hamburg ,, ...	11,505·0	,, ...	2·377 ,,
Amsterdam ,, ...	9,722·0	,, ...	2·0086 ,,
Acreme (old)	... ...	... ...	10 acres.
Are	100 square metres...		1,076·4 sq. ft.
Barony of Land	40 hides		4,000 acres.
Barrel	Bulk		5 cub. ft.
,, ...	Old Ale Measure ...		32 gals.
,, ...	Old Beer		36 ,,
,, ...	Ale and Beer (Imp.)		36 ,,
,, ...	Herrings...		500.
Beef	Firkin		100 lbs.
,, ...	Barrel		200 ,,
,, ...	Tierce (38 pieces of 8 lbs. each)... ...		304 ,,
Boll :—			
Wheat...	Berwick, &c.		6 bushels.
,, ...	Glasgow, &c.		4 ,,
,, ...	,, ,, ...		240 lbs.

Boll :—		
Wheat...	Hamilton	240 lbs.
,,	Newcastle, &c.	3 bushels.
Barley...	Linlithgow	0·728 qrs.
Oats	Ayrshire, &c....	8 bushels.
,,	Glasgow ...	6 ,, each 44 lbs.
Oatmeal	Ayrshire, &c....	140 lbs.
,,	Galloway	280 ,,
Ryegrass Seed	96 lbs.	4 bushels.
Old Boll—Corn	4 " bushels " ...	8 ,, Imp.
,, —Salt ...	2 ,,	4 ,, ,,
Bricks	Load	500.
Bristles ...	Cask	10 cwt.
Broccoli ...	Sack	60 to 70 lbs.
Bushels :—		
Imperial	1·28 cubic feet	8 gals.
Carlisle	...	24 ,,
Irish	...	7·85504 gals.
Staffordshire	38 qts.	9·5 gals.
Winchester	...	7·75557 gals.
Wheat...	Standard ...	62 lbs.
,,	Mark Lane	60 to 63 lbs.
,,	Aberystwith ...	65 lbs.
,,	Birmingham, &c. ...	62 ,,
,,	Chester, &c. ...	75 ,,
,,	Wolverhampton	72 ,,
,,	Liverpool, &c.	70 ,,
,,	Monmouth, &c.	80 ,,
Butter	Firkin	56 ,,
,,	Tub ...	84 ,,
,,	Barrel	224 ,,
,,	Dutch Cask	112 ,,
Butt or Pipe ...	Scots'	120 gals.
Cable Length...	120 fathoms	720 feet.
Cade	Red Herrings...	500.
,,	Sprats	1,000.
Cental or Quintal ...	...	100 lbs.
Chain	22 yards ...	66 feet.
Chalder ...	Corn	8 qrs.
Chaldron	Coals (London)	36 bushels
,,	,, ,,	25½ cwt.
,,	,, (Newcastle)...	53 ,,
,,	Corn	4 qrs.
Cheese	Clove	8 lbs.
,,	Stone	16 ,,

Cheese	Stone (Scotland) ...	24 lbs.
,, ...	Ordinary Wey ...	250 ,,
,, ...	Suffolk	256 ,,
,, ...	Sussex Wey	336 ,,
,, ...	Essex ,, ...	416 ,,
Cider	Pipe	100 to 118 Imp gals.
Clover Seed	Sack	2 to $3\frac{1}{2}$ cwt.
,, ,, ...	Cask	7 to 9 ,,
Coal	Chaldron	36 bushels.
,, ...	,, (Newcastle)	53 cwt. = 3 wains.
,, ...	Barge	21 tons.
,, ...	Keel (8 chaldrons)...	21 tons 4 cwt
,, ...	Shipload	20 keels.
,, ...	Wain	17·6 cwt.
,, ...	Ton	10 sacks.
,, ...	Sack	224 lbs.
,, ...	Room	7 tons.
Coomb	... ...	4 bushels.
Cubit	... ...	18 inches.
Cwt.	Imperial	112 lbs.
,, ...	American	100 ,,
Ell	English	45 inches.
,, ...	Scottish	37·0598 in.
,, ...	French	54 inches.
,, ...	Flemish	27 ,,
Faggots	"Hundred"	120.
Farundale or Farding-Land (old)		$\frac{1}{4}$ acre.
Feathers	Bale...	1 cwt.
,, ...	Last	17 ,,
Firlot	Scottish Standard ...	1 Imp. bush
,, ...	Wheat	0·998256 ,,
,, ...	Barley and Oat ...	1·4562794 ,,
Fish...	Box	90 lbs.
Flax	Last	17 cwt.
,, ...	Dutch Matt	126 lbs.
,, ...	Flemish ,, ...	224 ,,
,, ...	Russian ,, ...	5 to 6 cwt.
,, Seed	Riga Barrel	4 bushels.
,, ,, ...	Dutch ,, ...	8 ,,
Flour	Gallon	7 lbs.
,, ...	Peck	14 ,,
,, ...	Bushel	56 ,,
,, ...	Barrel	196 ,,
,, ...	Sack	280 ,,

Flour	Load or Pack... ...	240 lbs.
Gallon:—		
Imperial	277·463 cubic inches	1·0 Imp.gl.
American	231·0 ,,	0·833 ,,
Old Barn or Winchester	268·8013 ,,	0·96944 ,,
New Barn	589·203 ,,	2·1249 ,,
Old Wine	231·0 ,,	0·83311 ,,
,, Ale	282·0 ,,	1·01705 ,,
Scottish	833·6272 ,,	3·00651 ,,
Irish	217·6 ,,	0·78478 ,,
Gawn or Goan (old) ...	... ...	1 gallon.
Glass	Seam	120 lbs.
,, ...	Stone	5 ,,
Gramme	0·035 Avoir. oz. ...	15·432349 gr
Gross	... ...	144.
Guano	Bag	1½ cwt.
,, ...	Bushel	60 to 70 lbs.
Hand	... ...	4 inches.
,, ...	Radishes	12 to 30.
Hay	Bale...	2 cwt.
,, ...	Load	36 trusses.
Old Hay	Truss	56 lbs.
,, ...	Load	18 cwt.
New Hay	Truss	60 lbs.
,, ...	Load	19 cwt. 32 lbs
Hectare	11,960·3325 sq. yds.	2·4711431 ac.
Hectostere	100 cubic metres ...	130·802 c.yds
Hemp	Stone	32 lbs.
,, ...	Bale...	10 tons.
Herrings...	Cade	500 lbs.
,, ...	Barrel	26·66 gallons.
,, ...	Cran	37½ ,,
Hide of Land...	Standard = 100 acres	60, 80, or 100 a.
Hides	Dicker	10 skins.
,, ...	Last...	20 dickers.
Honey	Gallon	12 lbs.
Hoop (old)	... ...	1 peck.
Hops	Bag	2½ cwt.
,, ...	Pocket	1½ ,, (13 = ton).
Kainite	Bag	2 cwt.
,, ...	Bushel	75 to 80 lbs.
Keg	Herrings...	60 (two = "hundred").
Kemple	Straw	440 lbs.
Kilometre	1,000 metres	1,093·633 yds

Kilogramme	1,000 grammes ...	2·2046lbs.Av.
Kilolitre	1 cubic metre, or 1,000 litres... ...	220·09667gls
Last...	White Herrings ...	12 barrels.
,, ...	Red ,, ...	20 cades.
,, ...	Corn	10 qrs.
,, ...	Wool	12 sacks.
,, ...	Leather	20 dickers.
,, ...	Flax or Feathers ...	17 cwt.
,, ...	Gunpowder	24 barrels (2,400 lbs.)
,, ...	Meal	12 barrels.
Leap, or Lip (old) ...	... ...	½ bushel.
Linen (Irish)...	Piece	25 yards
Link	... ...	7·92 inches.
Litre	1·76 pints	0·22 gallon.
Load :—		
Bricks...	... ...	500.
Coals	Scots	1 cwt.
Flour	... ...	280 lbs. = 5 bushels.
Oatmeal (Scotland) ...	2 bolls	280 lbs.
Gravel or Earth ...	Ton	20 cubic feet
Hay	Old	18 cwt.
,, ...	New	19 cwt.32 lbs.
Cartload	Scotland	15 to 25 cwt.
Faggots	Load	50 to 60.
Old English	5 Winchester qrs. ...	38·77789 bus.
Timber	Rough	40 cubic ft.
,, ...	Squared	50 ,,
,, ...	Inch planking ...	600 sup. ft.
Straw	36 trusses	11 cwt. 64 lbs.
Tiles (pipe, 1″)	... ...	1,000.
Wheat...	Imperial	5 quarters.
,, ...	Market Load	5 bushels.
,, ...	Winchester (Old English)	4·8472 qrs.
,, ...	Sheffield, &c.	3 bushels.
,, ...	Ulverston	4½ bus. (144 qts.)
,, ...	Bedford, &c.	5 bushels.
Lugg (= pole : old) ...	16½ feet	Coppice = 18½ feet.
Met (old)	Strike	1 bushel.
Metre	39·37079 inches ...	1·09363 yds.
Mile	Imperial	1,760 ,,

Mile	Scottish	1,976·5226 yds.
,, ...	Irish	2,240 ,,
,, ...	Kilometre	1,093·6 ,,
,, ...	Admiralty knot ...	2,026·66 ,,
,, ...	Geographical or Nautical knot ...	2,027·55 ,,
Molasses	Puncheon	10 to 12 cwt.
,, ...	Barrel (36 gals.) ...	5 to 6 cwt.
Nail	Old	8 lbs.
,, ...	Cloth	2·25 inches.
Nitrate of Soda	Bag	$2\frac{1}{2}$ cwt.
,, ,, ...	Bushel	90 lbs.
Oil (Train)	Gallon	$7\frac{1}{2}$,,
,, ,, ...	Ton	1,770 lbs.
Oxgang, or Oxgate ...	... ...	15 acres.
Pace	Military	2·5 feet.
,, ...	Geometrical	5 feet.
Palm	... ...	3 inches.
Paper	Quire	24 sheets.
,, ...	Ream	20 quires.
Pint	Imperial	0·125 Imp. gl.
,, ...	Old English	0·12118 ,,
,, ...	Scots'	0·3758 ,,
,, ...	Glasgow	0·5 ,,
Plums	Carton	9 lbs.
,, ...	$\frac{1}{4}$ Box	20 ,,
Pork	Firkin	100 ,,
,, ...	Mess Barrel	200 ,,
,, ...	Army ,, ...	208 ,,
,, ...	Tierce (80 pieces) ...	320 ,,
Potatoes	Uncleaned	120 ,, to cwt.
,, ...	Sack (London) ...	168 ,,
,, ...	Barrel	200 ,,
,, ...	Ton	49 bushels.
Pottle	... ...	2 quarts.
Pound	Old Apothecaries' ...	12 oz. (5,760 grains).
,, ...	New ,, ...	16 oz. (7,000 grains).
,, ...	Avoirdupois	16 oz.
,, ...	Troy	12 ,,
,, ...	Old Edinburgh ...	22 ,,
,, ...	,, Glasgow (Trone)	$22\frac{1}{2}$,,
,, ...	Troyes or Dutch (Scot.)	$17\frac{1}{2}$,,

Pound	Old Berwick and Dumbarton... ...	23 oz.
,, ...	Selkirk	23½ ,,
,, ...	Ayrshire, Montrose, Brechin, Arbroath	24 ,,
,, ...	Kirkcudbright ...	26 ,,
,, ...	Kirriemuir	27 ,,
,, ...	Aberdeen	28 ,,
Punnet	Fruit	1 lb.
Quintal	... ...	100 lbs.
Rice...	East Indian Bag ...	1½ cwt.
,, ...	American Cask ...	6 ,,
Rock Salt	Bushel	65 lbs.
Rods	Building...	36 sq. yds.
,, ...	Brickwork	272·25 sq. ft.
,, ...	Imperial...	5·5 yards.
,, ...	Cheshire...	8 ,,
,, ...	Irish Plantation ...	7 ,,
,, ...	Woodland	6 ,,
,, ...	"Fall" (Scot.) ...	6·1766 yds.
Salt	Bushel	56 lbs.
Score	... ...	20.
Seam	Glass	120 lbs.
,, ...	Corn	8 bushels.
,, ...	Wood	Horse-load.
Sieve	Vegetables	7 Imp. gals.
,, ...	Currants...	20 quarts.
Soap	Firkin	64 lbs.
,, ...	Chest	3¼ cwt.
Soft Soap	Firkin	64 lbs.
,, ,, ...	Barrel	256 ,,
Span	... ...	9 inches.
Square	Flooring & Thatching	100 square ft.
Steel	Faggot	120 lbs.
Stere (cubic metre) ...	35·317 cubic feet ...	1·308 cub.yds.
Stone	Imperial...	14 lbs.
,, ...	Smithfield	8 ,,
,, ...	Old Hereford (Beef)	12 ,,
,, ...	Wool (Scots)... ...	16 ,,
,, ...	Troyes or Dutch (Scot.)...	17½ ,,
,, ...	Edinburgh Trone...	22 ,,
,, ...	Glasgow ,, ...	22½ ,,
,, ...	Ayrshire ,, ...	24 ,,
,, ...	Galloway	28 ,,

Stone	Glass (old)	5 lbs.
,, ...	Wax ,, ...	8 ,,
Straw	Truss	36 ,,
,, ...	Load (36 trusses) ...	11 cwt. 64 lbs.
Strike (old)	... ...	1 bushel.
Tar	Barrel	25 gallons.
Tally	Vegetables	50.
Tiles	Load	1,000.
Ton	Imperial	2,240 lbs.
,, ...	American	2,000 ,,
,, ...	Clay	17 cubic feet.
,, ...	Earth	18 ,,
,, ...	Sand	24 ,,
,, ...	Coal...	10 sacks.
,, ...	Portland Cement ...	10 ,, = 6 casks
,, ...	Shipping	42 cubic feet.
,, ...	Freight by measure	40 ,,
,, ...	Water	224 gallons.
Tovet or Tofet (old) ...	... ...	$\frac{1}{2}$ bushel.
Treacle	Puncheon	10 to 12 cwt.
,, ...	Barrel (36 gallons)	5 to 6 ,,
Truss	New Hay	60 lbs.
,, ...	Old ,, ...	56 ,,
,, ...	Straw	36 ,,
Virgate	"Yard"	15 to 40 acres.
Wey or Weigh	5 quarters	40 bushels.
Wheat	Bushel (standard at Mark Lane) ...	60 lbs.
,, ...	Barrel	280 ,,
,, ...	Hobbet	168 ,,
,, ...	Windle	220 ,,
Wood	Cord	128 cubic ft.
,, ...	Stack	108 ,,
,, ...	Standard	165 ,,
,, ...	Fathom	216 ,,
,, ...	Seam	Horse-load.
,, ...	Square	100 square ft.
,, ...	One Hundred	120 deals.
Wool	Pack	240 lbs.
,, ...	Legal Tod	28 ,,
,, ...	Stapler's Tod... ...	30 ,,
,, ...	Stone (Scottish) ...	24 ,,
,, ...	German Bale	350 ,,
Yard of Land...	30 acres = Standard	15, 20, 24, 30, & 34 acres.
Yoke of Land	Day's work of 2 oxen.	

MACHINERY AND BUILDINGS.

Steam Engine.

To find indicated horse-power of engines:—

A = area of piston in sq. in.
P = average pressure of steam in lbs. per sq. in. in cylinder.
S = length of stroke in feet.
R = number of revolutions per minute.
r = number of revolutions per second.

$$\text{Horse-power} = \frac{2\,A\,P\,R\,S}{33{,}000} = \frac{2\,A\,P\,r\,S}{550}.$$

To find the nominal horse-power of engines:—

D = diameter of cylinder in inches.
S = stroke in feet.
H = nominal horse-power.

$$\text{Then } H = \frac{D^2 \sqrt[3]{S}}{15 \cdot 6}.$$

The "nominal horse-power" of an engine is a misleading and vague term now going out of use. In a general way it means the ordinary working power of an engine in contradistinction to the "actual" or "indicated" power which it could exert if strained to its utmost: the "actual" or "indicated" is generally $2\frac{1}{2}$ to 3 times the "nominal" power in an ordinary engine

The effective pressure of the steam in the cylinder is taken as about ·6 of that in the boiler.

A horse-power = raising 33,000 lbs. one foot high in one minute, or = 33,000 "foot-pounds" = 33,000 "units of work."

The "Modulus" of an engine is the proportion of motive power which is given out as useful work: in ordinary farm engines it is about a half—the other half being used up in overcoming the resistance of the engine itself.

The "Duty" of an engine is the number of units of work it yields by the consumption of 1 bushel (94 lbs.) of Welsh coal.

Average duty of Cornish engines is 60,000,000 = 60 millions of pounds raised 1 foot high for every bushel of coal consumed.

D = Duty of engine in millions of pounds.
C = number of pounds of coal consumed per indicated horse-power per hour.

$$\text{Then } D = \frac{186 \cdot 12}{C}.$$

Fuel: Average Evaporative Power.

1 lb. of	petroleum	evaporates	12	lbs. of	water.
1 ,,	coke	,,	9	,,	,,
1 ,,	coal	,,	9	,,	,,
1 ,,	slack	,,	4	,,	,,
1 ,,	dry oak	,,	4·5	,,	,,
1 ,,	pine	,,	2·5	,,	,,
1 ,,	peat (black)	,,	4	,,	,,
1 ,,	brushwood	,,	2·7	,,	,,
1 ,,	wheat or barley straw	,,	2·25	,,	,,

The feed-water in the above supplied at 212° F.—natural draught. These figures are only about half the theoretical values, because in heating an ordinary steam boiler only about 47 per cent. of the theoretical heating power of the fuel is utilised, the residue being lost in imperfect combustion, radiation, &c.

The best results yet obtained in experiments in firing steam boilers have been 1 lb. of coal per horse-power per hour. The best engines in practice require 2 lbs. per horse-power per hour (*i.e.*, one-twelfth of the theoretical value of the coal); ordinary farm engines often take from 4 to 7 lbs. for the same results. McLaren's Highland Society prize 6-horse-power stationary engine (1888) required 4·13 lbs. of coal and 33·97 lbs. of water per horse-power per hour: while Davey, Paxman, & Co.'s 8-horse-power compound portable, in the R.A.S.E. trials (1887), used only 1·85 lbs. of coal.

For each nominal horse-power a boiler requires about:—

1 cub. ft. of water per hour.
1 sq. yd. of heating surface.
1 sq. ft. of fire-grate surface.
1 cub. yd. of capacity.
28 sq. in. of flue area.

For cylindrical double-flued boilers, a good rule is:—

$$\frac{\text{Length} \times \text{diameter}}{6} = \text{nominal horse-power.}$$

The Royal Agricultural Society of England allow 10 circular inches to each horse-power as the area of the piston. Thus, a 9-inch piston gives 81 circular inches, equal to 8·1 horse-power.

Proportion of Parts of a Stationary High-Pressure Engine.

D = diameter of cylinder in inches.
S = stroke in inches.
S = 2 D to 2·5 D.

Diameter of piston rod	= D × ·15.
Thickness of piston	= D × ·25.
Diameter of crank pin	= D × ·23.
Length of crank pin	= D × ·34.
Diameter of crank shaft	= D × ·33.
Length of connecting-rod...	= S × 2.
Diameter of connecting-rod at one end ...	= D × ·19.
Swell of connecting-rod	= $\frac{1}{16}$th inch per foot of length.
Mean diameter of fly-wheel rim	= S × $3\frac{1}{2}$ or 4.
Weight of fly-wheel rim	= 100 lbs. for each indicated horse-power.

VERTICAL ENGINES.

NOMINAL HORSE-POWER.	$1\frac{1}{2}$	2	4	6	8	10
Diameter of cylinder ... ins.	4	$4\frac{1}{2}$	$6\frac{1}{2}$	8	9	10
Length of stroke ... ... ,,	6	6	9	12	12	13
Revolutions per minute	225	200	185	140	125	115
Diameter of fly-wheel ... ins.	24	24	36	48	48	52
Face width of fly-wheel ... ,,	4	4	5	6	$6\frac{1}{2}$	8
Height of boiler ... ... ,,	63	63	80	96	102	120
Diameter of boiler ... ... ,,	24	30	33	42	48	54
Number of cross tubes	1	1	2	4	4	5
Weight of engine ... ... cwt.	18	21	40	60	80	110
,, ,, on wheels ,,	24	26	48	70	90	122

SINGLE-CYLINDER PORTABLE ENGINES.

NOMINAL HORSE-POWER.	4	6	8	10	12
Diameter of cylinder ... ins.	$6\frac{1}{2}$	8	9	10	$11\frac{1}{2}$
Length of stroke ... ... ,,	10	12	13	14	15
Revolutions per minute	150	125	115	110	100
Diameter of fly-wheel ... ins.	40	48	52	56	60
Face width of fly-wheel... ,,	5	6	$6\frac{1}{2}$	7	8
Weight of engine ... ... cwt.	55	77	100	130	146

Compound Portable Engines.

Nominal Horse-Power.	8	10	12	16	20	25
Diameter of high-pressure cylinder ... ... ins.	$5\frac{3}{4}$	$6\frac{1}{2}$	7	8	9	10
Diameter of low-pressure cylinder... ... ... ,,	9	10	11	$12\frac{3}{4}$	14	16
Length of stroke ... ... ,,	12	12	14	16	16	18
Revolutions per minute	140	125	120	115	110	95
Diameter of fly-wheel ... ins.	60	60	66	68	74	74
Face width of fly-wheel ... ,,	6	7	8	9	10	12
Weight of engine ... ...cwt.	105	136	153	180	205	220

Traction Engines.

	6-H.P.	8-H.P.	8-H.P. Compound.
Diameter of cylinder ...	$7\frac{3}{4}$ in.	$9\frac{3}{8}$ in.	$5\frac{3}{4}$ and 9 in
Length of stroke	10 in.	12 in.	12 in.
Diameter of fly-wheel...	4 ft. 3 in.	4 ft. 6 in.	4 ft.
Revolutions per minute	160	155	180
Speeds per hour	$1\frac{1}{2}$ & 3 miles	$1\frac{3}{8}$ & $2\frac{3}{4}$ miles	$1\frac{3}{8}$ & $2\frac{3}{4}$ miles
Diameter of driving wheels	5 ft. 6 in.	5 ft. 6 in.	5 ft. 6 in.
Width of do.	14 in.	17 in.	16 in.
Weight of engine when empty	$6\frac{1}{2}$ tons	$8\frac{1}{2}$ tons	$8\frac{1}{2}$ tons
Weight with coal and water ready for work	8 tons	$10\frac{1}{2}$ tons	10 tons
Extreme length of engine	16 ft. 6 in.	17 ft. 8 in.	16 ft. 10 in.
Extreme width over axles	7 ft. 0 in.	8 ft. 4 in.	7 ft. 9 in.
Height to top of fly-wheel	8 ft. 6 in.	9 ft.	8 ft. 8 in.

Points in Judging an Engine.

(High. Soc.)

	Points.
Price	20
Simplicity of construction and fewness of working parts	25
Economy of fuel	20
Rapidity of raising steam	5
Facility of erection and cheapness of foundations ...	5
Economy of water	5
Steadiness and regularity in running	15
Economy of lubricant	5
Total	100

Steam Tackle for 1,000 Acres.

Two 8-H.P. Ploughing Engines.
Five-furrow Balance Plough.
Nine-tined Turning Cultivator.
Five-framed Flat Reversible Harrow.
Eight hundred yards Steel Rope.

Capable of doing from 8 to 12 acres of ploughing, and 15 to 20 acres of cultivating per day. Cost, about £1,500.

Improved Steam Digger.

Maximum number of strokes of diggers per minute ...		70
Distance travelled per minute in ft. (6-in. spits)		35
Ordinary depth of digging	inches	8
Minimum horse-power required		3
Coal per acre	cwt.	1½
Limit of depth	inches	14

Oil Engines.

Average Data of 8-H.P. Nominal.

Diameter of cylinder	8·5 in.
Length of stroke	14·5 in.
Revolutions per minute	220.
Diameter of fly-wheel	4·75 ft
Face width of fly-wheel	6 in.
Weight	40 cwt.
Oil per indicated H.P. per hour	·91 lb.
Oil per brake H.P. per hour...	1·13 lbs.
Air required to explode 1 lb. oil	35 lbs.
Mean pressure on piston per square inch	50 lbs.
Mechanical efficiency	·81.
Jacket-water circulating per minute	12 lbs.
Rise in temperature of water...	50° F.

When engine is running at half power the consumption is about 25 per cent. higher than when at full power.

Oil.

Kind of Oil.	Flashing Point.	Pints used per Actual H.P. per Hour.
Royal Daylight	76° F.	1·09
Trinity House	152 ,,	1·07
Tea Rose	83 ,,	1·2
Storar's Scotch Gas Oil	—	1·17

73° F. is the lowest flashing point allowed for petroleums in this country. The cost for oil has been reduced as low as ¾d. per actual horse-power per hour. Small engines cost a little more proportionately than large ones, but they are much handier and cheaper than steam engines.

Water Power.

Theoretical Horse-Power of Water.

Q = quantity of water in cubic feet per minute.
H = head of water from tail race in feet.
P = theoretical horse-power.
$62{\cdot}5$ = weight of cubic foot of water in lbs.

$$P = \frac{Q \times 62{\cdot}5 \times H}{33{,}000}$$
$$= {\cdot}001892\ Q\ H.$$

Water Data.

1 cubic foot of water = 62·425 lbs. = ·557 cwt. = ·028 ton
1 cubic inch... ... = ·03612 ,,
1 gallon ... ... = 10 ,, = ·16 cubic foot.
1 cubic foot ... ... = 6·24 gals. = 6¼ gals. (say).
1 cwt. ... ... = 1·8 cubic ft. = 11·2 gals.
1 ton... ... ... = 35·9 ,, = 224 gals.
1 cubic ft. of sea water = 64·11 lbs. = 1·027 weight of fresh water.

P = pressure in lb. per square inch.
= ·4335 lbs. per foot in depth.
H = head of water in feet.
V = theoretical velocity in feet per second.
$P = H \times {\cdot}4335$; $H = P \times 2{\cdot}307$.
$V = 8{\cdot}025\sqrt{H}$; $H\ 62{\cdot}4$ = pressure per square foot.

The effective horse-powers of the various water motors are :—

Theoretical power	1·00
Undershot wheels	·35
Poncelet's undershot wheel	·60
Low-breast wheel...	·55
High-breast wheel	·60
Overshot wheel	·68
Turbine	·70
Hydraulic ram raising water	·60

Gauging Water.

H = height of surface of water above sill in feet.
W = width of sill in feet.
V = velocity of water approaching the sill in feet per minute.
C = cubic feet discharged over the sill per minute.

$$C = H \times W \times V.$$

In gauging, the water must all be made to pass through a rectangular aperture with a thin waste-board or sill. The height must be measured from the top of the sill to the level of the surface where it is not affected by the overfall. The sill must have a free overfall. For very accurate results a triangular notch or aperture is preferred, in which case $C = \frac{1}{2} H \times W \times V$.

Overshot Water Wheel.—To find the H.P. :—

H = fall between point where laid on and point where water leaves the wheel.
Q = quantity of water in cubic feet per minute laid on wheel.
P = useful effect in horse power.

$$\text{Then } P = \frac{Q \times H \times 62{\cdot}5 \times {\cdot}68}{33{,}000}$$
$$= {\cdot}001285\ Q\ H.$$

The point at which the water ought to be laid upon an overshot wheel is 52° 45′ below its vertex, or 37° 15′ above the centre.

Undershot Water Wheel.

$$P = \frac{Q \times H \times 62{\cdot}5 \times {\cdot}35}{33{,}000}$$
$$= {\cdot}000662\ Q\ H.$$

Poncelet's Undershot Water Wheel.

$$P = \frac{Q \times H \times 62{\cdot}5 \times {\cdot}60}{33{,}000}$$
$$= {\cdot}00113\ Q\ H.$$

Breast Water Wheel.

$$P = \frac{Q \times H \times 62{\cdot}5 \times {\cdot}55}{33{,}000}$$
$$= {\cdot}00104\ Q\ H \text{ for low-breast wheels;}$$
$$= {\cdot}00113\ Q\ H \text{ for high-breast wheels.}$$

Buckets

Distance apart in high-breast or overshot	...	12 in.
,, ,, low-breast	...	18 ,,
Openings of buckets in high-breast	...	6 to 8 ,,
,, ,, low-breast	...	9 to 12 ,,

In the Poncelet undershot wheel the buckets have a curve, up and back down which the water glides easily, so that there is no shock or jar, and the water thus gives up the whole of its kinetic energy. It is the best form of wheel for small heads of water.

Turbines.

$$P = \frac{Q \times H \times 62{\cdot}5 \times {\cdot}70}{33{,}000}$$
$$= {\cdot}00132\ Q\ H.$$

Turbines are best used where there is a large head giving a high pressure of water.

WIND POWER.

V = velocity of wind in feet per second.
P = pressure in lbs. per square foot.

$$P = {\cdot}002288\ V^2$$
$$\text{Horse-power} = \frac{A\ V^3}{1{,}080{,}000},$$

where A = area of sails of windmill in sq. ft.

Small self-regulating windmills, in which the vanes fill up the whole of the circumference of the wheel, are of the greatest value for pumping purposes about the farm.

TABLE containing the Velocity and Force of the Wind.

Miles per Hour.	Feet per Second.	Force in Lbs. per Sq. Ft.	Description.
1	1·47	·005	Hardly perceptible.
2	2·93	·020	Just perceptible.
3	4·4	·044	
4	5·87	·079	Gentle breeze.
5	7·33	0·123	
10	14·67	0·492	Pleasant breeze.
15	22·0	1·107	
20	29·3	1·968	Brisk gale.
25	36·6	3·075	
30	44·0	4·428	High wind.
35	51·3	6·027	
40	58·6	7·872	Very high wind.
45	66·0	9·963	
50	73·3	12·300	Storm.
60	88·0	17·712	Great storm.
70	102·7	24·108	
80	117·3	31·488	Hurricane.
100	146·6	49·200	Hurricane that tears up trees, carries away buildings, &c.

Data for Windmills.

Angle of shaft of sails with horizon = 8° on level ground up to 15° on exposed heights.
Length of sails = 4 times the breadth.
" " = $\frac{5}{6}$ of length of arm or "whip."
Arm divides sails = proportion of 3 × 5: narrow part next the wind.
Area of sails = $\frac{1}{4}$ area of circle.
" " = $\frac{7}{8}$ of area of part occupied by vanes in small self-regulating windmills: this gives greatest effect.
Angle of sails to plan of motion = 5° at tip up to 22° next the axis.
Revolutions of mill-stone = 5 to 1 of sails.
Revolutions of sails = 12 per minute with the wind at a velocity of 20 ft. per second.

Ordinary windmills have sails 24 ft. by 6 ft., and arms 28 ft. to 30 ft. long: this with a wind velocity of 20 ft. per second equals 4 horse-power, and will grind wheat into flour at the rate of about 5 bushels per hour.

A minimum of 10 ft. per second volocity of wind is required to drive the sails loaded, and the maximum of safety is 30 ft. per second.

Horse and Animal Power.

(Working eight hours per day.)

Watt's standard horse-power = raising 33,000 lbs. 1 ft. high in 1 minute.

= 33,000 units of work.

		Units.
Average of actual farm-horses	=	22,000
Horse in cart, walking	=	26,150
,, in gin, trotting	=	26,060
,, ,, walking	=	17,600
Ox ,, ,, ...	=	16,930
Mule ,, ,, ...	=	11,720
Ass ,, ,, ...	=	5,030
Man walking up incline	=	4,230
,, rowing	=	4,000
,, standard	=	3,300
,, pushing or pulling weight horizontally ...	=	3,130
,, on tread-wheel	=	3,100
,, turning winch	=	2,600
,, pumping	=	2,390
,, raising weights by pulley	=	1,560
,, ,, ,, hand	=	1,480
,, carrying weight up incline	=	1,130
,, wheeling loaded barrow up incline ...	=	520
,, lifting earth with spade $5\frac{1}{4}$ ft.	=	470

Cost of Labour.

Character of Agent.	Cost per Million Units of Work.
Labourer carrying weights up a ladder ...	88·67 pence
,, raising weights by rope and pulley	63·94 ,,
,, turning a winch	28·80 ,,
,, turning a capstan	24·00 ,,
Horse in gin, walking	3·791 ,,
,, in cart, ,, ...	2·040 ,,
Steam engine, duty 20 millions	0·429 ,,
,, ,, 90 ,, ...	0·196 ,,

In the above table the wages of a labourer is taken at 3s. per day; keep and attendance of a horse at 2s. 6d.; maintenance of engine at 12s. per day—coal being reckoned at 6d per bushel, or 12s. per ton.

Tractive Force of Horses.

Rate in miles per hour	2	2½	3	3½	4	4½	5
Tractive force exerted, in lbs.	166	150	125	104	83	62	41

Force of Traction required for carriages of one ton, on a level road :—

Description of Road.	Force of Traction per Ton.
1. On rails	8 lbs.
2. Well-made pavement	33 ,,
3. Macadamised road	44 to 67 ,,
4. Turnpike, hard and dry	68 ,,
5. ,, dirty	88 ,,
6. Hard compact loam	119 ,,
7. Gravel	150 ,,
8. Sandy and gravelly	210 ,,
9. Ordinary bye-road	237 ,,
10. Grass land	300 ,,
11. Turnpike, newly gravelled	320 ,,
12. Loose sandy road	457 ,,

A horse produces his greatest mechanical effect in drawing a load at 2½ miles per hour with a tractive force of 150 lbs.

Draught of Horses.

At 8 hours per day, 2½ miles per hour, and tractive force of 150 lbs. :—

On level hard road	3 tons.
On inferior or hilly road	1 ,,
On rails	16 ,,
On a canal	60 to 90 ,,
Carrying on his back	300 lbs.
Lifting over a pulley...	110 ,,

Corn Mills.

For each pair of ordinary stones, with all the necessary dressing machinery, &c., it is usual to allow four horse-power nominal for "low" grinding.

One pair of 4-ft. stones will grind about 5 bushels of wheat per hour. Each bushel of wheat so ground per hour requires 1·11 indicated horse-power, exclusive of dressing and other machinery.

Speed in Corn Mills.

	Revs. per Min.
Stones, 4 ft. dia.	150
Dressing machines, 21 in. dia.... ...	450 to 500
Creepers, $3\frac{1}{2}$ in. pitch	30
Elevators, Pulley, 18 in. dia.	40
Wheat screen, 18 in. dia.	300 to 350

Work done by Millstones.

Diameter of Stones.	30 in.	36 in.	42 in.	48 in.
Quantity of corn ground into fine flour per hour	$2\frac{1}{2}$ bus	$3\frac{1}{4}$ bus.	4 bus.	5 bus.
Produce of meal from ditto, at 60 lbs. to the bushel	150 lbs	190 lbs.	240 lbs.	300 lbs.
Produce of fine-dressed flour from ditto, for making bread	90 lbs.	120 lbs.	150 lbs.	180 lbs.
Quantity of corn ground into coarse meal for cattle feeding	5 bus.	$6\frac{1}{2}$ bus.	8 bus.	10 bus.
Produce of meal from ditto, for cattle-feeding purposes	330 lbs.	390 lbs.	490 lbs.	610 lbs.
Number of revolutions of the stones per minute	250	200	185	150
Power required	$2\frac{1}{4}$ H P.	3 H.P.	4 H.P.	5 H P.

THRASHING MACHINE.

Engine—Revolutions per minute	180
Drum ,, ,, ...	1,200
Shakers ,, ,, ...	180
Riddles ,, ,, ...	180
Fan ,, ,, ...	700
Elevator ,, ,, ...	100
Screen ,, ,, ...	25

Distance between drum and concave at bottom ... ... $\frac{3}{8}$ in.
,, ,, at middle ... ... $\frac{5}{8}$,,
,, ,, at top ... ... $1\frac{1}{2}$,,

Double-Blast Finishing Machine.

Width of drum ... ... ins.	60	54	48
Horse-power of engine required ...	8-10	6-8	4-6
Wheat thrashed per hour, bushels ...	60-80	50-70	40-60
Weight of machine ... ... cwt.	92	85	80

One-third to one-half more bushels of oats or barley than of wheat thrashed in a given time.

Weight of trusses from straw trusser, 24 lbs.

Horse-power Beater or Peg Mill (Scot.).

Speed of horses, revolutions per minute	... ...	2
Speed of horses, miles per hour	... ...	2
Diameter of horse-wheel	... ... feet	26
Revolutions of horse-wheel to pinion ...	... ...	1 to 7
,, of 3-ft. drum per minute ...	... ...	180
,, of 4-in. feed rollers per minute ...	...	30
,, ,, ,, to drum	... ...	1 to 6
Beats on each foot of straw	... ...	20
Wheat thrashed per hour (4 horses), bushels ...	...	20 to 30

Points in Judging a Thrashing Machine.

(R.A.S.E. Trials.)

Clean thrashing	30
Clean shaking	10
Cavings free from corn	5
Chaff free from corn	6
Chaff free from cavings, seeds, and dirt	5
Straw unbroken	5
Corn uninjured	15
Cleanliness of delivery from machines	2
Perfection of finishing	5
Construction and convenience of working	6
Power in proportion to results	5
Attendants...	4
Price	2
	100

In thrashing barley, the points for straw unbroken are not allowed, but added to the points for perfection of finishing, making this 10

Toothed Wheels in Millwork.

N = number of teeth in driving wheel.
V = revolutions ,, ,,
n = number of teeth in driven wheel.
v = revolutions ,, ,,

$$n = \frac{N\,V}{v}, \qquad v = \frac{N\,V}{n}.$$

Pulleys.

V = velocity of driving pulley.
D = diameter ,,
v = velocity of driven pulley.
d = diameter ,,

$$v = \frac{V\,D}{d}, \qquad d = \frac{V\,D}{v}.$$

In a train of pulleys the final velocity is

$$= \frac{V \times D \times D' \times D'', \&c.}{d \times d' \times d'', \&c.},$$

where D′, D″, are the diameters of the driving pulleys, and d', d'', those of the driven.

Convexity of pulley face to receive the belt = $\frac{1}{8}$ inch per foot in high speeds = $\frac{1}{4}$ inch in low speeds.

Width of single belting ($\frac{3}{16}$ inch thick) is = 1,100 × horse-power to be transmitted, and ÷ the velocity of the belt in feet per minute.

Chaff-Cutter.

	1-Horse Gear.	4-H.P. Engine.
Revolutions of knives per min. ...	120 ...	250
$\frac{5}{8}$ in. chaff cut per hour, bush. ...	80 ...	300
,, ,, ,, cwt. ...	$5\frac{1}{2}$ ...	21

Usual lengths of chaff are $\frac{1}{4}$ and $\frac{5}{8}$ in.

Carts and Waggons.

(R.A.S.E. Trials, 1874.)

	1-Horse Cart.	2-Horse Waggon.
Load, cwts.	20·0 ...	45·0
Draught, on good road, lbs. per ton	51·4 ...	68·1
,, on arable land, ,, ,,	201·0 ...	295·2

Draught percentage in favour of carts over waggons, 28·2

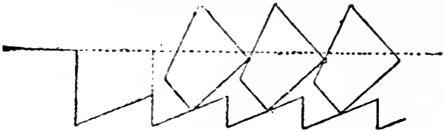
Ordinary cart carries 18 to 22 cwt.; wheels to be as large in diameter and as broad in the tyres as possible—usually $4\frac{1}{2}$ ft. diameter with 4-in. tyres. London haycart wheels 5 ft. diameter.

One-horse harvest cart carries about 170 sheaves, and a 2-horse waggon 200.

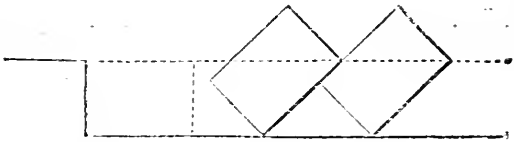
Ploughs.

Size of the furrow:—The standard size of a furrow slice in medium land is 10 in. wide by 7 deep—or, to be mathematically exact, 10″ × 7·02″—or in the same proportion.

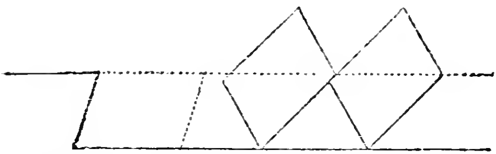
Shape of the Furrow.



"CRESTED" OR TRAPEZOIDAL FURROW SLICE.



RECTANGULAR FURROW SLICE



PARALLELOGRAMMATIC FURROW SLICE.

WIDE BROKEN FURROW SLICE.

The trapezoidal furrow slice is objectionable, as it leaves some soil unmoved at the bottom of the furrow, is not firm, allows seed a greater chance of dropping through, and, as it is narrower, takes a longer time to get over an acre. There is less open space below, however, and it harrows down and covers the seed better, though this latter is of no account where the seed is drilled.

The rectangular is better in most respects, but does not harrow down so easily, and the ploughs are not usually made so as to allow the coulter to be set perpendicularly.

The parallelogrammatic is the best form. It is crested, it is firm, all the soil is moved from bottom, it is wide in proportion to depth, and plough irons are easily set to it.

The wide broken form is that made by the short, wide-set chill-plough. It is suitable to and desirable on the lighter and more friable soils, but heavy clays cannot be satisfactorily pulverised by this means.

Length of Furrow:—250 yards long is the best average suited to the strength of horses.

Speed of Horses:—From $1\frac{1}{2}$ to 2 miles per hour while in the plough.

Distance Travelled per Acre:—

At a width of	8 in.	12·3 miles.
,,	9 ,, ...	11 ,,
,,	10 ,, ...	9·9 ,,
,,	12 ,, ...	8·2 ,,

Average Time to Turn:—$\frac{3}{4}$ of a minute.

Time Lost in Turning:—For 250 yards length of furrow, the loss is 1 hr. 30 min. every 10 hrs.

If a field has 50 turns to the acre, the loss will be	0 hrs. $37\frac{1}{2}$ min.
If 100 turns per acre	1 ,, 15 ,,
If 200 ,, ,, ...	2 ,, 30 ,,

And to these must be added time taken up in resting.

Limit of Draught:—7 cwt. per furrow. Ordinary ploughing varies from 3 to 5 cwt., or from 170 to 280 lbs. per horse, depending on nature of soil, &c. Steam plough = $6\frac{1}{4}$ cwt. per furrow (25 cwt. in all) at 100 yards per minute. Depth, 6 inches.

Proportion of Pressure on Parts of Plough in Work:—Sole-plate, 15 %; cheek-plate, 35 %; wrest, 6 %; share and coulter, 44 %—total, 100. In wheel ploughs the sole and cheek are absent, so that part of the pressures on them is done away with, thus rendering the draught easier—usually 1-6th less.

Weight of Ploughs:—Wooden frame, 200 lbs.; iron frame, 210 to 280 lbs.; steel chill, 200 lbs.

Cultivators.

On medium soil each horse can pull 4 tines at depth of 3 to 4 inches; a 3-horse cultivator thus may have 12 or 13 tines and take a width of 5 to 6 ft., if of the improved "spring-tooth" form

Corn Drills.

Thirteen coulters most useful form, as divisible by 2, 3, and 4 (with outside one over), when desirable to sow in wide rows, as in case of beans. Disc or shoe best forms of coulter, as hoe-coulter only admissible on light land. Force-feed better than cup-feed. Combined seed and manure drill is most useful form, and two horses with pole is sufficient to pull the modern improved kinds, depositing the seed 2 inches deep.

Harrows.

Zigzag Form:—Three leaves: 20 tines in each = 60 in all. Width covered, 6 to 7 ft. = 1 tine every 1·2 to 1·4 inches of width.

Weight:—1 cwt. to $1\frac{1}{2}$ cwt. for 2 horses; 2 cwt. for 3 horses.

Tines:—To have thick heads or necks where fastened to the frame; small necks with ordinary screw and nut will break easily.

Acme or Knife Form:—Valuable for cutting *across* tough ley furrows and preparing seed bed on the same.

Rollers.

Weight of Rollers:—12 cwt. required for light land; 17 cwt. or more for heavy land.

Crosskill or *Cambridge* weighs $1\frac{1}{4}$ tons, requiring 3 or 4 horses.

Water Ballast:—11 cwt. empty, 22 cwt. full.

Those with large diameters easiest to draw; 5 to 7 ft. long, and $2\frac{1}{2}$ to 3 feet diameter, divided into two or three segments to facilitate turning.

Reapers and Mowers.

Height of travelling wheels	2 ft. 8 in.
Revolutions of ,, to crank, reaper ...	1 to 25
,, ,, to ,, mower ...	1 to 33
Weight of mower	730 lbs.
,, combined machine	800 ,,
,, self-delivery ,, ...	1,200 ,,
,, self-binder ,, ...	1,600 ,,
Width of binder, transport	$8\frac{1}{4}$ ft.
,, cutting bar, corn	5 ,,
,, ,, grass	4 ft. 3 in.
Amount of twine used per acre in binding ...	3 to $3\frac{1}{2}$ lbs.

Elevators.

Shafts :—To be at hopper end, as most suitable for moving, setting up, and taking down.

Hopper :—To be as low as possible.

Height of Delivery :—26 and 30 ft. The former is sufficient, as the top part of ridge of stack can easily be carried higher by pitching with fork.

Pumps.

Ordinary Dimensions.—Wells under 30 ft. :—

Diameter of barrel	4 in.
Length of stroke	10 ,,
Quantity of water per min., 20-ft. well ...	24 gals.

The above is size best suited for one man, and for general use.

Wells from 30 to 70 ft. :—

Diameter of barrel	3½ in.
Length of stroke	9 ,,
Quantity of water per min., 50-ft. well ...	16 gals.

To be worked by fly-wheel and crank.

Horse Power :—

G = Gallons raised per hour.

h = Total lift in feet.

$$\text{H.P.} = \frac{G \times 10 \times h}{60 \times 33{,}000}$$

$$= \frac{G\,h}{198{,}000}.$$

It is usual to allow from 60 to 80 per cent. additional power to cover loss from friction, leakage, &c.

Quantity of Water raised :—

G = Gallons delivered per minute.

L = Length of stroke in feet.

D = Diameter of barrel in inches.

N = Number of strokes per minute.

$$G = \frac{N\,L\,D^2 \times \cdot 7854 \times 62 \cdot 5}{144 \times 10}$$

$$= N\,L\,D^2\ \cdot 034.$$

Useful Numbers for Pumps :—

D = Diameter of barrel in inches.

L = Length of stroke in inches.

$D^2\,L \times \cdot 7854$ = cubic inches per stroke.

$D^2\,L \times \cdot 002833$ = gallons per stroke.

$D^2\,L \times \cdot 0004545$ = cubic feet per stroke.

$D^2\,L \times \cdot 02833$ = lbs. per stroke.

Power for Deep Wells.

Galls. of Water raised per Hour:	200	350	500	650	800	1000
Height of lift for one man in ft....	90	51	36	28	22	18
,, ,, donkey ,, ...	180	102	72	56	45	36
,, ,, horse ,, ...	630	357	252	196	154	126
,, ,, 1-H.P. steam engine, in feet	990	561	396	308	242	198

Limekilns.

Narrow at mouth and bottom, and wide in middle, as the fire tends to burn through the stone in this form. Width of mouth, 4 ft.; width of middle, 8 ft.; width of throat at bottom, 2 ft.; height of cavity from throat to mouth, 23 ft. The throat to be high enough above the roadway to allow carts to back in to it. The above size will burn 120 cubic ft. of lime per day, or from 90 to 100 bushels.

Where an outcrop of limestone occurs on a farm it can be burnt on the spot in a trench or cavity dug into the side of the sloping ground, if wood, peats, or even brushwood, can be readily obtained.

Depreciation of Machinery, &c., per Annum, on First Cost.

	Depreciation.	Wear and Tear.	Total.
	Per cent.	Per cent.	Per cent.
Engines	3	3	6
Boilers	7	3	10
Barn machinery	5	3	8
Millwork and gearing	3	$2\frac{1}{2}$	$5\frac{1}{2}$
Bands and belts	5	40	45
Field implements...	4	6	10

Estimate of Principal Implements required on a Mixed Husbandry Farm.

Implements.	Ac. 100	Ac. 150	Ac. 200	Ac. 300	Ac. 500	Ac. 800
Carts—one-horse	3	4	4	6	8	10
Lorries or waggons	—	1	1	1	2	2
Liquid manure cart	1	1	1	1	1	1
Clod-crusher	—	1	1	1	1	2
Iron roller	1	1	1	1	2	2
Horse-hoe	—	1	1	1	1	2
Drill-harrows and grubbers ...	1	1	1	1	2	2
Ploughs...	1	2	2	3	5	8
Double-mouldboard plough ...	1	1	1	1	2	2
Light grass harrows and chain harrows	1	1	1	1	1	2
Heavy seed harrows	1	1	2	2	3	4
3-horse grubber and scarifier...	1	1	1	1	2	2
Corn-drills	—	1	1	1	1	2
Grass-seed sowing machine ...	—	—	—	1	1	1
Drag-harrows	—	—	1	1	1	2
Turnip-drill and clod-crusher	1	1	1	1	1	2
Turnip-scufflers	—	—	—	1	1	2
Mower and reaper	1	1	1	1	2	3
Sheaf-binder	—	—	1	1	1	2
Horse-rake	1	1	1	1	2	2
Tedder	—	—	1	1	1	2
Horse-fork or elevator ...	—	—	1	1	1	1
Potato-raiser	—	—	1	1	1	1
Thrashing machine	1	1	1	1	1	1
Chaff-cutter	1	1	1	1	1	1
Turnip-cutters	1	1	1	1	2	2
Winnowing machine	1	1	1	1	1	1
Oat-bruiser or millstones ...	1	1	1	1	1	1
Oilcake breaker	1	1	1	1	1	1

BUILDING MEMORANDA

Bricks:—A stock brick is $8\frac{3}{4}'' \times 4\frac{1}{4}'' \times 2\frac{1}{2}''$, and weighs about 5 lbs., 450 being about a ton; a load = 500. 360 London stock bricks weigh one ton.

Reduced brickwork is $1\frac{1}{2}$ brick thick.

One brick thick is = 9 in.; a course is taken as 3 in. deep.

One rod of brickwork = 272 sup. ft. $1\frac{1}{2}$ brick thick.
,, ,, = $11\frac{1}{3}$ cub. yds. = 306 cub. ft.
,, ,, = 4,350 bricks (laid with 27 bus. lime, 54 bus. sand, 126 gals. water; 4 days of bricklayer and labourer).
,, ,, = 5,370 bricks, laid dry.

One cub. yd. brickwork requires about $6\frac{1}{2}$ cub. ft. sand, and $2\frac{1}{2}$ cub. ft. lime.

Ordinary bricks absorb 1-6th of weight of water, and blue Staffordshire 1-15th.

A bricklayer's hod carries 16 bricks or $\frac{1}{2}$ a bushel of mortar, or = $\frac{2}{3}$ cub. ft.

A bricklayer should lay from 100 to 150 bricks per hour, according to the nature of the work.

Mortar:—100 of lime contains 25 striked bushels = 100 pks. 1 ton = 32 bush.

18 heaped = 22 striked bushels = 1 cub. yd. = 1 load of sand.

$2\frac{1}{2}$ to 5 parts of sharp clean sand to 1 of lime for mortar, according to quality of lime.

Or, 1 of lime to 2 of sand and 1 of blacksmiths' ashes.

Coarse mortar = 1 of lime to 4 of coarse gravelly sand.

Concrete = 1 of lime to 4 of gravel and 2 of sand.

One load of mortar = 1 cub. yd.

One load of sand = 1 cub. yd.

A rod of brickwork requires from $1\frac{1}{2}$ to 3 loads of mortar.

Portland Cement:—A bushel of cement weighs 112 lbs., and a barrel is $3\frac{1}{2}$ bushels (400 lbs.); a bag is 3 bushels, and a sack 2 bushels.

Equal parts of cement and sand are used for building purposes.

Portland cement concrete for floors or walls: 1 of cement to 6 or 7 of broken stone, mill cinders, burnt ballast, shingle, gravel, or slag. Must be free from loam, mud, fine sand, or dirt of any kind. Moulds to be soaped.

Roman cement only one-third the strength of the above.

Mastic cement is 1 of red lead to 5 of whiting and 10 of sharp sand, mixed with boiled linseed oil.

One yard of reduced brickwork requires about $2\frac{1}{4}$ bushels of equal parts of Portland cement and sand.

One sq. yd. of plastering with cement requires three-fourths of a bushel.

Concrete walls should be raised only 18 in. per day.

Concrete walls and buildings cost only two-thirds of the expense of brickwork, or at the rate of 14s. 6d. per cub. yd. for the former, against 22s. for the latter; the concrete is, of course, the most durable.

Plastering:—1 cub. yd. of lime, 2 yds. of sand, and 3 bus. of hair will cover 75 sup. yds. on brick, or 70 yds. on lath.

One bundle laths and 5 hundred of nails will cover $4\frac{1}{2}$ yds. sup.

Paving:—

32 bricks on flat	=	1 sq. yd. paving.	
52 ,, on edge	=	1 ,,	,,
42 small paving bricks on flat ...	=	1 ,,	,,
81 ,, ,, on edge ...	=	1 ,,	,,
36 blue ,, on flat ...	=	1 ,,	,,

Asphalte Flooring:—1 in. thick requires $12\frac{1}{2}$ lbs. per sq. ft.; $\frac{3}{4}$ in. thick, $9\frac{1}{2}$ lbs.

Asphalte floors to be laid on 6 in. of good lime-concrete foundation—7 of clean gravel to 1 of lime. Concrete to be dry and set before asphalting.

To be laid in 3-ft. widths with clean joints.

Asphalte is not suitable where oil or grease will fall.

Walls:—

Depth of foundations	18	inches.
,, concrete foundation	12	,,
Width ,, ,, ...	24	,,
Height of damp course above ground	6	,,
Thickness of outside stone walls	20	,,
,, ,, brick ,, ...	14	,,
,, inside stone ,, ...	16	,,
,, ,, brick ,, ...	9	,,

Timber:—Planks = 11 in. wide; deals, 9 in.; battens, 7 in.

100 sq. ft. of planking	=	1 square.
120 deals	=	1 hundred.
600 sq. ft. of 1-in. planking ...	=	1 load.

Ventilation.

Space required per Head in Buildings.

Infant School Room	96	cub. ft.
Ordinary School Room	250	,,
Common Lodging or Tenement...	300	,,
Barrack Dormitory	600	,,
Ordinary Hospital	1,000	,,
Fever or Surgical Hospital	1,400	,,
Cow-Shed (per cow)	800	,,
Stable, open-roofed (per horse)...	1,200	,,
,, with men over (per horse)	1,300	,,

Every Local Authority can enact its own regulations as to air space, ventilation, lighting, &c., under the "Dairies, Cow-Sheds, and Milkshops Order of 1885," subject to the approval of the Privy Council. It is considered that for medium-sized breeds 600 cubic ft. of air space, 30 sq. ins. of ventilator opening, and 2 sq. ft. of window, per head, is a good allowance. The Metropolitan Board of Works, as Local Authority for London, has issued the following regulation:—Standing room for each cow to be at least 8 × 4 ft.; double stalls at least 8 × 7 ft. Cubic air space to be at least 600 cubic ft. per head if ventilation is satisfactory; 800 cubic ft. if ventilation imperfect. Height of building over 16 ft. not to be taken into account.

Interior Dimensions of Farm Buildings.

	Length.	Breadth	Height.
	Ft.	Ft.	Ft.
Barn	40	20	20
,, Straw	60	20	20
Cattle feeding boxes—double	10	20	8
,, ,, single	10	10	8
Cattle-sheds—for each beast	5	15	8
Cart-sheds, &c.—each arch	8	20	10
Cow-house—for each cow—double ...	4	28	10
,, ,, single ...	4	16	10
Dairy	20	20	10
Fold yards—for each beast	5	30	6
Granary	30	20	8
Hospital	18	18	10
Manure house	18	18	8
Pigstyes—for 3 animals	6	10	8
Poultry house	18	18	9
Root house	20	20	10
Stable—for each horse	6·5	18	10
Workshop	18	18	9
General dimensions of other apartments	...	18	9

6·5 ft. allowed to the length of the stable for each horse in it, and 7 to 8 ft. for every pair of cows in cow-house. Cattle-boxes to be sunk 2 ft. below surface, and raised by a dwarf wall 1 ft. above surface of passage. Cattle folds and sheds should have a length of 5 ft. for every beast they are intended to contain; when covered, 150 sq. ft. allowed to every head. The pigstyes have small open areas attached to each.

Homesteads.

Farm buildings should be compactly put together, and not be scattered about anyhow over an acre of land. The proper arrangement of the departments greatly facilitates the labour, and may save a farmer an immense expense in feeding and handling his stock and produce. The planning should be entrusted to someone who understands these matters, and not to a professional architect. The general arrangement recognised as best is that in which the stables, sheds, and yards range north and south—opening to the south—with the barn, granary, stores, mixing house, implement shed, &c., across the north end of these, and communicating with them; but each site requires a modification to suit itself. Dwelling-house or cottages should be at least 50 yards from the dairy, in case of infectious diseases.

The site should be as near the centre of the farm as possible, near the public highway if one runs through the land, and sheltered from the north and east. The lower range of the farm is the more desirable, so that the greater part of the haulage may be downhill, and gravitation water supply and water power be obtainable; though sufficiently high to allow of proper drainage.

Dimensions of Details.

Stable.—Length of stable travis, 9′.

Height of travis at end near wall, 7′; at heel-post end 5′ 6″.

Thickness of division boards, $1\frac{1}{2}$″; width, 9″.

Heel-post:—6″ drum, or 6″ × 4″.

Head-post:—6″ drum, or 2 pieces, each 4″ × $2\frac{1}{2}$″.

Width of hay-rack, 18″; height above floor, 9″.

Width of manger, 18″; length, 2′.

Height of top of manger and rack, 3′.

Size of top and bottom rails of rack, 4″ × 3″

Size of spars, 2″ × $1\frac{1}{2}$″, or 2″ square.

Depth of manger, 9″ or 10″.

Width of windows for stables and cow-houses, 3′ 6″ × 4′ 6 in height, or 3′ 6″ square.

Glass, 21-oz.

Width of stable doors, 4′ × 7′ 6″ in height.

Width of gutter in stable, 12″.

Fall of ditto, 1 to 50.

Fall of floor of stall, 1″.

Loose-box in stable to be twice the width of single stall.

Louvre-boarded ventilator to allow 20 to 30 sq. in. on each side for every animal. To be divided longitudinally by boarding so as to have an up-going and a down-going current of air irrespective of the direction of the wind.

Cow-House.—Length of stall from front partition to gutter behind, 7′ for average cows, and 7′ wide; 8′ square for largest breeds only.

Length of travis, 4′. Height of travis, 4′ rising to 5′.

Thickness of travis, if of stone slab, 4″; if of wood—head, heel-posts, and top rail, 4″ × 3″; boards, $1\frac{1}{2}$″ thick and 9″ wide.

Length of feeding-trough, 3′; width, 15″; depth, 1′. Trough or manger to be set on level of floors—*never* raised up —and with top edge and corners slanted off with cement.

Width of gutter, 20″ to 24″. Height of cow's bed above bottom of gutter, 8″. Height of gangway above bottom of gutter, 6″ Gutter to have a fall of 1′ sideways (towards gangway), besides a fall lengthways of 1″ per stall. Gangway to be inclined towards gutter. Cows' beds are thus 3″ above level of passages.

Width of dunging passage, 6′.

Width of feeding ,, 4′.

Width of working passage in double-stalled shed, 8′ to 10′.

Hammels for feeding cattle: 10′ × 15′ for each animal in shed.

Cattle-boxes: 10′ square, with feeding passages, 6′ wide; each box provided with a door 4′ wide, and a turnip trough.

Cattle courts and sheds: 75′ superficial allowed for each animal in sheds; 150′ in the court.

Shed for 300 sheep: 100′ long × 15′ wide; court, 100′ × 80′, or 100′ square.

Roofs.

A roof of 2 of span to 1 of height is suitable for the smaller offices.

A roof of 3 of span to 1 of height is suitable up to 30′ span.

Roofs under 15′ span will do with simple tie-beam. Up to 25′ require king-post. Up to 30′ require struts in addition.

Scantlings of Purlins and Rafters.

Bearings in Feet.	Purlins.	Rafters.	Bearings in Feet.	Purlins.	Rafters.
	Ins.	Ins.		Ins.	Ins.
6	6 × 4	4 × 2	10	8 × 6	6 × $2\frac{1}{2}$
8	7 × 5	4 × $2\frac{1}{2}$	12	9 × 7	6 × $2\frac{1}{2}$

Rafters 1 foot apart.

Weight and Pitch of Roofs.

	Weight per Sq. of 100 Sq. Ft. Cwt.		Minimum Slope in Degrees.
Lead ($7\frac{1}{2}$ lbs. per sq. ft.)	7	...	4
Zinc	$1\frac{1}{2}$	...	4
Corrugated iron	3	...	4
Slates	$7\frac{1}{2}$ to 9	...	25 to 30
Tiles	8 to 15	...	30 to 40
Boarding, $\frac{3}{4}$ in.	$2\frac{1}{2}$	...	25
,, $1\frac{1}{2}$ in.	5	...	—
Timber framing for slates or tiles...	5 to 6	...	—
Pressure of wind	36	...	—
Steepest angle of roofs	—	...	60

Wooden Roofs.

Span in Feet.	Principal.	Tie-Beams.	King-Posts.	Queen-Posts.	Struts.
	Ins.	Ins.	Ins.	Ins.	Ins.
20	4 × 4	9 × 4	4 × 4	...	3 × 3
25	5 × 4	10 × 5	5 × 5	...	5 × 3
30	6 × 4	11 × 6	6 × 6	...	6 × 3
35	6 × 4	11 × 4	...	4 × 4	4 × 3
45	6 × 5	13 × 6	...	6 × 6	5 × 3
50	8 × 6	13 × 8	...	8 × 8	5 × 3
55	8 × 7	14 × 9	...	9 × 8	6 × 3
60	8 × 8	15 × 10	...	10 × 8	6 × 4

Roofs over 30 ft. span to have queen-posts.

Slates.

Names.	Sizes.	No. in a Square.	Weight per 1,000.	Weight per Square.
	Ins.		Cwt.	Cwt.
Doubles	13 × 6	480	15	$7\frac{1}{2}$
Ladies	16 × 8	276	25	$5\frac{3}{4}$
Countesses ...	20 × 10	170	40	$5\frac{3}{4}$
Duchesses... ..	24 × 12	115	60	6

There are 120 slates to the hundred.

Roof Tiles.

A pan-tile is $13\frac{1}{2}'' \times 9\frac{1}{2}'' \times \frac{1}{2}''$; weight, $4\frac{3}{4}$ lbs.; 1,000 weigh 42 cwt.

A plain tile is $10\frac{1}{2}'' \times 6\frac{1}{4}'' \times \frac{5}{8}''$; weight, $2\frac{1}{4}$ lbs.; 1,000 weigh 21 cwt. = a load.

A 10-in.	gauge	requires	180	pan-tiles	to the	square.
12	,,	,,	150	,,	,,	,,
8	,,	,,	576	plain tiles	,,	,,
6	,,	,,	760	,,	,,	,,

Tiling Laths.

Plain tile lath is $1\frac{1}{2}'' \times 1''$: 500 running ft. to a bundle; 30 bundles to a load.

12 pan-tile laths of 10′ to a bundle.

A bundle of laths allowed to each square.

Corrugated Galvanised Iron Roofs.

Curved roofs can be made up to 30′ span, with 20′ radius, of 18 Birmingham Wire Gauge Corrugated Iron without trusses; tie-rods 6′ to 10′ apart, $2'' \times \frac{3}{4}''$, or $1\frac{3}{8}''$ diameter; king-rods $\frac{5}{8}''$ diameter. Angle iron $2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''$ at eaves for "wall-plate," and top strengthened by angle iron $1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{2}''$ running along under sheets at ridge, and bolted to king-rods.

Smaller dimensions will do for smaller roofs.

Trussed spans without tie-rods can be made from 30 to 50 ft.

Radius of spans to be two-thirds of width.

One-tenth of the weight to be added for lappage. Sheets should overlap about 6 in., and be double riveted at the joints. 3 lbs. of rivets required per square of roofing.

On flat roofs purlins should be about 6 ft. apart.

All bolts or rivets to be on ridge of corrugations, and not in valleys, otherwise the roof will leak.

Corrugations may be from 1 to 5 in. wide.

Spangles of galvanising to be smooth and as large as possible.

Near towns or the sea-coast corrugated galvanised sheets should be painted with two coats of oxide of iron or zinc paint, or tarred and sanded.

Corrugated Sheets.

Birmingham Wire Gauge.	Size of Sheets.	Weight per Square.	Sq. Ft. per Ton.
	Feet.	Cwt. qrs. lbs.	
No. 16	6 × 2 to 8 × 3	3 0 14	800
,, 18	6 × 2 to 8 × 3	2 1 6	1,000
,, 20	6 × 2 to 8 × 3	1 3 6	1,250
,, 22	6 × 2 to 7 × $2\frac{1}{2}$	1 2 7	1,550
,, 24	6 × 2 to 7 × $2\frac{1}{2}$	1 0 24	1,880
,, 26	6 × 2 to 7 × $2\frac{1}{2}$	1 0 6	2,170

Nos. 18 and 20 are most in ordinary use.

Dimensions of Framing for Iron Roofs.

Span.	Rise.	Tie-Rods.	Angle Iron Purlins.
Feet.	Ft. in.	Inches.	Inches.
15	3 6	$\frac{5}{8}$	...
20	5 0	$\frac{3}{4}$	...
25	5 6	$\frac{3}{4}$	2 × 2 × $\frac{1}{4}$
30	6 0	$\frac{7}{8}$	2 × 2 × $\frac{1}{4}$
35	8 6	$\frac{7}{8}$	$2\frac{1}{4}$ × $1\frac{1}{2}$ × $\frac{1}{4}$
40	8 6	1	$2\frac{1}{2}$ × $1\frac{1}{2}$ × $\frac{1}{4}$

Roofing Felt.

Width, 32 in.; lap, 2 in.

To be put on with broad-headed nails, and tarred or varnished occasionally.

May be put on roofs below slates or iron as a non-conductor of heat.

Thatch.

Quantity of straw per square of 100 ft., about 4 cwt.
Size of laths below thatch, $1\frac{1}{4}''$ × $\frac{1}{4}''$ to $\frac{3}{4}''$, and 8″ apart
Thickness of thatch, 12″ to 16″.
Pitch of thatched roof, 45°.
Wheat straw lasts 15 to 20 years.
Oat straw lasts 8 to 9 years.

Thatching Stacks.

Quantity of straw per square of 100 ft., 6 trusses = about 2 cwt.

Thickness of thatch, 4″ to 6″.

Well-thatched stack should keep water-tight for at least two years.

LABOUR.

Ploughing.—*Quantity Ploughed:*—$\frac{3}{4}$ to 1 acre daily—8 hrs.

Extent of Land Ploughed by Fowler's Double-Engine System:—2 acres per 10 hrs. for each furrow—8 acres in all.

Digging.—To dig with a spade an acre of land from 9 to 12 inches deep, a man will take from 14 to 21 days in recently moved soil. If old lea, will take, in some cases, double this time.

Steam Digger:—5 acres per day, 8 to 10 inches deep.

Cultivating.—Does not bring up raw soil or bury fine top mould, and does not promote evaporation; mixes and pulverises the soil, and is the best kind of cultivation. 3 horses with 13-tine spring-tooth grubber, on light land, can cultivate 1 acre per hour, 3 to 5 in. deep; 4 horses on heavy land.

Ground Cultivated with Steam Grubber:—Double-engine system, 10 acres; single-engine system, 6 acres. Both 8 in. deep—10 hours.

Sowing.—*Quantity of Land Drilled per Day:*—1·25 acres per hour, employing 2 to 3 horses and 2 to 3 men. Steam, 20 acres.

Quantity Sown with Hand:—1$\frac{1}{2}$ acres per hour, single-handed.

Harrowing.—*Quantity done per Day:*—Zig-zag 7-ft harrow will give 1·25 acres per hour a single stroke. Steam, 30 acres.

Rolling.—*Quantity done per Day:*—8 to 10 acres.

Fallow-Crop Drilling.—*Quantity Drilled per Day:*—3$\frac{1}{2}$ to 5 acres with double-mouldboard plough and drills at 27 in.

Potato-Planting.—*Number of People required:*—2 men and 4 horses to open and close drills; 5 or 6 women to spread manure; 6 or 7 women planting sets; 1 man sowing artificial manures; 4 men and 4 horses carting manure to drills from dungstead, if near at hand; 2 men filling carts at dungstead. Men or boys replace women in the South. 0·4 acre finished per hour.

Cutting Sets:—A woman should cut about 8 to 10 cwt. of potatoes per day, with early kinds of seed; late varieties will be less.

Setting Plants.—From 15,000 to 20,000 can be dibbled in one day by two men, with boys to carry and help.

Sowing Turnips or other Drilled Crops.—With a double-drill machine and 27-in. drills, 1 acre per hour nearly can be done.

Thinning Plants:—4 to 5 people should do 0·1 of an acre on medium soil per hour.

Drill-Harrowing, or Horse-Hoeing.—0·4 acre per hour.

Sheep-Shearing.—With help to catch the sheep 1 man can shear 30 of the larger breeds daily, up to 60 of the small breeds, or from 3 to 6 per hour.

Mowing and Haymaking.—*Quantity Cut with Machine per Day*:—8 acres—nearly 1 acre per hour.

Quantity Raked or Tedded per Horse:—15 to 20 acres per day.

Number of People required in Stacking:—2 pitchers in field; 2 to 4 men and 2 to 4 horses carting home, according to distance; 2 to 3 men or women on stack, building; 1 man "keeping" stack. If elevator or horse-fork is used, then a pony and lad extra required.

In Scotland the hay is "ricked" in the field in little stacks, containing each from ½ to 1 cart-load (600 to 1,200 lbs.), and afterwards carted home to stackyard. In England the hay is stacked from the swathe or cock ("quile") direct, as soon as made.

Reaping and Harvesting.—One half-acre per hour cutting one side; one acre if round about, and with self-binder.

Number of People required:—1 driver; 1 tilter; 3 boys to make bands; 3 women to lift sheaves; 3 men to bind and stook. Or, 8 women to make bands, lift, and bind; 2 men to stook. 5 sets of workers required for round-about work.

In the South 8 men make bands, lift, and bind to a machine going round about, and stop at night to stook.

Stacking:—2 men and 2 horses keep one stack going, if in field; 3 or 4 if at a distance. 1 man to pitch sheaves in field; 2 men on stack, 1 "keeping."

A labourer will pitch from 5,000 to 6,000 sheaves of corn in a day.

Quantity cut with the Scythe:—¾ to 1 acre of meadow hay per day; ¾ to 1 acre of corn, according to crop—that with grassy bottom costing most. ¼ acre was cut with the old sickle.

Turnip-Lifting.—4 men or women can top and tail 1 acre per day.

Potato-Raising.—4 to 6 men can dig 1 acre per day.

Raising with Digging Machine:—2½ acres per day working one way (4½ acres working double); requiring 12 to 14 women or boys working in couples for each way.

THRASHING.—*Number of People required with Steam Machine*:—1 to 3 men pitching sheaves on to feeding board; 1 man cutting bands; 1 man feeding; 3 men and 1 boy to bunch loose straw, bands being ready made; 1 man at stack; 2 men building stack; 1 man to remove chaff; 1 man at sacks; 1 man carrying corn to granary; 1 boy to carry water to engine. Total, 15 to 18.

Average Quantity Thrashed per Day:—100 qrs. oats, 60 qrs. wheat. 2-horse machine, 20 to 30 qrs.

Thrashing with Flail:—A man can thrash 1 qr. of wheat, 2 qrs. of barley, $2\frac{1}{2}$ qrs. of beans, and 4 qrs. of oats per day.

CARTING.—*Carting Manure*:—1 man to assist at filling at dungstead; 2 to 4 men and horses (according to distance) carting out and emptying into heaps; 2 men to spread. A labourer can fill 18 to 20 loads (each 12 to 15 cwt.) of dung into a cart in 8 hours.

A labourer can dig and fill into a cart 8 cub. yds. of chalk, 10 of strong clay, 12 of strong and medium loams, and 13 of light loam, sand, or gravel, per day of 8 hours.

Quantity of Lime Spread:—8 tons per day of slaked or fallen shells.

ESTIMATE OF LABOURERS REQUIRED ON A MIXED HUSBANDRY FARM.

	Acres.			
	100	300	500	800
Ploughmen	1	3	5	8
Cattlemen	1	1	2	3
General labourers	1 boy	1	2	3
Shepherds	...	1	1	2

ESTIMATE OF HORSES REQUIRED ON A MIXED HUSBANDRY FARM.

100 acres	Three horses.
150 to 200 acres	Five ,,
300 to 500 ,, ...	Seven to ten horses.
800 acres	Seventeen ,,

Each team ought to be able to plough and otherwise cultivate from 50 to 60 acres annually, including in this the working of from 12 to 15 acres of fallow crop.

Cost of Labour by Piecework.

Bean-dibbling ...		5s. per acre.
Carting muck—1 mile...		1s. per ton.
Carrot-raising ...	20s. to	25s. per acre.
Cultivating—3 horses ..	2s. to	3s. ,,
Digging—turf ...		80s. ,,
,, garden soil ...		50s. ,,
Ditching (digging) ...		5d. per pole.
,, (cleaning out)		8d. per chain.
Drag-harrowing ...		3s. per acre.
Draining (3 ft.)—cutting and filling...		2s. per chain
,, mains...		2s. 6d. ,,
,, eyes ...		6d. each.
,, levelling and returfing		3d. per chain.
Drilling corn ...		1s. 6d. per acre.
Faggoting ...		4s. per 120.
Gate-hanging ...		5s. each.
Harrowing ...		1s. per acre.
Harvesting (men only)...	10s. to	12s. ,,
Haymaking ,, ...	5s. to	10s. ,,
Hedge-trimming (two sides) ...		4d. per chain.
,, laying ...	6d. to	8d. per pole.
,, setting quicks ...		1s. 1d. per pole
,, cleaning ,, ...		7d. per chain.
Hoeing wheat, &c. ...	5s. to	6s. per acre.
,, turnips, first time	6s. to	10s. ,,
,, ,, second time ...	4s. to	7s. ,,
,, (horse-power) ...		1s. 6d. ,,
Lime-spreading ...		4½d. per ton.
Mangold-raising ...		6s. per acre.
Mowing grass—hand ...	3s. to	3s. 6d. ,,
,, ,, mower ...	1s. to	1s. 6d. ,,
Ploughing ...		12s. ,,
Potato-raising—hand ...		30s. ,,
,, digger ...		10s. ,,
Reaping—hand...	3s. to	3s. 6d. ,,
,, reaper ...	1s. to	1s. 6d. ,,
Rolling ...		9d. ,,
Sowing seed—hand ...		2½d. ,,
,, grass seed—barrow ...		6d. ,,
Setting plants ...		8d. per 1,000.
Stacking grain ...		5s. per acre.
,, hay ...		3s. 6d. ,,
Sawing soft wood ...		3s. per square.
,, hard ...		4s. ,,
Thrashing ...		1s. 8d. per qr

COST OF LABOUR BY PIECEWORK—*continued.*

Turnip-raising	6s. to	8s. per acre.
,, swedes	7s. to	9s. ,,
Trussing hay (2 tons daily)		1d. per truss
Sheep-shearing...	4s. to	5s. per score.
Steam ploughing	12s. to	15s. per acre.
,, cultivating (twice)		12s. ,,
,, digging		12s. ,,
Thatching	1s. to	1s. 2d. per sq.

In the above table a labourer's wage is taken at 3s. per day; a man and pair of horses at 10s. per day.

Cost of Labour per Acre in Terms of a Day's Work.

	Root Crop.				Corn Crop.			
	Man.		Horse.		Man.		Horse.	
	Heavy Soils.	Light Soils.	Heavy Soils.	Light Soils.	Heavy Soils.	Light Soils.	Heavy Soils.	Light Soils.
Autumn ploughing, once	1·25	1·0	2·5	2·0	1·25	1·0	2·5	2·0
Spring ploughing, once	1·0	...	2 0	...	...	...	...	...
Cultivating, twice	0·2	0·15	0·6	0·4	...	...	...	...
Harrowing, four times...	0·4	0·4	0·8	0·8	0·4	0·4	0·8	0·8
Rolling, once ...	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1
Dung-carting, 20 loads per acre...	2·0	2·0	1·5	1·5	...	...	...	...
Dung-spreading, 20 loads per ac.	1·5	1·5	...	...	...	...	...	...
Sowing artificials	0·2	0·2	...	...	0·1	0·1	...	...
Ridging-opening and splitting ...	0·5	0·4	1·0	0·8	...	...	...	...
Sowing seed on ridges	...	0·2	...	0·2	...	...	...	...
Drilling seed and artificials	0·25	...	0·25	...	0·2	0·2	0·2	0·2
Singling roots ...	4·0	3·0	...	...	...	...	...	...
Horse-hoeing ...	0·25	0·2	0·25	0·2	...	...	...	...
Reaping	...	...	...	...	0·15	0·15	0·3	0·3
Tying & stooking	...	...	...	...	1·0	1·0	...	...
Pitching, carting, and stacking ...	...	...	...	...	1·0	1·0	0·5	0·5
Thatching	...	...	...	...	0·2	0·2	...	...
Thrashing (plus engine)	...	...	...	...	3·0	3·0	...	...
Lifting roots ...	4·0	3·0	...	...	...	...	...	...
Carting roots, 20 loads	2·0	2 0	1·5	1·5	...	...	...	...
	17·65 @ 3/-	14·15 @ 3/-	10 5 @ 3/6	7·5 @ 3/6	7·4 @ 3/-	7·15 @ 3/-	4·4 @ 3/6	3·9 @ 3/6
	53/-	42/6	36/9	26/3	22/2 5/6 27/8	21/5 5/6 26/11	15/4	13/7

5s. 6d. per acre is added for extra harvest wages, and a man is reckoned at 3s. and a horse at 3s. 6d. per day.

DRAINING.

Percolation of Water.

Lawes and Gilbert found that 44·6 % of the rain percolated to the depth of 20 in. on the average of ten years. With 25 in. rainfall every acre receives 567,168 gals. per annum, of which 250,000 gals. sink deeply into the soil. Rather more than half of the whole is evaporated, the average percolation over England being 42 %.

Percolation of Rain at Rothamsted Drain Gauges, 1871–80.

Years.	Rain-fall.	Percolation through Soil.			Difference reckoned = Evaporation.		
		20 in. deep.	40 in. deep.	60 in. deep.	20 in. deep.	40 in. deep.	60 in. deep.
	Ins.	%	%	%	%	%	%
4 years, 1871–74	27·33	35·4	34·7	28·4	64·6	65·3	71·6
6 ,, 1875–80	34·2	49·6	54·2	49·4	50·4	45·8	50·6
10 ,, 1871–80	31·5	44·6	47·4	42·1	55·4	52·6	58 9
		Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
10 ,, 1871-80	31·5	14·0	14·9	13·2	17·4	16·5	18·5

Evaporation 50% less on flat than on undulating rocky country. Mean daily evaporation of England = ·08 in.; India, ·2 in.

Rainfall.

Inches of Depth.	Cubic Feet per Acre.	Gallons per Acre.	Tons per Acre.
1	3,630	22,635	101·1
2	7,260	45.270	202 2
3	10.890	67,905	303·3
4	14,520	90,539	404·4
5	18,150	113,174	505·5
6	21,780	135,809	606·6
7	25,410	158,444	707·7
8	29,040	181,072	808·8
9	32,670	203,714	909·9
10	36.300	226,349	1,011·0
11	39,930	248,984	1,112·1
12	43,560	271,619	1,213·2

Motion of Water in Open Watercourses.

According to Smeaton, large and deep rivers run sufficiently swift and discharge vast quantities of water with a descent of 1 ft. per mile.

Small rivers and large brooks require about 2 ft. per mile.

Small brooks hardly keep an open watercourse under 4 ft. per mile; and ditches, covered drains, &c., require at least 8 ft. of fall per mile.

The Effects of Velocities on Channels of Watercourses.

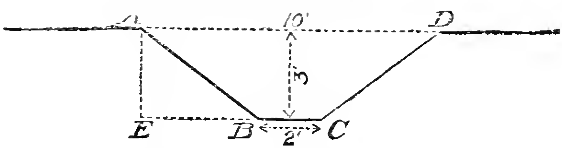
3 ft.	per second	will move	fine clay.
6 ,,	,,	,,	fine sand.
8 ,,	,,	,,	coarse sand.
12 ,,	,,	,,	water-worn gravel 1 in. diameter.
36 ,,	,,	,,	angular stones as large as a hen's egg.

Velocity of Current, in feet per second, due to depth of water running:—

Unconfined over a weir	$8{\cdot}04\sqrt{d}$
In a channel with side walls	$7{\cdot}5\sqrt{d}$
Through opening in sluice	$5\sqrt{d}$

where d is the depth in feet.

Open Watercourses.



The form to which watercourses naturally approximate is that shown above, where width at top, depth, and width at bottom are as 10 : 3 : 2. Where the banks are grassy, with no live stock, they will retain a steeper slope for many years, but the action of frost and rain, and other causes, wear them down till they reach the "angle of repose" sooner or later. This angle of repose for different soils will be that in which the base B E will be to the height A E as follows:—

Clay or strong earth ...	1·0 of base	to 1	in height.
Sand	1·2 ,,	1	,,
Common mould	1·33 ,,	1	,,
Wet gravel	1·43 ,,	1	,,

The form which gives the least amount of excavation together with the easiest flow of the largest amount of water, is that in which the section is one half of a hexagon; or, in other words, where the bottom and sides form tangents to a semicircle whose diameter is the surface line of the water.

Drains.

In draining, the outfall is first to be fixed on; then a main drain to be run up every hollow—3 to 6 in. deeper than the others—and the small drains run directly up and down the slope; $2\frac{1}{2}$ in. in bore is the standard size now used.

Best theoretical shape for pipes is an oval or elliptical bore with one or two flat outside bottoms; but in practice cylindrical pipes are often employed, as they are more easily laid correctly.

They must be made of well-tempered, well-ground clay; well burnt; not too much sand in composition; straight, smooth, and free from ragged ends; and emit a clear ringing noise when struck.

The length of the small collecting drains should not exceed 300 yards. If the field to be drained would need them to be longer than this, then sub-mains must be put in across the slopes, so as to take away part of the drainage separately.

Rule for Obtaining Size of Main Pipes.—Multiply the square root of the number of small drains (of fair average length) by the diameter of small pipes: quotient gives the diameter of main sufficient to carry all the water when the feeders are full; in practice they are never full, and one-fourth or one-fifth this area (*i.e.*, one-half this diameter) will be sufficient in ordinary draining.

If the distance apart of drains in feet be denoted by F, that in links by L, and the length of drains in chains per acre by C, then

$$C = \frac{660}{F} = \frac{1{,}000}{L}.$$

Number of 12-in. Pipes required per Acre at different Distances between the Drains.

Distance, Ft.	No.	Distance, Ft.	No.
12	3,630	33	1,320
15	2,904	40	1,089
18	2,420	50	871
21	2,073	60	726
27	1,613		

Table of Size of Pipe Tile of Main Drain.

Fall.	Acres Drained.					
	3-in. Tile.	4-in. Tile.	6-in. Tile.	8-in. Tile.	10-in. Tile.	12-in. Tile.
1 foot in 20	18·6	26·8	74·4	150·0	270·0	426·0
1 ,, 30	15·1	21·8	60·4	128·0	220·8	346·0
1 ,, 40	12·9	18·6	51·6	108·8	189·6	298·4
1 ,, 50	11·9	17·0	47·7	98·0	170·4	269·0
1 ,, 60	10·9	15·6	43·4	90·0	156·0	246·0
1 ,, 70	10·0	14·5	39·9	83·0	144·4	228·1
1 ,, 80	9·3	13·4	37·2	77·0	135·0	213·0
1 ,, 90	8·1	12·6	35·0	72·5	127·0	200·5
1 ,, 100	7·3	11·9	33·1	69·2	120·6	190·5
1 ,, 150	6·7	9·5	26·6	56·0	97·3	154·4
1 ,, 200	5·7	8·2	22·8	48·0	83·9	132·5
1 ,, 250	5·1	7·5	20·4	42·4	74·4	117·0
1 ,, 300	4·6	6·9	18·4	38·2	65·5	107·0
1 ,, 400	4·1	5·9	16·5	32·6	60·3	90·7
1 ,, 500	3·7	5·2	14·8	30·1	54·0	81·6
1 ,, 600	3·3	4·7	13·3	28·0	48·6	74·0
1 ,, 800	2·9	4·1	11·4	24·0	41·9	65·0
1 ,, 1,000	2·6	3·7	10·2	21·2	37·2	56·0
1 ,, 1,500	2·1	3·0	8·5	16·8	30·8	47·0
1 ,, 2,000	1·9	2·8	7·4	15·0	25·0	40·8

Comparative Cost of Digging, Laying Pipes, and Filling Drains, at per chain of 22 yards, in terms of a day's work.

Depth in Feet.	Digging Drains.	Laying Pipes.	Filling Drains.	Total Cost.
2½	·3	·04	·06	·4
3	·52	·04	·11	·67
4	·8	·04	·16	1·0
5	1·25	·04	·21	1·5
6	1·8	·06	·3	2·16
7	2·2	·06	·4	2·66

THE NUMBER AND WEIGHT OF 12-IN. PIPE TILES of different diameters of bore that can be carried on an agricultural cart drawn by one horse :—

Bore of Pipe. Diameter.	Number of Pipes.	Thickness.	Weight of 1,000.
1 inch	900 to 1,200	$\frac{1}{4}$ inch	$11\frac{1}{4}$ cwt.
$1\frac{1}{2}$ inches	750 ,, 1,000	$\frac{3}{8}$,,	14 ,,
2 ,,	500 ,, 750	$\frac{3}{8}$,,	17 ,,
$2\frac{1}{2}$,,	400 ,, 620	$\frac{1}{2}$,,	25 ,,
3 ,,	300 ,, 500	$\frac{1}{2}$,,	$34\frac{1}{2}$,,
$3\frac{1}{2}$,,	275 ,, 450	$\frac{1}{2}$,,	40 ,,
4 ,,	250 ,, 400	$\frac{1}{2}$,,	$45\frac{3}{4}$,,
5 ,,	200 ,, 350	$\frac{5}{8}$,,	$71\frac{1}{2}$,,
6 ,,	150 ,, 180	$\frac{3}{4}$,,	103 ,,
7 ,,	100 ,, 150	$\frac{3}{4}$,,	120 ,,
8 ,,	70 ,, 100	$\frac{7}{8}$,,	160 ,,
9 ,,	50 ,, 80	$\frac{7}{8}$,,	180 ,,
10 ,,	40 ,, 70	1 ,,	228 ,,
11 ,,	30 ,, 50	1 ,,	$251\frac{1}{2}$,,
12 ,,	25 ,, 40	1 ,,	$274\frac{1}{2}$,,

The first column of the numbers of pipes refers to those that may be carried in a cart with shelvings, and the other to those that may be carried in a long harvest cart.

AREA OF BORE OF PIPES ACCORDING TO DIAMETER.

Diameter in Inches.	Area in Sq. Inches.	Diameter in Inches.	Area in Sq. Inches.
1	·785	9	63·617
$1\frac{1}{2}$	1·767	10	78·540
2	3·141	11	95·033
$2\frac{1}{2}$	4·908	12	113·097
3	7·068	13	132·732
$3\frac{1}{2}$	9·621	14	153·938
4	12·566	15	176·715
5	19·635	16	201·062
6	28·274	17	226·980
7	38·484	18	254·469
8	50·265		

Drainage Data.

Kind of Soil.	Depth in Feet.	Distance apart in Feet.	No. of Feet and 12-in. Pipes per Acre.	Cost of Laying per Acre.		Cost of Mains per Acre.		Cost of Pipes, including Cartage, at 30s. per 1,000.			Cost of Cutting and Filling per Acre.			Total Cost per Acre.		
				s.	d.	s.	d.	£	s.	d	£	s.	d.	£	s.	d.
Very stiff clay	2·5	12	3,630	13	7	3	6	5	9	0	4	3	11	10	10	0
Stiff clay	2·5	15	2,904	11	2	3	6	4	7	0	3	17	4	8	19	0
Friable clay	2·5	18	2,420	9	1	3	6	3	12	6	2	10	5	6	15	6
Soft clay	2·75	21	2,073	7	10	3	9	3	2	0	2	12	7	6	6	2
Loamy clay	3·0	21	2,073	7	10	4	0	3	2	0	2	17	6	6	11	4
Loam with gravel ...	3·25	27	1,613	6	0	4	3	2	8	0	2	8	5	5	6	8
Light loam...	3·5	33	1,320	5	0	4	9	1	19	6	2	2	7	4	11	10
Sandy loam	3·75	40	1,089	4	1	5	1	1	12	6	1	17	10	3	19	6
Light sand with gravel	4·0	50	871	3	3	5	7	1	6	0	1	12	2	3	7	0
Coarse gravelly sand	4·5	60	726	2	9	6	3	1	1	6	1	10	3	3	0	9

The foregoing table applies only to drains in which the soil is easily cut by the ordinary draining spade. For drains requiring the use of picks, or in very hard soil, an allowance of from 30 to 50 per cent. additional must be made for the cutting and filling.

Mole-Plough Draining.

The coulter of the plough has on the back of its point a "mole," or steel plug, which leaves an open channel behind it when drawn through the soil either by horse-windlass or steam. The channels thus made deliver into properly constructed mains laid with pipe tiles. The coulter can be set to any moderate depth, not over 3 ft.; while, of course, it is better adapted for pasture than for arable land. It can only be carried out on clays or free loams. Cost averages as follows per acre—drains 8 yards apart:—

	£	s.	d.
605 yards at $\frac{1}{4}$d. per yard	0	12	6
Cutting main drains	0	4	6
Pipes	0	5	0
Labour, coals, &c.	0	3	0
	£1	5	0

Hill Draining.

Open trenches 24 in. wide at top, 16 in. deep, and 6 in. wide at bottom; turf laid 10 in. from side, and clearings thrown beyond this. Trenches to be from 9 yds. apart on best land up to 35 yds. on poor or peaty surfaces. On "Draw-Bent" or "Moss-Crop" peat-mosses the drains must be 60 yds. apart, else these plants—valuable for spring feeding of sheep—will be destroyed. Cost up to 1d. per yard to cut.

Results of Draining are—

1. Soils are more easily and sooner worked.
2. Lime and manures act better.
3. Seed time and harvest earlier.
4. Larger and better crops, and
5. Good natural grasses spring up.
6. Green-cropping can be introduced, and
7. Bare-fallowing very largely done away with.
8. The climate becomes warmer.
9. There are fewer noxious insects.
10. The health of the live stock is improved.

Embanking

Cost of Labour in forming embankments, per cubic yard, in decimals of a day's work :—

Digging and filling or casting ...	·0666	to	·0833
Picking in strong or stony soil ...	·0333	,,	·0416
Levelling and forming	·0333	,,	·0416
Wheeling—20 yards run	·0133	,,	·0133
Total cost per cubic yard ...	·1400		·1800

Cost of Labour in covering embankments with turf, per superficial yard, in decimals of a day's work :—

Paring turf and filling barrows	·0833
Wheeling, every 20 yards	·0133
Laying turf	·0833
Total cost per superficial yard	·1800

A *turf* is 3 ft. long and 1 ft. wide.

In Excavating, one man will get, and fill into waggons, carts, or barrows, the following quantities of earth in a day's work of 10 hours; the decimal of a day's work as the cost of getting and filling 1 cubic yard being also given, viz. :—

Description of Earth.	Cub. Yds. in a Day's Work.	Cost of Cub. Yd. in a Day's Work.
Easily got	$12\frac{1}{2}$	·08
Tough earth	10	·1
Hard earth	$8\frac{1}{3}$	·12
Very tough or hard	7	·143
Difficult to dig or separate	$6\frac{1}{4}$	·16
Soft stone easily parted	4	·25
Hardish stone	3	·3
Hard stone	2	·5
Very hard and tough stone	$1\frac{1}{2}$	·6

In removing soil with a wheelbarrow, a man will wheel and tip a load, and return empty a distance of 30 yards on a level plank, or 20 yards up a ramp or steeply inclined plank, in one minute. A barrow-load is considered to be 1-7th of a cubic yard of excavation. In removing stuff by horses and carts, the distance being one mile, and the load $\frac{3}{4}$ of a cubic yard, the time required is one hour for each horse.

Proportion of Labourers required in Earthwork, barrow run being calculated at 50 yards:—

	Diggers.	Fillers.	Wheelers.
Loose earth, sand, &c.	1	1	1
Compact earth	1	2	2
Marl	1	2	2
Hard clay	1	$1\frac{1}{4}$	$1\frac{1}{4}$
Compact gravel	1	1	1
Rock, from	3	1	1

Three cubic yards of stone in a quarry are about 4 in rubble; 6 cubic yards of rubble make 5 of road metal; or 9 in the solid is 10 as road metal Clean gravel is nearly the same in all states.

Cubic feet to a ton weight of Stone for Metalling Roads:—

Description.	Solid Cub. Ft.	Rubble Cub. Ft.	Broken Cub. Ft.
Whinstone (basalt) ...	12·3	16·4	13.7
Limestone, compact...	13·6	18·0	15·0
Sandstone (quartzite)	14·5	19·3	16·0
Gravel free from soil	20·0	...	21·0

Cubic feet of Soil, &c., to weigh one ton:—

Limestone	13·5 cub. ft.
Shale...	13·8 ,,
Sandstone	14·5 ,,
Grey chalk	15·0 ,,
Sandy soil, unstirred, wet...	15·0 ,,
Rough water gravel	15·8 ,,
Sandy soil, loose, wet	16·5 ,,
Clayey surface soil when it has been compressed, wet	18·0 ,,
Gravelly clay	18·0 ,,
Wet sand	19·2 ,,
Clayey surface soil in tillage, but not recently stirred	20·0 ,,
Common gravel	20·0 ,,
Marl...	20·7 ,,
Sandy loam...	22·5 ,,
Clayey surface soil in a loose state	23·0 ,,
Dry sand	24·5 ,,
Common earth, unstirred...	25·0 ,,
Same, in a loose state	27·5 ,,
Wet peat	36·0 ,,
Dry peat	72·0 ,,

Loads of Carts and Waggons.

An ordinary one-horse box tip-cart, with shelvings, is 5·0′ × 3·8′ × 1·75′, and holds 33 cub. ft. = 1·23 tons earth.

Do., larger size (two horses), is 6·3′ × 3·66′ × 1·8′ = 41·5 cub. ft. = 1·53 tons earth.

Two-horse waggon is 11·5′ × 4·3′ × 1·5′ = 74 cub. ft. = 2·74 tons earth.

Navvy wheelbarrow, 2·1′ × 1·9′ × 1·0′ = 3·8 cub. ft. = 0·14 tons earth.

Height of face of bank in excavations which various soils will retain for a short time without falling in :—

Clean dry sand and gravel	1 to 2 ft.
Moist sand and ordinary earth	2 ,, 3 ,,
Loam, drained	5 ,, 8 ,,
Clay soil	10 ,, 12 ,,

Angle of the *Natural Repose* of different soils (with the horizontal line) :—

	Deg.		Deg.
Gravel	40	Shingle	39
Dry sand	38	Rubble	45
Sand, wet	22	Clay, drained	45
Vegetable earth	28	,, dry	29
,, ,, wet	45	,, wet	16
,, ,, punned	65	Peat, loose	14
Compact earth	50	,, firm	45

Proportion of the bulk of materials in the solid and in embankment :—

Chalk	15 in solid	= 16	in embankment.
Clay	11 ,,	= 12	,,
Gravel	12 ,,	= 13	,,
Rock	2 ,,	= 3	,,
Sand, dry	1 ,,	= 1	,,

Whenever a change of direction is necessary in an embankment, open stream, or a covered drain, it should always be in a parabolic curve, as water flows most naturally round this curve.

Earth in embankments for dams or ponds should be laid in courses 1 ft. thick at a time, and well rammed. The courses should also be laid concave, to prevent slipping. There should be a central wall of puddled clay in the embankment, carried down into the solid ground at the bottom and sides. An overflow 3 ft. wide is necessary for every 100 acres of catchment area, and made in the solid ground.

Mill-Dams and Ponds.

Width at top in high dams, from 7 to 20 ft
Width at top in low dams = height.
Breast slopes ... ... = 3 to 1.
Water slopes ... ... = 2 to 1.
Height above the surface of water, not less than 3 ft. 6 in.

Stone Fences.

A man accustomed to the work will build 7 cub. yds. of dry rubble wall in a day, requiring 10 loads of stone, each = 19·3 cub. ft. He can also lay 30 sup. yds. of rough bottoming pavement for roads.

Sewage Irrigation

One acre of land sufficient for 100 people at 25 gallons daily per head.

One acre of land sufficient for 5 head of live stock where liquid properly diluted with twice its bulk of water, and run on by gravitation.

Best soils are those of a light, free, or loamy nature.

On sloping land the "catchwork" system is best; that is, parallel trenches forming nearly level contours across the face of the slope.

On nearly level land the "bedwork" system is advisable; that is, the trenches carried along the crown of ridges or beds laid out for the purpose.

Width from trench to trench: 28 to 30 ft. is recommended.

Land should be deeply underdrained.

Town sewage should be applied intermittently, and not more than equal to 1 in. deep of liquid at a time.

For cutting green the most suitable crop is grass, especially Italian ryegrass; but for hay, timothy is the best. Sewage-grown Italian ryegrass can rarely be made into even third-class hay. Root crops and vegetables also do very well.

Warping.

A process carried out on the Humber and other estuaries where a stretch of peat or poor land lies under the level of high tide, and the water contains a lot of silt in suspension. The field to be warped is surrounded with embankments, and the water led on in a canal or large ditch, allowed to deposit its silt, and then run off gently again at low tide. One-eighth of an inch of deposit may be left at each flood, and the level of the soil raised 1 ft. in a year. The soil thus made is a rich alluvium having a tendency to produce grain dark in colour. Spring and summer are the most suitable periods for the operation, and as much as 200 to 300 acres may be warped in one area.

Roads.

Public roads...	30 feet wide.
Occupation roads	15 ,,
Headland roads	10 ,,
Metalling of occupation roads ...	10 ,,
Convexity of roads	1 in 50 to 1 in 72.
Height of middle above sides ...	6 ins.

Site of road to be dug out 10 in. deep; the bottom laid with big stones on the flat, with points upward, 6 in. deep—or with brushwood in default of anything else—and 4 in. of small metal put on top and well rammed. Side drains to be made 3 ft. deep, and best laid with pipes and filled with loose stones, if material is plentiful. Burnt clay laid 1 ft. deep makes good bottoming for roads; and this may be made by burning the clay dug out on the site of the road, at a cost of 1s. per square yard, inclusive.

Great point is to keep the road dry by surface draining, making the top convex, and maintaining low, well-trimmed fences alongside. The bottom of farm roads is best dug out, otherwise the traffic will spread out the metal if originally laid on the surface; though wide public roads may be so made.

SOILS.

SOIL.

Soil is the upper stratum of the loose, incoherent earthy matter formed from the disintegration of rocks, with a certain proportion of animal and vegetable matter intermixed, modified by the action of worms and the ameliorating influence of the atmosphere

It is from 3 inches to over 1 foot thick, and usually much darker in colour than the subsoil below.

The part derived from the mineral matter is known as the *inorganic* portion, and that from the animal and vegetable as *organic*. In burning a quantity of soil the organic part only is consumed, and the inorganic left behind.

It does not always happen that a soil is formed from the *débris* of the subjacent rock, but often the material has been brought from a distance and mixed up by geological agencies. There are thus soils made from *transported* materials, and soils made from materials *in situ;* but the formation of the soil proper has always taken place on the spot where we now find it. Transported materials nearly all owe their origin to the occurrence of Boulder Clay, Glacial Drift, and Alluvium, which, however, largely take their character from the rocks of the immediate locality.

Proximate Constituents of Soils.

Sand.	Calcic Carbonate.	Vegetable matter (Humus).
Clay.		Gravel.

Classification of Soils.

Sandy	... ...	Under 10	per cent.	of clay.
Sandy loam	... ...	10 to 20	,,	,,
Loam	... ...	20 ,, 30	,,	,,
Clay loam	... ...	30 ,, 50	,,	,,
Strong clay	... ...	Over 50	,,	,,
Marly	... ...	5 to 20	,,	calcic carbonate.
Calcareous	... ...	Over 20	,,	,, ,,
Humous	... ...	Over 5	,,	vegetable matter.

Gravel may form part of any of the above, and give a special character to it. Gravel is unweathered fragments of some at least of the rocks from which a given soil was originally derived.

If there is less than 4 per cent. of calcic carbonate present in clay or peaty soils, an application of it is likely to do good.

Layers in a Natural Unstirred Soil.

(In Descending Order.)

Grass on surface.
Vegetable soil.
Soil proper, or weathered subsoil.
Subsoil, or weathered rock material (transported or *in situ*).
Rock.

Indications of Good Land.

Gentle slopes and flats.

Strong healthy woodlands, excepting as regards beech and fir.

Good hedges.

Rich green permanent pasture, with plenty of white clover.

Clover in the railway cuttings.

Deep soil, and of a reddish or dark brown colour.

Strong healthy weeds, such as ragwort, thistles, bracken, &c.

Indications of Bad Land.

Beech and fir the prevailing trees.

Stunted trees and hedges.

Sedges, daisies, and oxeye daisies plentiful.

Quaking grass, Yorkshire fog, and barren brome common in the pastures.

Thin soil, and wet or spongy under foot.

Thin, wiry couch and other inferior grasses.

Various bents (*agrostis*) common.

Heath or moss plentiful.

Natural Characteristics and Circumstances which affect the Value of Farms.

Climate.	Depth of Soil.
Altitude.	Colour ,,
Aspect.	Texture ,,
Shelter.	Wetness ,,
Contour.	

Equipments which affect the Value of Farms.

Field and Fences.	Drainage.
Roads.	Buildings.
Proportion of Pasture.	Markets.
Water Supply.	Labour Supply.

Comparative Absorptive, Evaporative, and Hygroscopic Power of Soils.

Soils.	Specific Gravity.	Water held per Cubic Foot.	Per Cent. of Water absorbed by 100 parts of each Earth.	Per Cent. of Water evaporated in 4 Hours at 60° Fah.	Hours required to evaporate 90 per Cent. of the Water.	Per Cent. absorbed from Damp Air at 62° in 12 Hours.
		Lbs.				
Siliceous sand ...	2·65	27·3	25	88	4·6	0·0
Calcareous sand ...	2·64	31·8	29	76	4·7	0·3
Sandy clay	2·60	38·8	40	52	5·1	2·1
Strong clay	2·56	40·4	50	46	6·9	2·5
Loamy arable soil...	2·40	40·8	52	46	7·8	3·0
Garden soil	2·33	48·4	89	32	11·2	3·5
Humus	1·37	50·1	190	21	17·5	8·0

There is thus, as shown on the above table, an ascending or descending scale in the comparative approximate physical characteristics of soils.

Water Supply from Formations.

The Chalk, Oolite, Lias, and Carboniferous Limestone yield hard water, from the presence of calcic carbonate. The water of Magnesian Limestone is extra hard. Trias, or New Red Sandstone, is permanently hard, from the presence of gypsum. Soft waters are derived from such sands and clays as the Bagshot Beds, London Clay, Wealden Beds, and Upper Carboniferous. Soft waters also from the grits and slates of the Cambrian and Silurian, Igneous and Metamorphic. Impermeable or dry formations are Gault Clay, Kimmeridge Clay, Oxford Clay, Upper Lias Clay, Lower Lias Clay, and Keuper Marls; on these ponds or dams require to be made to catch surface water.

A degree of "hardness" of water implies more than one grain of bicarbonate or sulphate of lime per gallon. Each degree destroys 1 oz. of soap in 40 gallons of water. Under 6 degrees of hardness is "soft;" above this, hard. Bicarbonate causes "temporary," and sulphate "permanent," hardness.

Rock-forming Minerals.

Relative Proportion of the ten most abundant rock-forming minerals of the crust of the earth, from which soils were originally derived :—

1. Felspar	48	per cent.
2. Quartz	35	,,
3. Mica	8	,,
4. Talc	5	,,
5. Carbonates of Lime and Magnesia...	1	,,
6. Amphibole (Hornblende) ...		
7. Pyroxene (Augite)	1	,,
8. Diallage		
9. Peridot (Olivine)		
10. Clay (in all its forms)	1	,,
11. Other substances	1	,,
	100	,,

Composition of the Principal Rock-forming Minerals.

Felspar.—Chemically is an anhydrous aluminic silicate with potash, soda, and lime. Disintegrated felspar forms clay ($Al_2 O_3 + 2 Si O_2 + 2 H_2 O$). Three principal varieties are orthoclase, or potash felspar ($Al_2 O_3 \cdot 3 Si O_2 + K_2 O \cdot 3 Si O_2$), in granite, &c.; albite, or soda-felspar ($2 Al_2 O_3 \cdot 2 Si O_2 + Na_2 O \cdot 3 Si O_2$); and anorthite, or lime felspar ($Al_2 O_3 \cdot Si O_2 + Ca O \cdot Si O_2$), in volcanic rocks.

Quartz.—Composed of silica or silicic oxide ($Si O_2$). Found in all crystalline rocks: occurs as ordinary sand; is the principal constituent of granite, sandstones, traps, &c.

Mica.—Aluminic silicates with potash, magnesia, lime, iron, lithium, and fluorine. Splits into thin shining plates, elastic and transparent; found in granite, mica-slate, micaceous sand, &c.

Potash mica (muscovite) has the composition, $3 Al_2 O_3 \cdot Si O_2 + K_2 O \cdot 3 Si O_2$.

Quartz, felspar, and mica together form granite.

Talc.—A silicate of magnesia ($6 Mg O \cdot 8 Si O_2 + 2 H_2 O$); white, grey, green, or translucent. Foliated and flexible (but not elastic), and greasy to the touch. Steatite or soapstone ("French chalk") is a massive amorphous variety.

Carbonates of Lime and Magnesia.—Occur in massive form in our limestone and chalk rocks, oolites, marls, &c. Pure varieties of the former consist of $Ca\,CO_3$, and of the latter of $Mg\,CO_3$. Magnesian carbonate may exist in limestones from mere traces up to a ratio of $Ca\,CO_3$ to $Mg\,CO_3 = 1 : 3$. Normal dolomite contains equal parts, the percentage composition being $Ca\,CO_3 = 54{\cdot}35$; $Mg\,CO_3 = 45{\cdot}65$.

Hornblende (Amphibole) and *Augite (Pyroxene)*.—Magnesic and calcic silicates $\{(Ca\,O{\cdot}Fe\,O)\,Si\,O_2\}$, or magnesic and ferric silicates $\{(Ca\,O{\cdot}Mg\,O{\cdot}Fe\,O)\,Si\,O_2\}$; occur in basalt as black or dark green minerals. *Diallage* is a thin, foliated variety of augite, of a clear translucent green colour.

Olivine (Peridot).—A ferric silicate of magnesia, $(Mg\,O{\cdot}Fe\,O)_2\,Si\,O_2$; found as small rectangular grains of a light olive or greenish colour imbedded in basalt.

Clays.—Soft hydrated silicates of alumina (pure form $= Al_2\,O_3 + 2\,Si\,O_2 + 2\,H_2\,O$) with more or less free silica; insoluble in acids. Have the property of becoming plastic in water and hardening in fire. Usually contain diffused oxides of iron or some organic carbonaceous matter which gives them colour. Protoxide of iron gives the blueish and greenish colours; anhydrous peroxide a deep red, which changes to bright yellow on hydration, intermediate stages being brown and purple. Carbonaceous or organic matter gives the grey, blueish-grey, and black tints.

Zeolites, which are the most important of the remaining minerals, are hydrated aluminic silicates with lime, soda, or potash, but no magnesia. Usually soft and readily decomposable, especially in $H\,Cl$. Found in vesicular cavities and interstices of trappean rocks and lavas. Analogous compounds are supposed to form in soils—especially after manuring—and modify their properties, and may exist there to the extent of 4 or 5 per cent.

WEATHERING OF ORTHOCLASE FELSPAR INTO CLAY.

Silicate of Aluminum + Silicate of Potash + Silicate of Iron.

As rain { Water containing oxygen and carbonic anhy.

Bisilicate of potash. Acted on by CO_2 in H_2O, and gives potassic carbonate and soluble silica.

Iron oxidised by O in H_2O to form sesqui-oxide (Fe_2O_3). Silica set free combines with potassic silicate to form a bisilicate.

Silicate of aluminum is left as clay; the others, being soluble, tend to wash out. If iron present, the clay is red or yellow.

The oxygen first attacks the iron, next the carbonic anhydride acts upon the newly-formed potassic bisilicate; this tends to get washed out, and clay or hydrated aluminic silicate ($Al_2O_3 + 2\,SiO_2 + 2\,H_2O$), more or less impure, remains.

Pure or pipe clay will not support vegetation, but potash, lime, soda, iron oxides, magnesia, &c., are usually present as impurities, and impart fertility to the soil, and organic matter gradually accumulates after a time.

Weathering of Crystalline Igneous Rocks into Soils.

	Granite.		Basalt.		Greenstone.	
	Unaltered.	Weathered.	Unaltered.	Weathered.	Unaltered.	Weathered.
Silica	73·1	74·6	44·4	42·5	51·4	44·5
Alumina	10·5	12·0	12·2	17·9	15·8	22·1
Lime	...	...	11·3	2·5	5·7	1·4
Magnesia	1·1	0·8	9·1	3·3	2·8	2·7
Soda	1·8	0·4	2·7	0·2	3·9	1·7
Potash	9·0	4·9	0·8	0·2	1·6	1·2
Iron, protoxide...	...	...	12·1	...	12·9	...
,, peroxide ...	3·2	3·2	3·5	11·5	2·5	17·6
Manganese oxide	...	...	...	...	0·5	
Water	0·5	3·2	4·4	20·4	1·7	8·6
Other substances and loss ...	0·8	0·9	...	1·7	1·2	0·2
	100·0	100·0	100·5	100·0	100·0	100·0

COMPARATIVE CONSTITUENTS OF IGNEOUS ROCKS, SOILS, AND PLANT ASH.

Igneous Rocks.	Soil.	Per Cent. in Soil.	Plant Ash.
Silica	Silica	From 5 to 94·0	Silica.
Alumina	Alumina	,, 1·0 to 15·0	Alumina (traces?).
Lime	Lime	,, 0 to 90·0	Lime.
Magnesia	Magnesia	,, 0·05 to 1·5	Magnesia.
Soda	Soda	,, 0 to 2·0	Soda.
Potash	Potash	,, 0 to 3·0	Potash.
Carbonic anhyd.	Carbonic anhyd. (CO_2)	Small am'nt	Carbonates.
Ferrous oxide	Ferrous oxide	Traces	Iron.
Ferric oxide	Ferric oxide	,,	,,
Phosphorus	Phosphoric anh. (P_2O_5)	0 to 1·5	P_2O_5.
Sulphur	Sulphur triox. (SO_3)	Small am'nt	SO_3.
Chlorine	Chlorine	,, ,,	Chlorine.
Manganese protox.	Manganese	Traces	Manganese (traces).
———	Bromine	Small am'nt	Bromine (traces).
———	Iodine	,, ,,	Iodine (sea and seashore plants).
Fluorine	Fluorine	,, ,,	Fluorine (grasses, &c.).

Analysis of Typical Fertile Soils.

	Insoluble Silicates and Sand.	Alumina.	Lime.	Magnesia.	Soda.	Potash.	Carbonic Anhyd.	Ferric Oxide.	Sulphuric Anhyd.	Chlorine.	Phosphoric Anhyd.	Organic Matter and Water of Combination.
1. Sandy soil	92·52	2·65	0·24	0·70	0·02	0·12	...	3·19	trace	trace	0·07	0·49
2. Sandy loam (Dumbarton) ...	78·30	2·60	0·34	0·28	0·17	2·22	...	4·27	0·10	0·14	0·38	9·05
3. Loamy soil	81·26	3·58	1·28	1·12	1·20	0·80	0·92	3·41	0·09	trace	0·38	5·66
4. Clayey loam (Essex)	81·26	5·46	1·23	0·56	0·15	0·58	0·32	4·60	0·07	0·003	0·13	5·62
5. Clayey soil (Carse of Gowrie)	61·20	14·04	0·83	1·02	1·44	2·8	...	4·87	0·09	0·01	0·24	11·25
6. Marly soil	55·52	5·96	11·15	0·25	0·71		8·77	5·96	0·04	0·76	0·38	10·50
7. Calcareous soil (Salisbury) ...	28·77	6·00	30·55	trace	1·03		23·91	3·31	trace	...	trace	6·33
8. Humous soil	72·80	9·30	1·01	0·20	0·01		...	6·30	0·17	...	0·13	10·08

As a rule, an exact chemical analysis of a soil is not of great practical use, for the reason that it does not show in what state the elements exist—whether suitable for plant food or not—but it may sometimes indicate the treatment to be followed. For instance, in the analysis above of soils from the Carse of Gowrie and Dumbartonshire, it is shown that potash manures would be useless—the superabundance of potash being due to the soil being the *débris* of felspathic rocks. Analysis of others may show a superabundance of lime, or a deficiency of some element; while, if barrenness is due to some poisonous material, it may thus be discovered. It has long been known, however, that the roots of plants have a certain amount of acid reaction, and have the power of dissolving food material for themselves out of the mineral fragments in the soil, and Dyer has shown that this solvent power is equal to a 1 per cent. solution of citric acid, and that the use of this acid instead of hydrochloric gives an analysis which agrees with the known results of manuring and cropping on a given soil.

Estimated Percentage of Elementary Substances in the Earth's Crust.

1. Silica	53·0
2. Alumina	19·0
3. Lime	6·3
4. Magnesia	5·8
5. Soda	2·5
6. Potash...	2·4
7. Carbonic anhydride	7·5
8. Iron oxides	
9. Sulphuric anhydride...	
10. (Chlorides)	
11. Other bodies	3·5
	100·0

The similarity of the above to the average composition of soils is notable.

The surface soil (9 inches deep), if in pasture, may contain when dry 0·25 % of nitrogen; on arable land, 0·15 %; and a clay subsoil, 0·05 %.

A good surface soil may have 0·2 % of phosphoric acid, or less; it may also contain 1 % of potash—usually less.

In ordinary soils the soluble salts are as follow:—

Soluble in water	0·1 to 0·27 per cent.
Soluble in acids	6·5 to 10·8 ,,
Insoluble sand or clay ...	77·0 to 87·0 ,,

The soluble substances in the soil which are removed by drainage water are chiefly nitrates, chlorides, and sulphates of calcium and sodium. Phosphoric acid, potash, and ammonia are rarely found in such water. The retentive ingredients of the soil are (chemically) hydrates of ferric oxide and alumina, and also humus. Red or brown colour of soils due to ferric oxide ($Fe_2 O_3$); blue colour to ferrous oxide ($Fe O$): becomes brown or yellow on weathering (= oxidation).

A useful rough analysis of a soil is made thus:—Dry a certain weight, the loss = water: burn on clean iron, loss = organic matter; pass the residue through a fine sieve to separate proportion of stones and fine gravel; put the residue into a glass vessel with pure water, and shake up vigorously or stir several times, allow the sand to settle, pour off the water holding clay in suspension; filter this last and evaporate the filtrate: the proportion of sand is found in the glass vessel, the clay on the filter paper, and the residue from evaporation of water = soluble salts.

Nitrogen in the First 9 Inches of Soil at Rothamsted.

	Per Cent.
Very old pasture	·247
Pasture laid down in 1838	·195
,, ,, 1863	·174
,, ,, 1872	·151
Ordinary arable land	·124
Arable soil—wheat grown continuously 38 years without nitrogenous manure	·100
Arable soil—roots grown continuously 27 years without nitrogenous manure	·093

Nitrogen in Successive Depths of Soil at Rothamsted.

	Arable Soil.		Old Pasture Soil.	
	Per Cent.	Lbs. per Acre.	Per Cent.	Lbs. per Acre.
First 9 inches... ...	·138	3,507	·247	5,336
9 to 18 ,, ...	·072	1,679	·072	1,916
18 to 27 ,, ...	·056	1,272	·044	1,329
27 to 36 ,, ...	·040	886	·043	1,290
36 to 45 ,, ...	·033	772	038	1,231
45 to 54 ,, ...	·031	773	·036	1,208
Total, 54 inches ...	...	8,889	...	12,310

NITROGEN IN FIRST 9 INCHES OF SOIL DIFFERENTLY MANURED FOR A SERIES OF YEARS AT ROTHAMSTED (BROADBALK FIELD: CONTINUOUS WHEAT-GROWING).

Plot.	Manuring.		Nitrogen, %.	Nitrogen, Lbs. per Acre.	Excess of Nitrogen over Plot 5, per Acre.	Average Total Produce per Acre, 1852-81.
		Lbs.			Lbs.	Lbs.
3	No manure		·1045	2404	...	2108
5*a*	Ash constituents		·1012	2328	...	2394
6*a*	Do. and ammonia salts...	200	·1153	2652	324	3954
7*a*	Do. do. do. ...	400	·1264	2908	580	5710
8*a*	Do. do. do. ...	600	·1320	3036	708	6778
9*a*	Do. and nitrate of soda...	550	·1253	2883	555	6903
9*b*	Nitrate of soda...	550	·1106	2543	215	4293
10*a*	Ammonia salts...	400	·1074	2471	143	3450
10*b*	Do. do.	400	·1077	2476	148	3923
11*a*	Superphos. and amm. salts	400	·1164	2676	348	4387
2	Farmyard manure ...	14 tons	·1957	4502	2174	5696

SOLUBLE CONSTITUENTS OF UNMANURED SOIL (PLOT 3) IN BROADBALK FIELD, 1865.

	Soluble in Dilute H Cl.	Soluble in Dilute Acetic Acid.		
	1st 9 in.	1st 9 in.	2nd 9 in.	3rd 9 in.
Silica	·434	·065	·080	...
Lime	2·298	2·065	·377	...
Magnesia	·092	·028	·013	...
Soda	·066	·012	·013	·014
Potash	·085	·015	·018	·011
Sulphuric anhydride	·015	trace	·002	·003
Phosphoric anhyd., soluble in dilute H NO_3 ...	...	·075	·047	·043

Ammonia in Soils.

	Per Cent.
Ordinary soils	·0002 to ·0008
Rich garden soils	·002
Rich alluvial soils (tropical) ...	·004 ,, ·009
Peat—one sample	·018
Leaf mould (South America) ...	·05

Carbonic Anhydride in the Air in the Soil.

(In 10,000 parts of air by weight.)

Ordinary atmosphere	4
Sandy subsoil of forest	38
Loamy ,, ,, ...	124
Surface soil ,, ...	130
,, vineyard	146
,, old asparagus bed	122
,, ,, freshly manured... ...	233
,, pasture land	270
,, rich in humus	543
Freshly manured sandy field, dry weather	333
,, ,, wet ,, ...	1,413

Composition of the Gas Held by Soils, but Driven Off at 284° F.

100 Grams of	Gas given off in Cubic Centimetres.	The Gas contained per Cent. of			
		CO_2.	CO.	N.	O.
A damp garden loam ...	13·7	24·1	8·8	64·3	2·9
Air-dried ,, ...	38·3	33·3	0·0	64·7	2·0
Peat	162·6	51·0	0·0	44·4	4·6
Hydrated ox. of iron (air-dried)	586·7	68·2	0·0	26·1	5·7
Clay	32·9	14·5	0·0	64·7	20·8
,, long exposed	25·6	25·1	0·0	70·2	4·7
Powdered gypsum	17·3	0·0	0·0	81·0	19·0
Pine charcoal	164·2	0·0	0·0	100·0	0·0
Poplar	467·0	16·5	0·0	83·6	0·0
Bone	84·4	45·8	0·0	54·2	0·0

Composition of Humus or Organic Matter of Soils.

Humic acid	... ...	$C_{40} H_{24} O_{12} + 3 H_2 O$
Ulmic ,,	... ...	$C_{40} H_{28} O_{12} + H_2 O$
Geic ,,	... ...	$C_{40} H_{24} O_{14}$
Crenic ,,	... ...	$C_{24} H_{24} O_{16} \pm 3 H_2 O$
Apocrenic acid...	...	$C_{24} H_{12} O_{12} + H_2 O$

The precise composition of humus is not known. It is believed to consist of the above acids in combination with water and nitrogenous basic compounds. From 1·5 to 2·5 per cent. of nitrogen has been repeatedly found in humic acid. It has great retentive power for moisture and for fixing bases added as manure, while its presence renders a stiff soil more porous and friable. The organic matter varies from 2 to 13 per cent. in ordinary soils.

Poor soils contain	... ...	0·0 to 0·5 per cent.
Intermediate ...	... ...	0·5 ,, 1·5 ,,
Rich soils	... ...	1·5 ,, 5·0 ,,

Over 5 per cent. of organic matter is classified as a humous or peaty soil.

Barrenness in soils may be due to a great many causes. "Sourness" is due to excess of water along with vegetable matter: draining and liming will help this. An excess of ferrous salts may be treated by liming and ploughing, while, of course, there may be an actual want of some ingredient of plant food. Subsoils very often contain poisonous matters which require to be oxidised for plant use, and for this reason the bringing up of subsoil to mix with the soil must be done very gradually, and only a little each rotation.

Nitrification.

The nitrogen contained in humus is not in a state fit for plant food as a general rule. By the action of minute *Bacteria* present in all soils, the organic nitrogen compounds and ammonia in the humus are oxidised, and their nitrogen converted into nitric acid. The work is due to at least two organisms, one of which converts the ammonia into nitrous acid, and the other converts this into nitric acid. The conditions most necessary for the active life of these organisms are a moist soil kept stirred up to admit the air, darkness, and the presence of some salifiable base with which the acid may combine as it is formed. Calcic carbonate is the most suitable for this latter purpose, and this is one of the good results which flow from liming. The ordinary mineral elements of fertility—especially phosphates—must also be present. Nitrification is most active at 98° to 99° Fah., and ceases below 40° and over 130°. It ceases also if there is no base present for the acid to unite with. The principal nitrifying organism is known as the *Micrococcus nitrificans*, and is seldom met with below a depth of 18 in. in the soil, while it is most active near the surface. It is a cause or accompaniment of the slow decay of organic bodies, but is not met with in ordinary putrefaction, though it is apparently the final stage of this fermentation. The germs are easily killed by drought, and by dressings of gas-lime, saline matters, and ferrous sulphate, so that the failure of crops from these may be due to the initial killing of the bacteria in the soil.

Cultivation.

The effect of ploughing and cultivation on the soil—besides preparing a suitable seed-bed and helping to keep the land free of weeds—is to loosen the particles and mix them; to allow the air to enter and thus promote oxidation; to make the whole body of the soil lighter, more porous, and more permeable to roots; and to allow the vegetable and mineral matter to decompose more rapidly and supply plant food. The formation of ammonia and of nitric acid (nitrification), and the absorption of these and moisture from the air, are also increased the more the soil is pulverised and mixed.

TABLE OF THE GEOLOGICAL FORMATIONS, WITH THE SOILS AND PRODUCTS CHARACTERISTIC OF EACH.

Formations.	*Soils.*	*Agricultural Economics.*
Recent. Alluvial and Estuarine Deposits.	Alluvial soils accompany the course of rivers, forming the level meadows, straths, and valley bottoms, and are found especially at their mouths, deltas, or estuaries. Occur abundantly at the Carses of Gowrie and Stirling, the valley of the Ouse and mouth of the Humber, the Fens, Romney Marsh, &c. Usually the most fertile soils of the locality, as they are mixtures of the *débris* of all the rocks and soils brought down by the rivers, but often subject to flooding, and sometimes marshy and difficult to drain. Salt marshes and deposits on the sea shore at river mouths are classed as "Estuarine."	Sand, Clay for brick-making, Gravel, Cobble stones; Alder, Willow.
Peat.	An example of a good peat soil occurs in parts of the Fenlands and parts of Allan's Bog; but peat usually is not fertile until improved by draining, liming, claying, &c.	Peat fuel, "Bog Oak," and other timbers; Birch and Firs.
Terraces and Raised Beaches.	Mostly shingly, gravelly, or sandy loams, the former along the sides of valleys at various heights above the rivers, the latter along the shores between the tide-marks and the bluffs or rocks a little inland. In some few cases a clay soil predominates. More or less level.	Sea sand, Gravel, Shingle, Paving cobbles, Boulders; Clay from some "Terraces."
Post Pliocene or Pleistocene. Glacial Drift and Boulder Clay.	The soil derived from this drifted material varies much in quality. It "masks" the formations in the greater part of Scotland, the northern half of England, and also of Ireland; but generally takes its character from the subjacent rocks. The mechanical texture varies from stiff clay ("till") to the lighter sands or gravels of the "Drift."	Sand, Gravel, Clay, Boulders, Paving cobbles.

Pliocene. Norwich Crag. Suffolk ,,	Form a strip of fertile, loose, loamy land on E. coast of Norfolk and Suffolk; are particularly fertile where they mix with the London Clay.	Suffolk coprolites, Building limestones, Lime, Clay, Marl, Shell-Sand.
Miocene.	(Awanting in Britain.)	
Oligocene. Fluvio-mar. Strata.	Occur in northern half of Isle of Wight and coast of mainland opposite the New Forest as clays and marls.	Clay, Marl, Limestone, Sand, Shelly building limestone; Oak.
Eocene. Upper Bagshot Sands, Bracklesham Beds, & Lower Bagshot Sands	Occur as detached patches of sandy and gravelly soils overlying the London Clay, as at Bagshot and Aldershot, and in Hampshire Basin; generally of a poor, hungry nature, but sometimes fairly fertile.	Sand, Flint gravel.
London Clay. Bognor Beds.	Yield a clay soil of a tenacious brown or blueish-grey colour. Expensive to work; much in grass, forming good pastures, but much improved by application of lime in any form; yielding good corn crops. Form the basis of the London and Hampshire Basins. Water difficult to get, from their impervious nature. Difficult to drain.	Clay, Marl; Oak, Elm.
Woolwich and Reading Beds. (Plastic Clays.)	Alternate formations of clay sand, loam, and gravel, with corresponding soils. The clays similar to London Clay, but distinguished as "plastic."	Sandy Clay, Sand, Flint gravel.

GEOLOGICAL FORMATIONS—*continued.*

Eocene—*cont.* Thanet Sands.	Protrude up through the London Clay in places, and form tracts of light, friable soil. The beds generally hold much water, and are valuable on this account for well-sinking purposes where they occur in the clay districts. Good soil in Kent.	Sand, Gravel.
Upper Cretaceous. Upper Chalk with Flints.	Good sheep land; form the various "Wolds" and "Downs," the natural habitat of the Down sheep. Soil thin, and whitish or light-coloured, with short, close sweet pasture, but in some places formed of loose flints. Dry and uncultivated, and water apt to be scarce in summer.	Flint building stones, Flint gravel, Limestone; Beech.
Lower Chalk and Chalk Marl.	Thin white light soil, well adapted for barley, roots, and leguminous plants, and mostly in cultivation. On the Lower Chalk there is often a stiff brown clay soil, the residue left from the dissolving away of the chalk. The Marl yields good soil, especially where it mixes with the Greensand.	Lime, Clay, Chalk rock for building.
Upper Greensand.	One of the most fertile of the lighter class of soils, especially where mixed with the chalk marls; grows good hops and fruit (Farnham).	"Firestones," Cambridge coprolites, Sand.
Gault Clay.	A strong, blue, tenacious and impervious soil, known in some localities as "blacklands;" requires draining, liming, and application of sand to make it yield good corn crops; good pasture.	Clay, Marl; Oaks.
Lower Cretaceous. Lower Greensand.	Light unproductive soils and barren heaths.	Silver Sand, "Ragstones."

Weald Clay.	Fine-grained yellowish clay, difficult and critical to work; very wet until drained, and much of the district still in oak-forest land and natural pasture; flat.	Clay, Lime; Oaks.
Hastings Sands.	Produce a poor brown sandy loam; protrude through the centre of the Weald deposit.	Sand, Sandy marl, Sandstone.
Upper Oolite. Purbeck Beds. Portland Beds.	Yield poor sandy, calcareous soils; much improved by mixing with the clay below, making soils of fair arable quality.	Purbeck Stone ("Marble"), Limestone, Portland Calcareous freestone.
Kimmeridge Clay.	Yields a tough, greyish, impervious, but often calcareous soil and subsoil of fair quality; difficult and expensive to work. Mostly in grass, as at Aylesbury.	Clay.
Middle Oolite. Coral Rag. Oxford Clay. Kelloway Rock.	The Oxford Clay is the most extensive member of this group. It is naturally much poorer than Kimmeridge Clay, and is mostly in pasture, and that often of poor quality. Where the two blend together, they give rise to an extensive tract of stiff clay soil, known as "The Clays," extending from Dorset through Lincoln to Yorkshire. Very difficult and expensive to work. The Coral Rag and Kelloway rock are both calcareous grits, giving rise to light sandy loams.	Building limestone, Road metal, Clay; Oak.
Lower Oolite. Cornbrash.	The Cornbrash, as its name indicates, has the character of yielding good corn crops. Soil is a "brashy" clay—that is, full of flaggy angular pieces of limestone, but of excellent quality.	Building limestone, Clay.

GEOLOGICAL FORMATIONS—*continued.*

Lower Oolite —*cont.* Forest Marble.	Yields heavier soils of moderate fertility, formed from the interstratified clay beds.	Building marble, Clay.
Great, or Bath Oolite.	The Great Oolite yields thin stony ("brashy") light soils, good for barley and sheep. They are moderately fertile, and form easily worked arable land, but rather elevated for cropping in some places. The Cotteswold Hills—the home of the sheep of that name—are on the Great Oolite, as also the Cleveland Hills and the "Heaths" of Lincolnshire. The beech tree is the "weed" of the Cotteswolds.	Building stone, Limestone; Beech.
Stonesfield Flags	This formation contains much phosphatic material, and shows a rich green sward of grass along its outcrop on the hillsides. Forms free-working stony land.	Roofing and paving flags.
Fuller's Earth—	A retentive heavy clay soil	Marl, Clay.
Inferior Oolites.	Light calcareous free-working soils of inferior character. Rising into precipitous hills in some places, and devoted to sheep.	Sand, Limestone, Building stone; Firs, Ashes.
Lias. Upper Lias Clay.	A soft, retentive brown clay soil, found mostly in the "combs" of the Oolitic hills, and sometimes mixed with the sand of these. Mostly in grass and requiring draining.	Clay.
Marlstone.	A rich yellowish loamy soil, forming a fertile strip overlooking the lower country of the Lower Lias, and noted for growing apples. Mostly arable.	Ferruginous sand; Firs.

Lower Lias Clay.	Gives rise generally to rich brown marly or clay soil. Much of it in pasture, as it is too stiff to cultivate. The Cleveland district, and the vales of Gloucester, Evesham, and Berkeley are examples of the best soils of this formation, while it forms the basis of the dairy districts of Somerset, Gloucester, Warwick, and Leicester shires, the pasture in these districts being good. Drainage sometimes converts these clays into good arable land, as in Cleveland. Flat or undulating.	Clay, Marl, Limestone, Building stone.
Trias. Rhaetic.	Forms a very narrow strip between the Lias and New Red Sandstone, of dark or black clayey soil, yielding good grass.	Marl.
Upper Trias or Keuper.	Yields a deep red clayey or marly soil, often rich pasture land, and highly favourable to agricultural operations. Forms a fine tract of land around Carlisle; masked with "Drift" in Durham; forms the "Vale of York," of variable fertility, and rich soil in the North Riding; masked with peat and alluvium in South Yorkshire; and underlies the "Garden of Derbyshire," and a large part of the Cheshire dairy districts and Notts.	Marl, Clay, Gypsum, Rock salt; Oak, Ash.
Middle Trias.	(Awanting in Britain).	
Lower Trias or Bunter. (Upper New Red Sandstone.)	Yields red or brown soils of a light loamy or sandy nature in Worcester, Salop, Cheshire, and other dairying districts. Where the subsoil is sandy or marly they are deep, rich, and dry. Where the middle "pebble beds" come to the surface the soil is a barren gravel, as in Sherwood Forest.	Red sandstone; Ash, Firs, Beech, Sycamore, Birch.

GEOLOGICAL FORMATIONS—*continued.*

Permian. Magnesian Limestone.	Forms a narrow strip principally up the central part of the northern half of England. Gives rise to a thin crumbly soil bearing poor pasture and requiring high farming. Masked by "Drift" in Durham.	Limestone for mortar only, Building stone, Flagstones; Beech, Chestnut, Lime, Birch, Firs.
Lower New Red Sandstone. (Rothliegende.)	Exists in detached "pockets" in the Midlands, Cumberland, Dumfries, and Ayrshire, and yielding a deep red friable and fertile soil like those of the Triassic sands and marls. A proof of the quality of these Triassic and Permian sandstone soils is, that they form the greater part of the three highest rented counties in Britain.	Red freestone; Firs, Beech, Ash.
Carboniferous Coal Measures.	Consist of alternate beds of coal, shale, sandstone, &c. Almost universally yield soils of inferior agricultural quality—thin, poor, and hungry sands, or else stiff, wet, yellowish clays—so that the coalfields, though of great value on account of their mineral wealth, are undesirable places to farm in as a rule. The coalfields in the Midlands break through, as it were, the fine farming lands of the New Red sandstones, and form inferior districts. In the North and in Scotland they are generally overlaid by the "Drift," so that the soil varies greatly in quality and texture.	Building material, Clay; Ash, Larch, Firs.
Millstone Grit.	Gives a light free-working soil of coarse sandy texture, but very poor and hungry. Forms large tracts of high-lying heath-covered land in central North England, generally round the edge of coal "basins," and devoted to sheep farming. Deficient in clay and lime.	Building material; Larch, Beech.

Mountain Limestone.	Forms a thin soil, but yielding a naturally sweet herbage, on which cattle and sheep thrive, the best sheep walks in the North of England being on the hills of this formation; the sheep's fescue grass forms a prominent part of the pasture. This limestone underlies the great central plain of Ireland, but in this case it is usually buried under "Drift," Peat Mosses, or lakes.	Limestone, Building material; Birch, Beech.
Carboniferous Limestones and Shales.	The soils from these are very inferior when not mingled with the limestone, being, in fact, much the same as those of the coal measures proper.	Limestone, Building stone; Larch, Beech, Birch.
Old Red Sandstone and Devonian. Upper: Red and Yellow Sandstones.	The sandstone beds form inferior, and even barren, sandy soils in some places, as in Sutherland, Gloucester, and Devon.	Building stone, Flagstones.
Middle: Old Red Conglomerate, Cornstones, & Marls.	Occur in the North-East of Scotland in districts of noted fertility, along the shores of the Moray Firth, and are basis of the East Lothian farming. Yield soils of first-rate quality in the Hereford, Devonshire, and Cornish districts, and also in the South-West of Ireland, as in the "Golden Vale" of Tipperary. The soils of the middle Old Red Sandstone generally may be said to be among the best in Britain. Wherever they occur the district is known as good land, and often celebrated for the style of farming. Even the "Drift" which overlies the rocks partakes of their nature and forms good soil. Cheviot sheep follow this formation in Scotland; and Hereford cattle are indigenous to it in England. The Cornstone and Marl divisions give the soils of the greatest richness—often letting for £5 per acre, and carrying the finest orchards, oaks, and pasture. Old Red Sandstone soils generally are said to ripen wheat furthest north of any in Scotland.	Limestone, Building stone.

Geological Formations—*continued.*

Old Red Sandstone and Devonian —*cont.*	Poor, sandy soils, similar to the upper beds. The tilestones met with in parts of Caithness yield worthless, unreclaimed soils.	Building stone, Roofing flags.
Lower: Grey Flags, Tilestones, & Conglomerates.	The Devonian and Old Red Sandstone formations differ from one another, but are reckoned of the same geological age, and their agricultural characters are similar.	
Silurian. Ludlow Beds. Wenlock Limestone. Upper Llandovery. Lower Llandovery. Caradock and Bala Beds. Llandeilo Flags.	The greater part of the Scottish Highlands, of the southern part of Scotland, of Cumberland and Wales, and of the East, North, and West of Ireland, are of these formations. Most of the hilly parts in sheep-walks, but in the lower districts often form good dark red or brown friable soils, though much broken up with rocks. Some of these soils are greatly deficient in lime, which must be applied to render them productive. Where shaly rocks predominate the soil is usually a cold *muddy* clay.	Building stone, Slates, Flags, Road metal, Limestone, Sandstones; Firs, Birch, Rowan, Larch. Spruce.
Cambrian. Tremadoc Slates. Lingula Flags. Longmynd Group.	Form the most rugged and little cultivated parts of the country in Wales, North-West of Scotland, and South-East of Ireland. Patches of good soil often occur in the hollows, especially in conjunction with the limestone beds; but usually the soil is thin and inferior, devoted to sheep and cattle walks.	Best slates, Flags, Building stone, Road metal, Sandstones, Phosphorites; Firs, Birch, Larch, Rowan.

Archæan. Fundamental Gneiss of the Hebrides.	The prevailing rocks of the Western Islands and North-Western part of Scotland. Rugged, bleak, and mountainous; little soil to speak of, and wholly in sheep and cattle walks.	Crystalline indurated building stones, Marbles, Road metal; Firs, Larch.
Igneous Rocks. Trappean Rocks.	These Igneous rocks (if Granite may be included in this term) do not belong to any one period, but break through and are found in conjunction with all formations except the most recent. Some of the Trappean rocks—such as felsites, porphyrites, tuffs, and melaphyres—weather down with comparative rapidity, and produce very fertile (though sometimes stiffish) soils. The basaltic plateau of Antrim—of Miocene age—is an example of this. Others—such as dolerite, diorite, and phonolite—remain rugged and precipitous. Met with in Skye, Mull, Renfrewshire, the Cheviots, and Antrim.	Building stone, "Whinstone" for road metal Paving blocks.
Granite Rocks.	Granite generally occurs in isolated tracts of the most rugged character. The felspar in decomposing gives rise to a clay, which is rendered sandy from the silicious matter of the Granite; but as this soil is high-lying and of no extent there is little cultivation carried on. Occurs at Aberdeen, Dalbeattie, Dartmoor, and Wicklow Mountains.	Building stone, Road metal, Paving blocks, White pipe clay.

Local circumstances, especially in the northern half of Britain, have often occurred to prevent the soil peculiar to the underlying deep formation from remaining *in situ* or appearing on the surface, such as the presence of the Boulder Clay, Drift, Alluvium, or Peat, which are fully shown on the 6-in. geological maps, and on the new series of 1-in. "Drift" maps, now being issued by the Geological Survey; but over the greater part of England, and where no glacial phenomena have been manifested, the above table will be found more or less true in conjunction with ordinary geological maps.

MANURES.

Composition of Animal Excreta.

	Water.	Organic Matter.	Nitrogen.	= Ammonia.	Phosphoric Anhydride.	= Tricalcic Phosphate.	Potash.	Lime.	Silica.
Fresh farmyard manure with straw:—									
Cow	77·5	20·3	0·34	0·41	0·16	0·34	0·40	0·31	0·85
Horse	71·3	25·4	0·58	0·10	0·28	0·61	0·53	0·21	1·77
Pig	72·4	25·0	0·45	0·54	0·19	0·41	0·60	0·08	1·08
Sheep	64·6	31·8	0·83	1·00	0·23	0·50	0·67	0·33	1·47
Mixed farmyard manure—fresh ...	75·0	21·2	0·39	0·47	0·18	0·39	0·45	0·49	1·08
Do. do. rotted ...	75·0	19·2	0·50	0·60	0·26	0·56	0·63	0·70	1·68
Peat moss manure	70·9	25·5	0·56	0·68	0·40	0·87	0·54	0·61	1·69
Liquid manure (drainings)	98·2	0·7	0·15	0·18	0·01	0·02	0·49	0·03	0·02
Human egesta—solids, fresh	77·2	19·8	1·00	1·21	1·00	2·18	0·25	0·62	0·19
Do. liquid	96·3	2·4	0·60	0·73	0·17	0·37	0·20	0·02	...
Night soil—solid and liquid	93·5	5·1	0·70	0·85	0·26	0·56	0·21	0·09	0·10
Do. dried	11·5	37·4	1·80	2·18	0·24	0·52	1·10	7·20	0·20

COMPOSITION OF ANIMAL EXCRETA—*continued.*

	Water.	Organic Matter.	Nitrogen.	= Ammonia.	Phosphoric Anhydride.	= Tricalcic Phosphate.	Potash.	Lime.	Silica.
Poultry manure—fresh :—									
Ducks	56·6	26·2	1·00	1·21	1·40	3·05	0·62	1·70	2·80
Geese	77·1	13·4	0·55	0·66	0·54	1·17	0·95	0·84	1·40
Hens	56·0	25·5	1·63	1·98	1·54	3·36	0·85	2·40	3·50
Pigeons	51·9	30·8	1·75	2·12	1·78	3·88	1·00	1·60	2·02
Town sewage	99·9	0·006	0·008	0·01	0·001	0·002	0·001	...	...
Do. dried sludge	12·7	19·20	0·52	0·60	0·40	0·87	...	11·20	41·10
Urine :—									
Cow	92·0	6·0	0·8	0·97	0·70	1·52	0·60	0·07	0·01
Horse	89·0	8·0	1·2	1·45	1·20	2·62	0·60	0·04	0·02
Pig	97·5	1·5	0·3	0·36	1·25	2·72	0·06	0·02	trace
Sheep	86·5	9·9	1·4	1·70	0·50	1·09	0·60	0·30	trace

Detailed Analysis of Farmyard Manure.

(Dr. Voelcker.)

	Fresh (14 days old).		
			s. d.
Water		66·17	
*Soluble organic matter		2·48	
Soluble inorganic matter (ash):—		1 54	
Soluble silica	0·237		
Monocalcic phosphate	0·299		
Containing phosphoric acid	(0·180)		0 ,, 11·8
Lime	0·066		
Magnesia	0 011		
Potash	0·573		2 ,, 1·8
Soda	0·051		
Sodic chloride	0·030		
Sulphuric acid	0·055		
Carbonic acid and loss	0·218		
†Insoluble organic matter		25·76	
Insoluble inorganic matter (ash):—		4·05	
Soluble silica	0·967		
Insoluble silica	0·561		
Ferric oxide, alumina, with phosphates	0·596		
Containing phosphoric acid	(0·178)		0 ,, 11·7
Equal to tricalcic phosphate	(0·386)		
Lime	1·120		
Magnesia	0·143		
Potash	0·099		0 ,, 4·5
Soda	0·019		
Sulphuric acid	0·061		
Carbonic acid and loss	0·484		
		100·00	
*Containing nitrogen		0·149	2 ,, 0·0
†Containing nitrogen		0·494	6 ,, 8·3
Whole manure contains free ammonia		0·034	
Do. in form of salts		0·088	
Cost per ton, valued by units			13 ,, 4·0

DETAILED ANALYSIS OF FARMYARD MANURE—*continued.*

	Rotted (6 months old)		s.		d.
Water		75·42			
*Soluble organic matter		3·71			
Soluble inorganic matter (ash) :—		1·47			
Soluble silica	0·254				
Monocalcic phosphate	0 382				
Containing phosphoric acid	(0·231)		1	,,	3·2
Lime	0·117				
Magnesia	0·047				
Potash	0·446		1	,,	8·2
Soda	0·023				
Sodic chloride	0·037				
Sulphuric acid	0·058				
Carbonic acid and loss	0·106				
†Insoluble organic matter		12 82			
Insoluble inorganic matter (ash):—		6·58			
Soluble silica	1·424				
Insoluble silica	1·010				
Ferric oxide, alumina, with phosphates	0·947				
Containing phosphoric acid	(0·274)		1	,,	6·0
Equal to tricalcic phosphate	(0·573)				
Lime	1·667				
Magnesia	0·091				
Potash	0·045		0	,,	2·0
Soda	0·038				
Sulphuric acid	0·063				
Carbonic acid and loss	1·295				
		100·00			
*Containing nitrogen...		0 297	4	,,	0·0
†Containing nitrogen...		0·309	4	,,	2·0
Whole manure contains free ammonia		0·046			
Do. in form of salts		0·057			
Cost per ton, valued by units			12	,,	9·0

The prices per unit used in the above estimates are:—Nitrogen, 13s. 6d. (= ammonia at 6d. per lb.); phosphoric acid (anhydride), 5s. 6d. (= 3d. per lb.); and pota h, 3s. 9d. (= 2d. per. lb.).

One ton of manure will thus contain :—

9	to 15	lbs. of	Nitrogen.
9	,, 15	,,	Potash.
4	,, 9	,,	Phosphoric Acid.

Farmyard manure in fermenting should not rise above 30° C. (86° F.) in temperature ; keep cool with liquid manure. Humic and ulmic acids are formed, which unite with and fix the ammonia and potash. Ferrous sulphate added forms ammonic sulphate and ferrous carbonate—both plant foods. Gypsum prevents the waste of nitrogen ; and kainite, if added, will fix the ammonia.

In fermenting, various kinds of dung give out different degrees of heat, and the fermentation lasts for different periods of time, as follows :—

Sheep dung ferments 4 months, temperature rising to from	141° to 158°
Horse dung ferments 6 months, temperature rising to from	122° ,, 140°
Cattle dung ferments 8 months, temperature rising to from	95° ,, 113°
Tanners' bark ferments 6 months, temperature rising to from	95° ,, 104°
Tree leaves ferment 12 months, temperature rising to from	95° ,, 104°

PERCENTAGE COMPOSITION OF THE ASH OF DUNG.

	Fresh.		Rotted.	
Soluble in water:—		27·55		18·27
Soluble silica...	4·25		3·16	
Monobasic phosphate of lime	5·35		4·75	
Lime	1·10		1·44	
Magnesia	0·20		0·59	
Potash	10·26		5·58	
Soda	0·92		0·29	
Chloride of sodium	0·54		0·46	
Sulphuric acid	0·22		0·72	
Carbonic acid and loss... ...	4·71		1·28	
Insoluble in water:—		72·45		81·73
Soluble silica...	17·34		17·69	
Insoluble silica	10·04		12·54	
Tribasic phosphate of lime...	...		...	
Oxides of iron, alumina, with phosphates	8·47		11·76	
Containing phosphoric anhydride	(3·18)		(3·40)	
Equal to tricalcic phosphate	(6·88)		(7·36)	
Lime	20·21		20·70	
Magnesia	2·56		1·17	
Potash	1·78		0·56	
Soda	0·38		0·47	
Chloride of sodium	...		...	
Sulphuric acid	1·27		0·79	
Carbonic acid and loss ...	10·40		16·05	
	100·00	100·00	100·00	100·00

SUBSTANCES contained in the Solid and Liquid Excrements of Live Stock, according to Sprengel.

1. Vegetable or woody fibre.
2. Wax and resin.
3. Chlorophyll—the green colouring matter of leaves—partly decomposed.
4. Humus.
5. A fatty and oily substance.
6. Mucus.
7. Brown colouring matter in excrement of oxen
8. Vegetable albumen
9. Animal gelatine.
10. Animal fibre.
11. Salivary matter.
12. Ozmazone.
13. Hippuric acid.
14. Uric acid.
15. Lactic acid.
16. Benzoic acid.
17. Urea.
18. Bilious matter.
19. Bilious resin.
20. Picromel.
21. Oxides of iron and manganese.
22. Earths—silica, alumina, lime, manganese
23. Salts with mineral acids.
24. Common salt.
25. Carburetted hydrogen.
26. Phosphoretted hydrogen.
27. Sulphuretted hydrogen.
28. Ammonia.
29. Hydrogen.
30. Water.

SOLID AND LIQUID MANURE PRODUCED BY STOCK PER ANNUM.

	Solid.	Liquid.
Horse	12,000 lbs.	4,000 lbs.
Cow	20,000 ,,	8,000 ,,
Sheep	760 ,,	380 ,,
Pig	1,800 ,,	1,200 ,,

Heiden found that the average of 30 cattle was 88 lbs. of solid and 21 lbs. of liquid—total, 109 lbs.—daily. In some experiments with Ayrshire cows in milk at Kinning Park, Ayr, in 1856, it was found that the animals voided 60 lbs. of solid and 18 lbs. of liquid daily.

Manure produced in six months by 50 head of cattle in covered yards:—

Voided by the animals	300 tons	
Litter (24 lbs. per head daily) ...	100 ,,	nearly
	400 ,,	

Averaging 8 tons.

The same stock in open yards will produce:—

Voided by the animals	300 tons	
Litter (48 lbs. daily)	200 ,,	nearly
Rain-water, *ad. lib.*		
	500 ,,	

Averaging 10 tons.

Composition of 1 ton of open yard manure:—Excrements, liquid and solid, 6 cwt.; litter, 4 cwt.; rainfall, 10 cwt.

The horse produces three-quarters of the weight of its food in manure, and makes 12 tons in the year.

An ox fed in box produces from 20 to 30 cubic yards of dung per year, according to litter supplied.

The amount of farmyard manure made during the six winter months in the homestead, where there is a fair allowance of litter, will amount to about 6 to 8 tons per head of live stock of all kinds.

A cubic yard of farmyard manure in the heap weighs from 12 to 16 cwt.

MINIMUM Amount of Farmyard Manure required to replace the Ingredients abstracted from the Soil by an Acre of each Crop:—

	Tons.		Tons.
Wheat	5	Turnips	15
Barley	5	Swedes	12
Oats	5	Mangolds	20
Meadow hay	6	Potatoes	10
Red clover	10	Cabbages...	20
Beans	10	Carrots	10

TABLE of the Estimated Value of the Manure obtained by the consumption of different kinds of Food, each supposed to be good quality of its kind (revised figures):—

Description of Food.	Money Value of Manure from One Ton of each Food.					
	Lawes.			Voelcker.		
	£	s	d.	£	s.	d.
Cottonseed cake, decorticated ...	5	13	0	5	6	6
Earthnut, decorticated		...		4	18	0
Rape cake	4	5	4	4	0	9
Linseed cake	3	18	6	3	15	8
Cottonseed cake, undecorticated ...	3	5	4		...	
Lentils	3	1	4	3	2	0
Beans	3	3	5	3	2	0
Tares...	3	2	1		...	
Cocoanut cake	3	0	7		...	
Linseed	2	19	5	2	17	9
English oilcake		...		2	18	0
Peas	2	15	0	3	2	0
Earthnut, undecorticated		...		2	10	0
Palmnut meal	1	19	10	1	14	0
Indian meal (Maize)	1	5	1	1	5	0
Locust beans	1	7	10	0	18	3
Malt coombs	3	10	9	3	11	0
Bran	2	18	5	2	15	0
Coarse pollard	2	17	9		...	
Fine pollard...	2	13	4		...	
Oats	1	9	10		...	
Wheat	1	8	7	1	7	0
Malt	1	6	8	1	6	0
Barley	1	6	1	1	5	0
Rice meal		...		0	15	0
Brewers' grains		...		0	12	0
Clover hay	2	1	3		...	
Meadow hay	1	8	7		...	
Bean straw	0	17	7		...	
Pea straw	0	18	10		...	
Oat straw	0	11	7		...	
Wheat straw	0	10	1		...	
Barley straw	0	10	1		...	
Potatoes	0	6	5		...	
Parsnips	0	5	5		...	
Mangold-wurzel	0	5	0		...	
Swedish turnips	0	4	7		...	
Yellow turnips	0	3	11		....	
White turnips	0	4	0		...	
Carrots	0	4	3		...	
Molasses		...		0	0	0

In the above table Sir John Lawes and Sir J. H. Gilbert value ammonia at 6d. per pound, phosphoric acid at 3d., and potash at 2½d.; while Dr. Voelcker valued ammonia at 6d., insoluble phosphate at 1½d., and potash at 1½d.

The following table gives the above figures, worked out to average percentages in the case of the principal Food-Stuffs, taking Decorticated Cotton Cake as 100:—

Decorticated cotton cake	100
Linseed cake	63·5
Undecorticated cotton cake	58·5
Beans	56·5
Tares	55·5
Linseed	52·5
Peas	52·5
Maize	22·5
Malt coombs	64
Bran	51
Pollards	50
Oats	27
Wheat	25
Barley	23
Rice	13·5
Brewers' grains	10·5
Clover hay	37
Meadow hay	25·5
Pea straw	17
Bean ,,	16
Oat ,,	10·5
Wheat straw	9
Barley ,,	9
Potatoes	6
Mangolds	5
Swedes	4·2
Carrots	3·8
Soft turnips	3·6

Composition of Fresh and Stale Cow's Urine.

		Fresh.		A Month Old.
Water in 1,000 parts by weight		926·24		954·42
Urea, with some resin		40·00		10·00
Albumin		0·10		—
Mucus		1·90		0·40
Benzoic acid (= hippuric acid)	combined with potash, soda, and ammonia	0·90		2·50
Lactic acid	combined with potash, soda, and ammonia	5·16		5·00
Carbonic acid	combined with potash, soda, and ammonia	2·56		1·56
Acetic acid	combined with potash, soda, and ammonia	—		0·01
Ammonia		2·05	Partly uncombined	4·87
Potash		6·64	Partly uncombined	6·64
Soda		5·54	Partly uncombined	5·54
Sulphuric acid	combined with soda, lime, and magnesia	4·05		3·38
Phosphoric acid	combined with soda, lime, and magnesia	0·70		0·26
Chlorine	combined with soda, lime, and magnesia	2·72		2·72
Lime		0·65		0·52
Magnesia		0·36		0·22
Alumina		0·02		—
Oxide of iron		0·04		0·01
Oxide of manganese		0·01		—
Silica		0·36		0·05
Sulphuretted hydrogen		—		0·01
Sediment, consisting of phosphate and carbonate of lime; also magnesia, alumina, silica, and oxides of iron and manganese		—		1·80
		1,000·00		1,000·00

Hippuric acid ($C_9 H_9 NO_3$) can only be obtained from the urine of stall-fed cows or horses; if the animals are actively exercised, benzoic acid ($C_7H_6O_2$) takes its place.

Percentage Composition of the Saline and Mineral Ingredients of Urine.

	Horse.	Ox.	Sheep.	Pig.
Carbonate of lime	21·75	1·07	0·82	—
Do. magnesia	11·26	6·93	0·46	—
Do. potash	33·12	77·28	—	12·1
Do. soda	15·26	—	42·25	—
Chloride of sodium	6·27	0·30	32·01	53·1
Do. potassium	—	—	12·00	trace.

Percentage Composition of the Saline and Mineral Ingredients of Urine—*continued.*

	Horse.	Ox.	Sheep.	Pig.
Sulphate of soda ...	11·03	—	7·72	7·0
Do. potash ...	—	13·30	2·98	—
Phosphate of soda ...	—	—	—	19·0
Do. lime ...	—	—	0·70	8·8
Do. magnesia	—	—		
Silica	0·52	0·35	1·06	
Oxide of iron and loss	0·79	0·77	—	
	100·00	100·00	100·00	100·00

The principal nitrogenous ingredient of urine is urea, and through the action of a ferment (*Micrococcus ureæ*) this takes up water and becomes ammonic carbonate, thus:—

$$CH_4\,ON_2 + 2\,H_2\,O = (NH_4)_2\,CO_3$$
$$\text{Urea} + \text{Water} = \text{Ammonic Carbonate.}$$

Urine should be mixed with water to prevent loss of ammonia when it putrefies. It should be pumped over the dung-heap, and if there is a covered dungstead it will be all taken up by the solid manure, and do away with the necessity of dealing with it otherwise.

Drainings of Manure Heaps.

Dry matter	18 %	Nitrogen	1·5 %
Water	82	Phosphoric acid ...	0·1
	100 %	Potash	4·9
		Magnesia	0·4
		Lime	0·3
Organic matter ...	7·3 %	Sulphuric acid ...	0·7
Ash	10 7	Silica	0·2
	18·0 %		

Liquid Manure Tank.

The tank should be constructed to hold not less than 10 days' liquid at the rate of 2 gallons per head daily, or a total of 20 gallons of space per head. Allowing for 30 % of unavoidable rain-water in wet weather, this would necessitate the emptying of the contents every 7 to 10 days: this is to be the minimum size.

Water retained by one part of litter:—Dead leaves, 2; cut straw, 2–3; sawdust, 4; tan bark, 4–5; peat, 5–8.

Specific gravity of horse urine, 1·03 to 1·06.

Ten tons of sewage have been found to contain:—

In Solution	Nitrogen	1·7	= 4·2 lbs.
	Sodic salts	1·6	
	Potassic salts	0·5	
	Phosphoric acid ...	0·4	
In Suspension	Organic compounds ...	1·4	= 1·9 lbs.
	Nitrogen	0·3	
	Calcic phosphate ...	0·2	

Sewage is considered worth $1\frac{1}{2}$d. per ton.

Composition of the Atmosphere.

Certainly essential	Nitrogen	77·98
	Oxygen	20·61
	Watery vapour	1·40
	Carbonic dioxide	0·04
Probably essential	Ozone	Traces.
	Ammonia	
Possibly essential	Nitric acid	
	Carbonic monoxide	
	Carburetted hydrogen ...	
	Sulphuretted hydrogen ...	
	Argon	
	Organic matter	
		100·03

The atmosphere contains $3\frac{1}{2}$ volumes of carbonic dioxide in every 10,000; or 1 lb. in 3,500 cubic yards of air.

The nitrogen, in form of ammonia or nitric acid, carried to the soil by rain, is equivalent to 4·4 lbs. per acre per annum at Rothamsted. The average of observations carried on at nine stations on the Continent over a period of 22 years shows 10·23 lbs. supplied with a rainfall of 27·03 inches. The proportion for different localities in Great Britain is as follows, taking Valencia as the standard:—

	Ammonia.	Nitric Acid.
Valencia (Ireland)	1·00	1·00
Inland parts of England	5·94	2·02
Sea coast of Scotland (average) ...	4·10	1·01
London	19·17	2·27
Manchester	35·94	2·79
Glasgow	50·55	3·72

Composition of Guanos.

	Water.	Organic Matter.	Nitrogen.	= Ammonia.	Phosphoric Anhydride.	= Tricalcic Phosphate.	Potash.	Lime.	Silica.
Angamos	8·7	69·9	19·3	23·4	5·5	12·7	2·1	6·5	0·9
Aves	7·8	7·7	0·2	0·2	33·8	73·6	0·1	40·1	0·4
Baker Island	11·0	7·0	0·5	0·6	34·8	75·9	0·1	40·0	0·6
Ballestas	22·9	42·0	12·2	14·8	13·1	28·6	2·8	10·5	1·2
Bats' Guano	10·5	9·2	0·3	0·4	17·4	38·0	2·3	29·4	15·8
Curaçao	8·7	5·8	...	...	33·5	73·1	0·5	43·0	0·3
Falkland Islands	33·4	21·4	4·3	5·2	14·6	32·0	1·5	18·8	4·4
Guanape Island	21·6	36·3	9·3	11·3	13·4	29·2	3·7	11·3	6·3
Huanillos	10·0	40·9	8·0	9·7	15·0	32·7	3·6	14·6	3·8
Ichaboe	16·0	29·5	8·0	9·7	11·3	24·6	0·8	21·0	8·3
Jarvis Island	11·8	8·2	0·4	0·5	20·6	44·9	0·4	39·1	0·5
Lacepede Island	7·8	11·3	0·6	0·7	34·6	75·6	...	40·7	0·9
Malden Island	5·1	6·9	...	..	35·6	77·7	0·2	46·5	0·1
Mejillones	7·3	6·9	0·9	1·1	32·9	71·7	1·5	36·7	2·2
Pabellon de Pica	6·2	48·8	9·2	11·1	13·5	29·4	2·1	13·7	5·3
Patagonian	23·0	26·5	4·1	4·9	18·5	40·5	1·3	22·0	2·3
Patos Island	14·3	10·2	0·9	1·1	24·5	53·5	0·8	30·3	14·7
Penguin Island	26·8	30·0	5·5	6·6	10·9	24·0	1·3	13·1	8·3
Peruvian	15·0	42·0	7·0	8·5	14·0	30·5	3·3	12·6	3·9
Punta de Lobos	14·3	42·8	8·3	10·0	13·4	29·2	1·9	12·8	3·9
Raza Island	3·3	11·2	0·8	0·9	36·5	79·6	1·1	36·2	4·2
Saldanha Bay	12·2	35·5	9·0	10·9	9·2	20·0	1·3	7·6	18·5
Starbuck Island	5·1	11·7	0·8	0·9	37·8	82·5	...	41·6	1·3
Sydney	7·4	7·3	0·3	0·4	34·4	75·1	...	42·9	1·9

In a nitrogenous guano the nitrogen is chiefly present as uric acid and ammonium salts. Ammonium carbonate may be present in small quantities. Phosphoric acid exists as calcic phosphate, and some of it as ammonic phosphate (very soluble). *Guanine* ($C_5\ H_5\ ON_5$) also exists. Unwashed guano may contain 3 to 4 % of potash (alkaline salt). There is less than 1 % of nitrates present. A high-class guano should contain from 8 to 12 % of nitrogen, while those with less than 4 to 5 % are reckoned low-class, or "phosphatic." Some varieties, such as Mejillones, are purely phosphatic material, having had all the nitrogen leached out by the filtration of water where they have accumulated in a rainy climate. The very highest class guanos are not now imported, the supply being exhausted. "Dissolved" guano is made by adding a proportion of sulphuric acid to guano, thus fixing the ammonia and rendering its phosphates more soluble. It is thus equivalent to a superphosphate. "Equalised" or "Rectified" guano is made from low-class guanos by adding a proportion of ammonium sulphate, and thus making the analysis of the mixture similar to that of high-class material.

Guanos are suitable for general application, while they are the best nitrogenous manure for clayey soils.

The following deposits are still being worked :—

I.—*Nitrogenous.*

Huanillos.
Ichaboe.
Pabellon de Pica.
Punta de Lobos.
Saldanha Bay.

II.—*Phosphatic.*

Pacific Islands :—
- Arbrohlos.
- Baker.
- Browse.
- Chesterfield.
- Enderbury.
- Huon.
- Malden.
- Phœnix.
- Shark's Bay.
- Sydney
- Timor.

Bolivian Coast :—
- Mejillones.

West Indian Islands :—
- Aves.
- Tortola.
- Mona.

Arabian Coast :—
- Kuria Muria Is.

CONSTITUENTS OF CHINCHA GUANO DRIED AT 212° F.

Soluble in Water.

Ammonium oxalate	13·60
,, urate	12·74
,, -magnesium phosphate ...	4·00
,, sulphate	1·82
,, chloride	1·55
,, phosphate	0·90
Potassium sulphate	3·30
Sodium chloride	2·44
Nitrogenous and sulphurous organic substances	3·61
	43·96

Soluble in Acids, Alcohol, and Ether, but with difficulty in Water.

Uric acid	21·14
Calcium phosphate	18·22
Iron phosphate	1·04
Silica	0·64
Fatty acids	1·60
Resin	1·11
Nitrogenous and sulphurous organic substances	2·29
	46·04
Water	10·00
	100·00

TESTING "HIGH-CLASS" GUANO.

1. *Colour* should be that of coffee and milk; if too grey, it is earthy; if too brown, it contains too much water.
2. *Taste*, strong—salt, piquant, caustic.
3. Smells strongly; varies with the dryness or dampness.
4. *Consistency:* oily to the touch; in small grains, though sometimes adhering in large pieces; if rich in urates, will appear shining and crystallised when broken across.
5 *Flame:* will blaze up quickly if good, and leave residue of charcoal ashes. There is less charcoal in guanos poor in organic matter.
6. Mixed with *quicklime* ought to give strong evolution of ammonia.
7, Weighs about 60 to 70 lbs. per bushel.

Composition of Bone Manures.

	Water.	Organic Matter.	Nitrogen.	= Ammonia.	Phosphoric Anhydride.	= Tricalcic Phosphate.	Potash.	Lime.	Magnesia.	Silica.
Bone ash	6·0	3·0	...	...	35·4	76·3	0·3	46·0	1·2	6·5
Bone black—spent	10·0	6·0	0·5	0·6	26·0	56·7	0·1	37·1	1·1	15·0
Do. fresh	6·0	10·0	1·0	1·2	32·0	69·8	0·1	43·0	1·1	5·0
Bone dust...	13·0	23·8	2·6	3·1	17·6	38·4	0·1	24·4	1·0	3·5
Bone meal—average ...	6·0	30·3	3·8	4·6	23·2	50·6	0·2	31·3	1·0	3·5
Do. solid parts	5·0	31·5	3·5	4·2	25·2	55·0	0·1	33·0	1·0	3·0
Do. porous parts ...	7·0	37·3	4·0	4·8	20·0	43·6	0·2	29·0	1·0	3·5
Crushed bones...	7·1	36·6	3·7	4·5	22·1	48·2	0·1	30·2	1·0	0·8
Raw bones	6·2	39·1	3·8	4·6	22·3	48·6	0·2	29·2	0·3	0·3
Steamed bones...	5·2	17·5	1·6	1·9	30·9	67·4	0·1	41·8	1·1	0·4

As the fat contained in bones interferes to a great extent with their manurial value, a certain amount of boiling is beneficial in removing it; but as the nitrogen is principally contained in the ossein, or gelatinous matter, and as this is extracted by continous boiling or steaming, the operation must not be carried on too far. Steamed bones, or those boiled under pressure, are little better than bone ash.

Bones contain from 50 to 80 % of mineral matter or ash, chiefly tricalcic phosphate (Ca_3 2 PO_4).

Bone black is "bone charcoal," such as is used by the sugar refiners for clarifying brown sugar, and when so used or "spent" contains practically no nitrogen.

Fermented bones are made by mixing with one-third their weight of earth or clay and keeping saturated with urine.

Vitriolated bones are those which have been moistened (in the meal form) with sulphuric acid, and allowed to ferment in a heap for a long time, and are thus equivalent to a mixture of bone meal and bone superphosphate.

Bone manures act best on light, free-working soils, and decompose very slowly on heavy land.

Composition of Natural Phosphates.

	Water.	Phosphoric Anhydride.	= Tribasic Phosphate.	Lime.	Silica.	Ferric Oxide and Alumina
Alta Vela phosphate ...	16·5	20·4	44·6	11·3	28·5	19·2
Aruba phosphate...	5·5	31·1	68·0	41·7	0·2	14·7
Basic cinder (Slag) ...	3·4	16·3	35·7	45·0	7·2	24·5
Bordeaux, Lot, or French phosphate ...	4·8	35·5	77·5	47·8	2·3	2·8
Canadian apatite...	0·2	37·6	82·2	51·0	4·3	6·8
Caroline (Charleston) phosphate ...	2·8	24·1	52·7	35·7	19·1	7·2
Coprolites :—						
Bedford...	3·3	23·5	51·2	36·3	20·8	12·6
Boulogne or French ...	3·1	20·0	45·2	30·4	26·1	11·6
Cambridge ...	3·8	26·0	56·8	43·6	7·7	18·7
Russian...	3·6	22·4	48·9	33·8	30·2	9·9
Suffolk (pseudo) ...	1·0	25·5	55·6	37·2	12·1	20·5
Wieken ...	1·2	20·8	45·4	32·1	22·5	19·5
Estramadura (Spanish) phosphorite ...	3·6	33·4	72·8	47·1	3·7	3·5
German, Lahn, or Nassau phosphate—rich (Staffelite) ...	0·6	40·5	88·5	56·3	0·3	1·2
Do. do. do. medium ...	2·5	32·3	70·5	43·2	6·5	13·5
Kladno phosphate ...	26·0	31·5	68·2	2·5	6·0	27·2
Navassa phosphate ...	11·3	31·1	68·0	37·7	2·9	4·3
Pedro Keys phosphate ...	9·3	29·7	64·8	36·0	5·2	19·7
Portuguese phosphorite ...	1·3	24·9	54·3	36·1	21·2	13·3
Redonda phosphate ...	21·1	30·2	66·0	3·1	20·6	19·3
Sombrero phosphate ...	8·1	32·8	71·6	45·3	1·0	7·1
St. Martin phosphate ...	3·5	35·1	76·7	50·4	0·8	2·7
Welsh or Silurian (black) phosphate...	4·0	29·6	64·7	37·1	22·1	6·9

Alta Vela phosphate contains 5·7 % ferric oxide, 13·5 % alumina.

Redonda phosphate contains 3·64 % ferric oxide, 15·72 % alumina.

Basic slag owes its value to the presence of about 16 to 18 % of phosphoric acid combined with lime to form a tetracalcic phosphate, having the composition $Ca_4 P_2 O_9$ ($= 4 CaO \cdot P_2 O_5$). This is an unstable compound (having been formed in the furnace at a high temperature), is easily decomposed when put in the soil, and is practically as good as the monocalcic phosphate if reduced to a fine enough powder. It is at present the cheapest source of phosphoric acid, but of course only those slags derived from iron ore rich in phosphorus are suitable for its manufacture.

Coprolites are believed to be the fossilised bones and dung of extinct animals, and those from Cambridgeshire are the best English variety.

Some of these phosphates—such as those from Navassa and Sombrero—are really guanos, but have had all the nitrogen and potash eliminated by leaching with rain water.

Mineral phosphates should be ground as finely as possible, and 80 to 85 % should pass a sieve of 10,000 meshes to the square inch.

Mineral phosphates suit the lighter class of soils best, and give quickest returns when applied in autumn.

COMPOSITION OF SUPERPHOSPHATES.

MADE FROM	Water.	Organic Matter.	Nitrogen.	= Ammonia.	Phosphoric Anhydride.	= Monocalcic Phosphate.*	= Tricalcic "rendered soluble."	Phosphoric Anhydride.	= Tricalcic Phosphate.	Calcic Sulphate.	Silica.
Baker Is. guano	15·0	6·2	0·3	0·3	20·0	32·9	43·0	2·0	4·3	48·4	0·9
Bone ash	15·0	7·0	0·5	0·6	14·5	23·9	31·6	1·5	3·2	37·4	9·3
Bone black	5·0	8·0	0·3	0·3	17·3	28·5	37·7	0·1	0·2	35·7	9·3
Bone meal (dissolved bones) ...	13·0	24·0	2·5	3·0	14·7	24·2	32·0	2·0	4·3	29·7	2·5
Cambridge coprolites	14·1	12·1	...	...	11·8	19·4	25·7	3·9	8·8	44·2	4·2
Mejillones guano	14·0	7·0	0·6	0·7	16·1	26·5	35·1	5·4	11·7	48·4	2·3
Navassa phosphate	15·0	2·5	...	...	11·0	18·1	24·0	3·0	6·5	33·1	2·3
Peruvian guano (dissolved) ...	16·0	30·0	7·0	8·5	9·2	15·1	20·0	1·3	2·8	24·5	1·5
Sombrero phosphate	15·0	...	...	...	15·1	24·8	32·9	5·1	11·1	45·0	...

* This is the monocalcic tribasic form—having the symbol $Ca\,H_4 \cdot 2\,PO_4$ or $Ca\,O \cdot 2\,H_2\,O \cdot P_2\,O_5$—the quantity of phosphate that is actually soluble.

"Superphosphate of Lime."

Made by adding sulphuric acid to steamed bone, bone ash, or phosphates ($Ca_4\ 2\ PO_4$), thus :—

Tetrahydric monocalcic diphosphate
(soluble phosphate).

$2\ PO_4 \quad Ca\ H_4$

Tricalcic diphosphate (insoluble), one molecule. $\quad 2\ PO_4 \quad Ca_3 + 2\ H_2\ SO_4$ $\quad$ Sulphuric acid, two molecules.

$2\ Ca\ SO_4$

Calcic sulphate—two molecules

Or :—

$$Ca_3\ 2\ PO_4 + 2\ H_2\ SO_4 = Ca\ H_4\ 2\ PO_4 + 2\ Ca\ SO_4$$

Superphosphate is rarely made from raw bones, as the organic matter interferes with the action of the acid and the after usefulness of the manure ; but bone ash, steamed bones, and phosphatic minerals are largely used.

The great bulk is at present derived from mineral phosphates or coprolites ; high-class samples should contain 30 to 40 % of tricalcic phosphate "rendered soluble" (equivalent to from 22·6 to 30·1 % of "actually soluble," *i.e.*, $Ca\ H_4\ 2\ PO_4$) ; low-class samples may contain under 23 % "rendered soluble" (*i.e.*, 17·3 of $Ca\ H_4\ 2\ PO_4$). Superphosphate from bones is known as "dissolved bones," but the dissolved bones of commerce are often made from bone ash and mineral phosphates, "fortified" with some nitrogenous material.

Those phosphates which contain the smallest percentage of iron oxide or alumina are the most desirable for making superphosphate. The monocalcic phosphate has an affinity for these substances, and will recombine with them to form a tribasic (or possibly bibasic) compound, thus giving rise to a "reduced" or "reverted" superphosphate. For this reason Alta Vela and Redonda phosphates, and many others, are not much used for this purpose.

Proportion of materials employed to make superphosphate of lime at home :—

1 ton ground boiled bones.
850 lbs. (50 gals.) of brown sulphuric acid.
50 gals. of water to moisten the bones, and
50 ,, to mix with acid.

Mix gradually in a leaden or wooden cistern, and sprinkle on the acid; mix with ashes, earth, or gypsum, after a day or two, to dry the mass.

Corn, grass, mangold, and potato manures are made by compounding superphosphate, potash, and ammonic salts together, and give best results on light soils.

COMPOSITION OF ASHES AND SALTS.

	Water.	Organic Matter.	Nitrogen.	=Ammonia.	Phosphoric Anhydride.	=Tribasic Phosphate.	Potash.	Lime.	Magnesia.	Silica.
Ammonic chloride ...	3·0	...	24·7	30·0	...	...	...	...	...	0·5
Do. sulphate... ...	4·0	...	20·0	24·2	...	...	...	0·5	...	3·0
Anthracite coal ash ...	5·0	5·0	...	...	0·1	0·2	0·1	...	3·0	(?)
Ash of deciduous tree leaves	5·0	5·0	...	...	6·5	14·1	10·0	30·0	5·0	18·0
Do. evergreen do.	5·0	5·0	...	...	4·5	9·8	6·0	35·0	6·0	18·0
Do. mixed do.	5·0	5·0	...	...	3·5	7·6	10·0	30·0	5·0	18·0
Do. pine do.	5·0	5·0	...	...	2·5	5·4	6·0	35·0	6·0	18·0
Coal ash	...	...	...	...	0·2	0·4	0·2	3·5	0·8	72·0
Gas lime	7·0	1·3	0·1	0·4	...	...	0·2	64·5	1·5	3·0
Gypsum	20·0	...	...	...	...	...	...	31·0	0·1	4·5
Leached wood ashes ...	20·0	5·0	...	...	6·5	14·1	2·5	30·0	5·0	18·0
Peat ash—calcareous ...	5·0	...	...	...	1·2	2·6	0·5	45·7	0·5	(?)
Do. ferruginous ...	5·0	...	...	...	1·4	3·0	0·8	33·3	0·4	(?)
Do. common... ...	5·0	...	...	...	0·6	1·3	1·5	(?)	1·5	(?)
Sodic nitrate	1·9	...	15·6	19·0	...	...	...	0·2	...	0·5
Soot—wood...	5·0	71·8	1·3	1·5	0·4	0·8	0·1	4·0	1·5	(?)
Do. coal	6·1	70·4	3·6	4·4	...	...	...	3·9	...	12·4

Ammonic chloride contains 31·78 % of ammonia when pure.

The ammonia in chemically pure *ammonic sulphate* contains 21·21 % of nitrogen. The commercial salt, however, contains only about 95 % pure sulphate, yielding at most 20 % of nitrogen, equivalent to about 24 % of ammonia. It must be free from sulphocyanate of ammonium, as this salt is poisonous to plants; if it is present it will become blood-red on addition of ferric chloride. This is a good nitrogenous manure for corn crops, especially in wet seasons or in wet districts, but it is best used in conjunction with superphosphate. It is not so soluble as nitrate of soda, and should be sown along with the seed, so as to give the ammonia time to be oxidised into nitric acid—the form in which plants take up their nitrogen. It improves the quality as well as the quantity of grass crops.

Ferrous sulphate (copperas) is of no manurial value, and, in fact, is injurious to plants if in too large quantity; but on the Continent it is often added to manure heaps to prevent their decay and the escape of ammonia by forming a sulphate.

Gas lime is the spent lime from gasworks which has been used in purifying the gas, especially for the removal of carbonic acid and sulphuretted hydrogen. When quite fresh it contains a large proportion of the sulphide of lime, which is poisonous to plants, but on exposure to the air this takes up oxygen and changes into the sulphite and then into the sulphate, the latter being a valuable manurial substance.

DETAILED ANALYSIS OF GAS LIME WHICH HAS BEEN EXPOSED TO THE AIR FOR SOME TIME. DRIED AT 212° F.

Water of combination and a little organic matter ...	7·24
Oxides of iron and alumina, with traces of phosphoric acid	2·49
Sulphate of lime	4·64
Sulphite of lime	15·19
Carbonate of lime	49·40
Lime	18·23
Magnesia and alkalies	2·53
Insoluble matter	0·28
	100·00

Gas lime may be put on the land fresh in the autumn, so that it may be oxidised before the crop is sown in spring; and as much as six tons per acre may be thus used, though smaller quantities at short intervals are desirable. Besides its manurial properties it is an insecticide, and will even kill out the weeds. It is, of course, liable to kill the nitrifying organisms in the soil. Mixed with earth or waste vegetable matter it forms good compost. Gas lime gives the best results on stiff clay soils, while as much as three tons per acre may be spread directly on rough pasture land with benefit.

Gypsum applied directly to soils acts as a fixer of ammonia, but its greatest value is for use in cow-houses and on dunghills. It gives good results on clover, but is now seldom used as a separate manure, as all superphosphates contain it in large quantity.

Potassic nitrate (saltpetre) is seldom used as a manure directly, on account of its high price; but this salt is formed in composts of earth, lime, and dung or urine, in the same way as in the "nitre beds" of some Continental districts.

Nitrate of soda should contain 95 % of the pure salt, equivalent to about 19 % of ammonia. It is well adapted for corn crops and for grass, and gives the most lasting results on clayey land, as it is perfectly soluble, and is feebly retained by the soil. Should be applied as a top-dressing to the braird, and not sown with the seed. If applied frequently without other manure it will tend to "exhaust" the land. It may be mixed with slag or bone manures, but not with superphosphates. A mixture of nitrates of potash and soda is sometimes offered in the market.

Wood ashes are sometimes employed as a potash manure—contain from 5 to 15 % of potash, mostly in form of carbonate; young twigs are the richest. Produce most effect on pastures, clover, and green crops.

Composition of German Potash Salts.

	Water.	Potash.	Lime.	Magnesia.	Soda.	Sulphuric Anhydride.	Chlorine and Fluorine.
Carnallite	30·2	15·1	0·7	14·7	0·5	1·4	36·5
Concentrated potash salt	3·1	27·0	0·3	4·6	17·1	19·2	31·4
Do. do. (threefold)	3·4	29·6	0·5	3·9	14·6	4·1	42·3
Do. do. (fivefold)	4·6	47·5	0·2	0·9	8·6	0·6	47·2
Grugite	12·2	11·2	14·0	4·1	5·1	36·0	7·7
Kainite, prepared	20·8	16·9	...	18·5	...	36·6	12·9
Do. common	12·8	13·8	1·1	10·1	17·1	22·2	28·8
Kieserite...	16·4	0·6	...	27·8	...	53·0	2·4
Polyhalite	7·2	14·9	18·2	6·8	...	52·1	0·3
Tachydrite	42·5	...	10·1	16·7	...	...	40·9

The most important of these potash salts is *kainite* ($K_2 SO_4 \cdot Mg SO_4 \cdot Mg Cl_2 + 6 H_2 O$), of which the following table gives a detailed analysis of the form in which it is usually met with in the market:—

Water	3·4
Water of combination	10·9
Potassic sulphate	24·4
Sodic chloride (common salt)	30·4
Magnesic chloride	14·3
Magnesic sulphate	13·2
Calcic sulphate	2·7
Insoluble silica	0·7
	100·0

Carnallite in the pure form is an hydrous chloride of potassium and magnesium, having the symbol $2 Mg Cl_2 \cdot K Cl + 12 H_2 O$.

Concentrated potash is the name given to various preparations of the crude Stassfurt salts by dissolving and refining, and in which potash is the principal ingredient.

Grugite is principally a sulphate of potash and lime; *kieserite*, a sulphate of magnesia ($Mg SO_4 + H_2 O$); *polyhalite*, a sulphate of potash, lime, and magnesia ($Mg SO_4 \cdot K_2 SO_4 \cdot 2 Ca SO_4 + 2 H_2 O$); and *tachydrite*, a chloride of calcium and magnesium.

Potassic chloride is also prepared from the crude salts, and usually contains 80 % of the pure salt, while it is cheaper proportionally than the sulphate: but some hold that it is not so suitable for potatoes and mangolds, while sugar from beets manured with the chloride will not crystallise. It is considered by some the best form of potash salt for beans.

It is seldom that a potash manure is required by a soil, except when growing potatoes and beans, clover, or other leguminosæ. If, however, a soil contains less than ·25 % of potash, or the same of magnesia, an addition of these substances is likely to be beneficial.

Composition of Limestones and Marls.

	Calcic Carbonate.	Magnesic Carbonate.	Tribasic Phosphate.	Alumina and Ferric Oxide.	Silica.
Limestones :—					
Carboniferous limestone (Lanark)	93·9	2·0	1·1	1·6	0·4
Do. do. (Alston Moor)	97·3	1·4	...	0·2	1·0
Chalk with flints (Kent)	98·4	0·1	...	0·4	1·1
Great Oolite limestone (Bath)	94·6	2·5	...	1·2	...
Magnesian limestone (Bolsover)	51·1	40·2	...	1·8	3·6
Marlstone (Lias)	...	...	...	...	...
Shelly limestone (Portland)	79·0	3·7	...	2·0	10·4
Silurian limestone (Wales)	44·6	3·6	...	...	51·4
Marls :—					
Carboniferous clay marl (Ayrshire)	8·4	...	...	87·1	
Chalk marl (Farnham)...	66·6	0·6	1·8	3·0	26·0
Green marl (Greensand)	12·7	4·0	5·2	22·4	53·9
Grey marl (Cretaceous)	94·7	0·6	0·4	4·8	18·8
Keuper marl (Worcester)	7·7	5·1	2·9	25·3	53·6
Kimmeridge clay marl (Dorset)	34·2	..	...	65·7	
Peat shelly marl (Forfar)	81·7	...	...	0·6	3·1

A marl is an earthy or clayey mixture, which may contain anywhere between 5 and 80 % of calcic carbonate, and is applied directly to the soil at from 30 (Essex) to 80 (Lincoln) cubic yards per acre. The richer varieties are sometimes burnt for lime. Soft chalk rock is also sometimes applied to the land in the same way, but it must be dug out and spread while wet at the approach of frost, so as to get it to crumble, otherwise the lumps harden on drying. Limestone is always burnt in kilns and applied as freshly as possible. Lanarkshire carboniferous limestone, when burnt, gives the following composition:—

Lime (calcic oxide)	89·78
Calcic sulphate	1·45
Calcic phosphate	1·93
Magnesia (magnesic oxide)	1·69
Alumina and ferric oxide	2·76
Silica as silicate	0·70
Carbonic acid and water	1·69
	100·00

There should not be too much magnesic carbonate present in a limestone, as it is considered less valuable for agricultural purposes, and magnesian limestone is not much used. Limestones containing phosphates or other "impurities" are of course the most effective on the crops.

Chemical Changes through which lime passes in its application to land:—

1st—$Ca\,CO_3$	Pure limestone rock, calcic carbonate: before burning.
2nd—$Ca\,O$	Lime, calcic oxide, quicklime, caustic lime, lime shells: as it comes from the kiln after burning.
3rd—$Ca\,H_2\,O_2$	Slaked lime, calcic hydrate, fallen shells: after water has been put on it, or it has absorbed water from the atmosphere; still somewhat caustic, and usually spread on the land in this state.
4th—$Ca\,CO_3$	Mild lime, the state to which it eventually returns on long exposure: has yielded up its water and absorbed carbonic dioxide. In this condition it is equivalent to finely powdered limestone or chalk, as it is identical in chemical composition with them.

Effect of Lime on Soils.

1. Unites with felspar or clay (double silicates), setting free potash or other alkalies.

2. Acts on vegetable matter, setting free ammonia, water, nitric acid, and carbonic dioxide (which it unites with)—tending to destroy excess of humus.

3. Neutralises organic acids (humic, ulmic, geic, &c.)—thus "sweetening" the soil—and decomposes excess of ferrous sulphate.

4. Takes up the nitric acid as formed by the nitrifying *Bacteria*.

5. Is a plant food in itself.

6. Aids in the formation of zeolites (secondary silicates).

7. Opens up clay soil by the "curdling" or flocculating effect it has on the molecules of that substance, while on a light or sandy soil it binds the particles together and makes them more retentive.

8. Renders harmless injurious salts of copper, iron, &c.

Soils which contain more than 4 % of lime (carbonate) should not have any applied as a rule. Loamy and clayey soils contain 1 to 3 % of calcic carbonate, and defective soils less than 1 %. Quicklime should be applied to all clayey and humous soils, but light soils are best treated with the mild form in the shape of marl or chalk.

Quantity of Lime applied to Land in Different Districts, per Imperial Acre.

	Bushels.	Years.	Bushels per Year.	How applied.
Roxburgh...	200	every 19	= 10½	to the fallows.
Ayr (Kyle)	40	,, 5	= 8	do. or lea.
Carse of Stirling...	50	,, 6	= 9	do. do.
S. Durham	90	,, 12	= 8½	do. do.
Worcester	70	,, 6 or 8	= 10	before tares or grass.

Lime has a tendency to sink in the soil, and Darwin has shown that the action of earth-worms buries it, so that it is best to apply small doses of lime at short intervals rather than large doses at long periods.

The weight of lime per bushel varies from 70 lbs. to nearly 1 cwt., according to the particular kind. The better it is burnt or the less sand it contains, the lighter it is comparatively. A bushel of chalk weighs about 180 lbs.

When lime from the stone is burnt it will take 37 cubic feet to make a ton, and 40½ when from chalk. When slacked, will take 80 and 86 cubic feet respectively to make a ton. Pure varieties of limestone yield a little over 11 cwt. of burnt lime per ton.

Lime should only be applied as a rule to soil containing much clay or humus: not in close contact with nitrogenous manures such as dung or guano, as it sets free the ammonia, which is liable to escape into the air, unless there is sufficient covering of soil present to fix it.

> "Lime and lime *without manure*,
> Will make both farm and farmer poor."

This means that lime is only a stimulant, and does not add to the fertility of the soil, but enables the soil to yield up the fertility it already contains, and it must therefore only be used in conjunction with manure.

Nitrogen in various Waste Products.

	Nitrogen %	= Ammonia.
Acid clotted blood	5·15	5·25
Concentrated shoddy	12·4	15·05
Crude ammonia	7·7	9·35
Feather waste	6·34	7·69
Fur waste	8·5	10·32
Glue refuse	2·63	3·2
Leather cuttings	8·1	9·83
Leather dust (white)	3·66	4·58
Do. (blue)	7·01	8·51
Patent ammonia (sawdust)	13·4	16·27
Seed cake	3·55	4·3
Shoddy	7·90	9·59
Skin waste	5·67	6·88
Spent iron oxide	5·7	7·0
Sugar scum	2·8	3·4

Composition of Miscellaneous Manurial Substances.

	Water.	Organic Matter.	Nitrogen.	= Ammonia	Phosphoric Anhydride.	= Tribasic Phosphate.	Potash.	Lime.	Magnesia.	Silica.
Blood—ordinary	79·0	13·1	3·2	3·8	0·4	0·8	0·6	0·1	..	0·1
Do. dried (meal)	13·4	78·4	11·8	14·3	1·2	2·6	0·7	0·8	0·2	2·1
Cotton cake—damaged	11·2	82·2	6·2	7·5	3·0	6·5	1·5	0·3	1·0	0·5
Fish guano—Norwegian ...	9·8	56·2	8·5	10·3	13·8	30·1	0·3	16·0	0·9	0·5
Do. Polar	6·4	55·9	8·3	10·0	13·9	30·3	...	16·6	0·5	2·4
Frey Bentos guano (flesh meal)	6·7	89·5	10·9	13·2	0·4	0·9	0·6	0·1	0·4	1·7
Gristle meal	27·8	56·6	9·7	11·7	6·3	13·7	...	7 0	0·3	1·1
Horn meal	8·5	68·5	10·2	12·3	5·5	12·0	...	6·6	0·3	11·0
Rape cake...	9·1	71·1	4·8	5·9	2·0	4·3	1·3	0·7	0·7	11·3
Seaweed—dried	15·0	72·8	1·4	1·7	0·4	0·8	1·6	1·7	1·0	0·3
Do. fresh	85·0	12·3	0·3	0·3	0·2	0·4	0·8	0·9	0·6	0·2
Tanyard waste...	63·3	17·9	1·4	1·7	1·3	2·8	...	13·2	0·3	4·8
Wheat straw—dried	12·0	84·0	0·4	0·4	0·2	0·4	0·4	0·2	0 1	2·8
Wool dust refuse	10·0	56·0	5·2	6·3	1·3	2·8	0·3	1·4	0·3	25·0

EXPLANATION of the Terms used in the Analysis of a Manure.

Water or Moisture.—All manures contain more or less water naturally. Under this head is estimated the moisture which is driven off if the substance is heated up to boiling point and kept there until it ceases to lose weight.

Water of Combination.—Some salts can only exist in a crystalline state when several molecules of water are combined with them. This water is driven off when the substance is burnt or raised to a high temperature. Thus gypsum becomes "plaster of Paris" when the two molecules of "water of combination" are driven off by heat.

Organic Matter.—Applied to all substances of animal or vegetable origin, decomposable by burning or subject to decay. The nitrogen, which is the most valuable constituent of a manure, usually exists as an ingredient of this substance, though it may also be in the form of an ammoniacal salt or a nitrate.

Nitrogen equal to Ammonia.—In the combustion of the organic matter of a manure the nitrogen unites with hydrogen, and is driven off and estimated as ammonia: nitrogen forms 14-17ths of ammonia by weight, or as 1 : 1·214.

Nitrogen equal to Ammonic Sulphate.—As both nitrogen and ammonia are invisible gases, and ammonic sulphate is a solid crystalline salt, it is sometimes found in an analysis that the two former are calculated into the corresponding quantity of the latter to give a tangible idea of the amount, and probably also to make it look as large as possible: nitrogen forms 14-65ths of ammonic sulphate by weight, or as 1 : 4·7.

Soluble Phosphate of Lime.—This is really the monocalcic phosphate ($Ca\,H_4\,2\,PO_4$)—soluble in cold water, and which has been made from a larger proportion of the tricalcic ($Ca_3\,2\,PO_4$) by the application of sulphuric acid; 25 % of the latter yielding about 18·8 % of the former. It was common at one time, however, to give the anhydrous form in an analysis ($Ca\,2\,PO_3$ or $Ca\,O\;P_2O_5$, the "biphosphate" of some chemists), in which case 25 % of the tricalcic yields only about 16 % of this latter monobasic form. It is now usual to give the quantity of the tricalcic form which has been "rendered soluble," and it it is now even customary to call this "soluble phosphate." Care must be taken to understand which one is meant, though this ambiguity is not satisfactory; the best method would be to state only the amount of phosphoric anhydride present in a soluble form. In the subjoined table of "unit values" the "soluble phosphates" represent the amount of undissolved phosphates (tricalcic) which has been "rendered soluble."

Precipitated or Reduced Phosphates.—The monocalcic phosphate has always a great tendency to revert back to its tribasic state (or, as some chemists hold, to an intermediate dibasic state), by uniting with any base which may be present, such as lime, iron, alumina, soda, or organic matter. Hence superphosphatic manures always show the largest proportion of soluble (monocalcic) phosphate when recently made; and hence also those mineral phosphates which contain the least iron or alumina are to be preferred. It must also be borne in mind that soluble phosphates always become reduced when put on the land, and that the superiority of dissolved over ground materials of this class lies in the finer division of the former, and the greater readiness with which they can be mixed through the soil. They must be again dissolved by the action of carbonic acid, salts of ammonia, &c., in the soil, before the roots of plants will absorb them.

Insoluble Phosphates.—It is inexpedient in practice to dissolve the whole of the tribasic phosphate, as the resulting superphosphate would be too damp, so that a proportion is always left over and estimated under this head. This eventually becomes slowly suitable for plant food in the majority of cases, when acted upon by agents in the soil.

Sulphate of Lime or Gypsum.—This results from the union of the acid with the lime of the tricalcic phosphate or of the calcic carbonate which may be present; it is sometimes added afterwards as a "dryer."

Alkaline Salts.—Consist mostly of sodic and potassic sulphates, nitrates, &c.

Insoluble Silicious Matter.—Consists of the earthy and sandy matter naturally present in all manures. Resists the action of ordinary acids, and is quite valueless. May form a large percentage in adulterated manures.

"Unit" Prices of Manures.

	Usual Guarantee.	Price per Unit.	
	%	s.	d.
Ammonia in ammonic sulphate 95%	24 Am	7	2
,, Ichaboe guano	10 ,,	10	6
,, Peruvian guano, sifted ...	5 ,,	12	0
,, phosphatic guano... ..	1 ,,	8	3
,, fish guano	10 ,,	8	0
,, bone meal	5 ,,	8	0
,, dissolved bones	3 ,,	8	0
,, compound manures ...	—	8	0
Nitrogen in sodic nitrate ... 95%	15·5 Nit.	10	8
,, potassic nitrate ... 73%	17 ,,	12	0
,, ammonic sulphate 95%	20 ,,	8	9
,, Ichaboe guano	8 ,,	12	9
,, Peruvian guano	4 ,,	14	6
,, phosphatic guano... ...	0·8 ,,	10	0
,, fish guano	8 ,,	9	9
,, bone meal	4 ,,	9	9
,, dissolved bones	2·5 ,,	9	9
,, compound manures ...	—	9	9
"Soluble phosphate" in dissolved bones	16 Phos.	2	4
,, ,, superphosphates	28 ,,	1	6
Undissolved phosphate in Ichaboe guano	20 ,,	1	9
,, ,, Peruvian guano ...	55 ,,	2	0
,, ,, phosphatic guano ...	67 ,,	1	2
,, ,, fish guano	26 ,,	1	0
,, ,, bone meal	50 ,,	1	0
,, ,, dissolved bones ...	20 ,,	1	3
,, ,, superphosphates ...	3 ,,	0	0
,, ,, compound manures...	—	1	2
,, ,, Charleston phosphate	57 ,,	0	7
,, ,, Belgian phosphate ...	40 ,,	0	6
,, ,, Algerian phosphate...	64 ,,	0	7
,, ,, slag phosphate ...	37 ,,	1	1
Potash in kainite 23%	12 Pot.	3	4
,, chloride (muriate) ... 80%	50 ,,	3	6
,, nitrate 73%	40 ,,	3	9
,, sulphate 50%	27 ,,	3	4

The percentage of each ingredient in an analysis is to be multiplied by its price per unit (an unit being the 1-100th part of a ton): the sum total of all the ingredients gives the price of the manure per ton.

It is customary in fixing the prices of manures per ton, on the system of valuing by units, to allow only for the phosphates dissolved or soluble, the phosphates undissolved or insoluble, the nitrogen equal to ammonia, and the potash. Other items are seldom taken notice of, and in the case of a mineral superphosphate it is not even usual to allow for the insoluble phosphate.

The above prices are of course only approximate, as they vary according to markets, and only represent the value at the ports or manufactories; the cost of bags, carriage, credit, &c., must be added on according to circumstances.

It must be borne in mind that the commercial values bear no relation to the manurial values; the soluble phosphate in a mineral superphosphate, for instance, being probably as good for the plants as that in a bone superphosphate, although the latter has a higher market value. The cheapest sources should be tried first in experiments.

Relative Manurial Value of Different Manures.
Average of several Authorities.

Nitrogen in	ammonic sulphate, guano, &c. ...	100
,,	sodic nitrate...	98
,,	fish guano, meat meal, &c. ...	81
,,	bone meal, horn meal, &c. ...	77
,,	farmyard manure	56
Phosphoric acid in	superphosphate	100
,,	guano	92
,,	bone meal	88
,,	medium meal	64
,,	coarse meal...	40
,,	basig slag	33
,,	farmyard manure	33
Potash in	sulphate	100
,,	chloride (muriate)	82

Nitrogen, *phosphoric acid*, and *potash* are the only three substances which require to be applied in ordinary manuring, and all manures are valuable only in proportion to the amounts of these they contain; while manurial experiments usually resolve themselves into testing the effect of the various commercial compounds and mixtures of these three bodies on different soils. The other mineral foods required by plants exist in superabundance in the great majority of soils.

Table of Synonymous Terms employed in Agricultural Chemistry.

NAME.	SYNONYMS.
Alkaline salts	Potassic and sodic salts; common salt.
Ammonic chloride (NH_4 Cl)	Muriate of ammonia, sal-ammoniac, chloride of ammonium.
Ammonic sulphate $\{(NH_4)_2\ SO_4\}$	Sulphate of ammonia; ammoniacal salt.
Anhydrous	Free from chemically combined water.
Calcic and magnesic phosphates (Ca_3 2 PO_4) (Mg_3 2 PO_4)	Earthy phosphates.
Calcic sulphate ($Ca\ SO_4$)	Gypsum; anhydrous form (heated) is "plaster of Paris."
Carbonic dioxide or anhydride (CO_2)	Carbonic acid or "choke damp."
Carbonic ac. or dihydric carb. ($H_2\ CO_3$)	Carbonic acid hydrate.
Chloride	Muriate.
Cupric sulphate ($Cu\ SO_4$)	Sulphate of copper, bluestone, blue vitriol.
Ferrous sulphate ($Fe\ SO_4$)	Sulphate of iron, copperas, green vitriol.
Hydrated	Containing water in chemical combination.
Hydric acetate ($H_4\ C_2\ O_2$)	Acetic acid; diluted = vinegar.
Hydric ammonic oxide ($NH_4\ HO$)	Hydrate of ammonia, spirits of hartshorn.
Hydric calcic oxide ($H_2\ Ca\ O_2$)	Hydrate of lime, slaked lime, milk of lime.
Hydric chloride ($H\ Cl$)	Hydrochloric acid, muriatic acid, spirits of salt.
Hydric nitrate ($H\ NO_3$)	Nitric acid, aquafortis.
Hydric sulphate ($H_2\ SO_4$)	Sulphuric acid, oil of vitriol.
Magnesic sulphate ($Mg\ SO_4$)	Epsom salts.
Nitrogen (N)	Azote.
Nitrogenous matter	Organic substances containing nitrogen, and capable of yielding, by their decomposition, ammonia or nitric acid.

TABLE OF SYNONYMOUS TERMS—*continued.*

NAME.	SYNONYMS.
Phosphoric anhydride ($P_2\ O_5$)	Anhydrous phosphoric acid, diphosphoric pentoxide: the valuable component of phosphatic materials.
Potassic nitrate ($K\ NO_3$)	Nitre, saltpetre.
Potassic sulphate ($K_2\ SO_4$)	Sulphate of potash: salt of Glaser.
Silicic oxide ($Si\ O_2$)	Silicic ac., silica, silex, quartz, sand.
Sodic chloride ($Na\ Cl$)	Muriate of soda, common salt.
Sodic nitrate ($Na\ NO_3$)	Chili saltpetre, cubical nitre, nitrate of soda.
Sodic silicate ($Na_2\ Si\ O_3$)	Silicate of soda: soluble glass.
Sodic sulphate ($Na_2\ SO_4$)	Sulphate of soda: Glauber's salt.
Tetrahydric monocalcic diphosphate ($H_4\ Ca\ 2\ PO_4$)	Superphosphate of lime, soluble or acid phosphate, monocalcic phosph. It is a hydrated salt ($Ca\ H_4\ 2\ PO_4 = Ca\ O \cdot P_2\ O_5\ +\ 2\ H_2\ O$), and some chemists give the anhydrous form in an analysis under the name of monobasic or "bi-phospate."
Dihydric dicalcic diphosphate ($H_2\ Ca_2\ 2\ PO_4$)	An intermediate form, found largely in Rossa guano and other phosphates; some chemists consider this to be the state in which "reduced phosphates" exist. Synonym = hydric calcium phosphate ($H\ Ca\ PO_4$).
Tricalcic diphosphate ($Ca_3\ 2\ PO_4$)	Insoluble phosphate of lime, bone ash, bone earth, bone phosphate; basic, tribasic, or tricalcic phosphate.
Tetracalcic phosphate ($Ca_4\ P_2\ O_9$)	Slag phosphate (Thomas phosphate), the form which occurs in some slags from steel smelting furnaces.
Vitriolised bones	Sulphated bones, partially dissolved by sulphuric acid.

USEFUL FACTORS.

Amount of	Multiplied by	Gives corresponding amount of
Nitrogen (N)	1·214	Ammonia.
,,	4·714	Ammonic sulphate.
,,	6·33	Albuminoid matter.
,,	6·071	Sodic nitrate.
Ammonia (NH_3)	0·824	Nitrogen.
,,	3·882	Ammonic sulphate.
,,	3·147	Ammonic chloride.
,,	3·706	Nitric acid.
,,	5·0	Sodic nitrate.
Potash (anhydrous) (K_2 O)	1·85	Potassic sulphate.
,, ,,	1·585	Potassic chloride.
,, ,,	2·146	Potassic nitrate.
,, ,,	7·4	Kainite.
Phosphoric anhydride (P_2 O_5)	2·183	Tricalcic phosphate.
,, ,,	1·4	Anhydrous monobasic phosphate.
,, ,,	1·648	Soluble (monocalcic) phosphate.
,, ,,	2·555	Tetracalcic (slag) phosphate.
Soluble (monocalcic) phosphate (Ca H_4 2 PO_4)	1·325	Tricalcic phosphate.
Anhydrous monobasic phosphate (Ca 2 PO_3)	1·536	Tricalcic phosphate.
Lime (Ca O)	1·845	Tricalcic phosphate.
,,	1·786	Calcic carbonate.
,,	2·43	Calcic sulphate.
Magnesia (Mg O)	2·09	Magnesic carbonate.
,,	3·0	Magnesic sulphate.
Chlorine	1·648	Sodic chloride.

Classification of Manures according to Action and Composition: some classified under more than one head, as they contain more than one chemical compound, and act in more than one way.

I.—*Nitrogenous Manures.*

a.—Substances containing ammonia (very quick acting).
Ammoniacal salts.
Peruvian guano.
Putrid animal substances—blood, flesh, wool.
Gas-liquor; soot.
Putrid urine and liquid manure.
Short dung, especially sheep and horse dung.

b.—Nitrogenous matters which pass easily into putrefaction (tolerably quick in action).
Bones—dissolved, boiled, or finely powdered.
Oilcakes of all kinds; malt dust.
Fresh urine and liquid manure.

c.—Nitrogenous manures which decompose with difficulty (slowly acting, forcing).
Half-inch bones.
Horn shavings; glue.
Woollen rags.
Long dung.

d.—Substances containing nitric acid (quick acting, forcing).
Potassic nitrate (saltpetre).
Sodic nitrate (Chili saltpetre).
Nitre earth.

II.—*Phosphatic Manures.*
Burnt bones; animal black; refuse of sugar manufactories.
Phosphatic minerals (ground); apatite; coprolites.
Basic slag.
Mejillones guano.
Fresh bones; bone dust.
Guano of all kinds.
Animal matters of all kinds.
Oilcakes; malt refuse.
Human egesta; farmyard dung.
Wood ashes, straw, leaves, &c.

III.—*Potassic Manures.*
Potash salts; nitre; kainite; malt dust.
Urine; wood and peat ashes.
Leaves; green manures.
Road scrapings; compost.
Burnt clay; some kinds of marl

CLASSIFICATION OF MANURES—*continued.*

IV.—*Calcareous Manures.*

Burnt lime; chalk; all marls.
Gypsum; gas lime.
Road scrapings; coal and peat ashes.

Weights of Manures per Bushel.

	Lbs.		Lbs.
Guano	65	Kainite	82
Bone superphosphate ...	74	Slag phosphate	147
Mineral do. ...	66	Lime (average)	90
Nitrate of soda	87	Gas lime	62
Sulphate of ammonia ...	60	Soot	28

CONSTITUENTS OF PLANTS.

I. COMBUSTIBLE PART:—	Carbon	= ½ dry combustible part	Active constituents.
	Hydrogen		Active constituents.
	Oxygen		Active constituents.
	Nitrogen	= 4 %	Active constituents.
	Sulphur	= very small %	Active constituents.
II. ASH:— Essential	Phosphorus		Active constituents.
	Potassium		Active constituents.
	Calcium		Active constituents.
	Magnesium		Active constituents.
	Iron		Active constituents.
Not so essential	Sodium		Partially dormant constituents.
	Silicon		Partially dormant constituents.
	Chlorine		Partially dormant constituents.
	Manganese		Partially dormant constituents.
Possibly essential to some plants	Iodine		Partially dormant constituents.
	Fluorine		Partially dormant constituents.
	Lithium		Partially dormant constituents.
	Bromine		Wholly dormant constituents.
	Caesium		Wholly dormant constituents.
	Rubidium		Wholly dormant constituents.
	Copper		Wholly dormant constituents.
	Lead		Wholly dormant constituents.
	Arsenic		Wholly dormant constituents.
	Zinc		Wholly dormant constituents.
	Tellurium		Wholly dormant constituents.
	Barium		Wholly dormant constituents.

Chlorine and sodium are essential to animals; fluorine and silicon are present in teeth, bones, hair, &c.

WEIGHT AND AVERAGE COMPOSITION OF ORDINARY CROPS IN POUNDS PER ACRE.

	Weight of Crop.		Total Pure Ash.	Nitrogen.	Phosphoric Acid.	Potash.	Soda.	Lime.	Magnesia.	Sulphur.	Chlorine.	Silica.	Ash Percentage at Harvest.
	At Harvest.	Dry.											
Wheat, grain, 30 bushels	1,800	1,530	30	33	14·2	9·3	0·6	1·0	3·6	2·7	0·1	0·6	1·6
,, straw	3,158	2,653	142	15	6·9	19·5	2·0	8·2	3·5	5·1	2·4	96·3	4·5
Total	4,958	4,183	172	48	21·1	28·8	2·6	9·2	7·1	7·8	2·5	96·9	3·4
Barley, grain, 40 bushels	2,080	1,747	46	35	16·0	9·8	1·1	1·2	4·0	2·9	0·5	11·8	2·2
,, straw	2,447	2,080	111	13	4·7	25·9	3·9	8·0	2·9	3·2	3·6	56·8	4·5
Total	4,527	3,827	157	48	20·7	35·7	5·0	9·2	6·9	6·1	4·1	68·6	3·4
Oats, grain, 45 bushels	1,890	1,625	51	38	13·0	9·1	0·8	1·8	3·6	3·2	0·5	19·9	2·7
,, straw	2,835	2,353	140	17	6·4	37·0	4·6	9·8	5·1	4·8	6·1	65·4	4·9
Total	4,725	3,978	191	55	19·4	46·1	5·4	11·6	8·7	8·0	6·6	85·3	4·0

WEIGHT AND AVERAGE COMPOSITION OF ORDINARY CROPS IN POUNDS PER ACRE—*continued.*

	Weight of Crop.		Total Pure Ash.	Nitrogen.	Phosphoric Acid.	Potash.	Soda.	Lime.	Magnesia.	Sulphur.	Chlorine.	Silica.	Ash Percentage at Harvest.
	At Harvest.	Dry.											
Meadow Hay, 1½ tons	3,360	2,822	203	49	12·3	50·9	9·2	32·1	14·4	5·7	14·6	56·9	6·3
Red Clover Hay, 2 tons	4,840	3,763	258	102	24·9	83·4	5·1	90·1	28·2	9·4	9·8	7·0	5·3
Beans, grain, 30 bushels	1,920	1,613	58	77	22·8	24·3	0·6	2·9	4·2	4·4	1·1	0·4	3·0
„ straw	2,240	1,848	99	29	6·3	42·8	1·7	26·3	5·7	4·9	4·3	6·9	4·4
Total	4,160	3,461	157	106	29·1	67·1	2·3	29·2	9·9	9·3	5·4	7·3	3·7
Tare Hay, 1¼ tons	2,800	2,380	156	62	12·8	36·4	4·2	47·0	8·4	3·9	6·5	10·3	5·5
Turnips, roots, 17 tons	38,080	3,126	218	63	22·4	108·6	17·0	25·5	5·7	15·2	10·9	2·6	0·5
„ leaf	11,424	1,531	146	49	10·7	40·2	7·5	48·5	3·8	5·7	11·2	5·1	1·2
Total	49,504	4,657	364	112	33·1	148·8	24·5	74·0	9·5	20·9	22·1	7·7	0·7

WEIGHT AND AVERAGE COMPOSITION OF ORDINARY CROPS IN POUNDS PER ACRE—*continued.*

	Weight of Crop		Total Pure Ash.	Nitrogen.	Phosphoric Acid.	Potash.	Soda.	Lime.	Magnesia.	Sulphur.	Chlorine.	Silica.	Ash Percentage at Harvest.
	At Harvest.	Dry.											
Swedes, roots, 14 tons	31,360	3,349	163	70	16·9	63·3	22·8	19·7	6·8	14·6	6·8	3·1	0·5
,, leaf	4,704	706	75	28	4·8	16·4	9·2	22·7	2·4	3·2	8·3	3·6	1·5
Total	36,064	4,055	238	98	21·7	79·7	22·0	42·4	9·2	17·8	15·1	6·7	0·6
Cabbages, 25 tons	56,000	5,600	470	168	58·0	55·0	96·0	98·5	27·9	32·9	26·9	3·5	0·8
Mangolds, roots, 22 tons	49,280	5,914	426	87	34·0	222·8	69·4	15·9	18·3	4·9	42·5	8·7	0·8
,, leaf	18,233	1,654	254	51	15·1	77·9	49·3	27·0	24·2	9·1	40·6	9·2	1·3
Total	67,513	7,568	680	138	49·1	300·7	118·7	42·9	42·5	14·0	83·1	17·9	1·0
Potatoes, tubers, 6 tons	13,440	3,360	127	47	21·5	76·5	3·8	3·4	6·3	2·7	4·4	2·6	0·9
,, haulm	4,274	954	50	20	2·7	1·1	2·0	22·7	12·4	2·1	1·9	2·1	1·1
Total	17,714	4,314	177	67	24·2	77·6	5·8	26·1	18·7	4·8	6·3	4·7	0·9

By "pure ash" in the above table is understood the ash minus sand, charcoal, and carbonic acid. The composition of grain is nearly constant, but straw, leaves, roots, and tubers vary with the soil, climate, manure, and season.

Composition of the Animal Exports from a Farm—in Lbs.

	Nitrogen.	Phosph. Anhyd.	Potash.	Lime.	Magnesia.
Fat ox, per 1,000 lbs. fasted live weight ...	23·26	15·51	1·76	17·92	0·61
Fat sheep, do. do. ...	19·76	10·40	1·48	11·84	0·48
Fat pig. do. do. ...	17·65	6·54	1·38	6·36	0·32
Milk, 1,000 lbs.... ...	5·92	2·00	1·70	1·70	0·20
Wool, unwashed, 1,000 lbs.	54·00	0·70	56·20	1·80	0·40

Phosphoric Acid removed off the Farm in various Products: *per acre per annum.*

	Lbs. per Acre per Annum.
Wheat, 30 bushels	14·2
Barley, 40 ,, ...	16·0
Oats, 45 ,, ...	13·0
Beans, 30 ,, ...	22·8
Hay, 1½ tons	12·3
Clover, 2 ,, ...	24·9
Turnips, 17 ,, ...	22·4
Swedes, 14 ,, ...	16·9
Mangels, 22 ,, ...	34·0
Potatoes, 6 ,, ...	21·5
Store ox, 1,300 lbs.	4·0
Milk cow (500 gals. milk) and calf	4·2
Sheep, 150 lbs	4·7

In the above the straw, tops, shaws, &c., are left out of account; a store ox is taken at 2 years old, 1,300 lbs. live weight, and is allowed to eat the produce of 5 acres in 2 years: a cow is allowed the produce of 3 acres per annum, and the calf at birth to contain 3 lbs. of phosphoric acid; a sheep to weigh 150 lbs. live weight, and to graze 3 to the acre. In the ordinary run of farming these three kinds of stock will about equal one another in the phosphoric acid they require.

The method of giving the total amount of manurial ingredients removed by crop and stock is the best, and explains why certain manures have been found in practice more beneficial to some crops than to others. The plan of giving the percentage composition of the ash of each plant is of very little use, and is, in fact, misleading. For example, the potash taken from the soil by a crop of turnips is in the above table 108 lbs., while that taken by potatoes is put at 76½ lbs. Now in a percentage analysis potash forms about 60 % of the ash of potatoes, and only 34 % of that of turnips, and thus an erroneous impression is given.

But even the total quantity of each ingredient removed from the soil is not a correct guide to prescribing the proper kinds or quantities of manure for a crop. It would seem that certain chemicals have the power of modifying the soil or of acting as a tonic in stimulating the absorptive power of the roots, and this altogether apart from the amount of those elements actually required by the plants. For instance, phosphoric acid is not taken up by swedes in anything like as large a proportion as potash, yet phosphates are the manures which give the best results of any one kind of artificial manure on this crop, both as regards quantity and quality, while potash may actually do injury, or at least no good. Again, in the case of clover and other *Leguminosæ*, though they contain a larger proportion of nitrogen than of anything else in their composition, yet a nitrogenous manure may do actual harm, while potash and gypsum do good. A symbiotic organism (a species of microbe—*Bacillus radicicola*) found in the tubercles on the roots of leguminous plants is believed to manufacture nitrogenous compounds from the air in the soil, which compounds are then absorbed by the roots. Roots in general, again, have the power of dissolving out by their acid secretions a certain amount of food out of the mineral fragments of the soil, while it is certain that many kinds of microbes therein play a part in preparing plant food out of manurial materials which is at present little understood. It is, therefore, not advisable to prescribe definite quantities of artificial manures for crops, for, in addition to the paradoxical state of matters just mentioned, there are further complications due to peculiarities of soil, climate, cultivation, and previous manuring, so that a prescription suitable for one field might fail completely in the next one Thus it is only by actual experiment or experience that each farmer can find out for himself the system of manuring best adapted for his land. As the general result, however, of investigations carried on during past years, we have arrived at a knowledge of the relative importance of each manurial ingredient to each crop, and the comparative proportion which should be allowed of each in a mixed manure. This is here given, the figures signifying relative proportions only.

	Nitrogen.	Phosphoric Acid.	Potash.
Wheat	2	1	($\frac{1}{2}$)
Barley	2	2	($\frac{1}{2}$)
Oats	2	2	($\frac{1}{2}$)
Grass	2	2	1
Clover	—	$1\frac{1}{2}$	3
Beans	($\frac{1}{2}$)	$1\frac{1}{2}$	3
Tares	($\frac{1}{2}$)	$1\frac{1}{2}$	3
Turnips	1	3	1
Mangolds	3	2	3
Potatoes	2	2	3
Cabbages	3	1	1

Those constituents enclosed in brackets should not be applied unless it is known from observation or experiment that the soil is deficient in them.

While no definite quantities of manure can be given as certain to yield good results everywhere, it may at the same time be stated that the following dressings approximate to those generally employed in practice where the soil is in fair condition, or where dung is used conjointly :—

Wheat.—$\frac{1}{2}$ to $1\frac{1}{2}$ cwt. of nitrate of soda as a top-dressing in spring, either alone or in conjunction with 2 cwt. of slag or superphosphate.

Barley.—$\frac{1}{2}$ to $1\frac{1}{2}$ cwt. of nitrate of soda, 3 cwt. of slag or superphosphate, and 3 cwt. of salt.

Oats.—$\frac{1}{2}$ to $1\frac{1}{2}$ cwt. of nitrate of soda, and 2 to 3 cwt. of slag or superphosphate.

Grass for Hay.—1 to 2 cwt. of nitrate of soda, 1 cwt. of slag or superphosphate, and 2 to 4 cwt. of kainite.

Clover.—2 cwt. slag or superphosphate, 4 cwt. of kainite, and 5 cwt. of gypsum.

Beans.—$\frac{1}{2}$ cwt. nitrate of soda, 2 cwt. slag or superphosphate, and 2 cwt. of chloride of potassium.

Tares.—1 to 2 cwt. of slag or superphosphate, and 5 cwt. of kainite.

Turnips.—1 cwt. of nitrate of soda, and 5 cwt. of slag or superphosphate.

Mangolds.—2 cwt. of nitrate of soda, 3 to 4 cwt. of slag or superphosphate, 5 cwt. of kainite.

Potatoes.—2 cwt. of nitrate of soda, 4 cwt. of slag or superphosphate, and 4 cwt. of kainite.

Cabbages.—2 to 3 cwt. of nitrate of soda, 2 to 3 cwt. of slag or superphosphate, and 4 cwt. of kainite.

In the above list nitrate of soda, slag or superphospate, and potash salts are used as being the cheapest sources of the three essential ingredients, but others may be substituted where thought desirable. Where, however, land is known to be in fair manurial condition, the dominant manures only should be used, as these only are likely to give a good return for outlay.

Ville's "Dominant Ingredients."

On the principle that certain ingredients have more effect on certain crops than others, M. Georges Ville, of the Experimental Farm at Vincennes, formulated the following table of "Dominant Ingredients," and below are given some selected samples of the mixtures with which he has been able to raise full crops on poor, sandy land, though these manures would be too heavy and expensive for use in ordinary farming.

The principle of "dominant ingredients" is a thoroughly sound one, however, and is the keynote of all scientific manuring.

Crop.	Dominant Ingredient.	Corresponding Chemical Products.
Beetroot Wheat Barley Oats Rye Meadow land	Nitrogen	Ammonic sulphate. Sodic nitrate. Potassic nitrate.
Turnips Swedes Maize Artichokes	Phosphoric acid	Bone manures. Bone black from sugar refinery. Burnt bones. Superphosphate. Slag phosphate.
Peas Beans Clover Sainfoin Tares Lucerne Flax Potatoes	Potash	Potassic chloride. Potassic nitrate. Purified potash. Potassic silicate. Kainite.

VILLE'S FORMULÆ FOR CHEMICAL MANURES.

Dominant Ingredient: Nitrogen.

Colza, Hemp, Cereals, Meadows.

	Per Cent.	Lbs. per Acre.
Calcic superphosphate	33·34	352
Potassic chloride at 80 %	16·66	176
Ammonic sulphate	32·50	343
Calcic sulphate	17·50	185
	100·00	1,056

Beetroot, Carrots, Garden Stuff.

Calcic superphosphate	33·34	352
Potassic chloride at 80 %	16·66	176
Ammonic sulphate	11·64	123
Sodic nitrate	25·00	264
Calcic sulphate	13·36	141
	100·00	1,056

Dominant Ingredient: Potash.

Potatoes, Flax.

Calcic superphosphate	40·00	352
Potassic nitrate	30·00	264
Calcic sulphate	30·00	264
	100·00	880

Ville's Formulæ for Chemical Manures—*continued.*

Vines, Fruit Trees.

	Per Cent.	Lbs. per Acre.
Calcic superphosphate	40·00	528
Potassic chloride at 80 %	33·33	440
Ammonic sulphate	23·33	308
Calcic sulphate	03·34	44
	100·00	1,320

Dominant Ingredient: Calcic Phosphate.

Turnips, Maize, Sugar-Cane, Sorghum, Artichoke, Rape.

Calcic superphosphate	50·00	528
Potassic nitrate	16·67	176
Calcic sulphate	33·33	352
	100·00	1,056

Incomplete Manure: No Nitrogen.

Leguminous Plants.

Calcic superphosphate	40·00	352
Potassic chloride at 80 %	20·00	176
Calcic sulphate	40·00	352
	100·00	880

Valuation of Unexhausted Manures.

Sir John Bennett Lawes' table of the estimated money value of the unexhausted residue of manures remaining after the growth of different crops. The values are expressed in shillings, for every 20s. original *manure value* of the purchased feeding stuff or manure employed:—

Purchased (or Saleable) Feeding Stuffs consumed with Roots, or Manure applied for Roots.

After		Purchased or Saleable Food.	Dung.	Rape or other Cake as Manure.	Bones.	Nitrate of Soda.	Sulphate of Ammonia.	Guano, Natural or Manufactured.	Compound Artificial or Refuse Manures.	Mineral Super-phosphates.
1st year	Food consumed with roots on land	17	—	—	—	—	—	—	—	—
	Food consumed with roots in yard	16	—	—	—	—	—	—	—	—
	Manure applied to roots consumed on land	—	17	16	17	15	15	15	12	9
	Manure applied to roots consumed in yard	—	16	15	16	14	14	14	10	8
2nd year	Corn crop, grain sold, straw left	7	9	7	8	4	4	4	2	2
3rd ,,	Do. do. do.	1	3	1	2	1	1	1	—	—
3rd ,,	Grass or hay consumed ...	2	5	3	4	2	2	2	—	—
4th ,,	Do. do. do. ...	—	2	—	1	—	—	—	—	—
3rd ,,	Hay sold	—	2	—	1	—	—	—	—	—

Manure applied for a Corn Crop.

After		Purchased or Saleable Food.	Dung.	Rape or other Cake as Manure.	Bones.	Nitrate of Soda.	Sulphate of Ammonia.	Guano, Natural or Manufactured.	Compound Artificial or Refuse Manures.	Mineral Superphosphates.
1st year	Corn crop, grain sold, straw left	—	12	7	—	6	6	6	6	5
2nd ,,	Do. do. do.	—	6	1	—	—	—	—	—	—
2nd ,,	Grass or hay consumed ...	—	8	3	—	1	1	1	1	—
3rd ,,	Do. do. do. ...	—	4	1	—	—	—	—	—	—
2nd ,,	Hay sold	—	4	—	—	—	—	—	—	—

Feeding Stuff consumed on, or Manure applied to, Grass Land—Grazed.

1st year	Grazed	18	18	—	18	16	16	16	14	12
2nd ,,	Do.	12	14	—	13	10	10	10	6	4
3rd ,,	Do.	4	8	—	6	2	2	2	—	—
4th ,,	Do.	—	2	—	1	—	—	—	—	—

Feeding Stuff consumed on, or Manure applied to, Grass Land—Hay consumed.

After		Purchased or Saleable Food.	Dung.	Rape or other Cake as Manure.	Bones.	Nitrate of Soda.	Sulphate of Ammonia.	Guano, Natural or Manufactured.	Compound Artificial or Refuse Manures.	Mineral Super-phosphates.
—	No crop	18	—	—	—	—	—	—	—	—
1st year	Hay consumed	11	16	—	16	14	14	14	13	10
2nd ..	Do.	2	12	—	10	8	8	8	4	2
3rd ,,	Do.	—	6	—	3	1	1	1	—	—
4th ..	Do.	—	—	—	—	—	—	—	—	—

Feeding Stuff consumed on, or Manure applied to, Grass Land—Hay Sold.

—	No crop	18	—	—	—	—	—	—	—	—
1st year	Hay sold	2	10	—	10	2	2	2	2	—
2nd ,,	Do.	—	4	—	4	—	—	—	—	—
3rd ,,	Do.	—	—	—	—	—	—	—	—	—

Examples of Scale of Compensation taken from an Actual Farm-Agreement.

(South of England.)

IMPROVEMENT.	COMPENSATION.
Drainage where landlord provides pipes	Upon a 12 years' principle.
Drainage where tenant provides pipes ...	,, 20 ,,
Bush-draining and mole-ploughing by tenant	,, 8 ,,
Boning with undissolved bones over $\frac{1}{4}$ inch	,, 4 ,, where applied to arable land.
,, ,,	,, 8 ,, on pasture land.
Chalking, claying, and marling	Upon a 12 years' principle, but the entire cost to be allowed for the first 4 years, and after that period $\frac{1}{8}$ deducted yearly for the remaining 8 years.
Liming (not with gas lime)	Upon a 6 years' principle.
Purchased artificial or other manures in excess of the quantity required to replace any hay or straw or roots sold	One-third of the cost of the following, viz.:—Rape, mustard, and cotton cakes, greaves, malt culms, town-made and farmyard manure used for roots or other green crops during the last year; but where a root crop fails and the land has been properly cultivated, and is left in a clean condition, one-half of the cost of the above manures, and also one-half of the value of the farmyard manure used thereon.

SCALE OF COMPENSATION—*continued.*

IMPROVEMENT.	COMPENSATION.
Cake or other feeding stuffs not produced on the holding, consumed by cattle, sheep, or pigs, in excess of the quantity required to replace any hay or straw or roots sold	One-third of the cost of linseed and cotton cake, linseed and cotton-seed meals, beans, and peas, and one-sixth of the cost of all the corn (not corn consumed by horses) and feeding stuffs consumed on the holding during the last year of the tenancy; also one-sixth of the cost of linseed and cotton cakes, and linseed and cotton-seed meals, beans, and peas consumed in the preceding year of the tenancy.

SCALE OF COMPENSATION ADOPTED IN MANY OF THE SOUTHERN COUNTIES.

BONING with undissolved bones:—	
On grass land, fed	Upon a 6 years' principle.
,, ,, mown	,, 3 ,,
On roots or green crop, fed	,, 3 ,,
,, ,, otherwise ...	,, 2 ,,
Chalking, claying, and marling	,, 12 ,, but the whole cost to be allowed the first two years, and after that period one-tenth to be deducted yearly for the remaining 10 years.
Clay-burning	Upon a 5 years' principle.
Liming	,, 5 ,,

SCALE OF COMPENSATION—*continued.*

IMPROVEMENT.	COMPENSATION.
Application of purchased artificial or other purchased manure	For artificial manures of approved manurial value, including carriage, cost of spreading, &c. :—The *whole* cost where no crop has been taken, and such sum as the same is worth to an incoming tenant where one crop only has been taken.
Farmyard manure purchased	The full value where no crop has been taken, and one-half its cost where one crop only has been taken.
Rags and shoddy	Same as farmyard manure purchased.
Consumption on the holding by cattle, sheep, or pigs of cake or other feeding stuff not produced on the holding	One-third the cost of linseed, cotton, or rape cake, peas, beans, malt, and malt dust, and one-sixth of the cost of other feeding stuffs which have been consumed during the last year of tenancy, and from which no crop shall have been taken from the land; and one-sixth the cost of linseed, cotton, or rape cake, peas, beans, malt and malt dust, and one-twelfth the cost of other feeding stuffs which have been consumed during the preceding year of tenancy, and from which one crop shall have been taken off the land.

GENERAL CONDITIONS OF MANURING.

Soluble manures, such as nitrate, guano, &c., should be applied to the land in spring; undissolved manures, such as phosphates, slag, &c., in autumn. Soluble manures, again, suit heavy land; while undissolved varieties, whole bones, and the like, give best results on light soils. Dung may be ploughed in in autumn on heavy land, but kept over till spring on the lighter kinds: on grass should be applied as a top-dressing in autumn on all varieties of land. The soil has great retentive power for phosphates and potash, but nitrogenous material easily decomposes, and the resultant nitrates wash out. Little at a time and more frequent dressings is therefore a good rule to follow with all manures, but especially with the nitrogenous—nitrate of soda, for instance, giving better results if put on at twice on a crop.

Mixing Manures.

In mixing artificial manures great care must be taken not to put those together which are likely to have chemical reactions among their constituents. Thus, nitrate of soda must not be mixed with superphosphate, because the free sulphuric acid in the latter has a very great affinity for soda, and will set free the nitric acid in the form of poisonous fumes (nitric anhydride, N_2O_5), whereby the nitrogen is lost. Again, slag phosphate contains a strong alkali in the form of caustic lime, and if sulphate of ammonia is mixed with it, the ammonia is displaced by the lime and dissipated into the air. Or, again, if superphosphate and bones or slag are mixed, the soluble phosphate will take up some more base and become reverted, or reduced, phosphate. The following mixtures are safe:—

Superphosphates with sulphate of ammonia.
Bones with nitrate of soda or sulphate of ammonia.
Bones with slag.
Slag with nitrate of soda.
Fish guano with any mineral manure.
Phosphatic guanos with nitrate of soda or sulphate of ammonia.
Organic manures with any mineral manure.

The following mixtures should *not* be made :—

Dung with lime.
Guano with lime.
Guano with slag.
Nitrate with superphosphate.
Sulphate with slag.
Superphosphate with slag.

If the manures are perfectly dry, and sowed immediately, there is less chance of chemical reactions taking place, but in any case sowing should be carried out as soon as possible after mixing.

Farmers' Experiments.

It is desirable that each farmer should test for himself the manurial requirements of his own soil, and for this reason some simple experiments should be carried out. One of the handiest modes of procedure is to select seven ridges, or stetches, right up the length of a field, and number them 1 to 7, and apply the manure as follows :—

1. Nitrate.
2. Nitrate and phosphate.
3. Nitrate, phosphate, and kainite.
4. Phosphate and kainite.
5. Kainite.
6. Phosphate.
7. Nothing.

It is absolutely necessary to have one plot with no manure, and, indeed, in every application of artificials there should be a part left undressed. for purposes of comparison ; and if thought advisable, any number of extra trials might be made with different kinds of manures yielding the same elements. This system does not interfere with the ordinary working of the field, while the crops will reveal which is the best dressing to use in future.

It is also desirable to adopt some standard of value per acre for the manures applied, say 10s. or £1 : no definite comparison of results can be made if, say, £3 worth of dung per acre is put on one plot as against 10s. worth of phosphate on another. and £1 worth of mixture on a third.

ROTHAMSTED EXPERIMENTS.

Experiments on the Growth of WHEAT.

MANURES PER ACRE, PER ANNUM, AND AVERAGE PRODUCE PER ACRE, PER ANNUM, OVER 42 YEARS, 1852–93.

PLOTS.	Super.	$Na\ NO_3$	$(NH_4)_2\ SO_4$	$NH_4\ Cl$	$K_2\ SO_4$	$Mg\ SO_4$	$Na_2\ SO_4$	Rape Cake.	Dressed Grain. Quantity.	Dressed Grain. Weight per Bushel.	Total Straw.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Bushels	Lbs.	Cwts.
0	1,170	...	...	...	...	...	...	...	16¼	58⅜	13⅜
1	...	...	...	...	400	200	200	...	13	58⅛	11⅝
2a & b	...	...	...	...	14 tons Farmyd. Manure			...	34⅝	60⅜	32¼
3	...	...	...	...	Unmanured continuously			...	12¾	58⅜	10⅝
4	...	...	...	...	Unmanured since 1852			...	11¾	58½	10⅞
5a & b	390	...	...	...	200	100	100	...	14¾	59	12¼
6a & b	390	...	100	100	200	100	100	...	24	59¾	21½
7a & b	390	...	200	200	200	100	100	...	32¾	59⅞	32¾
8a & b	390	...	300	300	200	100	100	...	36¼	59⅝	39¾
9a	390	275	...	...	200	100	100	...	34¾	59⅛	38½
9b	...	275	...	...	...	...	...	...	22⅛	56¾	22⅝
10a	...	...	200	200	...	...	...	...	19½	57¼	17¾
10b	...	...	200	200	...	...	...	...	21⅞	57⅝	20
11a & b	390	...	200	200	...	...	...	...	21½	57⅝	23
12a & b	390	...	200	200	...	...	366½	...	30⅛	59⅛	28½
13a & b	390	...	200	200	200	...	...	...	31¼	60⅛	31⅛
14a & b	390	...	200	200	...	280	...	...	30¾	59¼	29⅜
15a	390	...	200	200	200	100	100	...	30¾	59⅞	29½
15b	390	...	200	200	200	100	100	...	31⅛	59⅞	30⅛
16a & b	390	550	...	...	200	100	100	...	27⅛	59⅛	28¾
17a & b	390	...	...	...	200	100	100	...	15⅛	58⅞	12⅞
18a & b	...	...	200	200	...	...	...	...	30¼	59⅞	29¼
19	...	...	...	...	...	...	...	1,889	28	58⅞	25⅝
20	...	...	...	...	Unmanured continuously			...	13¼	58⅛	11⅜
21	390	...	...	100	200	100	100	...	19	58⅝	16⅞
22	390	...	100	...	200	100	100	...	19⅜	58⅜	17⅛

Experiments on the Growth of BARLEY.

PLOTS.	MANURES PER ACRE, PER ANNUM.									AVERAGE PRODUCE PER ACRE, PER ANNUM, OVER 42 YEARS, 1852–93.		
	Super.	$Na\,NO_3$	$(NH_4)_2\,SO_4$	$NH_4\,Cl$	$K_2\,SO_4$	$Mg\,SO_4$	$Na_2\,SO_4$	$Na_2\,Si\,O_3$	Rape Cake.	Dressed Grain. Quantity.	Dressed Grain. Weight per Bushel.	Total Straw.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Bushels.	Lbs.	Cwts.
1 *o*	Unmanured continuously				...	...	...	...	...	16⅜	52⅛	9¼
2 *o*	390	...	...	...	...	...	...	...	...	21⅜	53¼	10¼
3 *o*	...	...	...	...	200	100	100	...	..	17⅝	52½	9½
4 *o*	390	...	...	...	200	100	100	...	...	22	53⅛	11¼
5 *o*	390	...	...	...	200	...	...	...	...	18½	53⅜	10
1 *a*	...	...	100	100	...	...	...	...	...	28½	52	15¾
2 *a*	390	...	100	100	...	...	...	...	...	42½	53	23⅜
3 *a*	...	...	100	100	200	100	100	...	...	31⅛	52¾	17⅞
4 *a*	390	...	100	100	200	100	100	...	...	43½	54⅛	25¾
5 *a*	390	...	100	100	200	...	...	...	...	39	53⅞	24⅜
1 *aa*	...	275	...	...	...	...	...	...	...	32⅜	52⅛	18¾
2 *aa*	390	275	...	...	...	...	...	...	...	45½	53⅜	26¼
3 *aa*	...	275	...	...	200	100	100	...	...	33⅛	52⅝	20½
4 *aa*	390	275	...	...	200	100	100	...	...	46¼	53¾	28¼
1 *aas*	...	275	...	...	...	...	...	400	...	35	53¾	19⅞
2 *aas*	390	275	...	...	...	...	...	400	...	45¼	54½	26¼
3 *aas*	...	275	...	...	200	100	100	400	...	38¼	54¼	22¼
4 *aas*	390	275	...	...	200	100	100	400	...	46⅜	54⅞	28⅝
1 *c*	...	...	...	...	...	...	...	...	1,000	41	53⅞	23¼
2 *c*	390	...	...	...	...	...	...	..	1,000	43¼	54⅛	24¾
3 *c*	...	...	...	...	200	100	100	...	1,000	39⅜	54	23⅜
4 *c*	390	...	...	...	200	100	100	...	1,000	42¾	54	25⅜
1 *n*	...	275	...	...	...	...	...	...	...	34¼	52¾	20
2 *n*	...	275	...	...	...	...	...	...	...	38⅛	53	22⅝
m	390	...	...	...	...	100	100	...	...	19¼	53⅜	10¾
6 { 1	Unmanured continuously				...	...	...	...	...	18	52½	10
6 { 2	Ashes (burnt soil and turf)				...	...	...	...	...	18¾	52⅝	9⅞
7 { 1	Farmyard Manure, 14 tons; unmanured since 1871							...	...	38⅝	54⅛	22⅛
7 { 2	Farmyard Manure, 14 tons every year					...	...	...	...	48¾	54⅜	29⅛

Experiments on the Growth of Black Tartarian OATS.

PLOTS.	MANURES PER ACRE, PER ANNUM.							AVERAGE PER ANNUM, 5 YEARS, 1869–1873.			AVERAGE PER ANNUM, 4 YEARS, 1874, 5, 6, and 8.		
								Dressed Corn.			Dressed Corn.		
	Super.	$Na\,NO_3$	$(NH_4)_2\,SO_4$	$NH_4\,Cl$	$K_2\,SO_4$	$Mg\,SO_4$	$Na_2\,SO_4$	Quantity.	Weight per Bushel.	Total Straw.	Quantity.	Weight per Bushel.	Total Straw.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Bushels.	Lbs.	Cwts.	Bushels.	Lbs.	Cwts.
1	Unmanured		...	...	...	...	...	$19\frac{7}{8}$	$33\frac{3}{4}$	$10\frac{5}{8}$	$13\frac{3}{4}$	$31\frac{1}{4}$	6
2	390	...	...	...	200	100	100	$24\frac{1}{2}$	35	$13\frac{3}{8}$	$13\frac{1}{8}$	$31\frac{5}{8}$	$6\frac{1}{8}$
3	...	...	200*	200*	...	...	...	47	$35\frac{7}{8}$	$28\frac{1}{2}$	$28\frac{7}{8}$	$33\frac{1}{4}$	$14\frac{1}{8}$
4	390	...	200	200	200	100	100	59	37	$41\frac{1}{8}$	38	$35\frac{1}{2}$	20
5	...	550†	...	...	...	...	...	$47\frac{1}{8}$	$35\frac{1}{2}$	$27\frac{1}{2}$	$26\frac{3}{8}$	$31\frac{5}{8}$	$11\frac{1}{8}$
6	390	550†	...	...	200	100	100	$57\frac{1}{2}$	$35\frac{3}{4}$	35	$28\frac{1}{2}$	$34\frac{1}{8}$	14

* 100 lbs. only applied during the last four years. The experiments were discontinued after 1878.

† 550 lbs. of nitrate of soda is reckoned to contain the same amount of nitrogen as 400 lbs. "ammonia salts" (equal parts sulphate and chloride). 275 lbs. only were applied during the last four years.

Experiments on Swedish Turnips—*Fifteen Seasons*, 1856-1870.—*Roots and Leaves carted off the Land.*

Plots.	Manures per Acre per annum.							Series 1.		Each Plot manured as Series 1, and Cross-dressed as under :—							
										Series 2.		Series 3.		Series 4.		Series 5.	
	Farmyard Manure.	Super.	$(NH_4)_2SO_4$	NH_4Cl	K_2SO_4	$MgSO_4$	Na_2SO_4	No Cross-Dressing.		Cross-dressed : 5 years, 1856-60, 3,000 lbs. Sawdust ; 328 lbs. Nitric Acid. 10years, 1861-70, 550 lbs. Nitrate Soda.		Cross-dressed : 5 years, 1856-60, 200 lbs. Ammonia Salts. 10years, 1861-70, 400 lbs. Ammonia Salts.		Cross-dressed : 5 years, 1856-60, 200 lbs. Ammonia Salts, 3,000 lbs. Sawdust. 10years, 1861-70, 400 lbs. Ammonia Salts ; 2,000 lbs. Rape Cake.		Cross-dressed : 5 years, 1856-60, 3,000 lbs. Sawdust. 10years, 1861-70, 2,000 lbs. Rape Cake.	
								Roots.		Roots.		Roots.		Roots.		Roots.	
	Tons.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Tons	cwts.	Tons	cwts.	Tons	cwts.	Tons	cwts.	Tons	cwts.
1	14	...	...	...	...	...	...	6	4	7	9	8	8	8	16	8	0
2	14	390	...	...	...	...	..	6	7	7	13	8	5	8	14	7	16
3	Unmanured since 1846					...	...	0	11	0	19	0	13	3	6	3	8
4	...	390	...	...	300	100	200	2	16	5	2	4	12	6	12	5	8
5	...	390	...	...	...	...	...	2	12	4	13	3	16	5	16	5	0
6	...	390	...	...	300	...	...	2	7	4	11	4	5	6	6	5	3
7	...	390	$18\frac{1}{4}$	$18\frac{1}{4}$	300	...	...	2	12	4	13	4	12	6	15	5	9
8	Unman. 1853 and since; previously part. unman., part Superphosph.							1	3	1	13	1	2	3	19	3	14

Note.—"Sulphate of ammonia" is estimated to contain 23 per cent. ammonia, and "chloride of ammonium" 27 per cent. "Ammonia salts," in each case, equal parts sulphate and chloride of ammonium of commerce; and the mixture is estimated to contain 25 per cent. ammonia. The 328 lbs. of nitric acid (sp. gr., 1·35), mixed with sawdust, and used as a cross-dressing on the plots of Series 2, from 1856-1860, were estimated to contain nitrogen = 59 lbs. ammonia.

Experiments with MANGOLD WURZEL—*Average of Five Seasons*, 1886–90.—*Tops ploughed in.*

PLOTS.	MANURES PER ACRE, PER ANNUM.							SERIES 1.		SERIES 2.		SERIES 3.		SERIES 4.		SERIES 5.	
								No Cross-Dressing.		As Series 1, and Cross-dressed with 550 lbs. Nitrate Soda.		As Series 1, and Cross-dressed with 400 lbs. Ammonia Salts.		As Series 1, and Cross-dressed with 2,000 lbs. Rape Cake and 400 lbs. Ammonia Salts.		As Series 1, and Cross-dressed with 2,000 lbs. Rape Cake.	
	Farmyard Manure.	Super.	$(NH_4)_2 SO_4$	$NH_4 Cl$	$K_2 SO_4$	Na Cl	Mg SO_4	Roots.		Roots.		Roots.		Roots.		Roots.	
	Tons	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	T.	cwts.	Tons	cwts.	Tons	cwts.	Tons	cwts.	Tons	cwts.
1	14	...	...	...	...	...	...	15	15	20	19	20	2	21	9	21	11
2	14	390	...	...	...	...	...	16	7	22	11	19	15	21	11	21	8
3	Unmnrd. since 1846				...	...	...	4	3	13	13	6	7	10	8	10	15
4	...	390	...	...	500	200	200	4	15	18	8	14	16	22	7	19	7
5	...	390	...	...	...	...	...	4	14	15	12	8	2	10	10	11	10
6	...	390	...	...	500	...	...	4	4	15	4	13	13	19	13	16	6
7	...	390	18¼	18¼	500	...	...	5	1	15	16	14	14	20	10	17	3
8	Unmnrd. 1853 & since; previously part unmanured, part Super.							3	10	10	18	6	3	9	10	9	15
9*	14	390	...	...	...	...	...	...		...		16	11	...		...	

* Plot 9 sown on the flat and ridged up afterwards; rows 22 inches apart, and plants 10 inches, in rows.

Experiments with POTATOES—*Average of Five Seasons, 1886–90.—Tops ploughed in.*

Plots.	Manures per Acre, per Annum.								Produce per Acre.							
									Tubers.							
	Fmd. Manure.	Super.	Na NO_3	$(NH_4)_2 SO_4$	$NH_4 Cl$	$K_2 SO_4$	Mg SO_4	$Na_2 SO_4$	Good.		Small.		Diseased.		Total.	
	Tons.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Tons	cwts.	Tons	cwts.	Tons	cwts.	Tons	cwts.
1	Unmanured in 1876 and each year since							...	0	16½	0	3½	0	0¼	1	0½
2	Unmanured in 1882 and since; previously Farmyard Manure (14 tons)								1	16¾	0	3¾	0	0¾	2	1¼
3	14	...	...	...	...	...	...	...	3	5¼	0	4¼	0	1¼	3	13¾
4	14	...	...	...	...	...	...	...	3	12½	0	4¼	0	4¼	4	1
5	...	...	...	200	200	...	...	...	1	4½	0	4¾	0	0½	1	9¾
6	...	...	560	...	...	...	...	...	1	11¼	0	3¾	0	1	1	16
7	...	390	...	200	200	300	100	100	3	15¼	0	3¾	0	4¼	4	3¼
8	...	390	550	...	...	300	100	100	4	1½	0	3¾	0	4¼	4	9½
9	...	390	...	...	...	...	...	...	1	17½	0	3	0	0¾	2	1¼
10	...	390	...	...	...	300	100	100	2	3½	0	3¼	0	1	2	7¾

Plots		Manure per Acre, per Annum.								Produce per Acre, Weighed as Hay.					
										Average per Annum, 20 Years, 1856-75. (First Crops only.)			Average per Annum, 17 Years, 1876-92. (First & Second Crops.)		
		Super.	$Na\,NO_3$	$(NH_4)_2\,SO_4$	$NH_4\,Cl$	$K_2\,SO_4$	$Mg\,SO_4$	$Na_2\,SO_4$	$Na_2\,Si\,O_3$	10 Years 1856-65.	10 Years 1866-75.	20 Years 1856-75.	First Crops.	Second Crops.	Total.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
1	1856–63	...	...	100	100	and 14 tons Farmyard Manure				48 3/8	37 3/4	43	28 1/4	11	39 1/4
	Since	...	...	100	100	..	..	...	...						
2	1856–63	14 tons Farmyard Manure				...	...	..	...	41 5/8	32	36 7/8	21 3/4	8 3/4	30 1/2
	Since	Unmanured		...	...	...	...	...	...						
3		Unmanured continuously				...	...	...	...	22 1/2	20	21 1/4	17 7/8	8 1/4	26 1/8
4	1	390	...	...	...	...	...	...	...	23 1/4	21 1/4	22 1/4	18 1/2	8 5/8	27 1/8
	2	390	...	200	200	..	...	...	...	33 7/8	30 1/2	32 1/4	30 5/8	10 1/2	41 1/8
5		...	...	200	200	...	...	...	...	30 1/2	22	26 1/4	17 3/4	10	27 3/4
6	1856–68	...	...	2 0	200	...	...	...	...	31 3/8	30 1/4	30 3/4	29 1/8	11 5/8	40 3/4
	Since	390	...	...	...	500	100	100	...						
7		390	...	..	...	500	100	100	...	33 7/8	36 3/4	35 1/4	30 3/8	13 3/4	44 1/8
8	1856–61	390	...	...	..	300	100	200	...	33 5/8	26 1/4	30 1/8	20 1/4	9 1/8	29 3/8
	Since	390	...	...	...	...	100	250	...						
9		390	...	200	200	500	100	100	...	53 5/8	48 1/2	51	46 5/8	15 5/8	62 1/4
10	1856–61	390	...	200	200	300	100	200	...	52 3/4	39 5/8	46 1/8	38 3/8	15 3/4	54 1/8
	Since	390	...	200	200	...	100	250	...						
11	1	390	...	300	300	500	100	100	...	61 3/4	53 5/8	57 5/8	48 3/8	27	75 3/8
	2	390	...	300	300	500	100	100	400	63 1/4	61 3/4	62 1/2	60 1/4	25 3/8	85 5/8
12		Unmanured continuously				...	...	...	...	25	22 7/8	24	18 3/8	10 1/2	28 7/8
13		390	...	200	200	500	100	100	...	55 1/4	59 5/8	57 1/2	51 1/2	20 1/2	72
14		390	300	...	...	500	100	100	...	53 1/8	60 1/2	57	51 1/2	13 1/2	65
15	1858–75	...	550	...	...	...	...	...	...	36 1/8	35	35 3/8	26 1/8	8 3/4	31 7/8
	Since	390	300	...	...	500	100	100	...						
16		390	275	...	...	500	100	100	...	45 1/4	47 5/8	46 1/2	40 5/8	12 1/8	52 3/4
17		...	275	..	...	...	...	...	...	34 1/4	33 1/2	33 7/8	29 5/8	10	39 5/8
18		Minerals and Nitrogen in a ton of hay					...	...	...	21	33 1/4	32 1/8	31 1/8	12 1/2	43 5/8
19		390	275	...	...	290	...	...	...	..	...	38 5/8	37 1/2	11 3/8	48 7/8
20*		390	327	...	...	...	...	...	...	...	...	36 1/3	38 3/8	10 7/8	49 5/8

* With 327 lbs. of nitrate of potash.

SUMMARY AND PRACTICAL CONCLUSIONS OF THE EXPERIMENTS AT ROTHAMSTED.

RAIN AND DRAINAGE WATERS.

1. Most of the nitrogen of farm crops is derived from the nitric acid of nitrates within the soil.

2. The nitric acid in the soil is produced from the nitrogenous compounds of the soil itself, from the nitrogenous organic matter of animal and vegetable manures, from the ammonia of artificial manures, and from the ammonia supplied by rain and condensation from the atmosphere. A very small quantity of ready-formed nitric acid is supplied by rain and condensation from the atmosphere. Nitric acid is also provided by the direct application of nitrates.

3. The ammonia of ammonium salts is rapidly converted into nitric acid in the soil, as also is the nitrogen of some organic matters, such as urine. The nitrogen of rape cake, that of the less soluble parts of farmyard manure, of stubble, of roots, &c., is much more gradually converted into nitric acid, and it may require many years for the conversion of the whole of it. The nitrogenous compounds of the soil itself are very slowly converted into nitric acid, but the soil yields a certain quantity every year.

4. When there is no vegetation, and there is drainage from the land, or even when there is vegetation, and excess of drainage, nitric acid is lost by drainage.

5. As in the case of permanent grass land the soil is always covered with vegetation, there will be with it the maximum amount of nitric acid utilised by the crop, and the minimum amount lost by drainage. Land without vegetation will be subject to the maximum loss of nitric acid by drainage.

6. The power of a growing crop to utilise the nitric acid in the soil is much diminished if there be a deficiency of available mineral constituents, and especially of potash and phosphoric acid, within the reach of the roots.

7. As the various crops grown upon a farm differ very much as to the period of the year of their most active growth, the length of time they remain on the land, and the character and the range of their roots, their capacity for taking up nitric acid from the soil is very different.

8. The recognised exhausting character of corn crops is largely due to the limited season of their active growth, and the long period during which the land is bare, or there is little growth, and so subject to loss of nitric acid by drainage.

9. When salts of ammonium, or nitrates, are applied as manure, the chief, if not the only unexhausted residue of nitrogen left within the soil available for future crops, is that in the increased roots and other residues of the crops; and this is only slowly available.

10. When oilcakes or other foods are consumed by stock, the formation of nitric acid from the manure produced is slower, but continues longer than when salts of ammonium are used. When there is a liberal use of animal manures, an accumulation of nitrogenous and mineral matter takes place in the soil, and such accumulation is known under the term "condition." Under such circumstances the fertility of the soil is maintained, or it may even be considerably increased.

Wheat.

The Soil.

1. A soil which in the ordinary course of agriculture would have received an application of manure before another crop was grown, has produced forty crops of wheat in succession, averaging 14 bushels per acre, solely by means of its existing fertility.

2. At the commencement of the experiments the soil contained a large amount of organic nitrogen, derived from the *débris* of pre-existing vegetation. It also contained a large amount of the mineral food of plants.

3. Every year a certain proportion of the organic nitrogen has been nitrified by the agency of organisms existing in the soil.

4. Part of the nitrates formed has been employed in the growth of the wheat crop; part has been washed out of the soil or otherwise lost.

5. The loss of nitric acid is greater in wet seasons, and the amount taken up by the wheat crop is in consequence smaller. Comparatively dry seasons should therefore be favourable for the production of large crops of wheat.

6. The stock of soil fertility in the form of organic nitrogen has been considerably reduced during the forty years that the experiments have been carried on; and the amount of such

reduction has been ascertained by analyses of the soil made at different periods. The stock of both potash and phosphoric acid has also been largely reduced.

7. Although so much soil fertility has been removed, the stock that remains would appear to be sufficient to grow crops of wheat for a very long period; the produce, however, must in process of time necessarily be lower than it has hitherto been.

Manures.

8 Mineral manures alone have added very slightly to the produce grown upon the unmanured land.

9. Manures containing nitric acid alone, or some compound of nitrogen which is easily nitrified, have considerably increased the crop.

10. The soil therefore contained a stock of minerals which the wheat crop was unable to make use of, owing to the insufficient supply of nitrogen in some available form.

11. Manures consisting of potash, phosphoric acid, and ammonia or nitrates, appear competent to grow large crops of wheat continuously.

12. A given weight of nitrogen as nitric acid, has produced more growth in the wheat crop than the same weight of nitrogen in salts of ammonia.

13. The amount of nitrogen supplied in the manures is very much in excess of the amount recovered in the increase of the crops.

14. After a certain amount of growth has been reached, each increase of crop requires a proportionately larger application of manure. When the price of grain is high, larger crops can be grown more profitably than when the price is low.

15. When farmyard dung is employed to grow wheat, a considerably larger amount of nitrogen must be applied to produce a given increase in the crop, as much of the nitrogen contained in the dung is not in an active condition.

16. A given weight of nitrogen, in the form of nitric acid, will produce more growth in the crop to which it is applied than the same weight of nitrogen in dung; but the influence of the nitrate upon succeeding crops will be very much less.

17. There is no evidence to show whether the whole available effect of the nitrogen in one manure is greater than it is in the other.

Unexhausted Manures.

18. In the absence of vegetation, or when applied to crops in excess of their requirement, both potash and phosphoric acid form insoluble compounds with the soil and become available for future crops.

19. In the absence of vegetation, or when the amount supplied is in excess of the requirements of the crop, nitrates and salts of ammonia do not appear to form permanent compounds with the soil, but, on the contrary, are liable to be washed out by rain, or to be otherwise lost.

20. The application of a larger amount of nitrogen, as nitrates or salts of ammonia, than the crop can utilise, does not appear to prevent the nitrification of the organic nitrogen of the soil.

21. The stock of nitrogen of the soil itself, therefore, may be reduced, although the annual application of nitrogen may be much in excess of the amount of that substance removed in the crop.

22. When large crops of wheat have been grown by the application of nitrates or salts of ammonia, with mineral manures, the soil does not appear to have gained or lost fertility. Nitrification of the organic matter in the soil may have gone on as usual, but the loss has been made good by the amount of nitrogen stored up in the stubble and underground roots of the large crops so grown.

23. When dung is applied continuously to land, the accumulation of unexhausted fertility becomes very large, and the removal by crops of the substance accumulated would extend over a long series of years.

24. Dung applied to land in the ordinary processes of agriculture will not be entirely exhausted until a considerable number of years have elapsed from the time of its application.

Permanent Pasture.

1. By the judicious employment of manures, both natural and artificial, arable land has been converted into permanent grass, not only without loss, but with some profit to the tenant.

2. The important constituents, nitrogen and phosphoric acid, were supplied in the manures in larger quantities than they were removed in the crops; but potash in only about the same quantity as it was removed.

3. The application of dung not only compensates for much of the exhaustion from the removal of hay, but it has a beneficial influence on the botanical character of the herbage.

4. Although the grass has been mown every year for nearly thirty years, there has been a considerable accumulation of fertility within the soil.

5. Analysis has shown that there has been an increase of nitrogen in the surface soil, beyond that which could be explained by excess supplied in manure over that removed in crops, and by the combined nitrogen coming down in rain, and the minor deposits from the atmosphere. Part, if not the whole, of this increase is probably derived from the subsoil by deep-rooted plants, which afterwards leave a nitrogenous residue within the surface soil. Or, possibly, some of it may have its source in the free nitrogen of the atmosphere, brought into combination within the soil, under the influence of micro-organisms, or other low forms.

6. In laying down arable land to permanent grass, especially if hay is to be removed, it is essential to supply, not only nitrogenous, but an abundance of mineral manures, and especially of potash, a large quantity of which is removed in the crops, and must be returned. When the grass is not mown, but fed, the exhaustion is much less, but it is greater when consumed for the production of milk than when for that of store or fattening increase.

Root Crops.

1. Like sugar-beet grown for sugar, roots grown for feeding purposes are very artificial productions. The swollen root consists of a very abnormal development of the reserve material for the second growth of stem and seed; and the conditions of growth, as to the period of the season selected, the soil, and the manuring, are such as to obtain the maximum development within the season.

2. Roots, as grown in our rotations, are generally considered to be restorative crops. But they depend for their successful development on large quantities of manure, which is sometimes applied for the previous grain crop, but more frequently directly for the roots themselves; and when grown without manure, even from the same seed as the manured crop, either for a few years in succession on the same land, or even in rotation, they soon revert to the uncultivated condition.

3. Independently of the great advantage arising from the opportunity which the growth of roots affords for the cleaning

of the land, the benefits of growing the crop in rotation are due—to the large amount of manure applied for its growth, to the large residue of the manure left in the soil for future crops, to the large amount of matter at once returned as manure again in the leaves, to the large amount of food produced, and to the small amount of the most important manurial constituents of the roots which is retained by the animals consuming them, the rest returning as manure again.

4. 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 land, so far as nitrogen is concerned, may be more rapidly exhausted by the growth of turnips by superphosphate than by any other crop.

5. 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.

6. If nitrogenous manures are used in excess—that is, in such amount as so 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. In fact, the higher the nitrogenous manuring, and the heavier the soil, the greater is the tendency to produce a large amount of leaf.

7. In the case of both common and swedish turnips, the leaf contains a much higher percentage of dry substance than the root; and the dry substance of the leaf contains a much higher percentage of both nitrogen and total mineral matter than does that of the root.

8. Common turnips yield a much higher proportion of leaf to root than swedish turnips: and if the leaf be unduly developed, there may even be more nitrogen, and more total mineral matter, remaining in the leaf, to serve only as manure again, than accumulated in the root to be used as food. In the case of swedish turnips, however, not only is the proportion of

leaf to root very much less under equal conditions of growth; but the amount of dry matter, of nitrogen, and of mineral matter, remaining in the leaf, is very much less than in the root. In fact, whilst in the case of common turnips a very large amount of the matter grown is accumulated in the leaf and only serves as manure again, in that of swedish turnips a comparatively small proportion of the produce is useless as food for stock.

9. The root of the swedish turnip contains a less percentage of water—that is, a higher percentage of solid matter or food material—than that of the common turnip. The dry or solid matter of the swedish turnip root also contains a lower percentage of mineral matter, and consequently a higher proportion of organic food substance.

10. The more deeply and powerfully rooting and more vigorous mangold is sown earlier, has a longer cycle of growth, and, even under the same conditions as to manuring, yields more produce per acre than either common or swedish turnips. It requires, however, for full crops, much heavier dressings of manure.

11. The proportion of mangold leaf to root is, as a rule, very much less than in the case of common turnips, but more than in that of swedish turnips.

12. With the more extended root range of the mangold, it is less dependent on continuity of rain when growth is once well established; and it bears, or rather requires, for its full development, a higher temperature than the turnip.

13. The mangold root contains a higher percentage of solid matter than either common or swedish turnips. But whilst the turnip leaf contains a much higher percentage of dry matter than the turnip root, the mangold leaf contains a much lower percentage of dry matter than the mangold root, and also a very much lower percentage than the turnip leaf.

14. As in the case of turnips, the dry substance of the mangold leaf contains a much higher percentage of both nitrogen and mineral matter than does the dry substance of the root. Indeed, the dry substance of the mangold leaf contains not far from twice as high a percentage of mineral matter as that of the turnip leaf; but it contains upon the whole a rather lower percentage of nitrogen than that of the turnip leaf. It would seem that the mangold leaf is more fully exhausted of migratory organic matters in the greater development of the root than is the swede leaf, and more still than the common turnip leaf.

15. Superphosphate is much less beneficial to mangolds

than to turnips. In mangolds, as in turnips, the amount of dry substance grown has a very direct relation to the amount of nitrogen available within the soil. But more vegetable substance was produced, and more stock food yielded, from a given quantity of nitrogen applied to mangolds than to either description of turnips. By the application of nitrogen to the soil for mangolds, there was, in many cases, an increased assimilation of about a ton of carbon per acre from the atmosphere.

16. Taking the average of six years, the amount of nitrogen recovered in the increased crop of mangold roots was about 60 per cent. of that supplied when nitrate of soda was used, about 42 per cent. when ammonium salts, about 50 per cent. when rape cake, and about 46 per cent. when an excessive amount in a mixture of rape cake and ammonium salts was employed. There was, of course, an additional amount accumulated in the leaves, but these were annually returned to the soil as manure.

17. When farmyard manure is applied for mangolds, larger amounts of nitrogen are supplied per acre than were used in any of the Rothamsted experiments with artificial manures, a less proportion of the nitrogen supplied is recovered in the increase of crop, and more remains for future crops. It is the nitrogen of the liquid ejections of the animals that is first rendered available within the soil, then that of the finely comminuted matter mixed with some secretions in the solid excrements, and finally that of the litter.

18. As in the case of turnips, these assumed restorative crops are themselves pre-eminently dependent on manure for their development. They produce a large amount of vegetable substance, but a large amount of the manure remains for future crops: whilst, of the substance grown, that accumulated in the leaf is at once manure again, and of the portion used as food by far the larger proportion of the constituents valuable as manure is eventually recovered as such in the excrements of the animals. When, however, the roots are consumed for the production of milk, the loss to the manure will be greater than when they are consumed by either store or fattening stock.

19. The selection of the proper description of roots to be grown cannot be settled merely by a consideration of the amount of produce obtained from a given quantity of manure, of the proportion of the crop which is available as food for stock or only remains for manure again, or of the high or low percentage of solid matter in the food portion of the crop. The general economy of the farm, the character of the soil, but more especially that of the climate of the locality, must

also be taken into account. The great influence of climate is strikingly illustrated by the different proportions in which the different descriptions of roots are grown in different divisions of the United Kingdom.

20. The experiments showed a higher percentage of dry matter in swedish than in common turnips, and a higher percentage in mangolds than in swedes. But, with each description of roots, the range in the percentage was considerable, according to season and to manuring. The percentage of dry matter was the lower, the greater the excess of nitrogeneous manure, the greater the luxuriance, the larger the crops, and the less matured the roots; and it was, conversely, the higher the more matured the roots.

21. The percentage of mineral matter in the roots was the higher, the greater the luxuriance, and the more crude and unripe the roots.

22. The percentage of nitrogen in the roots was very small, but very variable. It was the higher the more nitrogen was applied by manure, the greater the luxuriance, and the less matured the roots; and it was the lower, the riper the roots.

23. Nearly two-thirds of the dry substance of mangolds was found to be sugar. The *percentage* of sugar was the greater the more mature the roots: and it was consequently the greater in the roots of the smaller crops. But the amount of suger *per acre* was much the greatest with the largest crops —that is, where the most nitrogen was applied in the manure. The roots grown by farmyard manure alone contained more than one ton of sugar per acre; and by the addition of artificial nitrogenous manure to the farmyard manure, there was an increase of more than half a ton of sugar per acre. In several cases the addition of artificial nitrogenous to a complete mineral manure, increased the production of sugar by more than a ton per acre.

24. By the addition of nitrogenous to a complete mineral manure, 1 lb. of nitrogen applied as nitrate of soda yielded an increase of 22·1 lbs. of sugar; 1 lb. of nitrogen as ammonium salts, 19 lbs. of sugar; 1 lb. as rape cake, 20·8 lbs. of sugar; and 1 lb. of nitrogen applied in excessive amount in a mixture of rape cake and ammonium salts gave an increase of only 13·7 lbs. of sugar.

25. In ripened products by far the larger proportion of the nitrogen exists in the most favourable food condition of albuminoids, or protein compounds; but in unripened ones, and especially in such succulent, crude, and immature pro-

ductions as feeding roots, a large portion of the nitrogen exists in the much less valuable condition of amide compounds, and in some cases a not inconsiderable amount is in the non-food, or even injurious forms, of nitrates and ammonium salts.

26. In mangolds, with their more luxuriant growth, and frequent greater immaturity when taken up, there is probably, as a rule, a less proportion of the total nitrogen in the albuminoid condition than in either common turnips or swedes. There is also probably a less proportion of amide nitrogen, and pretty certainly a larger proportion of nitrogen as nitrates and in other forms. But the range in the proportion of the nitrogen as albuminoids varies very much with each description of roots, being the less the greater the luxuriance, and the less matured the crop.

27. Feeding roots are essentially *sugar crops*. Although the percentage of dry matter varies considerably with each description of root, according to the conditions of growth, the average amount of dry matter may be taken as, approximately, 8 per cent. in white turnips, 9 per cent. in yellow turnips, 11 per cent. in swedes, and 12·5 per cent. in mangolds. Of the dry matter of white and yellow turnips nearly, or more than, half may be sugar; of that of swedes more than half; and of that of mangolds nearly, or as much as, two-thirds may be sugar.

28. In cereal grains, the proportion of albuminoid matter to non-nitrogenous food material is about as 1 to 6. In roots the albuminoid ratio varies very greatly; but it is probably seldom more than 1 to 12, and frequently as low as 1 to 20 or more. The ratio will probably, as a rule, be lower in swedes than in common turnips, and lower still in mangolds.

29. With roots, should be given other foods, richer in albuminoid matters, and which contain a higher proportion of albuminoid to digestible non-nitrogenous substances; but they are, by virtue of the large amount of sugar they supply, very valuable for meeting the respiratory requirements of the animals, also for fat-forming, and for milk-production.

30. Both the quantity and the quality of feeding roots, and consequently the feeding value of the crop, depend greatly on the description grown, and on the character and amount of the manure, and especially on the amount of nitrogenous manures employed. Independently of the necessary consideration of the general economy of the farm, the choice on these points must be guided, partly by the character of the soil, but very much more by that of the climate of the locality.

CROPS.

Nat. Ord. *Gramineæ.*

WHEAT.

Botanical genus:—*Triticum.*

Species known are:—

1. *Triticum sativum* or *vulgare*—Common or soft wheat; smooth and bearded; winter and spring varieties.
2. *T. turgidum*—Turgid or plump wheat.
3. *T. durum*—Hard wheat.
4. *T. monococcum*—One-grained wheat.
5. *T. Polonicum*—Polish wheat.
6. *T. amyleum*—Starch wheat.
7. *T. spelta*—Spelt wheat.

The first two include all the varieties grown in this country. The following are the principal ones:—

T. sativum.

White Wheat.—Talavera, Essex, Chidham, Hunter (white and yellow), Hopetoun, Brodie, Uxbridge, Fenton, Woolly-eared Bearded or Velvet, Wells's Challenge, Trump, Hallett, Sheriff, Hardcastle, Victoria.

Red Wheat.—Browick, Spalding, Burwell or Old Red Lammas, Golden Drop, Nursery, White Chaff, April Bearded, Square-Head.

T. turgidum.

Rivett (common), Rivett (cone).

Quantity of seed per acre—1 to 3 bushels—the lesser quantity if put in in October—drilled 6 to 9 inches apart, and $1\frac{1}{4}$ to $1\frac{3}{4}$ in. deep.

Weight per imperial bushel—60 to 65 lbs. Average of experiments at Rothamsted with 26 varieties of wheat, over a period of 8 years—61·25 lbs. Average of Edinburgh market, for 13 years—62·2 lbs.

No. of grains in a bushel at 63 lbs. weight and 87 to the drachm—701,560.

Average produce per acre—30 bushels.

Average produce of straw per acre—30 to 33 cwts.

Proportion of grain to straw—33 % of grain to 67 % of straw and chaff, by weight.

Proportion of dressed corn to tail corn—100 dressed to 10 offal.

Proportion of grain to straw in stack—1 bushel to every 27 cubic feet.

Suited to the stiffer soils, after clover, beans, tares, or fallow; alternates with beans on the heaviest soils. Browick, Spalding, Square-Head, or Rivett best for cold, stiff, wet soils.

Usual size of sheaf—11 in. diameter.

Weight of sheaf 10 to 12 in. diameter—25 to 30 lbs., green.

Direction to set stooks—From north-east to south-west, to get the sun at both sides, and also to suit the direction of the wind for drying.

YIELD OF WHEAT IN THE BEST AND WORST SEASONS ON CERTAIN SELECTED PLOTS AT ROTHAMSTED.

No of Plot.	Best Season, 1863.			Worst Season, 1879.			Average of 32 Years.		
	Bushels per Acre.	Weight per Bushel.	Straw and Chaff.	Bushels per Acre.	Weight per Bushel.	Straw and Chaff.	Bushels per Acre.	Weight per Bushel.	Straw and Chaff.
		Lbs.	Lbs.		Lbs.	Lbs.		Lbs.	Lbs.
3	$17\frac{1}{4}$	62·7	1,600	$4\frac{3}{4}$	52·5	763	$13\frac{1}{2}$	58·8	1,272
2	44	63·1	4,279	16	56·8	2,239	$33\frac{1}{2}$	60·0	3,570
5	$19\frac{5}{8}$	63·0	1,723	$5\frac{5}{8}$	53·5	855	$15\frac{1}{4}$	58·7	1,464
6	$39\frac{5}{8}$	62·3	3,715	$10\frac{1}{2}$	56·5	1,592	$24\frac{1}{8}$	59·5	2,512
7	$53\frac{5}{8}$	62·5	5,866	$16\frac{1}{4}$	56·7	3,012	$32\frac{3}{4}$	59·5	3,771
9	$55\frac{5}{8}$	62·1	6,312	22	56·5	4,347	$36\frac{1}{4}$	58·7	4,688
8	$55\frac{3}{4}$	62·3	6,602	$20\frac{5}{8}$	56·5	4,176	$36\frac{1}{4}$	59·2	4,532

Average Results of Experiments at Rothamsted with different Descriptions of Wheat: 8 Years, 1871–78.

	Bushels per Acre, dressed.	Weight per Bushel, Lbs.	Total Grain per Acre, Lbs.
White Wheat:—			
Belgian	52·50	60·75	3,190
Main's Rough Chaff ...	50·63	61·37	3,107
Main's Standing White ...	50·12	61·75	3,095
Hardcastle	44·63	61·37	2,738
Casey's White	42·12	60·63	2,553
Woolly-Ear	41·37	61·37	2,540
Hallett's Victoria White ...	40·37	61·37	2,493
Red Chaff	39·00	61·37	2,392
Hallett's Hunter's White ...	37·87	60·75	2,300
Chidham	37·12	62·00	2,300
Red Wheat:—			
Rivett's	53·63	58·75	3,164
Square-Head (Club) ...	49·25	61·12	3,010
White Chaff	48·87	61·00	2,980
Hallett's Golden Drop ...	46·75	62·50	2,922
Red Rostock...	45·12	59·87	2,700
Bole's Prolific	44·00	61·50	2,700
Red Wonder	42·37	61·25	2,595
Red Bristol	42·12	61·25	2,580
Red Langham	41·63	61·63	2,565
Browick	41·63	61·00	2,540
Chubb	41·25	60·75	2,506
Golden Rough Chaff ...	40·37	62·00	2,503
Burwell (Old Red Lammas)	39·63	62·63	2,490
Red Nursery	39·12	63·12	2,470
Hallett's Original Red ...	36·50	59·37	2,167
Average of all ...	43·50	61·25	2,664

One quarter of wheat weighing 500 lbs. yields in grinding as follows:—

	Lbs.	Per Cent.
Flour	380 ...	76
Bran	26 ...	5·2
Pollards	50 ...	10
Sharps	34 ...	6·8
Shrinkage	10 ...	2
	500	100·0

Range of temperature at which wheat will ripen is from 78° to 44° F. The lower the temperature, the longer is the time required to grow a crop.

A dry climate is most suitable, and therefore it succeeds best on the East Coast.

Bearded and beardless, winter and spring growing, are not characteristics of particular kinds of wheat, but are due to soil, climate, and cultivation, and can be greatly modified thereby.

OATS.

Botanical genus :—*Avena.*

Species known are :—

1. *Avena sativa*—Common oat.
2. *A. Orientalis*—Tartary oat.
3. *A. brevis*—Short oat.
4. *A. nuda*—Naked oat.
5. *A. strigosa*—Bristle-pointed oat.
6. *A. fatua*—Wild oat.

The following are the varieties chiefly cultivated :—

A. sativa.

Potato, Hopetoun, Sandy, Angus (Early, Late, and Grey), Blainslie, Berlie, Dun, Barbauchlaw, Poland, Tam Finlay, Sheriff's varieties, Longfellow, Hamilton, Winter, and Clemrothery.

A. Orientalis.

White Tartarian. Black Tartarian.

A. strigosa often grows as a weed among cereal crops, and thus is sometimes confounded with the Wild Oat.

Quantity of seed per acre—2½ drilled to 5 bushels broadcast; occasionally 6 bushels for long oats.

Weight per bushel—42 lbs.: ranges from 35 to 48 lbs.

No. of grains in a bushel—White Tartarian at 42 lbs., 731,100.

Proportion of kernel to husk—75 % to 25 %.

Average produce per acre—40 to 70 bushels.

Average produce of straw per acre—25 to 40 cwts.

Proportion of grain to straw—37 % of grain to 63 % of straw and chaff, by weight.

Proportion of grain to straw in stack—1 bushel to 16 cubic feet.

1°. Varieties suited to the best soils and situations—Potato, Hopetoun, Early Angus, Poland, Hamilton.
2°. Varieties suited to intermediate soils and situations—Berlie, Blainslie, Grey and Late Angus, Poland, Tam Finlay, Dun, Sheriff's, Sandy, Longfellow, Clemrothery.
3°. Varieties suited to high altitudes and exposed situations—Black Tartarian, Barbauchlaw.

Oats suit all soils; replace wheat in the rotation. Usually the first cereal grown in reclaiming moors and bogs. A cool moist climate most favourable. Must be cut before ripe, as grain sheds easily. Thick husk. Chief albuminoid in grain is oat-legumine or *avenine*, which has an excitant effect on the motor cells of the nerve system; effect disappears if oats are bruised or ground in feeding horses. New oats cause scour or colic, and must be kept some time to ripen in store for horse feed.

100 lbs. of oats at 45½ lbs. per bushel will commonly yield in milling as follows:—

Oatmeal	60 lbs
Husks	26 ,,
Water (kiln-drying)	12 ,,
Loss	2 ,,
	100 ,,

MEAL yielded by various varieties of Oats per 100 lbs. of good quality grain:—

	Lbs.
Hopetoun	60·5
Barbauchlaw	60·5
Potato	60·33
Sandy	60·0
Berlie	58·0
Early Angus	55·66
Tam Finlay	55·36
Sheriff	52·3
Blainslie	51·75

The best oats may show four times more albuminous and starchy matter than the worst, by analysis; and one sample of oatmeal may contain three times more of these food elements than another, weight for weight. The best oats for oatmeal grow on clay land, while those from sandy or light soil are inferior for this purpose.

BARLEY.

Botanical genus:—*Hordeum.*

Species known are:—

1. *Hordeum distichum*—Ordinary two-rowed barley.
2. *H. vulgare*—Ordinary four-rowed barley: "bere" or "bigg."
3. *H. hexastichum*—Six-rowed barley.
4. *H. zeocriton*—Spratt or battledore barley; German rice or rice barley.

The first includes all the varieties of ordinary barley sown in the South country, of which the following are the principal:—Annat, Chevalier, Golden Drop, Beardless, Golden Melon, Hallett's Pedigree, and Giant.

H. vulgare.

Common Bere, Black Four-rowed, Victoria, and Winter White Bere. Bere was formerly much grown in Scotland.

Quantity of seed per acre—$2\frac{1}{2}$ to 4 bushels; if drilled 6 to 9 inches apart, 2 bushels. Sow in March.

Weight per bushel—55 lbs.

No. of grains in a bushel: Chevalier barley, at 57 lbs. per bushel—547,200.

Proportion of kernel to husk—90 % of kernel to 10 % of husk.

Average produce per acre—35 to 45 bushels.

Average produce of straw per acre—13 to 20 cwts.

Proportion of parts—Grain, 50 %; haulms, 8 %; straw, 42 %: by weight.

Proportion of grain to straw in stack—1 bushel to 21 cubic feet.

Suited to light and calcareous soils, after green crop; shallow and weak-rooted of itself.

Malted Barley is made by soaking the grain in water for 48 hours, and allowing it to germinate on a floor: the plumule and radicle develop, and the malted grain is then dried at a high temperature (145° to 164° Fah.) to kill the embryo plant; the shoots (= malt dust or combings) are separated by screening. In the process of germination one-eighth part of the starch is converted into sugar, as much probably into soluble compounds—dextrine, maltose, &c. ; 3 to 6 % is lost as carbonic acid (CO_2), and 3 to 4 % as "dust" or "combings." The whole process occupies from 10 to 20 days. For cattle-feeding it is used immediately after germination.

The comparative feeding composition of barley and malt is as follows :—

	Barley.		Malt (dry).
Water	12	...	8·0
Starch	68	...	51·6
Albuminoids	10	"Hordein"	11·0
Sugar	5	...	13·8
Gum	4	...	13·8
Resin	1	and Gluten	1·8
	100		100·0

RYE.

Botanical genus :—*Secale.*

Only one species—*Secale cereale.*

Varieties are—Common or Winter, Spring, St. John's Day or Midsummer (*S. cereale multicaule*), Russian, Giant or Tyrolese.

Quantity of seed per acre—2 bushels drilled to 4 bushels broadcasted. Sown in autumn for soiling.

Weight per bushel—54 lbs.

No. of grains in a bushel at 55 lbs.—1,161,600.

Average produce per acre—25 to 30 bushels.

Average produce of straw per acre—35 to 40 cwts

Proportion of parts—32 % grain to 68 % straw, by weight.

Suits light, poor soils up to 80 % of sand, and will grow up to 1,200 feet above sea level. Often grown on mossy land where oats would lodge. Must be cut immediately after it shoots for soiling. Straw tough and wiry, making best thatch and litter.

RYE-GRASS.

Botanical genus :—*Lolium.*

Three species are cultivated :—

1. *Lolium Italicum*—Italian rye-grass.
2. *L. annum vulgare*—Annual rye-grass
3. *L. perenne*—Perennial rye-grass.

The Italian differs from the Perennial in its growing more in tufts, having awns on the glumes, and yielding a larger produce under cultivation. It usually, however, dies out in two or three years, and is thus unsuitable for permanent pasture, though if highly manured it will crop for a long time

During the last few years the vitality of Perennial Rye-Grass has been called in question, but the bulk of the evidence goes to prove that it is a desirable component of all permanent mixtures on account of its hardiness and bulky yield. An examination of old pastures has shown that they are largely composed of this grass along with white clover. There are three varieties:—

1. *L. perenne*—Common.
2. *L. perenne Paceyanum*—Pacey's.
3. *L. perenne sempervirens*—Evergreen.

Quantity of seed per acre—2 bushels when sown alone, but less than 1 bushel if sown with other grasses and clovers.

Weight per bushel—Italian, 18 to 21 lbs.; Annual, 22 lbs.; Perennial, 24 to 28 lbs.

Average produce per acre—30 bushels.

Average produce of hay per acre—20 to 30 cwts.

Proportion of seed to thrashed hay—1 bushel per cwt.; varies greatly according to time of cutting.

Suited to all kinds of soils; will stand heavy manuring, as can be cut often, so that it is adapted for sewage meadows; a moist climate, also, is desirable.

TIMOTHY GRASS OR CATSTAIL.

Botanical genus:—*Phleum.*

Only one species cultivated—*Phleum pratense.*

Distinguished from Foxtail (*Alopecurus pratensis*) by its bulbous roots, and by the possession of firm, compact, largish "heads:" Foxtail having looser and softer florets, with long awns.

Quantity of seed per acre—20 lbs. alone.

Weight per bushel—48 lbs.

Average produce of hay per acre—40 to 80 cwts., green cut

Especially suited to marly, marshy, and mossy soils, and also to sewage meadows.

Can replace part of the rye-grass in a mixture.

LIST OF THE PRINCIPAL GRASSES.

A = Annual; P = Perennial; B = Biennial.

Botanical Name.	English Name.	Altitude: North of England.	Weight of Seed per Bush.	Percentage of Germination.	Number of Seeds in 1 Lb.	Week of the Month of Flowering.	Duration.
		Feet.	Lbs.		About		
Alopecurus pratensis ...	Meadow Foxtail	Up to 2,000	12	85	490,000	May 1	P
Anthroxanthum odoratum	Sweet Vernal	,, 3,400	14	70	738,000	May 1	P
Avena elatior	Tall Oat Grass	,, 1,500	14	90	138,000	June 3	P
Avena flavescens ...	Golden Oat Grass... ...	,, 1,600	12	70	1,400,000	July 3	P
Cynosurus cristatus ...	Crested Dogstail	,, 1,800	38	95	886,000	July 3	P
Dactylis glomerata ...	Cocksfoot	,, 1,600	22	95	426,000	June 3	P
Festuca duriuscula ...	Hard Fescue	,, 2,700	23	90	578,000	June 3	P
Festuca elatior ...	Tall Fescue	,, 1,300	24	95	246,000	July 1	P
Festuca ovina	Sheep's Fescue	,, 4,300	28	80	1,561,000	June 3	P
Festuca pratensis ...	Meadow Fescue	,, 1,600	30	96	236,000	July 1	P
Lolium Italicum ...	Italian Rye-Grass... ...	,, 1,000	23	96	270,000	June 2	B
Lolium perenne ...	Perennial Rye-Grass ...	,, 1,600	28	96	223,000	June 1	P
Phleum pratense ...	Catstail or Timothy ...	,, 1,400	50	98	1,320,000	July 1	P
Poa nemoralis	Wood Meadow Grass ...	,, 1,600	24	85	2,325,000	June 3	P
Poa pratensis	Smooth-stalked Meadow Grass	,, 2,400	32	75	1,860,000	June 3	P
Poa trivialis	Rough-stalked do. ...	,, 2,700	30	98	2,23[illegible],000	June 3	P

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LIST OF THE PRINCIPAL CLOVERS, &c.

A = Annual; P = Perennial; B = Biennial.

Botanical Name.	English Name.	Altitude: North of England.	Weight of Seed per Bush.	Percentage of Germination.	Number of Seeds in 1 Lb.	Week of the Month of Flowering.	Duration.
		Feet.	Lbs.		About		
Medicago lupulina ...	Trefoil or "Nonsuch" Clover	Up to 1,000	66	98	319,000	May 3	A
Medicago sativa ...	Lucerne	,, 1,000	64	98	224,000	June 3	P
Trifolium hybridum ...	Alsike Clover	,, 1,500	66	98	718,000	June 1	P
Trifolium pratense ...	Red or Broad Clover ...	,, 1,000	65	98	232,000	June 1	B
Trifolium pratense perenne	Perennial Red Clover ...	,, 1,500	65	98	218,000	June 2	P
Trifolium incarnatum...	Crimson Clover	,, 500	65	98	118,000	May 3	A
Trifolium procumbens..	Yellow Hop Trefoil ...	,, 1,000	66	96	...	June 3	P
Trifolium repens ...	White or Dutch Clover ...	,, 1,500	66	98	732,000	May 3	P
Achillea millefolium ...	Yarrow or Milfoil... ...	,, 1,000	36	85	3,510,000	June 4	P
Anthyllis vulneraria ...	Kidney Vetch	,, 2,700	64	96	193,000	June 3	P
Lotus major	Greater Birdsfoot Trefoil	,, 1,500	64	90	363,000	July 4	P
Lotus corniculatus ...	Birdsfoot Trefoil	,, 1,500	66	95	412,000	June 4	P
Carum petroselinum ...	Field Parsley	,, 1,000	48	85	230,000	July 1	B
Plantago lanceolata ...	Plantain or Rib Grass ...	,, 1,500	52	95	...	June 4	P
Poterium sanguisorba ..	Burnet	,, 1,600	24	75	54,000	June 3	P
Cichorium Intybus ...	Chicory	,, 500	36	85	335,000	July 4	P

Grasses of Secondary Quality, sometimes Grown under Special Conditions.

Botanical Name.	English Name.	Soil or Situation.	Altitude : N. of England.	Month of Flowering.	Duration.
Agrostis alba. var. stolonifera ...	Fiorin, Creeping Marsh Bent	Alluvial or peaty soils	1,400	7—8	P
Aira flexuosa	Wavy Hair Grass ...	Heath and mountain ...	4,000	7	P
Brachypodium sylvaticum ...	False Brome Wood Grass	Woodlands, covers ...	1,000	6—7	P
Bromus Schaederi	Schaeder's Brome ...	,, ,, ...	500	7—8	P
Elymus arenarius...	Upright Sea Lyme Grass	Sandy shores	500	6—7	P
Festuca gigantea	Giant Bearded Fescue...	Woodlands, moist places	1,000	7—8	P
Festuca loliacea	Darnel-leaved Fescue ...	Damp meadows ...	1,000	6—7	P
Festuca heterophylla	Various-leaved Fescue...	Calcareous soils ...	1,000	6—7	P
Festuca tenuifolia (F. ovina, var.)	Fine-leaved Sheep's Fescue	Hills and uplands ...	4,300	6—7	A
Festuca rubra ..	Red Fescue	Light dry soils	500	6	P
Glyceria aquatica...	Water Sweet Grass ...	Marshes and fens ...	1,000	7—8	P
Glyceria distans	Reflexed Sweet Grass ...	Salt marshes	500	7—8	P
Glyceria fluitans	Floating Sweet Grass ...	Marshes and fens ...	1,600	5—8	P
Milium effusum	Wood Millet Grass ...	Woodlands, covers ...	1,000	5—6	P
Phalaris arundinacea	Reed-like Canary Grass	Damp meadows ...	1,400	7	P
Psamma arenaria	Marram, Sand Reed ...	Loose sand	500	7	P

Identification of Grasses

Groups.	Names.	Sheath.	Ligule.	Base of Leaf.
I. Sheath characteristically coloured	Lolium perenne	Red, flat...	Very short	Eared ..
	Lolium Italicum	Red, round	Short ...	Smooth ...
	Lolium temulentum	do.	do. ...	Eared ...
	Festuca elatior	Red, round, split	do. ...	do. ...
	Festuca pratensis	do.	do. ...	do. ...
	Cynosurus cristatus	Yellow, flat, split	Small, eared	...
	Alopecurus pratensis	Violet or dark	Coloured; short, thick	...
	Alopecurus agrestis	Violet ..	Thick, coloured	...
	Holcus lanatus	Red veined on white	Hairy ...	Tapered ...
	Holcus mollis ...	do.	Short ..	...
II. Variegated grasses	Aira cæspitosa	...	Long, acute	...
	Dactylis glomerata (picta)	Entire, flat	Long ...	...
	Phalaris arundinacea (picta)	Round ...	do. ...	...
III. Bulbous grasses (low, flat ribs)	Phleum pratense	No keel ...	No hair on back, thin	Rough margin
	Avena elatior ...	Keeled ...	Hairy on back	Never rough
IV. Cord-rooted grasses (hill pastures)	Nardus stricta	...	Prominent	Thick ...
	Molinia cœrulea	...	Hair tuft	Taper ...
V. Acute sheathed grasses	Dactylis glomerata	Broad, flat; acute edges	Long thin membrane	...
	Poa trivialis ...	Flat, acute edges	Long, acute	Broadest part
	Glyceria aquatica	Netted, acute	Abrupt, acute	Two brown spots
	Avena pubescens	Downy, acute	Membrane	...

BY THEIR LEAVES, &c. (McAlpine's List.)

Blade.	Ribs.	Veins by Transmitted Light.	Apex.	Remarks.
Shining below, soft	Prominent	...	...	Blades folded = flat shoot.
Eared, keeled	Prominent, flat	Indistinct	...	Blades rolled = round shoot. Awns.
Firm, keeled	Prominent	...	...	Poisonous.
Margin rough	Flat mid-rib	White ...	...	Tall.
do.	do.			
Earless, shining below	Low, flat.			
Dark green	do.	...	...	Absence of bulb.
...	Acute ...	...	...	Arable clay soils.
Keeled, soft	...	...	...	Hairy, tufted; light-coloured.
Soft	...	...	...	Hairy, creeping.
Rough, toothed	Thick, prominent, toothed	Six, very distinct	Acute ..	Conspicuous tufts.
Keeled ...	None	Broad ...	do.	Ornamental variety
Rolled in bud	...	do.	do.	do. do.
Light-coloured, glaucous	Low, flat ...	...	...	Base of shoot bulbous.
Dark green, thin, dry, keeled	do.	...	...	Base of shoot bulbous; tall; feathery.
Hard bristle	...	...	Acute ...	Thick roots, solid blade.
Thin, dry, flat	None ..	...	do. ...	do. do.
Keeled	do.	...	do.	Strong growth.
Keeled, shining below	Two parallel median furrows	...	Tapered from base	Leaf narrow, flat, and tapering.
Thick; air cavities, smooth	do.	...	Rounded ..	An aquatic.
do.	do.	...	...	Hairy.

IDENTIFICATION OF GRASSES

Groups.	Names.	Sheath.	Ligule.	Base of Leaf.
VI. Net-sheathed grasses	Glyceria fluitans	Keeled ...	...	Two yellow spots
	Glyceria aquatica	Netted, flat; acute edges	Acute ...	Two brown spots
	Phalaris arundinacea	Rolled, round	Long ...	...
VII. Bitter-tasted grasses (containing cumarin)	Anthroxanum odoratum	...	...	Eared, bearded
	Milium effusum	...	Quadrate	Rough ..
VIII. Bristle-bladed grasses	Nardus stricta	...	Prominent	Thick ..
	Festuca ovina...	...	Ear-like, small	do. ...
	Aira flexuosa ...	...	Prominent	...
	Avena pratensis	Stiff, elastic	Short, acute	...
IX. Hard-bladed grasses	Elymus arenarius	...	Marginal, toothed	Eared ...
	Psamma arenaria	...	Very long	...
	Aira cæspitosa	...	Long, acute	...
X. Hairy grasses ...	Holcus lanatus	Red veins, keeled	Hairy ...	Tapered ...
	Holcus mollis...	Red veins	...	...
	Molinia cœrulea	...	Hair tuft	Tapered ..
	Brachypodium sylvaticum	...	Conspicuous, long-toothed	...
	Triticum repens	Sparse hair	Short; hair-like teeth.	Pointed ears
	Bromus asper	Downward hairs	...	Prominent ears
	Hordeum murinum	Downy ...	...	Eared ..
	Anthroxanum odoratum	...	...	Small round ears

BY THEIR LEAVES, &c.—*continued.*

Blade.	Ribs.	Veins by Transmitted Light.	Apex.	Remarks.
Ribbed ...	Acute ...	...	Split	Aquatic.
Smooth ...	None	...	Rounded ...	do.
Rolled in bud	...	...	Acute ...	do.
...	Low	...	...	Ensiform tapering blades; sweet-smelling.
Thin, keeled, taper-based	None	...	...	Sometimes hairy; small amount of cumarin.
Young, erect; old, spread	...	...	Acute ...	Cord-rooted; solid blade.
...	Ribbed ...	...	...	Cartilaginous thickening at junction of sheath and blade.
Heart-shaped section.				
Thin, dry, keeled	None; median lines	...	...	Glabrous.
...	Prominent	...	Thorn ...	Sandbinder.
Earless, hard	Prominent, mixed.	...	...	do.
Rough, toothed	Acute ...	Five or six snow-white	...	Tufts conspicuous
Keeled, soft	...	...	...	Blade and sheath hairy; tufted.
Soft	...	...	...	Short hair; downward hair at nodes.
Thin, dry, flat	None	...	Acute ...	On hills.
Thin, dry ...	do.	...	..	In woods.
do. ...	Low	White ..	...	Creeping roots.
White keel; taper-based	do.			
Broad, dry, thin	do.	...	...	Annual.
Bearded base	do.	...	...	Bitter-tasted.

Identification of Grasses

Groups.	Names.	Sheath.	Ligule.	Base of Leaf.
X. Hairy grasses—*cont.*	Avena flavescens	No keel ..	...	...
	Avena elatior ...	Keeled ...	Hairy on back	Never rough
	Avena pubescens	Acute edges, downy	Membrane	...
	Bromus mollis	Entire, round, keeled	Short	Earless ...
XI. Eared grasses	Elymus arenarius	...	Short ...	Eared ...
	Lolium perenne	Red, flat..	Very short	do. ...
	Lolium Italicum	Red, round	Short ...	Margin smooth
	Lolium temulentum	do.	do.	Eared ...
	Festuca elatior	do.	do.	Margin rough, eared
	Bromus asper..	Downward hair	...	Large ears
	Hordeum pratense	Long hair	...	Eared ..
	Hordeum murinum	Downy .	...	do. ...
	Anthroxanum odoratum	...	...	Small round ears, bearded
	Triticum repens	Sparse hair	Margin ...	Pointed ears
XII. Ribless-bladed grasses with median lines	Poa pratensis ...	Elliptical	Short, thick	...
	Poa annua ...	Flat	Prominent	...
	Poa trivialis ...	Flat, acute edges	Long, acute	Broadest part
	Poa nemoralis	Round ...	Short, blunt	...
	Poa fertilis ...	Round, acute	...	...

BY THEIR LEAVES, &c.—*continued.*

Blade.	Ribs.	Veins by Transmitted Light.	Apex.	Remarks.
Small keel ...	Low, acute	...	...	Hair on ribs.
Dark green, dry, keeled	Low, flat ...	...	...	Hair sparse, bulbous shoot. Tall.
Folded, dry, thin; median lines	None.			
Thin, soft.				
Hard, large	Prominent	...	Thorn ...	Sandbinder.
Soft, hairless	do.	...	...	Blade folded in sheath.
Eared, keeled	Prominent, flat	Indistinct	...	Blade rolled. Awns
Firm, keeled	Prominent	...	...	Reputed poisonous; annual.
Eared	Flat mid-rib, prominent	Pure white	...	Tall.
White keel, taper-based	Low	...	...	Leaf thick and firm
Firm	do.	...	...	Meadows.
Dry, thin, broad	do.	...	...	Annual. Dry walls.
...	do.	...	...	Bitter-tasted; sweet-smelling.
Rough above, thin, dry	do.	White ...	...	May have no hair.
Parallel edges, thick, hard	...	Two very distinct, median	Round ...	Never hairy, keeled blade.
Under surface dull, thin	...	do.	do. ...	Never hairy, annual, keeled.
Under surface strongly shining	Two parallel mid lines	do.	Acute ...	Thin-bladed, keeled
Thin, smooth	...	Two very distinct, median	Acute ...	do. do.
Rough ..	...	do.	do. ..	do. do.

Identification of Grasses

Groups.	Names.	Sheath.	Ligule.	Base of Leaf.
XII. Ribless-bladed grasses with median lines—*cont.*	Glyceria aquatica	Acute edges	Abrupt, acute	Two brown spots
	Avena pubescens	Acute edges, downy	Membrane	...
	Avena pratensis	Stiff, elastic	Abrupt, acute	...
XIII. Hairless grasses with very low flat ribs	Alopecurus pratensis	Dark coloured or violet	Coloured; short, thick; back hairy	...
	Phleum pratense	No keel, not coloured	Thin, toothed, not hairy	Rough upwards
	Briza media ...	Entire, not coloured	Short, broad	...
	Milium effusum	Not coloured	Quadrate	Rough
XIV. Ribs high and prominent—rounded or acute	Elymus arenarius	...	Short ...	Eared
	Psamma arenaria	...	Very long	...
	Aira cæspitosa	...	Long, acute	...
	Lolium perenne	Red, flat, entire	Short ...	Eared ...
	Lolium Italicum	Red, round, entire	do. ..	Smooth margin
	Lolium temulentum	do.	do. ...	Eared ...
	Cynosurus cristatus	Yellow, split	Small, eared	...
	Festuca elatior	Split ...	Short ...	Margin rough
	Agrostis stolonifera	...	Long, thin, acute	...
	Agrostis canina	...	do. ..	...
	Agrostis vulgaris	...	Thin, apex obtuse	...
	Alopecurus geniculatus	...	...	..
	Alopecurus agrestis	Violet	Thick, coloured	...

BY THEIR LEAVES, &c.—*Continued.*

Blade.	Ribs.	Veins by Transmitted Light.	Apex.	Remarks.
Smooth ..	...	...	Rounded ..	Net-sheathed.
Dry-bladed.				
Margins thorny, dry	None; median lines	...	...	Glabrous, thick-bladed.
Dark green	Low, flat.			
Light-coloured, glaucous Margin rough upwards.	do. ...	...	Acute ...	Bulbous shoot.
Taper-based, thin, keeled	None	...	...	Sometimes hairy, bitter.
Eared, hard	Prominent, flat	...	Thorn ...	Sandbinder.
Earless, hard	Mixed ...	...	...	do.
Rough, toothed	Acute ...	Five or six snow-white lines	Acute ...	Tufts.
Firm, keeled	Mid-rib not flat	...	...	Flat shoot.
Eared, firm, keeled	Mid-rib quite flat	Indistinct...	...	Round shoot.
Firm, keeled	Prominent	...	...	Annual.
Earless, thick, firm	do.			
Eared	Flat mid-rib	Pure white lines	...	Tall.
Thin, rough, rolled	High, acute	...	Tapered ...	Rough on both sides; creeping.
Bristle-like	High	...	Acute ...	do. do.
Rolled... ...	do.	...	do. ...	do. do.
...	Very acute	...	...	Aquatic. Bent-stemmed.
...	High	...	...	Clay soils.

List of the Commoner Inferior Natural Grasses.

Botanical Name.	English Name.	Month of Flowering.	Duration.
Agrostis canina	Brown Dog's Bent	6—7	P
Agrostis vulgaris	Common Fine Bent ...	6—7	P
Aira cæspitosa	Tufted Hair Grass, "Tussac"	6—7	P
Alopecurus agrestis ...	Field Foxtail, Black Grass	5–11	A
Alopecurus geniculatus	Bent-stemmed Foxtail ...	5—8	P
Avena pratensis	Narrow-leaved Oat Grass	6—7	P
Avena pubescens	Downy Oat Grass	6—7	P
Briza media	Quaking Grass...	6	P
Bromus asper	Hairy Brome	6—7	A B
Bromus mollis	Soft Brome	6	A B
Bromus sterilis	Barren Brome...	6	A
Holcus lanatus	Yorkshire Fog	6—7	P
Holcus mollis	Creeping Soft Grass ...	7	P
Hordeum murinum ...	Wall Barley Grass	6—7	A
Hordeum pratense ...	Meadow Barley Grass ...	6—7	P
Lolium temulentum ...	Darnel	6—9	A
Molinia cœrulea	Purple Molinia	7—8	P
Nardus stricta	Mat Grass...	6	P
Poa annua	Annual Meadow Grass ...	4—9	A
Triticum repens	Couch Grass	6—8	P

Mixture for General Purposes.

(Five years' lea, or permanent.)

	Lbs. per Acre.
Perennial Rye-Grass	10
Italian do.	5
Cocksfoot	5
Timothy, or Catstail	4
Tall Fescue	2
Foxtail	1
Red Clover	2
Cow-Grass (Perennial)	2
White Clover (Dutch)	3
Alsike	3
Trefoil (*Medicago lupulina*), or Lucerne	3
	40

Mr. Faunce de Laune's Mixtures for Permanent Pasture (No Rye-Grass).

	Good or Medium Soils. Lbs. per Acre.	Wet Soils. Lbs. per Acre.	Chalky Soils Lbs. per Acre.
Foxtail	10	4	—
Cocksfoot	7	10	14
Catstail	3	3	3
Meadow Fescue	6	3	2
Tall do.	3	8	—
Crested Dogstail	2	2	5
Rough Meadow Grass	1½	2	—
Hard Fescue	1	1	4
Sheep's do.	1	—	4
Fiorin	1½	2	—
Yarrow	1	1	2
Golden Oat Grass	--	—	1
Perennial Red Clover (Cow-Grass)	1	1	1
Red Clover	1	1	—
Alsike (Hybrid Clover)	1	1	1
Dutch Clover (White)	1	1	1
	41	40	38

Lord Leicester's Mixture.

	Lbs. per Acre.
Cocksfoot	4
Perennial Rye-Grass	2
Italian do.	2
Timothy	1
Tall Oat Grass	1
Meadow Fecsue	2
Hard Fecsue	1
Carried forward	13

	Lbs. per Acre.
Brought forward	13
Tall Fescue	1
Golded Oat Grass	¼
Alsike Clover	1½
White do.	1
Yarrow	¼
	17

Permanent Mixtures with Rye-Grass.

Name.	Average Quantities Recommended.								
	Rich Clay Soils.	Inferior Clay Soils.	Clay Uplands.	Alluvial Soils.	Loamy Soils.	Sandy Soils.	Marly Soils.	Brashy Lime-stone Soils.	Chalk Soils.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Crested Dogstail	...	...	1	1	1½	3	1	2	2
Cocksfoot	6	6	6	6	5	5	5	4	4
Hard Fescue	2	2	2	2	2	3	1	2	3
Meadow Fescue...	3	3	3	4	4	4	3	2	2
Meadow Foxtail	3	3	2	2	2	1	2	1	1
Perennial Rye-Grass	7	7	7	7	7½	9	6½	6½	5
Rough-stalked Meadow Grass...	1	1	...	1	...	...	...	...	...
Sheep's Fescue	...	...	2	...	2	2	1	2	3
Smooth-stalked Meadow Grass	...	...	...	...	2	3	2	2	1
Sweet Vernal	½	½	½	½	½	...	½	½	...
Tall Fescue	2½	2½	2½	2	2	1	2	1	1
Timothy	5	5	4	4	3	3	4	3	3
Alsike	2	2	2	2	1	...	2	2	1
Perennial Red Clover	3	3	3	3	2	...	2	2	2
Sainfoin	...	...	...	...	...	...	..	4	8
Field Parsley	...	...	...	½	1	1	2	1	1
Trefoil	2	2	2	2	1	1	2	2	1
White Clover	3	3	3	3	3	3	4	3	2
Yarrow	...	...	...	...	½	1	...	...	...
Total pounds per acre ...	40	40	40	40	40	40	40	40	40

ROTATION MIXTURES FOR MOWING OR GRAZING.

Name.	One Year.			Two Years.			Three or Four Years.		
	Heavy Soils.	Medium Soils.	Light Soils.	Heavy Soils.	Medium Soils.	Light Soils.	Heavy Soils.	Medium Soils.	Light Soils.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Italian Rye-Grass	12	14	17	8	10	12	4	5	6
Cocksfoot	3	2	2	5	4	3	6	5	5
Timothy	2	2	2	2	2	2	3	3	3
Broad Red Clover	7	6	5	5	4	3	2	1	...
Alsike	3	3	2	2	2	2	2	2	2
Trefoil	3	3	2	2	2	2	2	2	2
Perennial Rye-Grass	...	...	...	5	5	5	10	12	13
Meadow Fescue...	...	...	...	2	2	2	3	3	2
Perennial Red Clover	...	...	...	2	2	2	2	2	2
White Clover	...	...	...	1	1	1	2	2	2
Meadow Foxtail	...	...	...	1	1	1	2	2	2
Hard Fescue	...	...	...	...	...	...	2	1	1
Total pounds per acre ...	30	30	30	35	35	35	40	40	40

Example of a "Renovating" Mixture.

Perennial Rye-Grass	3 lbs.	per acre.
Cocksfoot	2 ,,	,,
Timothy	1 ,,	,,
Meadow Fescue	1 ,,	,,
Foxtail	1 ,,	,,
Cow-Grass	2 ,,	,,
Alsike	2 ,,	,,
	12	

HAY.

Hay is the stems and leaves of grasses and clovers which have been cut, and dried by exposure to the sun and wind, and which may afterwards be allowed to ferment to a certain stage in the stack. Rain falling while the crop is lying cut causes injury, as it tends to wash out the soluble constituents—such as soluble albumen, sugar, gum, &c. While lying in a heap and wet, fermentation sets up, and the sugary matter is converted into alcohol. Coumarine ($C_9\ H_6\ O_2$—the volatile organic principle which gives fragrance to hay, and is found to the largest extent in the sweet-scented vernal grass) is dissolved out by the alcohol in the presence of warm rain-water. The chlorophyll (the green colouring matter), again, is separated by alcohol, and, if the hay lies too long, becomes oxidised and "yellows." Thus both the fragrance and the colour of hay are lost by weathering. The fragrance is of most account, as the coumarine makes the fodder palatable and increases the flow of saliva. Grasses should be cut in full vigour and bloom, before any woody fibre or seed is developed. A certain amount of heating is usually considered desirable in the stack, as the hay is thought to be more relished by cattle and horses; but, if overdone, both the coumarine and sugar are lost, alcohol is produced and may be converted into acetic acid (thus making the hay "sour"), while deleterious fungi spring up Sometimes the body known as aldehyde—intermediate between alcohol and acetic acid—is produced, and as it is very volatile it forms the suffocating, inflammable gas often met with in cutting out a hot stack Over-heated hay may cause abortion in cattle and increased secretion of urine. From 10 to 20 lbs. of salt should be sprinkled over every ton in stacking; it checks fermentation by absorbing moisture (especially if it contains magnesic chloride), destroys fungi and insects, and is a condiment to stock—rendering badly made hay more palatable.

In practice, the farmer's energies are devoted to preventing too much weathering and washing by rain; too much drying or "sun-burning" in fine weather; and too much or too little fermentation in the stack. These are best attained by "cocking," or "quiling," the grass as soon as it is about half-dried The cocks allow the wind to play through the stuff, while the rain or excessive sunshine can only injure the exterior parts. The best-made hay comes out of the stack quite green in colour, but in many markets brown "sweated" hay is preferred. In Scotland, owing to the dampness of the climate and the excess of moisture in the grass, the hay is "ricked" in the field (p. 69), where it goes through a preliminary "heating" before being finally stacked. Heavily manured hay requires longer to "make" than that grown on poor soil, and clover longer than a "mixture" of grasses and clovers.

Analysis of Different Kinds of Hay.

	Water.	Albuminoids.	Fats.	Carbohydrates.	Fibre.	Ash.	Nitrogen.
Clover, average good ...	16·6	15·8	3·5	34·2	22·4	7·5	2·5
Do. weathered ...	20·4	8·7	2·5	32·2	29·5	6·7	1·3
Do. fermented brown	28·0	11·0	1·0	25·6	25·9	7·9	1·8
Meadow, average good	15·0	11·7	2·8	41·6	21·9	7·0	1·3
Do. fermented brown*	18·3	10·6	1·7	32·2	28·7	6·5	1·7
Perennial Rye-Grass ...	14·3	10·2	2·7	36·1	30·2	6·5	1·4
Timothy	14·3	9·7	3·0	45·8	22·7	4·5	1·5

* Contained acetic acid 1·9 per cent.

EFFECT OF VARIOUS MANURES ON THE BOTANICAL COMPOSITION OF MEADOW HAY AT ROTHAMSTED—BY WEIGHT (PERCENTAGES).

Manuring.	1862.			1867.			1872.			1877.			Mean of 1862, 1867, 1872, & 1877.			Plots.
	Graminaceæ.	Leguminosæ.	Other Orders.	Graminaceæ.	Leguminosæ.	Other Orders.	Graminaceæ.	Leguminosæ.	Other Orders.	Graminaceæ.	Leguminosæ.	Other Orders.	Graminaceæ.	Leguminosæ.	Other Orders.	
No manure	71·52	7·15	21·33	62·27	8·07	29·66	66·18	9·58	24·24	69·74	8·01	22·25	67·43	8·20	24·37	3 & 12
Mixed mineral manures	64·65	24·70	10·65	59·29	12·69	28·02	48·82	39·77	11·41	74·38	13·71	11·91	61·78	22·72	15·50	7
400 lbs. ammonium salts	86·32	0·12	13·56	71·85	0·34	27·81	84·70	0·46	14·84	94·06	0·19	5·75	84·23	0·28	15·49	5
Mixed mineral manures and 400 lbs. ammonium salts	88·59	0·13	11·28	77·06	0·16	22·78	92·19	0·02	7·79	94·65	0·41	4·94	88·12	0·18	11·70	9
Mixed mineral manures and 800 lbs. ammonium salts	89·38	0·01	10·61	94·12	0·01	5·87	98·84	0·01	1·15	97·53	...	2·47	94·97	0·01	5·02	11*a*

3 and 12. *Festuca ovina*, 21·67 per cent.; *Dactylis glomerata*, 6·9 per cent.

7. *Lathyrus pratensis*, very prominent; *Festuca ovina* and *Agrostis vulgaris*, conspicuous.

5. *Festuca ovina*, one-half; *Agrostis vulgaris*, one-fourth; *Rumex acetosa*, very conspicuous.

9. *Poa pratensis*, exceedingly prominent.

11*a*. *Dactylis glomerata*, 40 per cent.; *Alopecurus pratensis*, *Agrostis vulgaris*, *Holcus lanatus*, and *Avena elatior*, conspicuous

ENSILAGE.

Ensilage is the system of preserving green fodder by building into stacks or silos, and preventing decomposition by pressure, which excludes the air. Heating and chemical changes are due to the oxidising action of the living protoplasm of the cells of which plants are composed. If pressure is put on immediately, it requires to take its oxygen out of the other cell-contents, and thus the latter slowly go through the various stages of starch, sugar, alcohol, and acetic acid, resulting in "sour" silage. If, however, the pressure is not put on for a time, the access to air causes quick oxidation; the temperature rapidly rises to above 130° F.: this kills the cells, and the process is stopped at the sugar stage, forming "sweet" silage.

In practice, it is customary to build some 4 or 6 feet depth of the green forage at a time and allow that to develop heat; then another depth of 4 or 6 feet is put on, the pressure of which expels the air and stops the fermentation of the lot below; and so on, until the silo or stack is completed, when mechanical pressure is put on to the whole. A hay stack built on the top may give sufficient pressure. Not less than 100 lbs. up to 200 lbs. per square foot must be applied. The temperature must not rise above 160°; thus:—

Under 120°	"Sour" silage.
120° to 130°	Slightly acid.
130° to 140°	"Sweet" green silage.
140° to 160°	"Sweet" brown silage.
Over 160°	Burnt.

The best silage is made at about 130°, and is neither "sweet" nor "sour." The latter keeps better than the sweet variety when opened out.

It is customary to grow forage crops specially for the purpose of ensiling, and the following may be taken as a sample of mixed seed sown for this end or for general forage purposes:—

	Autumn. Bushels.	Summer. Bushels.
Tares	2	1½
Beans	1	½
Wheat	1	—
Oats	—	1
Peas	—	½
Rye	—	½
Bushels per acre	4	4

A crop of this nature takes the place of roots or fallow, and being removed early allows of a half-fallow or cultivation afterwards, forming a good preparation for wheat. Four tons of ensilage equal 1 ton of hay, and made from 5 tons of grass. Weighs from 30 to 70 lbs. per cubic foot.

Analysis of Silage.

	Water.	N. as Alb.	True Alb.	Fat.	Carbohy.	Woody Fibre.	Ash.	Acetic Acid.
Clover	78·1	1·40	1·06	·05	11·2	6·2	2·0	1·0
Old Pasture	75·4	1·21	1·10	·06	13·0	6·8	2·4	1·11
Plantation Grass	77·5	1·67	1·53	·08	12·4	5·5	1·8	1·05
Green Oats	78·0	1·20	0·60	·13	11·7	6·3	1·7	1·00
Tares, Oats, and Beans	74·7	2·01	1·82	·13	13·0	6·0	2·2	...
Tares and Grass	78·0	1·85	1·52	·11	12·6	4·9	1·5	...
Clover and Grass... ...	82·5	1·32	1·27	·14	9·3	4·1	1·6	...
Hill Pasture...	78·8	9·98	0·94	·09	12·8	6·4	1·0	...
37 samples, average ...	71·4	3·17	...	...	12·9	9·3	2·4	0·7

Analysis of Meadow Grass and the Silage made from it.

	Grass.	Silage.
Water	73·67	72·51
Soluble Albuminoids	·21	·65
Insoluble do.	1·94	·83
Soluble Carbohydrates, Chlorophyll, &c. ...	6·38	7·42
Digestible Fibre	8·64	7·64
Woody Fibre	7·36	7·93
Soluble Mineral Matter	1·19	1·55
Insoluble do.	·61	·76
Volatile Acids	—	·36
Non-volatile Acids	—	·35
	100·00	100·00
Total Nitrogen	·42	·51
Albuminoid Nitrogen	·34	·24
Non-albuminoid Nitrogen	·08	·27

Analysis of Sweet and Sour Silage made from the same Meadow Grass.

	Sweet.	Sour.
Water	74·40	74·40
Albuminous Compounds	2·56	1·62
Sugar and Carbohydrates soluble in Water	2·99	2·87
Fibre	17·90	19·27
Mineral Matter	2·15	1·84
	100·00	100·00
Nitrogen in Albuminous Compounds	·41	·26
Volatile Acids	·04	·21
Non-volatile Acids	·02	·22

Several different acids are developed when the fermentation goes on to the sour stage—such as acetic, lactic, and butyric, and which are the cause of the offensive smell—but it is customary to reckon the volatile varieties as acetic and the non-volatile as lactic acids in analyses.

Nat. Ord. *Leguminosæ.*

BEAN.

Botanical genus :—*Faba.*

Only one species—*Faba vulgaris.*

Two sub-species are :—

F. vulgaris arvensis, Common Field Bean.

F. vulgaris hortensis, Common Garden Bean.

Principal varieties are—Tick, Mazagan, Heligoland, Russian or Winter, Scottish or Horse, Broad Windsor, Longpod.

Quantity of seed per acre—2 to 3 bushels, drilled at 20 to 30 in. in autumn ; and 2 to 4 bushels in spring, as soon as frost leaves.

Weight per bushel—63 to 66 lbs.

Average produce per acre—25 to 40 bushels.

Average produce of straw per acre—25 to 30 cwts.

Proportion of grain to straw—Grain, 40 % to 60 % of straw, by weight.

Proportion of grain to straw in stack—1 bushel to 35 cubic feet.

Albuminoid is *legumin*—resembles the *casein* of milk.

Proportion of husk to kernel—14½ % husk to 85½ % kernel.

Average weight of specimen—12 grains, and 580 in a pound.

Varieties vary from 600 to 900 seeds in a pound; 40,000 in bushel, medium.

Suits clay soils, and is a fallow crop for such.

Alternates with wheat on heaviest soils; or between wheat and oats on some soils.

PEA.

Botanical genus :—*Pisum.*

Only one species—*Pisum sativum.*

Two sub-species are :—

P. sativum arvense, Field Pea.

P. sativum hortense, Garden Pea.

Varieties in cultivation are—Common Grey, Partridge or Grey Maple, Grey Warwick, Winter, Early Dun, Blue, Sangster's, Veitch's.

Quantity of seed per acre—2 to 3 bushels drilled, 4 to 6 broadcasted; in February or March.

Weight per bushel—63 to 65 lbs.

1,500 peas in a pound; other varieties, from 1,800 to 2,000; 97,000 in a bushel.

Average produce per acre—30 to 40 bushels.

Average produce of straw per acre—25 cwts.

Proportion of grain to straw—43 % grain to 57 % straw and pods.

Proportion of grain to straw in stack—1 bushel to 35 cubic feet.

Suits calcareous loams and sandy or gravelly soils limed recently, but will also do on clay soils, though it has a shallower root than beans. Best boiling peas grown on soil where lime present, so that liming likely to do good. Must not be manured heavily, as apt to injure flavour.

CLOVER.

Botanical genus :—*Trifolium.*

Species cultivated are :—

1. *Trifolium pratense*	Common Red or Broad-leaved Clover.
2. *T. pratense perenne*	Perennial Red Clover or Cow-Grass.
3. *T. hybridum*	Alsike.
4. *T. repens*	White or Dutch Clover.
5. *T. incarnatum*	Crimson or Italian Clover.
6. *T. medium*	Marl-Grass or Zigzag Clover.
7. *T. procumbens*	Yellow Hop-Trefoil.
8. *T. minus*	Red or Yellow Suckling Clover.

Common Red Clover differs from Perennial or Cow-Grass as follows :—

Red Clover.	Cow-Grass.
Leaf—Broad; white spot clear and oval-shaped; slightly woolly at edges and back.	Narrow; white spot obscure and elongated; very woolly at edges and back.
Stem—Succulent, hollow, hairy, and one colour.	Solid, light vein of red from top to bottom.
Flower—Light pink, round, large.	Dark pink, oval, medium size.

Red Clover is not suitable for permanent pasture, but only for alternate husbandry, while Cow-Grass only yields one crop in a year. White Clover springs naturally on most soils when drained and limed, or phosphates applied.

Scarlet Clover is usually drilled on stubble in autumn for * spring forage; 12 to 20 lbs. of seed per acre used. Annual; sown in the South only.

Alsike is suitable for damp land and irrigation; lasts for three years only.

Marl-Grass is sometimes confounded with Cow-Grass. There is a difference of opinion regarding this point, and a controversy has been carried on respecting it; but the bulk of the evidence goes to prove that there is a specific Perennial Red Clover or "Cow-Grass," and that *T. medium* is of inferior quality, growing in stools, and preferring dry banks as a habitat.

Hop-Trefoil and Yellow Suckling are small kinds sometimes included in mixtures; the latter is not desirable, as it is of such a small dwarf habit.

The Birdsfoot Trefoils (*Lotus corniculatus* and *L. major*) are allied to the Clovers; are sometimes added to mixtures in small quantities. Found growing naturally on sandy or loamy land.

The Kidney Vetch (*Anthyllis Vulneraria*) is useful as a forage crop for sheep-feed on poor sandy or chalky soils, where it is indigenous; grown mostly in Hampshire. Seed—20 lbs. per acre, sown down with corn crop; yields up to 8 tons of forage per acre per annum, and keeps the ground for several years.

Of the leguminous plants, other than those above, occurring in pasture, the principal one is the Meadow Vetchling (*Lathyrus pratensis*); indigenous on dry, light, and calcareous soils.

Quantity of clover seed per acre—12 to 20 lbs. when drilled

* the "trifolium" of farmers.

in alone; 10 to 12 lbs. of varieties when part of grass-seed "mixture." Usually sown with a cereal crop.

Weight per bushel—64 to 66 lbs.

Seeds in a pound—Red, 249,000; White, 686,000.

Average produce of hay per acre—2 tons. Sometimes yields 1 ton more as second cut.

Clovers generally best suited to stiffer soils and when well rolled, but grow fairly well on a lighter class. Usually precede wheat in clay land rotations. In Northern localities are generally sown in a grass mixture.

Seeds are often "doctored;" light-coloured ones are bleached with sulphur fumes, and dark ones treated with logwood or indigo. Moisten and lay on a sheet of white paper and examine with lens.

Affected with "clover sickness"—the plant dying off if too frequently grown on same land. Several known causes of this are:—A want of free potash in the soil; an attack of "stem eelworms" (*Tylenchus devastatrix*), or of clover mildew (*Peronospora trifoliorum*). Applications of lime, gypsum, magnesia, or potash help the plants. Avoid frequent growth of the crop on the same land.

Clover Dodder (Cuscuta europæa) is a parasitic plant which twines round the stems, extracts the juices, and kills the crop. Watering with 1 lb. of ferrous sulphate (copperas) to 1 gallon of water kills the dodder and does no harm to the clover; harrowing only spreads it: generally grows in spots only. The seed can be easily dressed out of the clover seed.

VETCH OR TARE.

Botanical genus:—*Vicia.*

Only one principal species cultivated—*Vicia sativa.*

Principal varieties are—Winter, Spring, Goa.

Quantity of seed per acre—3 to 4 bushels. Only occupies land for a short time, and is therefore used as a catch crop. Sometimes sown in autumn for spring forage: usually mixed with cereals or other seed to act as support. The following mixture is a type of autumn-sown crop:—Winter Tares, 2 bushels, Winter Beans, ½ bushel: Winter Rye, ½ bushel; Winter Oats, 1 bushel; total, 4 bushels per acre—sown at successive times.

Weight per bushel—64 lbs.

Seeds in a pound—8,300.

Average produce per acre—25 to 30 bushels.

Average produce of straw per acre—25 cwts.

Suits all soils, and will stand heavy manuring.

Do well on heavy land, and form a good preparation for wheat, as a thick crop will smother weeds out and leave much nitrogen accumulated in the roots.

For summer growth first sowing usually in February.

When vetches are grown for folding or soiling purposes, they should be supplemented with starchy foods, such as rice or maize, as, on account of the high percentage of albuminoids in their composition, the use of such foods as cotton cake might be unprofitable and even dangerous.

SAINFOIN.

Botanical genus:—*Onobrychis.*

Only one species cultivated—*Onobrychis sativa.*

Two varieties—Common and Giant Sainfoin.

Quantity of seed per acre—4 bushels of rough seed (in pod), or 50 lbs. milled (clean) seed, drilled or broadcasted. Usually sown down with barley on clean land.

Weight per bushel—28 lbs.

Seeds in a pound (rough)—23,300.

Average produce per acre—30 bushels.

Average produce of hay per acre—40 cwts.

Suits calcareous soils; replaces clover on the Oolite and Chalk Formations, as its deep roots descend into the subsoil and fissures in the rock, and renders it less liable to injury from drought.

It is a perennial plant, and when once started will crop for many years either for forage or hay. It is mixed sometimes with clover on clay soils, and treated in all respects as that plant.

The best hay is made when it is cut before coming into flower.

The crop is ploughed up when it gets smothered with grass or weeds. Turnips usually taken after it, as wheat liable to be infested with wireworm.

LUCERNE.

Botanical genus:—*Medicago.*

Species cultivated:—

1. *Medicago sativa*—Common Lucerne.
2. *M. lupulina*—Yellow "Clover," Nonsuch, Black Medick, or "Trefoil."

The former is grown mostly in Kent, Essex, and other Southern countries. The latter is often used in small quantities in clover and grass seed mixtures, to fill up the bottom herbage, but on some soils it deteriorates into a weed by self-sowing.

Quantity of seed per acre—10 to 20 lbs.; sown in April will afford cutting in following autumn.

Weight per bushel—60 to 62 lbs.

Seeds in a pound—205,000.

Average produce of fodder per acre—20 to 30 tons, green; hay, 2 to 3 tons.

Suits deep calcareous loams. Is perennial and deep-rooted, like sainfoin, so can resist drought. Is not suited to a moist climate.

LUPINE.

Botanical genus :—*Lupinus.*

Species cultivated are :—

1. *Lupinus albus* ... ... White Lupine.
2. *L. angustifolius* ... Blue ,,
3. *L. luteus* ... ... Yellow ,,

The two latter are preferred in this country, especially the blue.

Quantity of seed per acre—1 to 2 bushels, drilled at 15 inches. Sown in May or June.

Weight per bushel—62 lbs.

Average produce per acre—25 bushels.

Average produce of fodder per acre—15 to 20 tons forage.

Suits sandy soils, as it has long tap-roots, and can replace clover on such soils, being an annual: first crop grown in reclaiming them—either ploughed in or folded with sheep, for which kind of stock it is exceedingly suitable. Has been long grown in gardens as a flower, and therefore suits great diversity of climate.

Lupine-seed meal is a desirable ingredient of all milk substitutes for young calves.

Nat. Ord. *Cruciferæ.*

TURNIP.

Botanical genus :—*Brassica.*

Species known are :—

1. *Brassica campestris*, var. *Rapa*—Common Turnip, Rough-leaved Summer Rape.
2. *B. campestris*, var., *Rutabaga*—Swede, Smooth-leaved Summer Rape.

Varieties of Common Turnip most in cultivation are :—

Yellow-fleshed—Aberdeen Yellow Bullock, Dale's Hybrid, Fosterton's Hybrid, Purple-Top Yellow, Tankard (yellow).

White-fleshed—Greystone, Pomeranian, White Globe, White Stone, White Norfolk, Green Globe, Tankard (white, green, red).

Varieties of Swede are—Common Purple-Top, Green-Top, Skirving's Purple-Top, Bronze-Top, Bangholm, East Lothian.

Quantity of seed per acre—Swedes, 3 to 4 lbs.; soft varieties, 4 to 6 lbs., 2 to 4 lbs. when broadcasted.

Period of sowing—Swedes from middle of May to that of June, soft varieties in June. In the North, where there is no mildew, may be a month earlier; single out when 1 inch high in rough leaf.

Weight of seed per bushel—50 lbs.

Number of seeds in 1 lb.—140,000 to 200,000.

Weight of bulbs per bushel—42 to 45 lbs.

Average produce of seed per acre—Swedes, 28 bushels; Yellows, 20; Globes, 24.

Average weight of crop per acre—Whites, 20 to 25 tons; Yellows, 18 to 23 tons; Swedes, 12 to 20 tons. Average of England, 15 tons; Scotland, 18 tons.

Proportion of leaves to bulbs—Swedes, 14 % of tops to 86 % of bulbs, by weight; Turnips, 20 % of tops to 80 % of bulbs.

Best suited to lighter soils and cool moist climate; therefore do better in Scotland than England. Must be grown on flat, if rainfall of a district under 24 inches per annum. In a dry season are apt to mildew; cured by deep stirring of soil. Are a typical green-crop, coming between two straw crops.

Best width between drills—27 inches, 18 to 20 inches on flat; between the plants—8 to 10 inches.

Number of plants on acre at 27-in. drill, and 9 inches apart in rows=26,000, nearly.

Average weight and size of single well-developed specimens—White Turnips, 6 lbs., diameter 8 inches; Yellows, 6 to 8 lbs., diameter 8 to 10 inches; Swedes, 6 to 8 lbs., diameter $7\frac{1}{2}$ to $9\frac{1}{2}$ inches. If, however, a whole crop in the field be taken (small and large together), the average will not be above one-third of the above.

Large individual turnips do not give a heavy crop per acre, or best feeding quality, so that bulbs of medium size are best and there are more of them on an acre; therefore they should be left fairly close together—8 or 9 inches—in singling out.

They should be sown early, and thinned as soon as "rough leaves" appear.

A turnip seed weighs about $\frac{1}{25}$ of a grain, and taking a grown turnip—leaves and bulb—at 6 lbs., we find that in about five months the plant has increased to about 1,000,000 times its original weight, showing the necessity of good tilth and manuring for this plant.

As a rule, the heavier the specific gravity of a turnip, the better its feeding quality ; this holds still more true as regards the specific gravity of the expressed juice.

CABBAGE.

Botanical genus :—*Brassica.*

Only one species—*Brassica oleracea.*

Two distinct varieties are cultivated—the Common Cabbage, Drumhead or compact-headed (*capitata*) ; and the Kail, Cole, or open-headed (*acephala*) ; the " Thousand-headed " is a variety of this latter. The Common Cabbage requires to be harvested in autumn, as it is injured by frost and rain, but the open-headed varieties can remain out all winter. The principal varieties in cultivation are—Early York, Large York, Enfield Market, Savoy, Drumhead, and Ox Drumhead.

Quantity of seed per acre—1 to 2 lbs. of seed sown on two square rods of land yield sufficient plants for an acre ; sow in August or March six weeks before required to plant out.

Weight of seed per bushel—50 to 56 lbs.

Seeds in a pound—120,000.

Average produce of seed per acre—30 bushels.

Average produce of crop per acre—30 to 40 tons.

Suited to the very stiffest soils, and forms a capital fallow crop for such. Considered by some superior to turnips for feeding purposes. Will stand heavy manuring. Roots should be dipped in puddle of dunghill when transplanting.

Width between drills not less than 27 inches, and plants same distance apart in rows : at this distance will require 8,600 plants to the acre.

Average weight of a single well-developed specimen—10 to 20. lbs.

Cabbage and Kail may be sown on drills as turnips, with 4 or 5 lbs. of seed per acre, and afterwards singled out. Kail may be broadcasted in April for sheep-feeding in autumn.

KOHL-RABI.

Botanical genus :—*Brassica.*

Only one sub-species—*Brassica oleracea*, variety *Caulo-rapa.*

Two varieties in cultivation—purple and green—and of these there are round and oblong sub-varieties.

Quantity of seed per acre—10 to 16 oz. on 6 yds. square, if to be transplanted; 2 to 4 lbs. if drilled in. Sow in March for transplantation in May or June. Grown on the flat.

Weight of seed per bushel—54 to 56 lbs.

Seeds in a pound—131,000.

Average produce of crop per acre—20 to 25 tons.

Suits medium to heavy loamy soils in the Southern and Midland districts: unknown in the North. Hardy, though the bulb grows entirely out of ground. Cultivated in much the same way as swedes. Will stand heavy manuring. Very suitable for cows, as does not give a flavour to the milk.

RAPE.

Botanical genus:—*Brassica.*

Only one species—*Brassica campestris*, var. *Napus*—the Common Broad-leaved "Winter" Rape.

Quantity of seed per acre—4 to 5 lbs. in rows 15 inches apart. Sow in breaks any time after June. In August for spring feed or seeding. 10 to 12 lbs. broadcasted.

Weight of seed per bushel—50 to 55 lbs.

Seeds in a pound—118,000.

Average produce of seed per acre—30 bushels.

Average produce of forage per acre—10 to 15 tons.

Suits alluvial or fen land best, but will do well on other kinds. Is a good forage crop for sheep; often used as a catch crop, as when grown after early potatoes; often ploughed in for green manure.

Rape can be transplanted, or it is sometimes drilled and thinned afterwards, but the usual way is to broadcast or drill in and let it all grow. Sometimes sown along with vetches.

On the Continent this and the other Rapes are largely grown for seed, from which rape oil, colza oil, &c., and the corresponding "cakes," are manufactured.

Note on the *Brassicaceæ.*

The four foregoing plants, together with a few other garden vegetables, are all believed to be descended from one original stock—the "Sea Colewort" (*Brassica oleracea*), met with growing wild on the argillaceous sea-shores of the South of England. The members of this group are sometimes included in a separate sub-order (*Brassicaceæ*), but are all one and the same plant, differently developed by cultivation and by taking advantage of natural "sports." Thus the swede and turnip have the top of the root abnormally developed; cabbage, kail, and Brussels' sprouts, the leaves and leaf-stalks; kohl-rabi, the stem and base of the leaf-stalks; rape, colza, cole-seed, &c., both the stem and leaf; and in cauliflower and broccoli the flower-stalks are much increased in size and have become succulent.

Most, if not all, of these plants are biennials, and the roots of some of them require to be lifted during the winter, and planted out the following spring if intended for seed, though many individuals run to seed prematurely during the first year —due to bad seed, forcing manure, or too early planting.

MUSTARD.

Botanical genus:—*Sinapis.*

Two species are cultivated:—

Sinapis alba—White Mustard.

S. nigra—Black or Brown Mustard.

The former is most largely grown for forage or green manure, while the latter most for seed.

Quantity of seed per acre—1 peck: sown broadcast in end of April.

Weight of seed per bushel—50 to 56 lbs.

Seeds in a pound—75,000.

Average produce of seed per acre—30 to 50 bushels.

Average produce of forage per acre—10 to 15 tons.

Has been until lately a crop peculiar to the richest fenlands, but is now grown extensively for forage.

Usually sown in drills and thinned out when for seeding purposes. Seed is ground down to make ordinary table mustard.

Sometimes ploughed in before wheat, as it is said to be obnoxious to wireworm.

Nat Ord. *Chenopodiaceæ.*

MANGOLD-WURZEL.

Botanical genus:—*Beta.*

Two species cultivated:—

1. *Beta vulgaris*—Common Mangold and Field Beet.
2. *B. hortensis*—Garden Beet.

The Beet grown on the Continent for the manufacture of sugar is a variety of Mangold.

The varieties in field cultivation are the Oblong and Globular, with sub-varieties of Red, Orange, and Yellow.

Quantity of seed per acre—6 to 10 lbs.; sown in April or May. Seed may be steeped in water before sowing; will bear transplantation to fill up gaps.

Weight of seed per bushel—21 to 22 lbs.

Seeds in a pound 24,000.

Weight of roots per bushel—45 lbs.

Average produce of seed per acre—10 cwts. or 50 bushels.

Average produce of crop per acre—15 to 25 tons.

Mangold suits the stiffer soils and a comparatively dry climate, so that it is a crop which fills in England the place which the turnip does in Scotland. The Orange and Yellow Globes are the most suitable for every variety of soil.

When the seed is dibbled in it must be from $\frac{1}{2}$ to 1 in. deep, 12 inches apart. When pulled, must be topped only—best by wrenching off tops—and not tailed, so as to minimise bleeding. Very susceptible to injury from frost, must therefore cover with tops before pitting, as the roots are best to lie for some time to wither. Can be pitted in large quantities, and should lie till spring to allow of proper ripening. When fresh contain acrid substances liable to scour animals. The pectin and pectose of fresh roots become changed into soluble sugar when kept some time, the amides into albuminoids, and the nitrates reduced.

There are from 3 to 5 seeds in each capsule, and the germination should be at least 120 per cent.

As this plant has been developed from the *Beta maritima* of argillaceous shores, it requires salt as a manure, and from 3 to 10 cwts. per acre are usually applied. Nitrate of soda is also a specific manure, and it gives good results when used as a top-dressing after the plants are singled.

If a section of a root is made, concentric rings are seen: one of these is formed about every 15 days, and there are some twelve of them in a good specimen, and the last two or three contain as much matter as all the interior ones; therefore, the earlier the seed is sown, the greater the crop, in something like geometrical ratio. For this reason the crop is always sown before turnips, and the land is occasionally prepared and ridged up in the previous autumn. It is a biennial, like the turnip.

Nat. Ord. *Solanaceæ.*

POTATO.

Botanical genus:—*Solanum.*

One species cultivated—*Solanum tuberosum.*

Principal varieties are:—*Early:* Don, Rose, Kidney, Dalmahoy, Snowflake, Beauty-of-Hebron, Early Regent, Puritan. *Medium:* Schoolmaster, Abundance. *Late:* Champion, Prince-Regents, Magnum-Bonum, Bruce, Saxon, Main-Crop, Up-to-Date.

Quantity of seed per acre—12 to 15 cwts. of cut sets. Planted in February and March for early crops, and April for later.

Weight per bushel—53 lbs. striked; 56 lbs. heaped.

Average produce of crop per acre—5 to 8 tons; early potatoes, 4 to 6 tons.

Potatoes suit medium loamy soils, but are successfully grown on all kinds, except heavy clays. Are a typical green-crop. Wheat does well after them.

Do well on mossy or newly reclaimed land.

Can be propagated from the "plums," but as these are often the result of cross-fertilisation, less than a tenth develop into good new varieties, and this proportion only after three or four years' cultivation and selection.

The tubers are sometimes "sprouted" before planting to ensure an earlier crop. Small or medium sized potatoes are selected and placed whole in wooden trays, which are then piled up in byres or other cattle-houses. The eyes sprout out 2 to 4 inches of a tough blue stem, and they are afterwards carefully planted: this sprouting will make the crop ready to raise some three weeks earlier. From 12 to 20 cwts. required per acre for seed.

For ordinary crops medium-sized potatoes are best seed, and the "rose" end only should be used, as sprouts from the "heels" are weakly. Leave one or two good eyes in each set.

Fibres ramify from the eyes into the substance of the tuber, and towards the point where the root enters at the heel. In cutting the sets, these fibres should be left intact as much as possible, and this may be done by first removing the heel half and throwing aside, and then cutting the remainder *lengthwise* into sets.

Grown on drills or on the "lazy bed" system: the latter suits wet land and corners where horse labour would be awkward, and is equivalent to trenching the land when carried out for three successive years, if the ditches are slightly shifted each year.

Nat. Ord. *Umbelliferæ.*

CARROT.

Botanical genus:—*Daucus.*

One species cultivated—*Daucus carota.*

Principal varieties are—Red Altrincham, White Belgian, Red Surrey, James's Intermediate (principal field variety).

Quantity of seed per acre—8 to 10 lbs.; sometimes rubbed up with 2 bushels of sand or dry earth to make it sow more easily. May be steeped in water previously to help germination. Sown in end of March or beginning of April. The plants singled out to 3 or 4 inches apart, and generally drilled in double rows 27 to 30 inches apart, or single rows 18 inches apart.

Weight of seed per bushel—29 to 34 lbs. with hairs rubbed off; 15 to 18 lbs. in natural state.

Seeds in a pound—250.000 (rough).

Weight of roots per bushel—40 lbs.

Average crop per acre—10 to 20 tons.

Suits light and deep soils; will not do on those of a stiffer nature.

The Carrot is developed from a weed found on sandy soils, and is a biennial plant.

Forms a green-crop suitable to the lightest soils, but very expensive to work.

Carrot leaves are superior to any of the root crops as a food for milk cows.

PARSNIP.

Botanical genus:—*Pastinaca.*

One species cultivated—*Pastinaca sativa.*

Varieties are—Jersey Hollow Crown (principal field variety), Large Guernsey, Student, Cattle. The first named is the best for field growth and for cattle-feeding.

Quantity of seed per acre—6 to 8 lbs.; sown in February or March, or in the autumn previous.

Weight of seed per bushel—15 to 18 lbs.

Seeds in a pound—100,000.

Weight of roots per bushel—40 lbs.

Weight of crop per acre—8 to 14 tons.

Suit the same soils as carrots, and much the same style of cultivation.

Frost does no injury to them, as they grow deep in the ground; will keep longer than carrots if left in the ground, as they contain more oil and starch.

The Parsnip is a biennial plant, and has been developed from a weed found growing on chalky soils.

Nat. Ord. *Lineæ.*

FLAX.

Botanical genus:—*Linum.*

One species cultivated—*Linum usitatissimum.*

Quantity of seed per acre—6 to 8 pecks. Sown in beginning of April, broadcast or drill, covered lightly and on good tilth; 8 to 12 pecks sown for fibre (linen manufacture).

Weight of bushel of linseed—52 to 56 lbs.

Seeds in a pound—108,000.

Average produce of seed per acre—16 to 20 bushels.

Average produce of straw per acre—2 tons.

Average produce of fine fibre per acre—4 to 8 cwts.

Suits rich fertile land in good tilth. Does not suit gravel or heavy clay land. Usually taken after a corn or potato crop. If grown for fibre must not be forced too much, and should not be grown on same field oftener than once in eight or nine years: the Ulster rotation covers eight years.

Blooms in June, may be pulled any time thereafter: allow "bolls" to ripen for seed. Bolls "rippled" off and straw steeped in soft water, to rot the vegetable matter off the fibre, which is afterwards dried and "scutched;" but both seed and fine lint fibre cannot be obtained from same crop. If seeded the fibre is coarse and inferior.

Linseed oil is expressed from the seeds, the residue forming "oilcake."

The fibre makes the best quality of writing paper.

Riga seed is preferred—or at least the produce of this seed once sown ("one year from the barrel")—both in Ireland and Belgium.

Flax is usually pulled by hand for fibre, but may sometimes be cut by machine, as an ordinary cereal crop. "Seeds" may be sown down with it.

Nat. Ord. *Urticaceæ*.

HOP.

Botanical Genus:—*Humulus*.

One species cultivated—*Humulus Lupulus*.

Principal varieties are—Canterbury and Farnham Whitebines, Goldings, Grapes, Colegates.

Propagated by cuttings usually: 3 to each hillock, and hillocks 6 ft. apart each way; 3,630 slips to the acre: these previously raised in a nursery. Planted in autumn or early spring: 3 poles allowed to each "hill" for the bines to grow up. Perennial plant, which sends off fresh shoots every year, but not much produce first year.

Weight of bushel of commercial hops—36 lbs.

Average produce per acre—Varies from 2 to 25 cwts.; $6\frac{1}{2}$ to 7 cwts. is common.

Suits rich calcareous loams. Land to be well cultivated previously, and while crop is growing; large quantities of the richest manures to be applied to the hills.

Hops require to be hand-picked, and dried in a kiln before marketing; 4 parts by weight in the green state give 1 when dried. When dried are packed in "pockets." A pocket is a sack $7\frac{1}{2}$ ft. long by 3 ft. wide, weighs 5 lbs., and contains 1 cwt. 2 qrs.—say 170 lbs.—of hops.

The hop is a diœcious plant, and a certain proportion of males (usually 1 to 10) have to be planted to fertilize the females.

The chemical bitter principle is an aromatic resinous substance secreted on the scales, and known as "lupuline."

Poles require to be from 15 to 18 ft. long, and must be lifted always with the bines attached previous to picking. Chestnut wood considered best.

Sixty-five per cent. of the total crop is grown in Kent. It is a very speculative and hazardous branch of farming, as the plants are so liable to injury from weather, insects, and mildew.

HEMP.

Botanical genus:—*Cannabis*.

One species cultivated—*Cannabis sativa*.

Quantity of seed per acre—1 bushel, drilled in May, 18 in. apart; usually thinned out afterwards.

Weight of seed per bushel—40 lbs.

Average produce per acre—16 bushels.

Average produce of straw per acre—2 tons.

Average produce of fibre per acre – 6 to 8 cwts.

Suits rich alluvial soils ; worked the same as flax.

A diœcious plant, and male plants must be allowed to grow when crop seeded.

Grown mostly in Lincoln and Dorset.

Nat. Ord. *Boragineæ.*

PRICKLY COMFREY.

Botanical genus :—*Symphytum.*

One species cultivated—*Symphytum asperrimum.*

Russian Comfrey is the commonest variety. There are two British wild varieties very similar to this—*S. officinale* and *S. tuberosum.* The proper kind has very prickly leaves and stalks, is solid-stemmed, and has *blue* flowers.

Quantity of seed per acre for a "comfrey meadow"—6 lbs.; sown along with oats in March or April. Usually propagated by sets or cuttings, planted a yard each way during spring ; useful for growing in out-of-the-way corners.

Average produce per acre—40 to 50 tons of forage in 6 or 8 cuttings, after first year. Must be manured heavily and kept clean.

Comfrey is a perennial, and requires only to be kept clean and well manured.

It must be withered before eaten, but otherwise used fresh.

Requires deep, rich soils to grow on.

Nat. Ord. *Compositæ.*

JERUSALEM ARTICHOKE.

Botanical genus :—*Helianthus.*

One species cultivated—*Helianthus tuberosus.* Allied to the sunflower.

Propagated by sets usually ; planted in rows 3 ft. apart and 18 in. in the rows, in March.

Weight of bushel of tubers—45 lbs.

Average produce of crop per acre—3 to 8 tons.

Suits only the poorest sandy soils, and will yield a fair crop in out-of-the-way corners.

Is practically perennial, as the small tubers left in raising the crop are sufficient for sets for the succeeding year.

Stems are sometimes cut while young for forage.

CHICORY OR SUCCORY.

Botanical genus:—*Cichorium.*

One species cultivated—*Cichorium Intybus.*

Quantity of seed per acre—4 to 7 lbs. in drills 18 in. apart, in May: thinned afterwards.

Weight of seed per bushel—27 to 30 lbs.

Seeds in a pound—335,000.

Weight of raw roots per bushel—40 lbs.

Weight of kiln-dried roots per bushel—28 lbs.

Weight of powdered chicory per bushel—38 lbs.

Average produce of roots per acre—6 to 8 tons, yielding 18 to 24 cwts. of dried root.

Suits the lighter soils; roots to be dug up, sliced in a turnip-cutter, and dried in a kiln. Used to mix with coffee.

Is a perennial plant, and the leaves and stems sometimes fed off as a forage crop by sheep.

Nat. Ord. *Dipsaceæ.*

TEAZLE.

Botanical genus:—*Dipsacus.*

One species cultivated—*Dipsacus Fullonum*, Fuller's Teazle, domesticated from wild form.

Quantity of seed per acre—2 pecks, drilled in April. Is a biennial. Transplanted after harvest on to trenched cleaned stubble land, 16 in. apart each way: thus about 16,000 plants to the acre.

Average crop—5 to 10 "packs" per acre.

Suits poor clays, which are benefited by the thorough spade cultivation necessary for this crop.

The Teazle is grown for the sake of the "heads," which are masses of stiff-pointed calyx husks (epicalyx). These are used for raising the "nap" on cloth. They are tied together in "handfuls" and strung on "staves" for market purposes: 25 heads make a "hand;" 20 hands are strung on a "stave;" and 40 staves, or 20,000 heads, make a "pack."

The flowers blossom in July, and harvesting commences as soon as the bloom is off.

Nat. Ord. *Polygoneæ.*

BUCKWHEAT.

Botanical genus :—*Polygonum.*

Three species cultivated :—

1. *Polygonum Fagopyrum*—Common.
2. *P. Tartaricum*—Siberian.
3. *P. emarginatum*—Notch-seeded.

The first only in general use.

Quantity of seed per acre—1 bushel drilled, to 3 broadcast. Sow late in May when no chance of frost.

Weight of seed per bushel—50 lbs.

Seeds in a pound—25,000.

Average produce of crop per acre—25 to 30 bushels.

Suits poor light, dry soils. Is a very desirable grain for poultry, and often grown for pheasants. Suits odd corners. Seed does not all ripen at one time; must be cut when greatest quantity is matured.

Nat. Ord. *Salicineæ.*

OSIER.

Botanical genus :—*Salix.*

Many species cultivated, but the most important is *Salix viminalis*, Common Willow.

Propagated by cuttings, 15 to 18 inches long; planted 18 inches between rows, and 15 inches apart in rows: over 23,000 required to acre. Land previously laid up in beds and cultivated.

Suits wet alluvial or sandy land on banks of rivers where liable to flood, but water must not be stagnant.

Rods grow annually 7 to 9 feet: cut every year or every second year; tied in bundles and stacked for market.

Roots will continue sending up shoots for many years. Land must be annually dug over and cultivated.

LIST OF PRINCIPAL INSECTS INJURIOUS TO FARM CROPS.

NAME.	Destructive Stage.	Plant Affected.	Part Affected.	Treatment Recommended.
COLEOPTERA.				
Apion apricans ... ... Purple Clover Weevil	Larva	Clover	Unripe seeds	Cut early; feed green, sheep folding; shift the crop often in rotation; high fermentation in stack, or as ensilage.
Apion assimile ... ... Common Clover Weevil	do.	do.	do.	do. do. do.
Bruchus granarius ... ... Bean-Seed Weevil	do.	Bean and pea	Seed in granary	Clean seed; kiln-drying under 133° F.; pickling seed with blue vitriol and dilute carbolic acid.
Calandra granaria ... ... Granary Weevil	do.	Corn in granary	Inside the grains	Frequent turning of grain; clean, whitewashed granary; winnow out and destroy the light, affected grains.
Centorhyncus sulcicollis ... Turnip Gall Weevil	do.	Turnip, swede, cabbage	Galls on the bulbs or roots	Clean cultivation; liming, gas-liming.

LIST OF PRINCIPAL INSECTS INJURIOUS TO FARM CROPS—*continued.*

NAME.	Destructive Stage.	Plant Affected.	Part Affected.	Treatment Recommended.
COLEOPTERA—*cont.*				
Elater lineatus, &c. ... Wireworms; Click-Beetles: various kinds	Larva	Corn and all crops	Roots just below the surface	Lime or gas-lime lea before breaking up; clean cultivation; forcing manures at first stage of plant; roll with Cambridge roller across the line of drills; rape-cake manure.
Haltica concinna ... ... Tooth-legged Flea-Beetle; Hop Flea	Beetle	Turnip, swede	Cotyledon leaves	Thick sowing; forcing manure at first stage to get into the "rough leaf;" spray with paraffin, soot, lime, sulphur, &c.; keep down cruciferous weeds.
Haltica nemorum ... ... Turnip Flea-Beetle	do.	do.	do.	The well-known "Turnip Fly;" treat same as *H. concinna.*
Melolontha vulgaris ... Cockchafer	do. and larva	Grass, corn, vegetables	Roots	Expose by cultivation; forcing manures and Cambridge roller.
Phædon betulæ... ... ... Mustard Beetle; Black Jack	Larva	Mustard, crucifers	Leaves	Burn straw and rubbish; burn smoky fire to prevent migration into a field.
Sitones lineatus, &c. ... Bean and Pea Weevils	Beetle and larva	Bean, pea, clover	do. and roots	Spray with lime or soot, &c.; good cultivation, and plenty of manure.

THYSANOPTERA.				
Thrips cerealium ... ... Corn Thrips	Larva and fly	Corn	Ears	Draining; early sowing; gas-liming; clean cultivation.
HYMENOPTERA.				
Athalia spinarum ... ... Turnip Saw-Fly; Niggers	Larva	Turnip	Leaves	Spray with lime, soot, &c.; dress with stimulating manure, as nitrate of soda, liquid manure, &c.
Cephus pygmæus ... ... Corn Saw-Fly	do.	Corn	Nodes at ground	Destroy stubble by burning or deep ploughing.
LEPIDOPTERA.				
Agrotis exclamationis ... Heart and Dart Moth (surface grub)	do.	Turnip, roots, &c.	Roots and crowns	Deep and clean cultivation; good manuring and liming.
Agrotis segetum ... ... Turnip Moth (surface grub)	do.	do.	do.	do. do. do.
Charæas graminis ... ... Antler Moth	do.	Grass	Roots and shoots	Firing the surface; muir-burning on the hills.
Depressaria daucella, &c. Carrot-Blossom Moth, and others	do.	Carrot	Young seeds	Dusting hellebore on damp leaves: intersperse a proportion of parsnips, which they prefer.

LIST OF PRINCIPAL INSECTS INJURIOUS TO FARM CROPS—*continued.*

NAME.	Destructive Stage.	Plant Affected.	Part Affected.	Treatment Recommended.
LEPIDOPTERA—*cont.*				
Grapholitha pisana ... ... Pea Moth	Larva	Pea	Peas in pods	Plough deeply after crop to bury chrysalids; burn haulm; if on a small scale dust with lime or soot.
Hepialus humuli ... ... Otter Moth	do.	Hop	Root	Examine roots and hand-pick; keep down rubbish at sides of fields.
Mamestra brassicæ ... Cabbage Moth	do.	Cabbage	Leaves	Dust with fine, dead gas lime; hand-pick.
Noctua pronuba ... ... Great Yellow Underwing Moth (surface grub)	do.	Roots, vegetables	Roots at surface	Deep cultivation; good manuring and liming.
Pieris brassicæ, &c. ... Large White Cabbage Butterfly, and others	do.	Cabbage, rape	Leaves	Hand-pick; spray with Paris green solution, or lime, soot, or sulphur.
Plutella cruciferarum ... Diamond-Back Moth	do.	Turnip	do.	Spray with soot, lime, &c.
Pyralis rostralis ... ... Hop-Vine Snout Moth	do.	Hop	do.	Spray with soft soap solution or some hop-wash.
HOMOPTERA.				
Aphis brassicæ ... ... Cabbage Green-Fly	do.	Cabbage	Leaf	Heavy manuring; spray with soap solution, tobacco infusion, lime, &c.

Aphis granaria ... ... Corn Green-Fly	do.	Corn	Ears	Good manuring; dust with soot, lime, &c., in young crop.
Aphis humuli ... ... Hop Green-Fly ("Blight")	do.	Hop	Leaves	Spray with "hop-wash," soft soap or tobacco or paraffin solutions.
Aphis rapæ ... ... Turnip Green-Fly	do.	Turnip, swede, &c.	Leaves	Spray with soap and tobacco wash—28 lbs. soft soap, ½ lb. tobacco, 100 gals. water.
Aphis fabæ ... ... Collier Fly; Black Dolphin	do.	Bean	Flower heads	Cut off and destroy tops; spray with above washes or paraffin oil.
DIPTERA.				
Anthomyia betæ ... ... Mangold Fly	do.	Mangold	Leaf	Good cultivation; liberal manuring, including salt and kainite; spray with paraffin and water.
Anthomyia brassicæ ... Cabbage Fly	do.	Cabbage, turnip	Stem and roots	Gas-liming; rotation of crop; good cultivation; heavy manuring.
Anthomyia ceparum... ... Onion Fly	do.	Onion	Bulb	Autumn cultivation; good manuring; raise and destroy affected plants; spray with paraffin before attack.
Cecidomyia destructor ... Hessian Fly	do.	Wheat, barley	Inside leaf sheath	Late sowing in autumn; burning stubble; destroying screenings from thrashing machine; deep ploughing.
Cecidomyia tritici ... ... Wheat Midge; Red Maggot	do.	Wheat	Ears	Burn stubble; deep ploughing with digging plough; destroy chaff and screenings.

LIST OF PRINCIPAL INSECTS INJURIOUS TO FARM CROPS—*continued.*

NAME.	Destructive Stage.	Plant Affected.	Part Affected.	Treatment Recommended.
DIPTERA—*cont.*				
Chlorops tæniopus ... ... Gout Fly; Ribbon-footed Corn Fly	Larva	Corn, barley	Ears in sheath	Early sowing; draining; clean fences; stimulating manures.
Oscinis frit ... ... Frit Fly	do.	Oats, corn	Young stems	Early sowing; dressing with nitrate of soda; deep cultivation.
Psila rosæ... ... ... Carrot Fly; "Rust"	do.	Carrot	Root	Good cultivation; single as soon as plants can be handled; spray with paraffin, soap solution, gas lime, &c., immediately after thinning out; fine soil.
Tipula oleracea ... ... Crane Fly; "Daddy Long Legs"	do.	Corn, grass	Root and underground stem	Drainage; autumn cultivation; gas-liming; Cambridge rolling across line of drills; stimulating manures.
Tylenchus devastatrix ... Stem Eelworm (Nematode)	...	Clover and oats	Stem and root	One form of "clover sickness;" "tulip root" in oats. Sulphate of potash 3 cwt., or sulphate of iron 2 cwt. per acre on clover; general good cultivation; long rotation, and keep oats and clover apart.

Tylenchus tritici ... ... Ear Cockle (Nematode)	...	Wheat	Young grain	Pickling with bluestone; separating diseased grains by dressing machine or floating off in pickling.
Julidæ ... ... Snake Millipedes (Myriapod)	...	All crops	Roots	Deep trench ploughing; good manuring; apply soot, nitrate of soda, salt, &c.
Polydesmus complanatus... Flat Millipede (Myriapod)	...	do.	do.	do. do. do.
Arion ater... ... ... Black Slug (Mollusc)	...	do.	Leaves	Draining; good cultivation and manuring; gas-liming; successive dressings of lime, soot, salt, &c.
Limax agrestis ... ... Field Milky Slug (Mollusc)	...	do.	do.	do. do. do.
Tetranchus telarius... ... Red Spider (Arachnid)	...	Hop, fruit	do.	Spray leaves with wash—100 gals. water, 5 lbs. soft soap, 5 lbs. quassia extract; dress roots with lime and soot in winter.

FUNGOID DISEASES OF PLANTS.

MYXOMYCETE.

Plasmodiophora brassicæ.—Club Root, Anbury, Finger-and-Toe. Different names given to different forms of the same disease affecting the roots of turnips, swedes, cabbages, &c. Attacks plants in the young stage, causing the roots to grow into spindle shaped swellings. Confined to cruciferous crops. Prevention by keeping such plants wide apart in the rotation; keep down such weeds as charlock. Dress with lime, compost, and potash manures. Destroy old club-root refuse. Well-manured, strong healthy plants less liable to the attack.

round lime best, & just before the ridge plough, sow the seed the same day, Use ammonia sulphate then than nitrate of soda, & avoid superphosphate of lime

FUNGI.

Peronosporeæ.

Peronospora infestans.—The Potato Disease.—The spores ("zoospores"), while still contained in a sporangium, fall on the leaf or surface of a tuber, emerge from this, germinate, and the mycelium enters the tissues of the plant both directly and through the stomates, and produces the brown diseased spots. The starch in the cells is not much injured by the disease—only the albuminoids—so that it can be used for manufacturing purposes. It is generally acknowledged that the "disease" is consequent on a weak, degenerated condition of the plant brought about by long forcing culture or adverse weather. "Disease-proof" potatoes, which are brought out from time to time, always succumb in the course of years. Dry, sunny weather acts as a check, as there is no moisture to cause the spores to germinate, while close, misty weather favours its progress. Jansen's system of treatment is to bend over the tops and plough up 4 or 5 inches of soil on to the top of the drill, so as to prevent the spores from being washed down to the tubers by rain.

Spraying with a solution of bluestone or of *bouillie bordelaise* (2 lbs. copper sulphate, 1 lb. quicklime, 10 gals. water), in the early stages, will help to check it.

Select early, sound, and hardy varieties of potatoes; keep stored in a dry, airy place during winter; cut sets to be dried with powdered lime. Destroy all crop refuse which may harbour the "resting spores" during winter.

Peronospora parasitica.—Putrefactive mildew of turnips and cabbages. Similar in appearance to the ordinary mildew, but thinner and more scattered, and on the under side of the leaves only. Destroy all crop refuse; keep down cruciferous weeds; have the crops as far apart as possible in the rotation.

Peronospora viciæ.—Vetch and pea mould. Occurs early in the season as brownish down-like spots on leaves, causing putrefaction. Worst in damp, sultry seasons. Destroy rubbish; change course of cropping.

Peronospora trifoliorum.—Clover mildew. One cause of "clover sickness." Attacks leaves first as white spots, becoming brownish. Imperfect drainage is a predisposing cause. Use potash manures; change rotation of cropping.

Cystopus candidus.—White rust of cabbages, shepherd's purse, &c. Appears as white pustules or blotches on leaves and stems. All stages of the plant. Destroy rubbish and change cropping.

Ustilagineæ.

Ustilago carbo.—Smut of oats; "blackhead;" "dust brand;" "black ball," &c. Affects oats mostly; no disgusting odour like "bunt." Travels up the stem from the roots, and attacks germs, glumes, &c., but washes off before harvest. Pickle the seed with bluestone—one pound to a sack of four bushels.

Tilletia caries.—"Bunt," "blight," or "smut" of wheat; stinking rust. Affected grains get filled with a black powdery mass of spores, having a fœtid odour. Grain cannot be used for food. Almost confined to wheat, rarely on barley. Difficult to detect in growing crop. A single grain may contain 4,000,000 spores. "Pickling" is done specially for the purpose of preventing the ravages of this disease; 1 lb. of sulphate of copper dissolved in sufficient water to wet 4 bushels of grain—turned over and mixed on a water-tight floor.

Tubercini scabies.—Potato smut: one form of "scab." Dark brown spots, especially on the stored tubers. Prevention consists in using clean seed. The common scab or cracking of potatoes is usually due to the presence of some irritating substance in the soil, such as lime, ashes, builder's refuse, &c., and possibly continued drought or a sudden supply of superabundant moisture. Fungi are not the cause of this, but may attack the injured spots.

Ascomycetes.

Erysiphe graminis.—Grass mildew; white rust. Common in warm, dry weather on the stems and leaves of grasses, especially on impoverished land. Drain and farm well; top-dress grass land.

Erysiphe Martii or pisi.—Pea mildew. Affects late varieties most, and is worst in dry seasons. Plants appear as if powdered over with chalk. Watering helps the plants to recover, otherwise the crop succumbs, and ought to be destroyed. Spray with bluestone solution.

Oidium Balsamii.—Turnip mildew. Common since 1880. Early-sown plants suffer most. Appears as a white mould all over the leaves, choking up the stomata or breathing pores. Worst in dry seasons, and a shower of rain will often cure it. Deep stirring of the soil with a horse-hoe will help. It is supposed to be the early form of some *Erysiphe*, but the life-history has not been worked out.

Claviceps purpurea.—Ergot of rye. Attacks all grasses, the spores settling on the young flowers and developing a viscid mass ("honey-dew"), out of which grow the blackish "horns" which displace the young grains. Worst on ill-drained soils and in wet seasons. Sow clean seed. Liable to cause gangrene (ergotism), and abortion in cows, if partaken of too liberally.

Peziza postuma.—Black nodules on potato stems. A new disease. First appears in July as a white mould, enveloping whole of the plant and causing it to wither. Later on the black nodules appear, varying in size from a pin-head to a bean, embedded in the stem. Burn infested stems. Use artificial manures, or keep the sets out of contact with the dung.

Fusisporium Solani.—Fusispore disease of potatoes. Common in the South of England. Accompanies *Peronospora infestans*, and may be treated in the same way.

Fusisporium culmorum.—"Red corns" of grain crops, especially barley. Attacks the grains and glumes. Worst on inferior crops. Clean seed; improved cultivation.

Isaria fuciformis.—Seaweed-like fungus of grass. Appears as pink or blood-red strings on grass, especially the fescues (notably *F. ovina*), on chalky or sandy soil; not on clay. Appears in September, and remains till January. Drainage, eat the grass well down, so that there may be few stalks to attack. May be fatal to cattle. Considered to be the early stage of a *Cordyceps*.

Uredineæ.

Uredo Rubiga-vera.—The true spring corn rust and mildew. Attacks the plants as minute yellow spots on the leaves during April and May. Each spot contains a mass of yellow spores, which, when scattered, give rise to fresh growths of *Uredo.* In autumn the spots become black in colour from the growth of the mildew form of the fungus—*Puccinia Rubiga-vera*—containing the resting spores, which lie dormant during winter, and germinate in spring. Low-lying lands worst affected, and also hill-tops. Bad in damp, sheltered corners, and wet seasons. Sow clean seed. Destroy all mildewed grass and rubbish. Rot the dung from the straw as well as possible.

Uredo linearis.—Summer corn "rust;" the early stage of summer mildew, *Puccinia graminis.* Attacks wheat specially. *Uredo* stage met with in March, April, May, while the later stage begins in June and July. Appears as yellow pustules on leaves, more elongated than in the case of the preceding species. *Puccinia* stage appears as dark brown or black pustules, which develop resting spores, that live through the winter. These resting spores (teleutospores) are supposed to germinate in the spring, giving rise to *Uredo* pustules once more; but many botanists hold that mildews must first go through another "alternation of generation" in some form of *Æcidium.* In this case the *Æcidium Berberidis*, or "Barberry Blight," is believed by some to be a third stage of the same fungus, thus acting as a nurse to the rust. This is held to be without proof by Mr. Worthington G. Smith. The attack is worse in wet, mild seasons; on undrained land; in damp, sheltered corners; in cases where dung and nitrate of soda have been applied too heavily in preference to mineral manures, producing heavy, flaggy crops. Liming, draining, and mixed manuring are desirable. Cut down tall fences to give free access of wind. Use clean seed. Change cropping, and use red wheat in preference to white.

MISCELLANEOUS CROP NOTES.

Comparative Characteristics of the various Crops.

A.—Corn Crops.

	Suitable Soils.	Latitude.	Height above Sea Level.	Order of Sowing.	Root Depth.	Drought Resisting.	Period of Growth.	Rapidity of Growth.	Order of Flowering.	Order of Ripening.	Total Sun's Heat required	Water in Grain.	Nitrogen in Grain.	Albuminoid Ratio.
												%	%	1 :
Wheat ...	Heaviest	Southern	Lowest	1	Deepest	Most ...	Longest	Slowest...	4	4	Most	14·4	2·0	5·4
Oats	Medium	Medium	Higher	2	Medium	Less ...	Less ...	Quicker	3	3	Less	14·3	1·9	6·7
Barley ...	Lighter	do.	do.	3	Less ...	do. ...	do. ...	do.	2	2	do.	14·0	1·7	6·8
Rye	Lightest	Northern	Highest	4	Least ...	Least...	Least ...	Quickest	1	1	Least	14·0	1·7	6·9

B.—Root Crops.

	Latitude.	Height above Sea Level.	Order of Sowing.	Root Depth.	Drought Resisting.	Period of Growth.	Rapidity of Growth.	Order of Harvesting.	Order of Seeding.	Total Sun's Heat required	Order of Consumption	Proportion of Tops to Roots	Weight of Roots per Acre	Dry Matter.	Nitrogen.	Sugar.	Albuminoid Ratio.	Manurial value of 1 ton.	Dominant Manure.
														%	%	%	1 :	s. d.	
White Turnip	Northern	Highest	6	Least	Least	Least	Most	1	1	Least	1	Most	Most	8·0	·14	Least	6 0	3 11	Phos. Acid
Yellow Turnip	Less ...	Lower	5	More	More	More	Less	2	2	More	2	Less	Less	9·5	·15	More	7·0	4 0	Phos. Acid
Swede ...	do. ...	do.	4	do.	do.	do.	do.	3	3	do.	3	do.	do.	10·6	·16	do.	8·3	4 7	Phos. Acid
Mangold	do. ...	do.	3	do.	do.	do.	do.	4	4	do.	4	do.	do.	12·0	·18	do.	8·4	5 0	Nitro.
Carrot ...	do. ...	do.	2	do.	do.	do.	do.	5	5	do.	5	do.	do.	12·5	·23	do.	8·5	5 3	Nitro.
Parsnip ...	Southern	Lowest	1	Most	Most	Most	Least	6	6	Most	6	Least	Least	15·0	·26	Most	8·6	5 5	Nitro.

C.—Forage Crops.

	Suitable Soils.	Latitude.	Height above Sea Level.	Order of Sowing.	Root Depth.	Drought Resisting.	Period of Growth.	Rapidity of Growth of Forage.	Order of Flowering.	Order of Seeding.	Order of Forage Use.	Total Sun's Heat.	Duration of Life.	Dry Matter.	Nitrogen.	Albuminoid Ratio.	Manurial Value.
			Feet.						Week.					%	%	1 :	
Vetch... ..	Clay ...	North	800	Feb.	Least	Least	Long	Least	May 4	1	1	Least	Ann.	18·0	·58	2·9	Least
Sainfoin ...	Calc. loam	Med.	600	Mar.	Med.	Med.	Med.	Med.	June 2	2	2	Med.	Per.	18·6	·70	3·0	Med.
Lucerne ...	do.	South	400	April	Most	Most	Short	Most	June 4	3	3	Most	do.	26·0	·75	3·1	Most

D.—Clovers.

	Suitable Soils.	Latitude.	Height above Sea Level.	Order of Sowing.	Root Depth.	Drought Resisting.	Period of Growth.	Rapidity of Growth of Forage.	Order of Flowering.	Order of Seeding.	Order of Forage Use.	Total Sun's Heat.	Duration of Life.	Dry Matter.	Nitrogen.	Albuminoid Ratio.	Manurial Value.
Crimson ...	Loam ...	South	500	Sept.	Least	Least	Short	Most	May 2	1	1	Most	Ann.	18·0	·45	5·4	Least
Broad Red	Clay ...	Med.	1,000	Mar.	Med.	Med	Med.	Med.	May 3	2	2	Med.	Bi. ...	18·5	·53	3·8	Med.
Alsike ...	do. ...	do.	1,250	April	do.	do.	do.	do.	May 4	3	3	do.	Tri.	19·0	·55	3·2	do.
White ...	Marl ...	North	1,500	do.	Most	Most	Most	Least	June 1	4	4	Least	Per.	19·5	·58	3·0	Most

CHARACTERS AND IMPURITIES OF SEEDS (FREAM).

Seed.	Qualities.	Impurities.
Wheat ...	Bright thin skin; freedom from smell; plump grain; "gutter" or groove well filled in; colour red or white, according to variety; dryness	Seeds of wild oats, ranunculus, goose-grass, charlock, wild onion.
Oats ...	Thin skin, plump grain; colour black or white—not brown, which indicates heating at some period	Wild oats, goose-grass, charlock.
Barley ...	Thin wrinkled skin; grain not shrunk, but plump, with small fine ends; pale white to light golden colour; freedom from smell; dryness	Wild oats, charlock.
Rye ...	Dryness.	
Bean ...	Colour light brown, no black ones; no smell; hardness	Easily cleaned.
Pea ...	Dryness, and full size of the variety; colours white, blue, brown, and mottled: black ones have been subjected to wet in field or stack, and are useless	Easily cleaned.
Red Clover and Cow Grass	Large proportion of purple seeds; no dull brown seeds, as they are dead	Docks, plantain; dodder.
Crimson Clover	Light brown colour	Docks, plantain, easily cleaned.
Alsike ...	Large proportion of dark green seeds; some light green ones met with in the best samples; no brown ones permissible	Docks, plantain, sorrel, shepherd's purse, cranesbill.
White Clover	Light golden colour—very light ones weak in germination, brown ones dead.	Docks, plantain, sorrel, shepherd's purse, cranesbill.
Vetch ...	Dryness; freedom from black seeds	Small peas.
Sainfoin...	In husk (unmilled) or helled (milled)	Burnet, docks.

CHARACTERS AND IMPURITIES OF SEEDS—*continued.*

Seed.	Qualities.	Impurities.
Lucerne...	No brown seeds	Trefoil.
Trefoil ...	Light brown colour	Rarely unclean.
Turnip, Swede, and Cabbage	Dryness; freedom from mouldiness	Charlock.
Mangold	Should germinate at least 120%	Coarse, rough seeds.
Potato ...	Firmness; tubers free from dry rot, and not too much sprouted	
Carrot ...	Dryness; not compact, as may have heated	Light rough seeds such as goose-grass.
Parsnip ...	Dryness.	

PERIODS FOR WHICH SEEDS retain their Germinating Power:—

	Years.		Years.
Barley (winter)... ...	3 to 4	Lucerne	4
,, (spring)... ...	2 to 3	Oats	2
Bean	5	Pea	5
Beetroot	6 to 7	Red clover	2 to 3
Buckwheat	2 to 3	Rye	4
Cabbage	5 to 6	Sainfoin	4 to 5
Carrot	4	Swede	5 to 6
Colza (Rape)	3	Timothy	5 to 6
Flax	2	Wheat (winter)... ...	3 to 4
Hemp...	3	,, (spring).. ...	2 to 3

If any doubt arises as to the vitality of a sample of seed, the proper course is to test it by sprouting a small quantity. Procure 3 flower-pot saucers—2 of the same size, 1 a little smaller; put 100 seeds into the smaller and set into one of the larger, in which there is to be a little water; invert the other large saucer over the top; set aside in the living room. All the requisites of speedy germination are present: sufficient moisture soaks through the inside saucer to keep the seeds moist but not wet; there is access to the air; and there is an equable temperature; while the seeds can be examined at any time.

Clover and other leguminous and turnip seeds can be tested quickly by rolling in flannel and dipping in boiling water for four or five minutes: on examination, good seeds will be found to have "sprouted"—the cotyledons and radicle having burst out through their coverings; dead or bad seeds will not so swell out.

Germination.

Heat, moisture, and air are necessary for germination of seeds, and they will freely sprout if exposed to light. The seed absorbs moisture, swells, and softens. Seeds in the resting state contain *zymogen*, or "mother of ferment," located in the grain plants (*Gramineæ*) in the scutellum between the embryo and the food store, and in others (as in *Leguminosæ*) diffused through the mass of cells forming the cotyledons. The absorption of water at a medium temperature develops a weak acid which converts the zymogen into various ferments, which act as follows:—*Diastase* converts the starch and cellulose into forms of sugar (dextrine and dextrose); *vegetable trypsin* converts the proteid or albuminous matter into an amide—asparagin; and another ferment splits up the oil into its fatty acids and glycerine, which are further changed into a crystalline acid and sugar by the action of the protoplasm, or living matter, of the cells. In this way the whole of the stored-up food material is rendered soluble, enters into the circulation of the embryo, and is used to build up the new tissue of the sprouting plant. Oxygen is absorbed, carbonic anhydride given off, and heat developed (from oxidation). The rootlets descend through their sheaths (in wheat) and the plumule ascends.

In malting barley the large mass of starch is largely converted into sugar, and the process is stopped at this stage by kiln-drying, and thus killing the germ. The diastase formed is more than is needed for the seed, and extra quantities of starchy materials are sometimes "malted" without fresh germination by mixing with from 10 to 20 per cent. of sprouted grain.

Some seeds bear a heat which destroys others. They do not germinate below 37° F. or above 128° F., but summer temperature (65°) is the best average.

If the time required for a plant to come to the surface in germination from 1 inch deep is taken as 1, then at 2, 3, 4, 5, and 6 in. the times will be as 1·5, 1·6, 1·7, 1·8, and 1·9, and the percentage of seeds sprouting as 90, 80, 50, 40, and 15. They will not germinate at a depth of 7 in., but may retain their vitality for a long time.

The best depth for wheat is from 1 to 2 in.; the largest percentage sprouts, and in from 12 to 18 days. For grasses and clovers experiment has shown that they are usually sown far too shallow. The greatest number and the strongest plants will come in the open field if the seed is covered from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch Bush-harrows or light seed harrows, therefore, do not give enough of cover, but heavy ones must be used, or other means taken to ensure depth of soil.

Growth and Ripening.

After germination, the development of root, stem, and leaves next proceeds—carbonic acid being absorbed from the air by the leaves, and water and mineral food from the soil by the roots. About 90 % of the growing plant is water and carbon, while the ash ranges from 1 to 5 % ; the growth of the plant depending on the small amount of mineral matter (*plus* nitrogen), which is readily available in the soil. The material absorbed causes the cells and tissues to swell, divide, and enlarge, and thus the whole plant grows in size. When the full size is attained it sends up a flowering stalk, the material to form which is mostly transferred from the cells of the root, stem, and leaves by a process of "metastasis"—*i.e.*, the albuminoids, fats, and carbo-hydrates become soluble as above described, and thus enter into the circulation of the sap and are carried to where they are required. Finally, the formation of the seed proceeds from the further depletion of the same, the last process being to thicken the seed-coats (such as the bran on wheat) at the expense of the material of the seed itself. In a crop allowed to ripen, therefore, the straw of corn plants, and the bulbs of root crops, are only a mass of indigestible "fibre," the seed having absorbed all the soluble food material out of them.

Harvesting and Storing.

Harvesting should therefore always be proceeded with before crops are fully ripe, where it is desirable to have good fodder; though, of course, they must be ripened when required for seed purposes. Corn crops should be cut while they are still a little green, and hay and forage at flowering time. As the ripening process goes on after the plants are severed from the roots, while still full of moisture, the particular time of cutting can be made to suit the weather.

Stuff must be dry before stacking, as otherwise it will heat and spoil. An open, breezy stackyard is better than one too much sheltered; and the stacks should be small in an upland district or damp climate, and larger in lower districts or where the rainfall is less: this is owing to the fact that a crop contains more moisture, and is more difficult to dry, in proportion to the rainfall. This rule extends to the grain also, and heaps in a granary should be turned over from time to time and opened up to the air, or else they will become musty and spoiled.

RULES to be attended to in selecting Seed:—

1. The seed must be true to its variety.
2. It must be large and well developed.
3. It must be ripe.
4. It must be free from injury.
5. It must be fresh.

CHANGE OF SEED.

It is found that, if a farmer continually uses seed of his own growing, his crops deteriorate in a few years, while fresh seed—if judiciously selected—will yield good crops. A change should always be made, if possible, from an earlier district or a better soil. At the same time, much improvement may be made by a more rigid selection of home seed. Major Hallet developed his well-known varieties by careful selection of the best grains year after year—without changing—and the same principle might be applied by farmers to their ordinary crops. Select the best part of a field when growing, let it ripen well, harvest carefully, and afterwards dress the grain over two or three times with the most suitable dressing machine, so that only the very best grain be retained. If this system is persevered in, a better crop will result than from an annual change of seed.

CROSS-FERTILISATION.

In order to produce a variety of plant which shall combine the good characteristics of two separate kinds, the system of cross-breeding has been largely practised, especially with wheat.

On one of the selected parent plants the glumes are opened and the anthers removed some time before these latter are ripe. When the pollen is ripe for shedding in the other parent plant, it is dusted over the feathery stigmas of the young germ in the plant first operated on, the glumes closed, and the heads tied up in muslin, to protect from birds, &c. The operation requires much careful manipulation, and the delicate organs must not be exposed to the weather; while it requires to be done early, as self-fertilisation naturally takes place inside the glumes, some time before the empty anthers are pushed outside. "Cross-bred" varieties are now common.

TABLE TO ASCERTAIN THE WEIGHT OF ROOT-CROPS PER ACRE BY WEIGHING AN AVERAGE LINEAL YARD.

A Square Acre with Ridges:—	30 in. apart.				29 in. apart.				28 in. apart.				27 in. apart.			
No. of Ridges:—	83·24				86·11				89·19				92·49			
	tons	cwts.	qrs.	lbs.	tons	cwts.	qrs.	lbs.	tons	cwts.	qrs.	lbs.	tons	cwts.	qrs.	lbs.
If there be 1 lb. of roots in 1 yard, it will yield per acre	2	11	3	12	2	13	2	16	2	15	2	6	2	17	2	13
If 2 lbs. per yard... ...	5	3	2	24	5	7	1	4	5	11	0	12	5	15	0	26
If 3 lbs. ,, ...	7	15	2	8	8	0	3	20	8	6	2	18	8	12	3	11
If 4 lbs. ,, ...	10	7	1	20	10	14	2	8	11	2	0	24	11	10	1	24
If 5 lbs. ,, ...	12	19	1	4	13	8	0	24	13	17	3	2	14	8	0	9
If 6 lbs. ,, ...	15	11	0	16	16	1	3	12	16	13	1	8	17	5	2	22
If 7 lbs. ,, ...	18	3	0	0	18	15	2	0	19	8	3	14	20	3	1	7
If 8 lbs. ,, ...	20	14	3	12	21	9	0	16	22	4	1	20	23	0	3	20
If 9 lbs. ,, ...	23	6	2	24	24	2	3	4	24	19	3	26	25	18	2	5
If 10 lbs. ,, ...	25	18	2	8	26	16	1	20	27	15	2	4	28	16	0	18
If 11 lbs. ,, ...	28	10	1	20	29	10	0	8	30	11	0	10	31	13	3	3
If 12 lbs. ,, ...	31	2	1	4	32	3	2	24	33	6	2	16	34	11	1	16
If 13 lbs. ,, ...	33	14	0	16	34	17	1	12	36	2	0	22	37	9	0	1
If 14 lbs. ,, ...	36	6	0	0	37	11	0	0	38	17	3	0	40	6	2	14
If 15 lbs. ,, ...	38	17	3	12	40	4	2	16	41	13	1	6	43	4	0	27
If 16 lbs. ,, ...	41	9	2	24	42	18	1	4	44	8	3	12	46	1	3	12

Rotations.

1. Two-years' course for heaviest land.
   1st. Wheat.
   2nd. Beans.
   With an occasional bare summer fallow.

2. Three-years' course for the same.
   1st. Wheat.
   2nd. Clover.
   3rd. Potatoes, Turnips, Cabbages, &c.

3. Norfolk four-course.
   1st. Wheat.
   2nd. Turnips, or other roots.
   3rd. Barley or oats.
   4th. Clover, or other leguminous plant.
   Suited to lighter land.

4. Berwick five-course.
   1st. Wheat or oats.
   2nd. Roots.
   3rd. Barley or oats.
   4th. Clover and "Seeds," cut or pastured.
   5th. Clover and "Seeds," pastured.
   Very common in Scotland.

5. East Lothian six-course.
   1st. Oats (top-dressed).
   2nd. Beans or Potatoes (manured).
   3rd. Wheat.
   4th. Green-Crop (manured).
   5th. Wheat or Barley (half-manured).
   6th. Rye-Grass.

A six-course is also made from the Berwick five-course by having three years' seeds, and another—practised in the Lothians—by substituting potatoes for the third years' seeds.

6. Seven-years' course on strong land.
   1st. Wheat.
   2nd. Beans.
   3rd. Wheat.
   4th. Vetches and Mangold.
   5th. Wheat.
   6th. Clover (twice cut).
   7th. Clover (once cut, then fed).

In Forfar, Kincardine, &c., the East Lothian six-course is expanded into a seven-course by having two years' seeds.

7. Eight-years' course: strong loam.

1st. Oats.	5th. Roots.
2nd. Wheat.	6th. Barley.
3rd. Beans or Green-Crop.	7th. Clover.
4th. Wheat.	8th. Clover.

Practically an extension of the Berwick five-course.

8. Ulster eight-course.

1st. Oats.	5th. Flax (with "seeds").
2nd. Flax.	6th. Seeds, cut.
3rd. Potatoes (or Turnips).	7th. Seeds, grazed.
4th. Wheat.	8th. Seeds, grazed.

Very common in the North of Ireland.

The above are examples of the leading rotations practised in various parts of the country; but there are innumerable modifications of these, due to the influence of soil, climate, markets, &c. The rotation of a particular locality, though generally the result of years of experience, is not a hard-and-fast rule, but may sometimes be varied with advantage, especially when the markets have changed.

Reasons for Rotating Crops.

1st. It is more economical of manure, as different crops require ingredients in different quantities.

2nd. For the same reason, is more economical of food in soil.

3rd. Allows of a better distribution of labour throughout the year.

4th. Allows of better cleansing of the land.

5th. Allows deep-rooted—or air-feeding—crops to enrich the top soil for the benefit of shallow-rooted varieties to follow.

6th. Some crops are a good preparation for others, as beans or clover before wheat.

7th. Checks the devastation of insects and fungi by shifting locality of crop which they affect.

8th. Changes the locality of the live stock every year.

9th. A variety of crops are needed for market and live stock requirements.

Lawes and Gilbert have shown that a crop may be grown for an indefinite time on the same land by a special course of manuring, but certain ingredients must accumulate in the soil and no good be got from them when this course is followed, not to mention other evil results.

LIST OF WEEDS.

* Numbers express months of the year.
A, Annual; B, Biennial; P, Perennial.

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	* Time of Flowering.	Duration.
RANUNCULACEÆ.					
Traveller's Joy... ...	Clematis vitalba	Hedges	White ...	7	P
Meadow Rue	Thalictrum flavum ...	Moist meadows ...	Ochre ...	7	P
Pasque-Flower... ...	Anemone Pulsatilla ...	Chalky pastures ...	Violet ...	4–5	P
Wood Anemone ...	,, nemorosa ...	Woods	White ...	3–6	P
Corn Pheasant's Eye ...	Adonis autumnalis ...	Cornfields	Scarlet ...	5–10	A
Mouse-Tail	Myosurus minimus ...	,, ...	Yellow ...	5	A
Greater Spearwort ...	Ranunculus Lingua ...	Wet clay	,, ...	7–9	P
Lesser do. ...	,, Flammula ...	Wet land	,, ...	6–8	P
Crowfoot or Buttercup	,, acris	Pastures	,, ...	6–7	P
Do. do.	,, repens ...	,, ...	,, ...	6–8	P
Do. do.	,, bulbosus ...	,, ...	,, ...	5	P
Do. do.	,, arvensis ...	Cornfields	,, ...	6	A
Pilewort	,, Ficaria ...	Hedge banks ...	,, ...	4	P
Common Monk's Hood	Aconitum Napellus ...	Hedgerows ...	Blue ...	5–7	P
Stinking Hellebore ...	Helleborus fœtidus ...	,, walls...	Purple ...	2–4	P

BERBERIDEÆ.					
Barberry	Berberis vulgaris	Hedges	Yellow ...	5–6	P
PAPAVERACEÆ.					
Long Smooth-headed Poppy	Papaver dubium	Cornfields	Light scarlet	6–7	A
Corn Poppy ...	,, Rhœas	,, ...	Scarlet ...	6–7	A
FUMARIACEÆ.					
Fumitory	Fumaria officinalis ...	Arable land ...	Rose ...	5–8	A
CRUCIFERÆ.					
Ladies' Smock	Cardamine pratensis ...	Moist pastures ...	Purple ...	4–5	P
Hedge Mustard ...	Sisymbrium officinale ...	Commons	Yellow ...	7	A
Garlic do. ...	,, alliaria ...	Hedge banks ...	White ...	5–6	B
Charlock or Wild Mustard	Sinapis arvensis	Corn and root crops	Yellow ...	5–8	A
Scurvy-Grass	Cochlearia officinalis ...	Sea-shore	White ...	6	A
Shepherd's Purse ...	Capsella Bursa-Pastoris ...	Corn and root crops	,, ...	3–10	A
Candytuft (bitter) ...	Iberis amara	Cornfields	,, ...	7	A
Wild Radish or Runch	Raphanus Raphanistrum...	Corn and root crops	Yellow ...	5–8	A
CARYOPHYLLEÆ.					
Bladder Campion ...	Silene inflata	Damp loams ...	White ...	6–8	P
Ragged Robin	Lychnis Flos-cuculi ...	Wet pastures ...	Rose ...	5–7	P
Red Campion	,, diurna	Hedges	Red ...	6–7	P
Campion	,, vespertina ...	Sandy fields ...	White ...	7	A

LIST OF WEEDS—*continued.*

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	* Time of Flowering.	Duration.
CARYOPHYLLEÆ—*continued.*					
Corn Cockle	Githago segetum	Cornfields	Purple ...	6–7	A
Mouse-Ear Chickweed	Cerastium triviale ...	Pasture	White ...	5–9	A
Do. do.	,, arvense ...	Cornfields	,, ...	5–8	P
Chickweed	Stellaria media	Arable land ...	,, ...	2–11	A
Stitchwort	,, palustris... ...	Moist meadows ...	,, ...	6–7	P
Sandwort	Arenaria tenuifolia ...	Sandy fields ...	Purple and white ...	6–8	A
Spurrey	Spergula arvensis... ...	Wet sandy fields ...	White ...	7–8	A
MALVACEÆ.					
Common Mallow ...	Malva sylvestris	Damp meadows ...	Purple ...	6–9	P
LINEÆ.					
Bitter Flax	Linum catharticum ...	Light land	White ...	6–8	A
GERANIACEÆ.					
Cranesbill	Geranium pratense ...	Moist pastures ...	Blue ...	6–7	P
Do.	,, columbinum ...	Cornfields	Rose ...	6–7	A
Wood Sorrel	Oxalis Acetosella ...	Shady places ...	White and purple ...	6–10	P

LEGUMINOSÆ.					
Gorse, Whin, Furze ...	Ulex europæus	Stony places ...	Yellow ...	2–7	P
Broom	Cystisus scoparius ...	,, ,, ...	,, ...	5–6	P
Rest Harrow	Ononis spinosa	Poor pastures ...	Rose ...	6–8	P
Trefoil	Medicago lupulina ...	Arable fields ...	Yellow ...	5–8	A
Melilot	Melilotus altissima ...	Cornfields	,, ...	6–7	P
Hairy Vetch	Vicia hirsuta	Hedges	Blue ...	6–8	A
Hedge do.	,, Cracca	,, ...	,, ...	6–8	P
ROSACEÆ.					
Queen of the Meadow...	Spiræa Ulmaria	Moist meadows ...	White ...	6–7	P
Bramble	Rubus fructicosus ...	Hedges	White & pink	7–9	P
Cinquefoil	Potentilla comarum ...	Spongy bogs ...	Purple ...	6–7	P
Silverweed	,, anserina ...	Moist fields ...	Yellow ...	6–7	P
Ladies' Mantle... ...	Alchemilla arvensis ...	Cornfields	Green ...	5–8	A
Do. do.	,, vulgaris ...	Dry pastures ...	,, ...	6–8	P
Agrimony	Agrimonia Eupatoria ...	Border of cornfields	Yellow ...	6–7	P
ONAGRARIEÆ.					
Willow-Herb	Epilobium hirsutum ...	Hedge banks ...	Purple ...	7–8	P
Do. (smaller)	,, parviflorum ...	Wet fields	,, ...	7–8	P
UMBELLIFERÆ.					
Marsh Pennywort ...	Hydrocotyle vulgaris ...	Marshes	White ...	5–8	P
Hemlock	Conium maculatum ...	Hedges	,, ...	6–7	B
Cow-Bane	Cicuta virosa	Ponds	,, ...	6–8	P
Arnut	Bunium flexuosum ...	Woods, meadows...	,, ...	5–6	P

List of Weeds—*continued.*

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	* Time of Flowering.	Duration.
Umbelliferæ—*continued.*					
Gout-Weed	Ægopodium Podagraria...	Damp places ...	White ...	6–7	P
Shepherd's Needle (Venus' Comb) ...	Scandix Pecten-Veneris ...	Cornfields	,, ...	6–7	A
Fool's Parsley	Æthusa Cynapium ...	,, ...	,, ...	7–8	A
Pepper Saxifrage ...	Silans pratensis	Meadows	Yellow ...	7–9	P
Hog-Weed	Heracleum Sphondylium	Pastures and hedges	White ...	7	B
Wild Angelica	Angelica sylvestris ...	Wet clay	Pink ...	7–8	P
Araliaceæ.					
Ivy	Hedera Helix	Trees, hedges ...	Green ...	11	P
Rubiaceæ.					
Bedstraw	Galium palustre	Moist meadows ...	White ...	7	P
Goose-Grass; Cleavers	,, Aparine	Fields and hedges...	,, ...	5–8	A
Birdlip	,, tricorne	Cornfields	,, ...	7	A
Field Madder	Sherardia arvensis ...	Sandy soil	Pink ...	4–10	A
Dipsaceæ.					
Wild Teazle	Dipsacus sylvestris ...	Hedges	Purple ...	8–9	B
Devil's-Bit Scabious ...	Scabiosa succisa	Pastures	Violet ...	8–10	P
Field Scabious... ...	,, arvensis... ...	Damp loam ...	,, ...	8–10	P

Compositæ.					
Daisy	Bellis perennis	Pastures	White ...	3–12	P
Ploughman's Spikenard	Inula Conyza	Chalky pastures ...	Yellow ...	7–8	B
Golden Samphire ...	,, crithmoides ...	Salt marshes ...	,, ...	7–8	P
Flea-Bane	Pulicaria vulgaris ...	Moist	,, ...	7–8	P
Cudweed, Marsh ...	Gnaphalium uliginosum ...	Wet sandy soil ...	,, ...	7–8	A
Chamomile, Corn ...	Anthemis arvensis ...	Cornfields	White ...	6–7	A
Stinking Mayweed ...	,, Cotula	,, ...	,, ...	6–7	A
Chamomile, True ...	,, nobilis	Gravelly pastures	,, ...	8–9	P
Wild Chamomile ...	Matricaria Chamomilla ...	Cornfields	,, ...	6–8	A
Goose-Tongue	Achillea Ptarmica ...	Moist places ...	,, ...	7–8	P
Yarrow	,, Millefolium ...	Dry Pastures ...	,, or pink	6–9	P
Corn Marigold	Chrysanthemum segetum	Cornfields	Yellow ...	6–8	A
White Oxeye Daisy ...	Chrysanthemum Leucanthemum...	,, ...	White ...	6–8	P
Common Feverfew ...	Chrysanthemum Parthenium	Waysides	,, ...	7–9	A
Tansy	Tanacetum vulgare ...	Waste land ...	Yellow ...	8	P
Mugwort	Artemesia vulgaris ...	Sandy soil	,, ...	7–9	P
Wormwood	,, Absinthium ...	Waste land ...	,, ...	7–9	P
Butterburr	Petasites vulgaris... ...	Wet meadows ...	Lilac ...	4	P
Coltsfoot	Tussilago Farfara ...	Marly soils ...	Yellow ...	3–4	P
Groundsel	Senecio vulgaris	Cornfields	,, ...	1–12	A
Ragwort...	,, Jacobæa	Pastures	,, ...	7–9	P
Burdock Thistle ...	Arctium Lappa	Waste places ...	Purple ...	7–8	B
Knapweed	Centaurea nigra	Pastures	,, ...	8–9	P
Hardheads	,, Scabiosa ...	Damp loam ...	,, ...	7-9	P

LIST OF WEEDS—*continued.*

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	* Time of Flowering.	Duration.
COMPOSITÆ—*continued.*					
Corn Flower	Centaurea Cyanus ...	Cornfields	Blue ...	7–8	A
Thistle, Musk	Carduus nutans	Waste places ...	Purple ...	7–8	B
Do. Welted... ...	,, crispus	Pastures	,, ...	6–8	B
Do. Spear Plume ...	Cnicus lanceolatus ...	Pastures	,, ...	7–8	B
Do. Woolley-headed	,, eriophorus ...	Chalk	,, ...	8	B
Do Way	,, arvensis	Cornfields	,, ...	7–8	P
Do. Marsh Plume ...	,, palustris	Moist meadows ...	,, ...	7–8	B
Do. Meadow Plume	,, pratensis	,, pastures ...	,, ...	6–8	P
Do. Cotton	Onopordon Acanthium ...	Rubbish heaps ...	,, ...	8	B
Hawk's Beard	Crepis fœtida	Chalky places ...	Yellow ...	6–7	B
Nipplewort	Lapsana communis ...	Arable land ...	,, ...	6–7	A
Hawkweed	Hieracium Pilosella ...	Dry pastures ...	,, ...	5–7	P
Dandelion	Taraxacum officinale ...	Moist pastures ...	,, ...	3–10	P
Thistle, Sow	Sonchus arvensis	Cornfields	,, ...	8	P
Do. Sow—Annual...	,, oleraceus ...	,, ...	,, ...	6–8	A
Goat's Beard	Tragopogon pratensis ...	Pastures	,, ...	6	B
Wild Chicory	Cichorium Intybus ...	Sandy fields ...	Blue ...	7–8	P
CAMPANULACEÆ.					
Sheep's Bit or Scabious	Jasione montana	Dry hilly pastures	Blue ...	6–7	B

Bell-Flower, Harebell	Campanula rotundifolia ...	Dry banks ...	,, ...	7–9	P
Do. do.	,, patula ...	Pasture	Violet ...	7–8	B
Do.	Specularia hybrida ...	Cornfields	,, ...	6–9	A
ERICACEÆ.					
Heath, Cross-leaved ...	Erica Tretralix	High pastures ...	Rose ...	7–9	P
Do. Ling	Calluna vulgaris	Heaths	,, ...	6–7	P
PRIMULACEÆ.					
Cowslip...	Primula veris	Meadows	Yellow ...	4–5	P
Scarlet Pimpernel ...	Anagallis arvensis	Cornfields	Scarlet ...	6–7	A
GENTIANEÆ.					
Common Centaury ...	Erythræa Centaurium ...	Pastures	Rose colour	7–8	A
Field Gentian	Gentiana campestris ...	Dry hilly pastures	Purple ...	9	A
BORAGINEÆ.					
Viper's Bugloss ...	Echium vulgare	Cornfields	Blue ...	6–7	B
Common Comfrey ...	Symphytum officinale ...	Moist places ...	Purple or yellow ...	5–6	P
Tuberous do. ...	,, tuberosum ...	,, ,, ...	Yellow ...	6–7	P
Bugloss	Anchusa arvensis ...	Cornfields	Blue ...	6–7	A
Gromwell, Corn ...	Lithospermum arvense ...	,, ...	White ...	5–6	A
Common Forget-me-Not	Myosotis palustris ...	Marshes	Blue ...	7–8	P
Scorpion Grass, or Field Forget-me-Not ...	,, arvensis ...	Cornfields	,, ...	5–7	A

LIST OF WEEDS—*continued.*

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	* Time of Flowering.	Duration.
CONVOLVULACEÆ. ...					
Small Bindweed	Convolvulus arvensis ...	Cornfields	Pink ...	6–7	P
Bearbind; Great Convolvulus	,, sepium ...	Hedges	White ...	6–8	P
Clover Dodder ...	Cuscuta europœa	Clover fields ...	,, ...	8–9	A
Flax do.	,, Epilinum ...	Flax fields... ...	,, ...	8–9	A
SOLANACEÆ					
Henbane	Hyocyamus niger	Waste places... ...	Straw	7	A
Bitter-Sweet...	Solanum Dulcamara ...	Hedges	Purple ...	6–8	P
Deadly Nightshade ...	Atropa Belladonna	Waste places... ...	Violet ...	6	P
PLANTAGINEÆ.					
Greater Plantain	Plantago major	Roadsides	...	6–8	P
Hoary do.	,, media	Pastures	...	5–9	P
Ribwort do.	,, lanceolata ...	,, ...	...	6–7	P
SCROPHULARINEÆ.					
Toad Flax	Linaria vulgaris	Damp loam	Yellow ...	5–9	P
Snapdragon; Calves' Snout...	Antirrhinum Orontium ...	Cornfields	Purple ...	7–9	A

Foxglove	Digitalis purpurea	Hedge banks... ...	,, ...	6–7	P
Field Speedwell	Veronica agrestis	Cornfields	Blue	4–9	A
Ivy-leaved Speedwell ...	,, hederæfolia ...	,, ...	,, ...	5–8	A
Speedwell	,, officinalis	Barren ground ...	,, ...	6–8	P
Germander Speedwell...	,, Chamædrys ...	Hedges	,, ...	5–6	P
Yellow Viscid Bartsia	Bartsia viscosa	Damp pastures ...	Yellow ...	6–10	A
Eye-Bright	Euphrasia officinalis ...	Pastures...	White ...	7–9	A
Yellow Rattle	Rhinanthus Crista-galli ...	Meadows	Yellow ...	6	A
Lousewort	Pedicularis palustris ...	Wet pastures ...	Purple ...	6–7	A
Cow Wheat	Melampyrum pratense ...	Woods	Yellow ...	5–8	A
OROBANCHEÆ.					
Broomrape, Larger ...	Orobanche major	Clover fields	Purplish ...	7–8	P
Do. Smaller ...	,, minor	,, ,, ...	,, ...	7–8	P
LABIATÆ.					
Corn Mint	Mentha arvensis	Cornfields	Rose	6–9	P
Ground Ivy; Gill ...	Nepeta Glechoma	Hedge banks... ...	Blue	4–5	P
Self-Heal	Brunella vulgaris	Damp pastures ...	Violet ...	7–8	P
Woundwort, Marsh ...	Stachys palustris	Wet places	Purple ...	7–8	P
Do. Corn ...	,, arvensis	Cornfields	,, ...	8–9	A
Hemp-Nettle	Galeopsis Tetrahit	,, ...	,, ...	7–9	A
Dead Nettle, Red ...	Lamium purpureum ...	Waste ground ...	,, ...	5	A
Do. Henbit ...	,, amplexicaule ...	Cornfields	Rose	5–8	A
Do. White ...	,, album...	Waste ground ...	White ...	5–9	P

LIST OF WEEDS—*continued.*

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	* Time of Flowering.	Duration.
ILLECEBRACEÆ.					
Common Knawel...	Scleranthus annuus ...	Sandy fields ...	Green...	6–8	A
CHENOPODIACEÆ.					
White Goosefoot ...	Chenopodium album	Waste ground	Green...	7–8	A
Red do.	,, rubrum	,, ,,	,,	8–9	A
Marsh Samphire ...	Salicornia herbacea ...	Salt marshes ...	,,	8–9	A
POLYGONACEÆ.					
Redshank	Polygonum amphibium ... (terrestre)	Wet ground ...	Rose ...	7–8	P
Knot Grass ...	,, aviculare	Moist fields ...	White	7	P
Common Dock	Rumex obtusifolius ...	Everywhere ...	...	7–8	P
Curled Dock	,, crispus ...	,,	...	6–8	P
Sorrel or Sourock	,, Acetosa	,,	...	5–7	P
Sheep's Sorrel	,, Acetosella ...	Dry banks ...	...	5–7	P
EUPHORBIACEÆ.					
Sun-Spurge ...	Euphorbia Helioscopia	Cornfields	Green...	6–10	A
Dog's Mercury	Mercurialis perennis	Woods ...	,,	3–5	P

URTICACEÆ.					
Small Nettle...	Urtica urens	Waste places... ...	Green... ...	6–10	A
Common Nettle	,, dioica	Hedges	,, ...	7–8	P
LILIACEÆ.					
Garlic, Crow	Allium vineale	Meadows	Pinkish ...	7	P
Do. Field	,, oleraceum ...	Cornfields	Green ...	7	P
Ramsen	,, ursinum	Moist places ...	White ...	4–6	P
Meadow Saffron ...	Colchicum autumnale ...	Meadows	Yellow ...	8	P
Bog Asphodel	Narthecium ossifragum ...	Boggy land ...	...	6–8	P
JUNCEÆ.					
Common Rush, &c. ...	Juncus effusus, &c. ...	Moist meadows ...	...	7	P
Spring Wood Rush ...	Luzula vernalis	Shady places ...	...	3–5	P
Wood Rush	,, campestris ...	Moist meadows ...	...	3–5	P
ALISMACEÆ.					
Water Plantain ...	Alisma Plantago	Marshes	Rose ...	6–8	P
CYPERACEÆ.					
Cotton Grass	Erisphorium vaginatum ...	Boggy moors ...	...	3–5	P
Common Carex ...	Carex vulgaris	Wet places ...	...	5–6	P
Sedge	,, paludosa	,, ,, ...	...	5–6	P
GRAMINEÆ.					
Field Foxtail	Alopecurus agrestis ...	Cornfields	...	5–11	A
Dog's Brown Bent ...	Agrostis canina	Wet soils	...	6–7	P

LIST OF WEEDS—*continued.*

English Name.	Botanical Name.	Soil or Situation.	Colour of the Flower.	* Time of Flowering.	Duration.
GRAMINEÆ—*continued.*					
Bent Grass	Agrostis vulgaris	Sandy fields ...	...	6–7	P
Tussac Grass	Aira cæspitosa	Pastures	...	6–7	P
Yorkshire Fog	Holcus lanatus	Light soils ...	...	6–7	P
Wild Oat	Avena fatua	Cornfields	...	8	A
Quaking Grass	Briza media	Poor grass land ...	...	6–7	P
Annual Meadow Grass	Poa annua	Everywhere ...	...	4–9	A
Soft Brome Grass ...	Bromus mollis	Meadows	...	6	A
Darnel Grass	Lolium temulentum ...	Cornfields	...	6–9	A
Couch Grass	Triticum repens	All soils	...	6–8	P
All other wild Grasses—	(p. 204).				
FILICES.					
Common Bracken ...	Pteris aquilina	Mountain pastures	...	7–8	P
Adder's Tongue ...	Ophioglossum vulgatum...	,, ,,	...	4–6	P
EQUISETACEÆ.					
Horsetail, Corn ...	Equisetum arvense ...	Wet fields	...	3–4	P
Do. Marsh ...	,, palustre ...	Marshy land ...	...	6–7	P
MUSCI.					
Various Mosses ...	Hypnum, Sphagnum, Funaria, &c.	Wet pastures ...	...	...	P

"A weed is a plant out of place."

"One year's seeding is seven years' weeding."

Most of the annual plants are propagated from seed only, and if they are cut before ripe, a second crop is prevented from growing.

Many of the seeds will maintain their germinating power while buried in the soil for an indefinite period: charlock is one of this nature, the seeds being oily, and thus able to resist putrefaction while lying in a wet soil. The easiest way to get rid of such is to scarify the land after the crop is off, allow the seeds to germinate, and then plough down before flowering again.

The modern system of ploughing tends to keep down weeds: the top surface is thoroughly and deeply buried, and a heavy, smothering crop grown.

Some of the perennials can only be dealt with by picking out of the land, as couch grass, for instance, which increases the more it is cut and broken, on account of it having an underground stem which will sprout from every node.

The large weeds—as docks and thistles—must be dealt with individually; the former dug out bodily, the latter cut through *below* the surface of the ground. Thistles in pastures should be cut in August where not previously spudded.

Liming, draining, manuring, and growing heavy crops, cause the disappearance of many weeds, and care must be taken to see that all seeds sown and manurial dressings applied are free from the seeds of noxious plants.

FEEDING.

COMPOSITION OF FOODS.

TABLE showing the percentage proportion of the proximate constituents (albuminoids, fats, and carbohydrates), together with ash, water, and fibre; also the proportion of constituents actually digestible: arranged alphabetically.

Foods.	Water.	Albuminoids.	Fats.	Carbohydrates.	Fibre.	Ash.	Digestible Matter. Albuminoids.	Digestible Matter. Fats.	Digestible Matter. Carbohydrates.	Organic Matter.
Acorns	56·0	2·5	1·6	34·5	4·4	1·0	2·0	1·5	34·0	43·0
Almond seed cake	9·7	41·3	15·2	20·6	8·9	4·3	37·2	13·7	20·2	86·0
American flesh meal	11·5	72·8	12·0	—	—	3·7	69·9	10·1	—	84·8
Apples	83·1	0·4	—	11·3	4·8	0·4	0·3	—	11·3	16·5
Artichoke, Jerusalem ...	80·0	2·0	0·2	15·5	1·3	1·0	2·0	0·2	15·5	19·0
Do. do. green leaves	80·0	3·3	0·8	9·8	3·4	2·7	2·0	0·4	9·4	17·3
Barley, seed	14·0	10·0	2·3	66·1	4·9	2·7	7·7	2·3	56·1	83·0
Do. meal (ground whole)	11·1	11·6	4·9	34·8	31·9	5·7	8·1	3·4	24·4	83·2
Do. common pearl ...	...	6·2	1·3	77·0	...	...	...	...	...	...
Do. bere	14·3	9·0	2·5	59·7	12·0	2·5	...	...	...	83·2
Do. bran	12·0	14·8	4·1	45·6	19·4	4·1	11·5	3·6	34·2	83·9
Do. chaff and husk ...	14·3	3·0	1·5	38·2	30·0	13·0	1·2	0·6	18·5	72·7
Do. straw (spring) ...	14·3	3·5	1·4	36·7	40·0	4·1	1·3	0·5	18·6	81·6

Do. do. (winter) ...	14·3	3·3	1·4	32·5	43·0	5·5	0·8	0·4	31·4	80·2
Beans (meal), common ...	14·5	25·5	1·6	45·9	9·4	3·1	23·0	1·4	43·6	82·4
Do. do. foreign ...	14·5	23·0	1·5	44·5	12·7	3·8	...	...	...	81·7
Do. pods—chaff	15·0	10·5	2·0	34·0	33·0	5·5	5·1	1·2	34·7	79·5
Do. straw	16·0	10·2	1·5	35·2	33·6	4·5	5·0	0·5	35·2	79·5
Bean forage	87·2	2·8	0·3	5·2	3·5	1·0	2·0	0·2	5·2	11·7
Beech mast, shelled	12·5	37·1	7·5	29·8	5·5	7·7	33·4	6·8	28·1	79·8
Do. do. cake	10·0	24·0	6·5	23·8	30·5	5·2	17·8	5·2	16·7	84·8
Beet (sugar)	81·5	1·0	0·1	15·4	1·3	0·7	1·0	0·1	15·4	17·8
Do. pulp, pressed	70·0	1·8	0·2	18·3	6·3	3·4	1·8	0·2	18·3	26·6
Do. do. centrifugal ...	82·0	1·0	0·1	12·1	3·6	1·2	1·0	0·1	12·1	16·8
Do. do. macerated ...	94·8	0·5	0·1	3·3	1·0	0·3	0·5	0·1	3·3	4·9
Do. do. do. fermented	92·0	0·8	0·1	4·8	1·8	0·5	0·8	0·1	4·8	7·5
Bokhara Clover, forage ...	87·5	2·9	0·4	3·5	3·6	2·1	1·6	0·2	3·9	10·4
Do. do. hay	14·3	16·7	2·8	27·9	30·3	8·0	8·5	1·6	31·7	77·7
Brewers' grains	76·6	4·9	0·5	10·6	6·2	1·2	3·9	0·4	9·5	22·2
Do. do. dessicated ...	12·0	18·7	8·1	49·0	7·9	4·3	...	...	...	83·7
Broom, forage...	51·5	4·5	2·0	17·0	21·0	4·0	2·3	0·8	17·1	44·5
Buckwheat, seed	14·0	9·0	1·5	58·7	15·0	1·8	6·8	1·2	44·0	84·2
Do. bran	14·0	17·1	4·4	46·4	14·7	3·4	13·5	3·9	38·1	82·6
Do. forage	85·0	2·4	0·6	6·4	4·2	1·4	1·5	0·4	6·6	13·6
Do. straw	13·3	15·0	1·2	44·1	14·1	2·3	...	...	...	84·4
Butter	10·0	1·0	87·8	0·3	—	0·9	1·0	87·8	0·3	89·1
Buttermilk	90·1	3·0	1·0	5·4	—	0·5	3·0	1·0	5·4	89·4
Cabbage, Drumhead, outer leaves ...	91·0	1·6	—	5·0	0·2	2·2	...	—	...	6·8
Do. Drumhead, inner leaves ...	89·4	1·5	—	7·0	1·3	0·8	...	—	...	10·8

Composition of Foods—*continued*.

Foods.	Water.	Albuminoids.	Fats.	Carbohydrates.	Fibre.	Ash.	Digestible Matter. Albuminoids.	Digestible Matter. Fats.	Digestible Matter. Carbo-hydrates.	Organic Matter.
Cabbage, white	89·0	1·5	0·4	5·9	2·0	1·2	1·1	0·2	6·0	9·8
Do. stalks	82·0	1·1	0·3	11·9	2·8	1·9	0·8	0·2	11·5	16·1
Candlenut cake	7·0	54·7	9·2	15·9	4·2	9·0	49·2	8·3	14·3	84·0
Carob Bean (Locust), with pods	14·0	7·0	1·0	68·0	7·0	3·0	...	...	...	83·0
Carrot leaves	82·2	3·2	1·0	7·1	3·0	3·6	2·2	0·5	7·0	14·2
Do. root	85·0	1·4	0·2	10·8	1·7	0·9	1·4	0·2	10·8	14·1
Chicory, forage	90·9	1·0	—	6·6	0·5	1·0	...	—	...	8·1
Clover, Red, forage	78·0	3·2	0·8	9·5	6·8	1·7	1·8	0·5	9·6	26·3
Do. do. hay, poor ...	15·0	11·1	2·1	37·7	28·9	5·1	5·7	1·0	37·9	89·9
Do. do. do. good ...	16·5	15·3	3·2	35·8	22·2	7·0	10·7	2·1	37·6	86·5
Do. Cow-Grass, forage ...	77·4	2·2	0·9	10·0	6·8	2·7	...	...	...	19·9
Do. do. hay ...	15·0	8·3	3·3	37·6	25·7	10·1	...	...	...	74·9
Do. straw (seeded) ...	16·0	9·4	1·0	28·5	39·6	5·5	...	...	...	78·5
Do. White, forage ...	80·5	3·5	0·8	7·2	6·0	2·0	2·2	0·5	7·9	17·5
Do. do. hay	16·5	14·5	3·5	3·9	25·6	6·0	8·1	2·0	35·9	77·5
Do. Hop Trefoil, forage...	80·0	3·5	0·8	8·2	6·0	1·5	2·2	0·5	8·7	18·5
Do. do. do. hay ...	16·7	14·6	3·3	33·2	26·2	6·0	9·2	2·0	36·4	77·3
Do. Alsike, forage ...	85·0	3·3	0·6	5·1	4·5	1·5	2·1	0·4	5·8	13·5
Do. do. hay	16·0	15·0	3·3	32·7	27·0	6·0	8·6	1·8	34·8	78·0

Do. Crimson, forage ...	81·5	2·7	0·7	7·3	6·2	1·6	1·5	0·3	7·5	16·9
Do. do. hay ...	16·7	12·2	3·0	32·6	30·4	5·1	6·2	1·4	34·9	78·2
Do. Trefoil (Nonsuch), forage ...	76·8	5·7	0·9	7·7	6·4	2·5	...	...	...	84·4
Do. Trefoil (Nonsuch), hay	16·7	19·7	3·2	27·6	23·9	8·9	...	...	...	20·7
Do. average, forage ...	79·5	3·3	0·7	8·1	6·3	1·9	...	...	...	18·6
Do. do. hay... ...	16·0	14·5	2·2	34·6	26·5	6·2	...	...	...	77·8
Cocoanut cake	12·7	23·4	9·8	34·4	14·6	5·1	17·1	8·1	30·3	82·2
Comfrey, Prickly, forage ...	88·4	2·7	—	6·8	0·2	1·9	...	—	...	9·7
Do. do. hay ...	16·0	19·5	—	49·1	1·7	13·7	...	—	...	70·3
Cottonseed	7·7	22·8	30·3	15·4	16·0	7·8	17·1	27·3	11·6	84·5
Do. cake, undecorticated	11·5	24·6	6·2	30·6	20·8	6·3	18·1	5·6	14·1	82·2
Do. do. decorticated...	10·1	34·3	10·9	27·4	9·6	7·7	28·8	9·9	17·0	82·2
Cow's Milk	87·5	3·2	3·6	5·0	—	0·7	3·2	3·6	5·0	11·8
Do. skimmed... ...	90·0	3·0	0·6	5·6	—	0·8	3·0	0·6	5·6	9·2
Do. separated ...	90·5	3·9	0·4	4·5	—	0·7	3·9	0·4	4·5	8·8
Do. condensed ...	21·5	10·2	12·9	52·9	—	2·5	10·2	12·9	52·9	76·0
Cream	62·0	2·7	31·8	2·9	—	0·6	2·7	31·8	2·9	37·4
Dari	11·3	10·0	4·0	68·3	3·6	2·8	...	...	...	85·9
Dates	20·7	5·4	0·2	7·0	1·0	1·7	...	...	...	77·4
Dodderseed cake	12·0	30·0	8·0	19·5	22·5	8·0	...	...	...	80·0
Earthnut cake, shelled ...	7·5	47·5	7·1	17·2	8·2	12·5	42·8	6·4	15·5	80·0
Do. do. unshelled ...	9·8	32·1	10·3	18·8	21·9	7·1	25·7	8·3	14·5	83·1
Do. seed...	6·3	28·2	41·2	7·2	13·9	3·2	23·7	39·1	5·8	90·5
Ensilage, sour:—										
Alsike	75·4	3·3	1·8	10·6	6·7	2·1	2·0	1·2	9·4	22·5
Beet leaves	80·0	3·0	1·2	9·0	2·7	4·1	2·0	0·7	6·3	15·9
Grass	86·0	2·0	0·8	8·1	6·5	2·0	1·4	0·8	8·5	12·0

COMPOSITION OF FOODS—*continued.*

Foods.	Water.	Albuminoids.	Fats.	Carbohydrates.	Fibre.	Ash.	Digestive Matter. Albuminoids.	Digestive Matter. Fats.	Digestive Matter. Carbohydrates.	Organic Matter.
Ensilage, sour—*continued.*										
Lucerne	82·9	3·8	1·5	4·7	5·0	2·1	2·8	0·9	5·3	15·0
Lupine	84·0	3·1	2·1	4·4	4·9	1·1	2·2	1·1	6·1	14·9
Maize	84·4	1·2	1·2	6·8	5·0	1·4	0·9	0·9	8·2	14·2
Mustard	84·9	2·5	0·4	6·1	3·8	2·3	1·6	0·4	5·2	12·8
Potato haulm	77·0	2·9	2·6	7·5	4·7	5·3	1·2	1·2	6·2	17·7
Red clover...	79·2	4·2	2·2	6·4	5·9	2·1	2·8	1·5	7·2	18·7
Rye...	86·9	1·6	0·5	5·7	4·4	0·9	0·9	0·3	6·0	12·2
Sainfoin	83·3	3·4	1·0	5·1	5·9	1·3	1·7	0·7	5·4	15·4
Ensilage, sweet:—										
Grass	68·0	3·8	2·7	12·9	9·9	2·7	2·3	1·6	13·4	29·3
Lucerne	72·5	4·0	3·2	6·1	10·7	3·5	3·0	1·9	8·5	24·0
Red clover...	70·0	5·6	2·0	11·6	8·5	2·3	3·9	1·3	11·6	27·7
Gluten refuse from starch ...	70·0	4·6	0·5	24·4	0·1	0·4	4·6	0·5	24·4	29·6
Do. dry	11·6	68·9	1·5	16·1	0·3	1·6	68·9	1·5	16·1	86·8
Gold of Pleasure seed ...	8·4	23·5	30·0	19·8	11·5	6·8	18·8	27·0	15·3	84·8
Do. do. cake ...	15·0	25·7	8·5	30·9	13·0	6·9	21·6	7·6	24·1	78·1
Gorse	72·0	3·2	1·2	8·2	13·4	2·0	...	...	...	26·0
Do. Petty-Whin	54·6	3·7	3·0	15·1	19·7	3·7	1·9	1·0	15·6	42·7

Gram	11·2	19·5	4·6	54·5	7·2	3·0	...	...	...	85·8
Grasses, mean of 18 species, forage	68·8	3·4	0·9	14·1	10·8	2·0	...	...	...	29·2
Do. do. do. hay ...	15·0	9·4	2·6	38·8	28·5	5·7	...	...	...	79·3
Do. before flowering, forage	75·0	3·0	0·8	13·1	6·0	2·1	2·0	0·4	13·0	22·9
Do. meadow hay, good ...	15·0	11·7	2·8	41·6	21·9	7·0	7·4	1·3	41·7	78·0
Do. do. do. poor ...	14·3	7·5	1·5	38·2	33·5	5·0	3·4	0·5	34·9	80·7
Do. do. aftermath hay	14·3	11·7	3·1	42·3	22·0	6·6	7·4	1·4	42·3	79·1
Do. pasture	80·0	3·5	0·8	9·2	4·5	2·0	2·4	0·4	9·9	18·0
Do. rich pasture	78·2	4·4	0·8	9·6	4·8	2·2	3·1	0·4	10·8	19·6
Do. Ryegrass, Italian, forage	73·4	3·6	1·0	12·1	7·1	2·8	2·3	0·4	12·6	23·8
Do. do. do. hay ...	14·3	11·2	3·2	40·6	22·9	7·8	7·1	1·4	41·5	77·9
Do. do. Perennial, forage	70·0	3·6	1·0	12·8	10·6	2·0	1·8	0·3	12·2	28·0
Do. do. do. hay ...	14·3	10·2	2·7	36·1	30·2	6·5	5·1	0·8	35·3	79·2
Do. Timothy, forage ...	70·0	3·4	1·1	16·3	8·0	2·2	2·1	0·5	16·0	27·8
Do. do. ...	14·3	9·7	3·0	45·8	22·7	4·5	5·8	1·4	43·4	81·2
Ground or Pea-Nuts	7·5	24·5	30·0	11·9	24·4	1·7	...	...	...	91·8
Heath (young)	54·6	3·7	3·0	15·1	19·7	3·7	1·9	1·0	15·6	41·7
Hempseed	12·2	16·3	33·6	21·3	12·1	4·5	12·2	30·2	15·0	83·3
Do. cake	10·5	27·0	6·2	28·3	22·0	6·0	20·0	5·0	20·8	83·5
Horse-Chestnuts	49·2	6·4	1·4	38·7	2·9	1·4	5·1	1·0	34·8	49·4
Irish Moss	18·8	9·4	—	55·4	2·2	14·2	...	—	...	67·0
Iceland Moss	10·0	8·7	—	73·5	2·8	5·0	...	—	...	85·0
Kohl-Rabi, leaves	85·0	2·8	0·8	8·2	1·4	1·8	2·0	0·4	7·6	13·2
Do bulbs	87·0	1·3	0·1	9·5	1·1	1·0	1·3	0·1	9·5	12·0
Lentils, seed	14·5	23·8	2·6	49·2	6·9	3·0	21·4	2·2	46·7	82·5
Do. forage	70·0	5·0	0·4	11·0	10·3	2·3	...	...	...	27·7

COMPOSITION OF FOODS—*continued.*

Foods.	Water.	Albuminoids.	Fats.	Carbohydrates.	Fibre.	Ash.	Digestive Matter. Albuminoids.	Digestive Matter. Fats.	Digestive Matter. Carbohydrates.	Organic Matter.
Lentils, straw	16·0	14·0	2·0	27·9	33·6	6·5	6·9	1·2	30·8	77·5
Lettuce...	93·0	0·7	—	4·7	0·6	1·0	...	—	...	6·0
Linseed	12·3	20·5	37·0	19·6	7·2	3·4	17·2	35·2	15·3	84·0
Do. meal, extracted ...	9 7	34·2	4·5	37·7	6·6	7·3	28·7	4·0	29·4	83·3
Do. cake	11·5	28·3	10·0	37·3	11·0	7·9	23·8	8·9	29·0	80·6
Do. chaff	11·6	3·5	3·4	35·0	40·7	5·8	1·7	1·7	33·8	82·6
Lucerne, forage	74·0	4·5	0·8	9·2	9·5	2·0	3·2	0·3	9·1	24·0
Do. hay	16·5	16·0	2·3	31·8	26·6	6·8	12·3	0·9	31·4	76·6
Lupines, seed, Yellow ...	13·0	35·4	5·0	28·8	13·8	4·0	31·9	4·3	27·4	83·0
Do. do. Blue	14·0	28·0	5·3	36·3	13·2	3·2	25·2	4·5	34·5	82·8
Do. forage	85·3	3·1	0·3	6·6	3·5	1·2	2·3	0·1	6·9	13·5
Do. straw (seeded) ...	16·0	5·9	1·1	32·1	40·8	4·1	2·2	0·3	41·6	79·9
Do. at flowering, hay ...	16·7	23·2	2·0	28·8	25·2	4·1	17·2	0·6	36·0	79·2
Do. after do. do. ...	15·0	11·8	2·9	33·5	30·5	6·3	7·8	0·9	38·4	78·7
Do. pods	14·3	4·5	1·7	39·0	37·0	3·5	1·7	0·5	44·2	82·2
Madia seed	8·4	20·6	38·8	5·0	22·5	4·7	15·4	36·9	3·7	86·9
Do. cake	11·2	31·6	15·0	9·8	25·7	6·7	22·1	12·8	6·9	82·1
Malt, with sprouts, (fresh) ...	47·5	6·5	1·5	38·5	4·3	1·7	5·2	1·0	34·7	51·8
Do. without sprouts (dry) ...	7·5	9·4	2·3	69·8	8·7	2·3	7·5	1·6	62·8	90·2

Do. dust or combs	8·0	23·0	2·5	42·2	17·5	6·8	18·4	1·7	38·0	85·2
Do. do. cake (maize) ...	10·2	15·4	11·3	45·6	10·3	7·2	12·3	10·2	41·0	82·6
Maize, grain	14·4	10·0	6·5	62·1	5·5	1·5	8·4	4·8	57·8	84·1
Do. bran	12·0	8·0	4·0	61·2	12·5	2·3	6·2	3·6	50·0	85·7
Do. straw	15·0	3·0	1·1	36·7	40·0	4·2	1·1	0·3	37·0	80·8
Do. cobs	14·0	1·4	1·4	42·6	37·8	2·8	0·6	0·4	41·7	83·2
Do. forage	82·2	1·2	0·5	10·3	4·7	1·1	0·8	0·2	9·9	14·7
Do. hay	15·0	5·7	2·3	4·7	67·1	5·2	...	...	...	79·8
Do. cake	11·5	12·6	8·2	60·7	1·1	6·8	...	...	...	81·7
Do. refuse from starch (dry)	11·0	16·1	7·8	64·0	0·3	0·8	...	...	...	88·2
Do. germs	11·9	...	...	...	...	5·5	10·5	14·8	44·0	82·6
Mangold-Wurzel, leaves ...	90·5	1·9	0·5	4·0	1·3	1·8	1·2	0·2	4·0	8·7
Do. roots ...	88·0	1·1	0·1	9·1	0·9	0·8	1·1	0·1	9·1	11·2
Matar or Muttor (split = "dhol")	11·8	19·2	1·6	56·7	7·3	3·4	...	...	...	84·8
Melon, Cattle	91·4	1·2	—	5·2	1·5	0·7	0·9	—	4·7	7·9
Milk:—										
Cow	87·5	3·2	3·6	5·0	—	0·7	3·2	3·6	5·0	11·8
Mare	91·0	2·1	1·2	5·3	—	0·4	2·1	1·2	5·3	8·6
Ass	89·6	2·2	1·6	6·0	—	0·4	2·2	1·6	6·0	10·0
Sheep	81·3	6·3	6·8	4·7	—	0·8	6·3	6·8	4·7	17·9
Goat	86·9	3·7	4·1	4·4	—	0·9	3·7	4·1	4·4	12·2
Sow	84·0	7·2	4·6	3·1	—	1·1	7·0	4·6	3·1	14·9
Millet, grain	14·0	12·7	3·3	57·5	9·5	3·0	9·5	2·6	43·1	83·0
Do. forage	70·0	3·7	0·8	13·4	10·2	1·9	2·1	0·3	14·2	28·1
Do. hay	13·4	10·8	2·2	38·5	26·4	5·7	6·1	0·9	41·0	80·9
Molasses	92·0	2·0	—	4·4	—	1·6	2·0	—	4·4	6·4
Mustard, forage	82·7	2·1	0·5	7·5	5·8	1·4	1·4	0·3	7·9	16·9
Oats, seed	14·3	12·0	6·0	55·7	9·3	2·7	9·0	4·7	41·8	83·0

COMPOSITION OF FOODS—*continued.*

Foods.	Water.	Albuminoids.	Fats.	Carbohydrates.	Fibre.	Ash.	Digestive Matter.			Organic Matter.
							Albuminoids.	Fats.	Carbohydrates.	
Oats, meal	10·5	11·0	4·5	52·2	14·5	6·8	8·5	3·6	48·2	83·7
Do. bran	9·4	2·7	1·3	52·2	27·9	6·5	1·3	0·6	40·1	84·1
Do. husk	14·0	1·8	1·5	0·4	75·9	6·4	...	...	...	79·6
Do. chaff	14·3	4·0	1·5	36·2	34·0	10·0	1·6	0·6	36·6	75·7
Do. straw	14·3	3·5	2·0	34·2	42·0	4·0	1·3	0·6	37·4	81·7
Do. forage	81·0	2·3	0·5	8·3	6·5	1·4	1·3	0·2	8·9	17·6
Do. hay	15·0	10·2	0·8	40·2	27·6	6·2	7·2	1·1	35·9	78·8
Do. and Vetches, forage ...	84·0	2·4	0·4	6·4	5·4	1·4	1·4	0·2	6·9	14·6
Do. do. hay ...	16·7	12·6	2·3	33·2	28·0	7·2	7·2	1·1	35·9	76·1
Olive seed cake	13·8	6·0	13·2	26·8	33·4	6·8	3·6	10·6	32·2	79·4
Palm-Nut meal, pressed ...	9·0	18·5	3·3	36·7	28·6	3·9	18·5	3·3	33·8	87·1
Do. cake	9·1	16·3	13·1	36·4	21·5	3·0	16·3	13·1	33·5	87·3
Parsnip, leaves	83·1	1·8	0·4	9·9	2·2	2·6	1·2	0·2	9·9	14·3
Do. root	85·0	1·3	0·3	10·9	1·4	1·0	1·3	0·3	10·9	14·0
Pears	83·1	0·4	—	11·3	4·3	0·4	0·3	—	12·9	16·6
Peas, seed	14·3	22·4	2·0	52·5	6·4	2·4	20·2	1·7	49·9	83·3
Do. meal	11·4	23·7	3·5	54·5	4·5	3·5	20·9	2·8	55·4	85·1
Do. shells	12·3	8·0	2·5	30·5	43·7	3·0	5·6	2·0	46·3	84·7
Do. pods (dry)	15·0	8·1	2·0	36·9	32·0	6·0	4·0	1·2	36·2	79·0

Do. forage	81·5	3·2	0·6	7·6	5·6	1·5	2·2	0·3	7·4	17·0
Do. hay	16·7	14·3	2·6	34·2	25·2	7·0	9·4	1·6	33·1	78·3
Do. straw	16·0	6·5	1·0	34·0	38·0	4·5	2·9	0·5	33·4	79·5
Plantain or Rib-Grass ...	84·7	2·1	0·6	6·0	5·3	1·3	...	...	...	14·0
Poppy seed	14·7	17·5	41·0	15·4	6·1	5·3	14·7	39·0	12·3	80·0
Do. do. cake	10·0	32·5	8·1	29·6	11·4	8·4	27·3	7·2	23·1	81·6
Potato	75·0	2·1	0·3	20·6	1·1	0·9	2·1	0·3	20·6	24·1
Do. frozen	61·6	1·6	0·1	34·7	0·8	1·2	1·6	0·7	25·5	37·2
Do. haulm	78·0	2·3	1·0	9·7	6·0	3·0	1·0	1·3	8·3	19·0
Do. refuse from starch ...	85·0	0·8	0·1	11·4	2·3	0·4	0·8	0·1	11·4	14·6
Pumpkin	89·1	0·6	0·1	6·5	2·7	1·0	0·4	0·1	5·8	9·9
Pumpkinseed cake	12·0	55·6	11·4	8·0	4·9	8·1	50·0	10·3	7·2	79·9
Rape seed	11·8	19·4	42·5	12·1	10·3	3·9	15·5	42·5	10·2	84·3
Do. meal, pressed	8·5	33·1	3·0	34·1	13·4	7·9	26·5	2·4	27·2	83·6
Do. cake	10·4	30·7	9·8	30·1	11·3	7·7	24·9	7·6	23·8	81·9
Do. straw	14·3	3·0	1·3	33·3	44·0	4·1	0·8	0·4	36·5	81·6
Do. forage	87·0	2·9	0·6	3·7	4·2	1·6	2·0	0·4	4·8	11·4
Do. chaff	14·0	4·0	1·6	31·3	40·0	8·5	2·0	0·7	33·4	77·5
Rice grain, naked	14·0	7·7	0·4	75·2	2·2	0·5	6·9	0·3	72·7	85·5
Do. meal	11·5	9·9	7·3	63·3	2·7	5·3	7·6	6·4	65·0	83·2
Rye, seed	14·0	11·0	2·0	67·4	3·5	1·8	9·9	1·6	65·4	84·2
Do. flour	12·0	13·6	2·9	63·2	4·2	4·1	10·6	2·3	53·3	83·9
Do. bran	12·4	14·7	3·2	58·7	6·2	4·8	11·5	2·2	47·3	82·8
Do. refuse from starch ...	70·0	6·1	1·5	18·9	2·7	0·8	5·2	1·2	17·0	29·2
Do. chaff	14·3	3·6	1·2	29·9	41·8	7·5	1·1	0·4	34·9	78·2
Do. straw (winter)	14·3	1·3	0·4	29·8	48·0	4·1	0·7	0·4	32·8	81·6
Do. forage	76·0	2·9	0·8	12·4	6·5	1·4	1·8	0·4	12·4	22·6
Do. hay	14·3	10·4	2·8	44·5	23·1	5·1	6·6	1·3	44·3	80·6

COMPOSITION OF FOODS—*continued.*

Foods.	Water.	Albuminoids.	Fats.	Carbohydrates.	Fibre.	Ash.	Digestive Matter. Albuminoids.	Digestive Matter. Fats.	Digestive Matter. Carbohydrates.	Organic Matter.
Sainfoin, forage	81·4	4·2	0·7	7·3	5·2	1·2	3·0	0·5	7·9	17·4
Do. hay	16·7	13·3	2·5	34·2	27·1	6·2	7·6	1·4	35·8	77·1
Seakale...	93·0	2·4	—	3·6	0·4	0·6	...	—	...	6·4
Serradella, forage	81·0	3·7	0·8	6·9	5·8	1·8	2·5	0·5	6·3	17·2
Do. hay	16·7	13·5	4·7	35·6	22·0	7·5	8·5	2·8	36·2	75·8
Sesame, seed	4·5	18·9	37·0	19·2	11·7	8·7	15·1	35·2	15·4	86·8
Do. cake	11·5	34·5	11·7	21·0	9·5	11·8	28·1	10·4	16·4	76·7
Sorghum	77·3	2·5	0·7	12·4	6·0	1·1	1·6	0·3	11·9	21·6
Spurrey, forage	80·0	2·3	0·7	9·7	5·3	2·0	1·5	0·3	9·8	18·0
Do. hay	16·7	12·0	3·2	36·6	22·0	9·5	7·6	1·9	36·8	73·8
Sunflower seed	8·0	13·0	23·6	23·9	28·5	3·0	11·1	21·2	28·1	89·0
Do. do. cake	10·8	32·8	9·1	27·1	13·5	6·7	27·9	8·1	25·1	83·5
Thistles, young	86·7	2·9	0·9	6·1	1·4	2·0	2·2	0·6	6·0	11·3
Tree leaves (July)	55·0	5·6	1·5	26·5	7·6	3·8	3·8	0·9	24·5	41·2
Do. withered	11·4	18·3	7·7	38·0	10·6	14·0	12·8	4·9	36·0	74·6
Turnip, Swede, leaves ...	88·3	2·1	0·5	5·2	1·6	2·3	1·5	0·3	5·1	9·3
Do. do. bulbs ...	89·4	1·4	0·2	7·1	1·3	0·6	1·3	0·1	6·3	10·0
Do. Yellow, leaves ...	87·2	2·8	—	4·0	4·2	1·8	...	—	...	11·0

Do. do. bulbs ...	90·5	1·8	0·2	4·6	2·3	0·6	...	...	...	8·9
Do. White, leaves ...	88·0	2·5	—	3·8	4·9	1·8	...	—	...	10·2
Do. do. bulbs ...	92·0	1·1	0·1	5·3	0·8	0·7	1·1	0·1	5·3	7·3
Vetch or Tare, seed	13·4	26·4	1·8	48·6	6·6	3·2	23·3	1·6	50·0	23·4
Do. pods	15·0	8·5	2·0	33·5	33·0	8·0	4·2	1·2	34·3	77·0
Do. straw	16·0	7·5	1·0	29·0	42·0	4·5	3·4	0·5	31·9	79·5
Do. forage	82·0	3·5	0·6	6·6	5·5	1·8	2·5	0·3	6·7	16·2
Do. hay	16·7	14·2	2·5	32·8	25·5	8·3	9·4	1·5	32·5	75·0
Do. Kidney, forage ...	83·0	1·9	0·4	7·9	5·8	1·0	...	...	...	16·0
Do. do. hay	15·0	9·5	2·4	39·5	22·5	5·1	...	...	...	78·9
Walnuts	44·7	12·6	31·5	9·0	0·5	1·7	...	...	...	53·6
Do. cake	13·7	34·6	12·5	27·8	6·4	5·0	31·1	11·2	28·2	81·3
Wheat, seed	14·4	13·0	1·5	66·4	3·0	1·7	11·7	1·2	64·3	83·9
Do. flour	12·6	11·8	1·2	74·1	0·7	0·7	...	...	...	86·7
Do. meal	11·5	13·9	3·3	63·5	4·8	3·0	10·8	2·9	54·0	85·5
Do. Spelt, seed	14·8	10·0	1·5	52·3	16·5	3·7	7·5	1·1	42·7	81·5
Do. bran (coarse)... ...	13·6	13·6	3·4	54·9	8·9	5·6	10·6	2·4	44·4	80·8
Do. do. from groats (fine)	12·1	14·1	4·2	58·2	7·3	4·1	11·0	2·9	47·2	83·8
Do. middlings (fine pollards	12·5	14·6	3·4	61·6	4·7	2·9	...	...	...	85·6
Do. sharps (coarse pollards)	12·8	14·6	3·9	54·6	9·2	4·8	...	...	...	82·6
Do. refuse from starch ...	72·0	6·3	1·5	16·5	3·0	0·7	5·4	1·2	14·8	27·3
Do. germs	9·9	27·7	10·5	45·7	1·5	4·5	...	...	...	85·6
Do. chaff	14·3	4·5	1·4	34·6	36·0	9·2	1·4	0·4	32·8	76·5
Do. straw (winter) ...	14·3	3·0	1·2	36·9	40·0	4·6	0·8	0·4	35·6	81·1
Do. do. (spring) ...	14·3	6·9	2·5	32·9	36·7	6·7	2·5	0·8	36·9	79·0
Whey	93·3	0·8	0·3	5·0	—	0·6	0·8	0·3	5·0	6·7
Yarrow, forage	76·0	2·8	0·7	12·6	5·4	2·5	...	...	...	21·5
Do. hay	14·0	10·3	2·5	45·4	18·8	9·0	...	...	...	77·0

CONSTITUENTS OF PLANTS.

Explanation of the Terms used in a Food Analysis.

Water.	Forms a very large proportion of all fresh plants, and 14 to 17 % of dry foods, such as hay. Is absolutely necessary as a vehicle of plant food, and for carrying on the vital processes.
Albuminoids: Glutin and Gluten. Vegetable Casein, as Legumin, Avenin, Hordein, &c.	Nitrogenous materials which go to form the flesh of animals (hence called "flesh-formers"), and also the gelatinoids and some of the fat, 100 parts of albumin yielding 51·4 of fat: by combustion in animal body yield heat and mechanical force; repair waste of nitrogenous tissue; supply in themselves most of the requirements of the animal.
Amides and Nitrates: Asparagin, Glutamin, Leucin, &c.	Non-albuminoid nitrogenous materials which do not form muscle, but are burnt to produce heat and force in the body. The nitrogen, in common with that from the albuminoids, is excreted as *urea*. They occur in very small proportion in ripe plants, but are in considerable amount in green fodders, roots, and tubers. Thus, in young grass 25 % of the nitrogen usually exists as amides; in potatoes, 40 %; in turnips, 50 %; while in mangolds 63 % is in the form of amides, and only 37 % as true albuminoids. The nitrogen of nitrates is rarely estimated in ordinary food analyses, but in the above table the "digestible albuminoids" include also the digestible amides.
Fats and Oils: Palmitin, Stearin, Olein, Margarin, &c.	Are first digested and taken into the blood, and then burnt in respiration to give heat and mechanical force; thus are "heat-givers;" 1 of fat = 2·29 of starch or other carbohydrates in food value. The principal use of fat in the body as

FATS AND OILS—*continued.*	a food seems to be to nourish the protoplasm of the tissues and prevent waste. The fat deposited in the body is formed from the decomposition of the protoplasm.
CARBOHYDRATES: Starch, Sugar, Gum, Dextrin, Mucilage, Fibre or Cellulose, &c.	Are more immediately used for heat and mechanical work; if taken in excess are stored up as fat. Consist of carbon, hydrogen, and oxygen, the last two in the proportion to form water—differing in this respect from hydrocarbons. They form the largest part of all vegetables. The portion of carbohydrates, including fibre, which is digested has always the general formula of starch or cellulose ($C_6 H_{10} O_5$) while the undigested part is richer in carbon. Lignin, deposited in tissues of older plants, contains more carbon, and is indigestible. In the table of analyses above, part of the "fibre" is digestible, and is included in the "digestible carbohydrates."
ASH: Salts of Potash, Soda, Magnesia, Phosphate of Lime, &c.	The incombustible or mineral part of plants or foods. Consists mostly of salts. Goes to form bone, blood, &c., in the animal.

CORRESPONDING CONSTITUENTS OF ANIMAL BODIES.

ALBUMINOIDS: Fibrin, Albumin, Casein, Globulin, &c.	Form animal tissue (muscle) and nerve, and greater part of solid matter of blood: of the first importance in the animal economy.
GELATINOIDS: Gelatin, Chrondrin, Ossein, &c.	Substances of skin and sinew and all connective tissue, and also the combustible part of cartilage and bone. Glue and isinglass are commercial forms.
HORNY MATTER: Keratin.	Material of which hair, horn, wool, and feathers are constituted.

The above are nitrogenous bodies.

FATS AND OILS:	Stearin preponderates in solid, and olein in fluid fats; palmitin also is present. Much the same in composition and properties as vegetable fats and oils.

Ash: Largest proportion contained in the bones, 75 to 85 % of the total ash constituents of fat animals being found in them. Bone ash chiefly consists of calcic phosphate, with a small quantity of calcic carbonate, and magnesic phosphate. Potassic phosphate is the most abundant salt in muscle. Potassic salts are also abundant in the "yolk" of unwashed wool. Sodic salts are very abundant in blood, forming about one-half of the solids.

The relative Heat and Force-producing Power of equal weights of the various food constituents are as follows (starch = 100):—

Fat	229
Albumin	107
Starch	100
Cane sugar and gum	97
Grape sugar and milk sugar	90
Cellulose	86
Asparagin	49

ALBUMINOID RATIO.

The proportion between the nitrogenous and non-nitrogenous digestible constituents in a food is of great importance, as upon this the economical and successful feeding of animals very much depends.

This proportion is called the "albuminoid" or "nutrient ratio," and varies considerably for the different kinds of live stock, as shown in the following tables :—

Albuminoid Ratios suitable for various Animals: Amides, &c., not reckoned. (Warington.)

Young animals on milk	1	:	3– 4
Rapidly growing animals	1	:	5– 7
Maintenance of oxen at rest	1	:	14
Do. sheep do.	1	:	12
Fattening oxen	1	:	9–10
Do. sheep	1	:	8– 9
Do. pigs	1	:	7
Horses working on maize will do with	1	:	9
Horses in severe exertion	1	:	4– 5
Milking cows	1	:	6– 7
General average	1	:	6

WOLFF'S FEEDING STANDARDS (AMIDES, &c., RECKONED).

Animal.		Live Weight.	Food Required per Day.				
			Dry Organic Matter.	Digestible.			Albuminoid Ratio.
				Albuminoids.	Fats.	Carbohydrates.	
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Horse at moderate work ..	per	1,000	22·5	1·8	0·60	11·2	1 : 7
Do. heavy do. ...	,,	1,000	25·5	2·8	0·80	13·4	1 : 5·5
Oxen, growing, 2– 3 months		150	3·3	0·6	0·30	2·1	1 : 4·7
Do. do. 3– 6 do.		300	7·0	1·0	0·30	4·1	1 : 5
Do. do. 6–12 do.		500	12·0	1·3	0·30	6·8	1 : 6
Do. do. 12–18 do.		700	16·8	1·4	0·28	9·1	1 : 7
Do. do. 18–24 do.		850	20·4	1·4	0·26	10·3	1 : 8
Do. in complete rest ...	per	1,000	17·5	0·7	0·15	8·0	1 : 12
Do. moderately worked	,,	1,000	24·0	1·6	0·30	11·3	1 : 7·5
Do. hard worked	,,	1,000	26·0	2·4	0·50	13·2	1 : 6
Do. fattening, 1st period	,,	1,000	27·0	2·5	0·50	15·0	1 : 6·5
Do. do. 2nd do. ...	,,	1,000	26·0	3·0	0·70	14·8	1 : 5·5
Do. do. 3rd do. ...	,,	1,000	25·0	2·7	0·60	14·8	1 : 6
Cow, maintenance	,,	1,000	17·0	0·7	0·20	8·0	1 : 12
Do. additional for milk ...	,,	1,000	8·0	1·8	0·20	4·5	...
Do. total for in milk ...	,,	1,000	25·0	2·5	0·40	12·5	1 : 5·4
Sheep, growing, 5– 6 months		56	1·6	0·18	0·04	0·87	1 : 5·5
Do. do. 6– 8 do.		67	1·7	0·17	0·04	0·85	1 : 5·5
Do. do. 8–11 do.		75	1·7	0·16	0·04	0·85	1 : 6
Do. do. 11–15 do.		82	1·8	0·14	0·03	0·89	1 : 7
Do. do. 15–20 do.		85	1·9	0·12	0·02	0·88	1 : 8
Do. fattening, 1st period	per	1,000	26·0	3·0	0·50	15·2	1 : 5·5
Do. do. 2nd do.	,,	1,000	25·0	3·5	0·60	14·4	1 : 4·5
Pigs, growing, 2– 3 months		50	2·1	0·38	1·50		1 : 4
Do. do. 3– 5 do.		100	3·4	0·50	2·50		1 : 5
Do. do. 5– 6 do.		125	3·9	0·54	2·96		1 : 5·5
Do. do. 6– 8 do.		170	4·6	0·58	3·47		1 : 6
Do. do. 8–12 do.		250	5·2	0·62	4·05		1 : 6·5
Do. fattening, 1st period	per	1,000	36·0	5·0	27·50		1 : 5·5
Do. do. 2nd do.	,,	1,000	31·0	4·0	24·00		1 : 6
Do. do. 3rd do.	,,	1,000	23·5	2·7	17·50		1 : 6·5

In calculating out this ratio the average percentages of the various digestible constituents are taken, the fat reduced to its equivalent in carbohydrates (by multiplying by 2·29), and the total quantity of non-nitrogenous matter is divided by the total quantity of nitrogenous. For example, take the feeding of London dray horses—animals used for heavy draught—oats, 13 lbs.; maize, 3 lbs.; beans, 6 lbs.; clover hay, 15 lbs.; in all 37 lbs. daily, at a cost of 2s.:—

		Dry Organic Matter.	Albuminoids.	Fats.	Carbohydrates.
	Lbs.	Lbs.	% Lbs.	% Lbs.	% Lbs.
Oats ...	... 13	10·79	9·0×13=1·17	4·7×13=0·61	41·8×13=5·43
Maize ...	... 3	2·52	8·4× 3=0·25	4·8× 3=0·14	57·8× 3=1·73
Beans ..	... 6	4·94	23·0× 6=1·38	1·4× 6=0·08	43·6× 6=2·61
Clover	.. 15	11·62	10·7×15=1·60	2·1×15=0·31	37·6×15=5·64
		29·88	4·4	1·15	15·42

```
             1·15
             2·29
            ------
             1035
             230
            230
            ------
            2·6335
           15·424
           -------
    4·40) 18·0575 (4·1
           1760
           ----
            457
            440
            ---
```

or,

Albuminoid ratio as 1 : 4·1.

In the above the sum arrived at in each case by multiplying the pounds of the food by the percentage of each ingredient is divided by 100, and gives the actual weight in pounds of each: thus, dry matter, 29·88 lbs.; albuminoids, 4·4 lbs.; fats, 1·15 lbs.; and carbohydrates, 15·42 lbs.

RATIONS FOR DOMESTIC ANIMALS.

(Taken from practice: Wolff's ratios.)

Horses.

Winter.

Large Farm-Horse in work.—Fleming.

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Fats.	Carbo-hydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Oats	18	14·94	1·62	0·78	7·51
Beans	2	1·64	0·46	0·02	0·50
Hay	18	14·61	1·04	0·24	7·78
Straw chaff	2	1·62	0·02	0·01	0·74
	40	32·81	3·14	1·05	16·53

Albuminoid ratio, 1 : 5·9.

Approximate Average of 6 Farmers in different parts of England.

Oats	10½	8·71	0·94	0·49	4·38
Beans	4½	3·70	1·03	0·06	1·96
Hay	15	12·18	0·87	0·21	6·51
Swedes	16	1·92	0·20	0·01	1·69
	46	26·51	3·04	0·77	14·54

Albuminoid ratio, 1 : 5·3.

Author's Ration.

Oats	15	11·45	1·35	0·69	6·27
Bean meal	2	1·64	0·46	0·02	0·50
Straw chaff	5	4·35	0·07	0·03	2·00
Hay	10	7·80	0·74	0·13	4·17
	32	25·24	2·62	0·87	12·94

Albuminoid ratio, 1 : 5·6.

The bean meal and the chaff in the above are mixed, and soaked with water to form a mash.

Approximate Average of 10 Tramway Companies.

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Digestible. Fats.	Digestible. Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Oats	5	4·15	0·45	0·23	2·09
Maize	10	8·41	0·84	0·48	5·78
Beans	2½	2·06	0·57	0·03	1·09
Bran	½	0·40	0·05	0·01	0·18
Hay	11	8·52	0·93	0·18	4·20
Straw chaff	1	0·81	0·01	0·00	0·37
	30	24·35	2·85	0·93	13·71

Albuminoid ratio, 1 : 5·5.

Army Rations for Cavalry in Camp.—Fleming.

Oats	12	9·96	1·08	0·52	5·01
Hay	12	9·74	0·69	0·16	5·19
Straw	8	6·53	0·10	0·04	2·99
	32	26·23	1·87	0·72	13·19

Albuminoid ratio, 1 : 7·9.

2 lbs. of oats extra allowed when used for draught purposes, giving a ratio of 1 : 7·7.

Ration for an Idle Horse.—Dick.

Oats	5	4·15	0·45	0·23	2·09
Hay	12	9·74	0·69	0·16	5·19
	17	13·89	1·14	0·39	7·28

Albuminoid ratio, 1 : 7·1.

Summer.

Approximate Average of 4 Farmers in different parts of England.

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Fats.	Carbohydrates.
	Lbs.	Lbs	Lbs.	Lbs.	Lbs.
Oats	10½	8·71	0·94	0·49	4·38
Beans	2	1·64	0·46	0·02	0·50
Straw chaff	2	1·62	0·02	0·01	0·74
Pasture, say	100	22·90	2·00	0·40	13·00
		34·87	3·42	0·92	18·62

Albuminoid ratio, 1 : 6·0.

Another Good Ration.

Oats	6	4·98	0·54	0·26	2·50
Hay chaff	16	12·48	1·18	0·20	6·67
Pasture, say	80	18·32	1·60	0·32	10·40
		35·78	3·32	0·78	19·57

Albuminoid ratio, 1 : 6·4.

Author's Ration.

Oats	15	11·45	1·35	0·69	6·27
Straw chaff	5	4·35	0·07	0·03	2·00
Pasture, say	56	12·81	1·12	0·22	7·28
		28·61	2·54	0·94	15·55

Albuminoid ratio, 1 : 6·9.

YOUNG HORSES.

The same rations as given above may be used, but in smaller quantity, with a medium proportion of nitrogenous ingredients, as young growing animals require foods rich in flesh-formers; 4 to 5 lbs. of crushed oats and bran mixed, daily while on grass, giving a ratio of about 1 : 6.

Winter.

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Fats.	Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Oats	5	4·15	0·45	0·23	2·09
Bran	1	0·80	0·10	0·02	0·44
Hay	5	3·90	0·37	0·06	2·08
Pasture, say	25	5·72	0·50	0·10	3·25
		14·57	1·42	0·41	7·86

Albuminoid ratio, 1 : 6·2.

Summer.

Oats	$2\frac{1}{2}$	2·07	0·22	0·11	1·04
Bran	$2\frac{1}{2}$	2·03	0·27	0·08	0·84
Pasture, say	50	11·44	1·00	0·20	6·50
		15·54	1·49	0·39	8·38

Albuminoid ratio, 1 : 6·2.

Cattle.

Fattening Animals.

A Common Ration.

Swedes	84	10·08	1·09	0·08	8·90
Hay	12	9·54	0 64	0·12	4·92
Linseed cake	4	3·16	0·99	0·35	1·10
		22·78	2·73	0·56	14·92

Albuminoid ratio, 1 : 6.

Silage Ration.

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Digestible. Fats.	Digestible. Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Clover silage	10	2·16	0·22	0·06	1·11
Oat straw...	10	8·17	0·14	0·07	4·01
Meadow hay	10	7·95	0·54	0·10	4·10
Linseed, extracted ...	5	4·20	1·39	0·16	1·73
Maize meal	5	4·35	0·45	0·21	3·36
		26·83	2·74	0·60	14·31

Albuminoid ratio, 1 . 5·7.

Ordinary Winter Ration.

Turnips	100	7·30	1·10	0·10	5·30
Oat straw...	20	16·30	0·26	0·10	7·48
Linseed cake	5	4·00	1·19	0·44	1·45
		27·60	2·55	0·64	14·23

Albuminoid ratio. 1 : 6·1.

Summer Pasturing (Author).

Undec. cotton cake ...	4	3·28	0·72	0·22	0·56
Pasture, say	112	25·64	2·24	0·44	14·56
		28·92	2·96	0·66	15·12

Albuminoid ratio, 1 : 5·6.

This ration would also suit cows in milk.

Economy of food is greatly promoted by allowing animals to rest quietly, and by keeping them at a temperature of 55° to 60° F.; below this, food is wasted in keeping up the temperature of the body, and above it perspiration is too free and causes loss from evaporation.

One ton of turnips consumed will yield 14 lbs. of beef. An ox can take as many as 3 cwts. of turnips per day, or 1 ton per week, if no other food but straw. A two-year-old Shorthorn will consume up to 26 tons, and a three-year-old 30 tons in the winter half-year.

Stall-fed animals assimilate 17 % of the food given them. An ox will consume daily from 11 to 13 lbs. of food per 100 lbs. of live weight.

Twenty-four pounds of litter required daily if fed in yards, but much less if under cover.

Cows in Milk—Winter.

Large Cows.

Foods.		Dry Organic Matter.	Digestible.		
			Albuminoids.	Fats.	Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Bran	4	3·22	0·50	0·10	1·71
Beans	2	1·64	0·46	0·02	1·00
Oats	2	1·67	0·18	0·09	0·86
Undec. cotton cake ...	3	2·46	0·52	0·16	0·44
Hay	16	12·72	0·86	0·16	6·56
Oat straw	4	3·26	0·05	0·03	1·60
Swedes	20	2·40	0·26	0·02	2·12
		27·37	2·83	0·58	14·29

Albuminoid ratio, 1 : 5·5.

Small Cows—No. 1.

Maize	$2\frac{1}{2}$	2·10	0·21	0·12	1·44
Dec. cotton cake ...	$3\frac{1}{2}$	2·84	1·08	0·43	0·64
Hay	10	7·80	0·74	0·10	4·21
Straw	10	8·17	0·13	0·06	3·7
Cabbage	30	2·94	0·33	0·06	1·80
		23·85	2·49	0·77	11·83

Albuminoid ratio, 1 : 5·4.

Small Cows—No. 2.

Foods	Lbs.	Dry Organic Matter. Lbs.	Digestible. Albuminoids. Lbs.	Digestible. Fats. Lbs.	Digestible. Carbohydrates. Lbs.
Dec. cotton cake ...	5	4·06	1·54	0·62	0·92
Hay	3	2·38	0·16	0·03	1·23
Hay chaff	6¾	5·36	0·36	0·06	2·76
Oat straw chaff	6¾	5·51	0·09	0·04	2·70
Mangolds	50	5·60	0·55	0·05	5·00
		22·91	2·70	0·80	12·61

Albuminoid ratio, 1 : 5·3.

Small Cows—No. 3.

Maize	3	2·52	0·25	0·14	1·89
Bran	6	4·89	0·70	0·15	2·76
Undec. cotton cake ...	3	2·46	0·54	0·17	0·44
Hay	5	3·90	0·39	0·07	2·00
Ensilage (grass)	30	9·60	0·36	0·15	3·60
		23·37	2·24	0·68	10·69

Albuminoid ratio, 1 : 5·4.

Author's Ration.

Bean meal	4	3·39	0·92	0·05	1·74
Oats (ground)	3	2·49	0·27	0·13	1·25
Bran	4	3·22	0·50	0·10	1·71
Straw chaff	5	4·08	0·06	0·03	1·87
Undec. cotton cake ...	2	1·64	0·36	0·11	0·28
Hay	6	4·76	0·32	0·06	2·46
Straw	6	4·84	0·07	0·04	2·40
		24·42	2·50	0·52	11·71

Albuminoid ratio, 1 : 5·1.

The bean meal, ground oats, bran, and chaff are soaked with boiling water for five hours and given as sloppy mashes.

Cows in Milk—Summer.

No. 1.

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Digestible. Fats.	Digestible. Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Bean meal	3	2·4	0·69	0·04	1·30
Linseed cake	1	0·8	0·23	0·09	0·29
Pasture, say	100	22·9	2·00	0·40	13·00
		26·1	2·92	0·53	14·59

Albuminoid ratio, 1 : 5·4.
The bean meal given as dough.

No. 2.

Cotton cake, undec. ...	2	1·6	0·36	0·11	0·28
Tares (forage)	10	1·6	0·25	0·03	0·67
Pasture, say	100	22·9	2·00	0·40	13·00
		26·1	2·61	0·54	13·95

Albuminoid ratio, 1 : 5·8.

Cows Dry to Calve—Winter.

No. 1.

Linseed cake	1	0·81	0·31	0·12	0·18
Dec. cotton cake ...	1	0·80	0·24	0·08	0·29
Straw	18	14·70	0·25	0·12	7·21
Turnips	50	6·00	0·65	0·05	5·30
		22·31	1·45	0·37	12·98

Albuminoid ratio, 1 : 9·5.

No. 2.

Ensilage (grass)	30	9·60	0·36	0·15	3·60
Dec. cotton cake ...	$2\frac{1}{2}$	2·03	0·77	0·31	0·46
Straw	15	12·24	0·18	0·09	5·61
		23·87	1·31	0·55	9·67

Albuminoid ratio, 1 : 8·3.

No. 3 (Author's).

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Fats.	Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Bean meal	3	2·46	0·69	0·03	1·50
Straw chaff	5	4·08	0·06	0·03	1·87
Hay	10	7·95	0·54	0·10	4·10
Straw	12	9·68	0·14	0·08	4·80
		24·17	1·43	0·24	12·27

Albuminoid ratio, 1 : 9.

The meal and chaff given as a mash.

Calves.

No. 1.

Milk	10	1·18	0·32	0·3	0·5
Barley meal	1	0·83	0·03	0·01	0·57
Linseed cake meal ...	1	0·80	0·23	0·08	0·29
		2·81	0·63	0·39	1·36

Albuminoid ratio, 1 : 3·5.

No. 2.

Milk	20	2·36	0·64	0·70	1·0
Barley meal	1	0·83	0·08	0 01	0·57
Linseed cake meal ...	1	0·80	0·23	0·08	0·29
		3·99	0·95	0·79	1·86

Albuminoid ratio, 1 : 3·8.

No. 3.

Calf meal	2	1·62	0·50	0·20	0·70
Linseed meal	1	0·84	0·17	0·35	0·15
Pasture, say	20	4·58	0·40	0·08	2·64
		7·06	1·07	0·63	3·49

Albuminoid ratio, 1 : 4·6.

Colostrum to a newly-dropped calf (albuminoid ratio, 1 : 0·5), and afterwards ordinary milk (ratio, 1 : 3·3), 1½ to 2 gallons daily; gradually substitute linseed cake meal and barley meal mixed, or "calf meals," up to 2 lbs. for a portion of the milk; also replace milk with buttermilk or whey; wean at 4 to 6 months. Place hay or forage within reach as soon as it chews the cud. Care must be taken to keep the food rich in bone and flesh formers.

Sheep.

Fattening Animals.

No. 1.

Foods.		Dry Organic Matter.	Digestible.		
			Albuminoids.	Fats.	Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Undec. cotton cake ...	½	0·41	0·09	0·02	0·07
Barley (bruised)... ...	½	0·41	0·04	0·04	0·28
Hay	½	0·39	0·04	0·00	0·20
Swedes	15	1·80	0·19	0·01	1·59
		3·01	0·36	0·07	2·14

Albuminoid ratio, 1 : 6·4.

No. 2.

Linseed cake	¾	0·60	0·17	0·06	0·22
Clover hay	1⅛	0·96	0·10	0·02	0·47
Swedes	15	1·80	0·19	0·01	1·59
		2·36	0·46	0·09	2·28

Albuminoid ratio, 1 : 5·4.

No. 3.

Linseed cake	¼	0·20	0·05	0 02	0·07
Dec. cotton cake... ...	½	0·40	0·08	0·02	0·06
Oats	½	0·41	0·04	0·02	0·20
Turnips	8	1·92	0·21	0·02	1·70
		2·93	0·38	0·08	2·03

Albuminoid ratio, 1 : 5·8.

No. 4.

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Digestible. Fats.	Digestible. Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Undec. cotton cake ...	1	0·82	0·18	0·04	0·15
Straw chaff	2	1·63	0·02	0·01	0·74
Pasture, say	5	1·14	0·10	0·02	0·65
		3·59	0·30	0·07	1·54

Albuminoid ratio, 1 : 5·6.

No. 5 (Author's).

Undec. cotton cake ...	½	0·41	0·09	0·03	0·07
Linseed cake	½	0·20	0·12	0·05	0·15
Pasture, say	20	4·00	0·40	0·08	2·60
		4·61	0·61	0·16	2·82

Albuminoid ratio, 1 : 5·2.

A Blackface will eat 18 to 28 lbs. turnips daily if no cake is given. A Leicester can do with 14 lbs. when cake is given.

The usual allowance of sheep to eat a crop of 30 tons of turnips per acre is 16 young or 8 old Leicesters, and 20 young or 10 old Blackfaces, during the winter half-year.

A sheep will consume weekly under cover for every 100 lbs. of live weight: 4¾ lbs. oilcake; 4¾ lbs. hay; 100 lbs. roots—about ⅐ of its own weight of the dry substance of the food, or 14 to 16 lbs. per 100 of live weight—and increase 2 % in weight weekly.

All sheep must have access to rock salt, except lambing ewes.

Ewes with Lambs.

No. 1.

Bran	1½	1·21	0·15	0·04	0·55
Oats	¾	0·62	0·06	0·03	0·31
Straw chaff	1	0·81	0·01	0·00	0·37
Pasture, say	5	1·14	0·10	0·02	0·65
		3·78	0·32	0·09	1·88

Albuminoid ratio, 1 : 6·5.

No. 2 (Author's).

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Fats.	Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Dec. cotton cake ...	½	0·40	0·08	0·02	0·06
Pasture, say	15	3·43	0·30	0·06	1·95
		3·83	0·38	0·08	2·01

Albuminoid ratio, 1 : 5·7.

On roots alone a ewe will consume 25 to 30 lbs. daily; but such feeding would be injurious, owing to the excessive quantity of water she would have to imbibe, so that some dry food, such as hay or cake, must be added.

Pigs.

Fatting, per 100 lbs. live weight.

No. 1.

Barley meal	4	3·34	0·32	0·06	2·30
Pea meal	1	0·84	0·20	0·01	0·50
		4·18	0·52	0·07	2·80

Albuminoid ratio, 1 : 5·7.

No. 2.

Wheat meal	1	0·83	0·11	0·01	0·63
Barley meal	1	0·83	0·08	0·01	0·57
Maize meal	2	1·68	0·16	0·09	1·14
Sharps	1	0·84	0·15	0·04	0·41
		4·18	0·50	0·15	2·75

Albuminoid ratio, 1 : 6·1.

No. 3 (Author's).

Maize meal	2	1·68	0·16	0·09	1·14
Pea meal	2	0·84	0·20	0·01	0·50
Whey	25	1·52	0·20	0·07	1·25
		4·04	0·56	0·17	2·89

Albuminoid ratio, 1 : 5·9.

Breeding Sows.

Per 100 lbs. live weight.

No. 1.

Foods.		Dry Organic Matter.	Digestible. Albuminoids.	Fats.	Carbohydrates.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Sharps	3	2·49	0·32	0·08	1·34
Bran	1	0·80	0·12	0·02	0·42
		3·37	0·44	0·10	1·76

Albuminoid ratio, 1 : 4·5.

No. 2.

Pea meal	1	0·84	0·20	0·01	0·49
Buttermilk	10	0·94	0·30	0·10	0·54
Potatoes (cooked) ...	10	2·41	0·21	0·03	2·06
		4·19	0·71	0·14	3·09

Albuminoid ratio, 1 : 4·8.

A good pig will consume 6 stones of meal per week, and increase 1 stone in live weight.

One pig will consume the whey from the milk of two cows, which is estimated to be worth from £1 5s. to £1 10s. in value per cow per annum.

A pig will consume 26 to 30 lbs. of dry food weekly for every 100 lbs. live weight.

Pigs permanently retain 20 %, sheep 12 %, and oxen 8 % of the dry weight of the food. Pigs whilst fattening store up 7½ %, and sheep but 5 % of the albuminous matter in food; thus sheep dung is richer than that of pigs.

Proportion of stomach to fat live weight:—3·2 % in ox; 2·5 % in sheep; 0·7 % in pig; but pig has largest proportion of intestines.

Too much water in roots diminishes their feeding value, as a part of the heat produced is used up in raising the water in them to the temperature of the body. With sheep the normal proportion of water to dry food is about 2 : 1; horses, 2–3 : 1; and with cattle whose skin perspiration is more active, about 4 : 1. Thus there is economy in supplying sheep with drier food.

PROPORTION OF ALBUMINOID NITROGEN IN VARIOUS FOODS PER 100 OF TOTAL NITROGEN.

Brewers' grains	98	Meadow hay	85
Barley	94	Wheat bran	85
Linseed cake	94	Clover hay	83
Oats	94	Oat straw	80
Rice meal	94	Malt	79
Dec. cotton cake	93	Grass (young)	75
Maize	93	Malt dust	72
Barley straw	90	Potatoes	60
Wheat	90	Carrots	52
Beans	88	Turnips	49
Peas	88	Mangolds	37

RATIO between the Nitrogenous and Non-Nitrogenous Constituents in the *Digestible Part* of the principal Foods.

	Albuminoids to Non-Albuminoids.	Total Nitrogenous to Non-Nitrogenous Substance.
Cotton cake, decorticated ...	1 : 1·4	1 : 1·2
Do. undecorticated ...	1 : 2·4	1 : 2·1
Linseed cake	1 : 2·6	1 : 2·3
Beans	1 : 2·7	1 : 2·3
Brewers' grains	1 : 2·9	1 : 2·8
Peas	1 : 3·3	1 : 2·8
Malt dust	1 : 4 2	1 : 2·6
Wheat bran	1 : 5·3	1 : 4 2
Oats	1 : 5 9	1 : 5 4
Pasture grass	1 : 6·4	1 : 4·0
Clover hay	1 : 7·5	1 : 5·0
Barley	1 : 8 0	1 : 7·3
Rice meal...	1 : 8·4	1 : 7·6
Meadow hay	1 : 9·5	1 : 6·9
Maize	1 : 9·9	1 : 9·0
Swedes	1 : 11·5	1 : 5·4
Turnips	1 : 12·1	1 : 5·8
Carrots	1 : 16·5	1 : 8·6
Potatoes	1 : 23·5	1 : 12·2
Mangolds...	1 : 24·1	1 : 8·6
Barley straw	1 : 108·0	1 : 53·8
Wheat straw	1 : —	1 : 65·9

In calculating the albuminoid ratio, where great accuracy is required, the percentage of the ingredients actually digested by each kind of animal should, if possible, only be taken. For instance, the same meadow hay has for horses a ratio of 1 : 6·7, while for sheep it has 1 : 9·1, as the sheep digest more of the non-nitrogenous constituents; while, in addition to this, there are constitutional differences between individual animals of the same kind. The following tables show the different proportions of the same ingredients which are actually digested by different animals. These percentages represent the "digestive coefficients" or "nutrient values."

EXPERIMENTS WITH CATTLE, SHEEP, AND GOATS.

Food.	Digested for 100 of each Constituent supplied.				
	Total Organic Matter.	Nitrogenous Substance.	Fat.	Soluble Carbohydrates.	Fibre.
Linseed cake	81	86	90	80	44
Beans	89	88	87	92	72
Oats	71	79	84	76	24
Barley	81	77	100	87	?
Maize	89	79	85	91	?
Wheat bran	72	78	69	77	33
Meadow hay	60	57	48	62	58
Clover hay	57	55	51	65	45
Lucerne hay	60	74	39	66	43
Oat straw	50	35	35	45	57
Wheat straw	46	17	36	39	56
Bean straw	51	49	56	64	39

EXPERIMENTS WITH PIGS.

Food.	Digested for 100 of each Constituent supplied.			
	Total Organic Matter.	Nitrogenous Substance.	Fat.	Soluble Carbohydrates.
Sour milk	97	96	95	99
Meat flour	95	97	87	...
Pea meal	91	88	49	96
Bean meal	84	79	71	91
Barley meal	83	78	68	90
Maize meal	92	86	76	94
Rye bran	67	66	58	75
Potatoes	94	81	...	98

Digestive Powers of Horses and Sheep Compared: I. Experiments with Horses.

Food.	Proportion of each Constituent Digested for 100 supplied.				
	Total Organic Matter	Nitrogenous Substance.	Fat.	Soluble Carbohydrates.	Fibre.
Pasture-grass	62	69	13	66	57
Meadow hay (very good)	51	62	20	57	42
Do. do. (ordinary)	48	57	24	55	36
Lucerne	58	73	16	70	40
Oats	68	86	71	74	21
Beans	87	86	8	93	69
Maize	91	78	63	94	100

II. Experiments with Sheep.

Pasture grass	75	73	65	76	80
Meadow hay (very good)	64	65	54	65	63
Do. do. (ordinary)	59	57	51	62	56
Lucerne	59	71	41	66	45
Oats	71	80	83	76	30
Beans	90	87	84	91	79
Maize	89	79	85	91	62

The digestibility of fodder plants is mainly determined by their age; a young plant being more digestible than an old one.

The two following tables exemplify this in the case of hay eaten by sheep.

Composition of Hay Harvested at different Periods.

Date of Cutting.	Albuminoids.	Fat.	Soluble Carbohydrates.	Fibre.	Ash.
May 14	17·65	3·19	40·86	22·97	15·33
June 9	11·16	2·74	43·27	34·88	7·95
June 26	8·46	2·71	43·34	38·15	7·34

Digestion of this Hay by Sheep.

Date of Cutting.	Proportion of each Constituent Digested for 100 supplied.				
	Total Organic Matter.	Albuminoids.	Fat.	Soluble Carbohydrates.	Fibre.
May 14	75·8	73·3	65·4	75·7	79·5
June 9	64·3	72·1	51·6	61·9	65·7
June 26	57·5	55·2	43·3	55·7	61·1

In ordinary farm practice the above figures relating to food ratios must not be adopted too literally. Wolff's standards were obtained from experiments with Continental cattle and foods, while his results were called in question by other authorities, and therefore for home practice they must be taken as approximate only; though any farmer who has been using ratios differing very much from the above tables will find it desirable to make an alteration, so as to bring his mixtures more into line with them. Another point is that the food is not the only thing to be attended to in keeping animals in a thriving condition: warmth in winter, ventilation, lighting, grooming, cleanliness, and the personal element of kindness have all an influence which must not be overlooked, while shade and relief from the torment of flies in summer is equally important.

It was formerly thought that work was performed at the expense of oxidation of muscle, but it is now known that force is derived from the combustion of the food—indifferently from either the fat, albuminoids, or carbohydrates—with a proportionate exhalation of carbonic acid. This explains why horses can work on maize; but it has been found that animals in undergoing severe exertion have a greater power for the digestion of albuminoids than for the other ingredients, while there is a certain extra amount of tear and wear of the muscles; and thus practical experience has shown that an addition of a small quantity of beans as an albuminoid food is always beneficial to their rations in a time of extra labour, thus raising the ratio, but it may be reduced again on the return to ordinary work. Albuminoids in being thus digested yield urea and fat, and fat is "muscular fuel," while the red corpuscles in the blood are increased and more oxygen is carried.

The heat and force-producing powers of fat, albumin, and starch are in the proportion of 100, 46·6, and 43·6 respectively; the albumin being reckoned minus its equivalent quantity of urea, as this product of its decomposition is not burnt, but excreted at the kidneys. Starch and albumin in their work-producing power are thus to one another as 100 : 107.

The comparative heat-producing values of equal weights of some foods are as follows:—

	Ordinary Condition.	Perfectly Dry.
Cotton cake (decort.)	100	100
Maize	97	100
Rice meal	94	96
Linseed cake	93	97
Peas	90	96
Beans	87	93
Barley	80	85
Malt dust	80	81
Oats	78	83
Wheat bran	69	73
Meadow hay	51	55
Clover hay	48	53
Barley straw	46	49
Wheat straw	40	43
Potatoes	26	95
Brewers' grains	16	64
Mangolds	13	90

Food Equivalents of 10 Lbs. of Hay.

	Lbs.		Lbs.
Meadow hay ...	10	White turnips ...	100
Clover hay ...	9	Cabbages ...	60
Green clover ...	48	Peas and beans ...	4·6
Wheat straw ...	14	Wheat	4·8
Barley straw ...	15	Barley	4·8
Oat straw ...	12	Oats	5
Pea straw ...	11	Maize	4·6
Bean straw ...	14·5	Linseed cake ...	4
Potatoes ...	40	Decort. cotton cake	4·25
Red carrots ...	50	Undec. cotton cake	5·3
White carrots ...	57	Bran	6
Mangolds ...	64	Malt coombs ...	5·3
Swedes	72	Middlings ...	5·3
Yellow turnips...	88	Rice Meal ...	5

Order in which Root Crops are Used, and Order of Nutritive Value.

Autumn.	*Winter.*	*Spring.*
Rape	Swedes	Mangolds
Cabbages	Mangolds	Carrots
White turnips	Carrots	
Yellow turnips		
Swedes		
Potatoes		

Food Required to Produce 1 Lb. Increase in Live Weight in Fattening Animals.

(Lawes and Gilbert.)

	Ox. Lbs.	Sheep. Lbs.
Linseed cake	2·5	2·5
Clover hay	6·0	3·0
Swedes	35·0	40·0

Pigs require about 5 lbs. barley meal to produce the same result.

Results obtained with Fattening Animals per 100 lbs. Live Weight per Week:—

	Received by Animal.		Results produced.		
	Total dry food.	Digestible organic matter.	Food consumed for heat and work.	Dry manure produced.	Increase in live weight.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Oxen ...	12·5	8·9	6·86	4·56	1·13
Sheep ...	16·0	12·3	9·06	5·10	1·76
Pigs ...	27·0	22·0	12·58	4·51	6·43

Results obtained in relation to Food consumed:—

	Increase in Live Weight.		On 100 Lbs. of Dry Food.		
	Per 100 lbs. dry food.	Per 100 lbs. digested organic matter.	Consumed for heat and work.	Dry manure produced.	Dry increase yielded.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Oxen ...	9·0	12·7	54 9	36·5	6 2
Sheep ...	11·0	14·3	56·6	31·9	8·0
Pigs ...	23·8	29·2	46 6	16·7	17·6

Comparative Feeding Values of the Principal Foods in Fattening Oxen and Sheep. (Rothamsted.)

OODS.	Food required to 1 lb. increase in live weight.	Live weight increase per ton of food consumed.	Value of live weight increase at 35s. per cwt.	Meat increase—$\frac{3}{5}$ of live weight increase.	Value of meat increase at 7d. per lb.	Manurial value per ton of food consumed.	Total value per ton.	Theoretical food value per ton, reckoned by "units."
	Lbs.	Lbs.	£ s. d.	Lbs.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1. Linseed...	5·0	448·0	7 0 0	268·80	7 16 9	2 19 5	10 16 2	11 5 2
2. Linseed cake	6·0	373·3	5 16 7	223·98	6 10 8	3 18 6	10 9 2	8 16 1
3. Decorticated cotton cake	6·5	344·6	5 7 8	206·76	6 0 7	5 13 0	11 13 7	9 15 8
4. Palm-nut cake	7·0	320·0	5 0 0	192·00	5 12 0	1 19 10	7 11 10	6 18 3
5. Undecorticated cotton cake ...	8·0	280·0	4 7 6	168·00	4 18 0	3 5 4	8 3 4	8 3 0
6. Cocoanut cake	8·0	280·0	4 7 6	168·00	4 18 0	3 0 7	7 18 7	7 13 8
7. Rape cake	(10·0)	(224·0)	3 10 0	134·40	3 18 5	4 5 4	8 3 9	8 12 2
8. Peas	7·0	320·0	5 0 0	192·00	5 12 0	2 15 0	8 7 0	6 15 10
9. Beans	7·0	320·0	5 0 0	192·00	5 12 0	3 3 5	8 15 5	7 2 0
10. Lentils	7·0	320·0	5 0 0	192·00	5 12 0	3 1 4	8 13 4	7 1 2
11. Tares (seed)	7·0	320·0	5 0 0	192·00	5 12 0	3 2 1	8 14 1	7 14 9
12. Malt	7·0	320·0	5 0 0	192·00	5 12 0	1 6 8	6 18 8	5 0 2
13. Maize	7·2	311·1	4 17 2	186·66	5 8 10	1 5 1	6 13 11	5 7 2
14. Wheat	7·2	311·1	4 17 2	186·66	5 8 10	1 8 7	6 17 5	5 7 0
15. Barley	7·2	311·1	4 17 2	186·66	5 8 10	1 6 1	6 14 11	4 16 7
16. Oats	7·5	298·7	4 13 3	179·22	5 4 7	1 9 10	6 14 5	5 10 7
17. Rice meal	7·5	298·7	4 13 3	179·22	5 4 7	1 7 10	6 12 5	5 19 8

Comparative Feeding Values—*continued.*

Foods.	Food required to 1 lb. increase in live weight.	Live weight increase per ton of food consumed.	Value of live weight increase at 35s. per cwt.	Meat increase—⅗ of live weight increase.	Value of meat increase at 7d. per lb.	Manurial value per ton of food consumed.	Total value per ton.	Theoretical food value per ton, reckoned by "units."
	Lbs.	Lbs.	£ s. d.	Lbs.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
18. Locust beans	9·0	248·9	3 17 8	149·34	4 7 1	1 2 6	5 9 7	4 2 6
19. Fine pollard	7·5	298·7	4 13 3	179·22	5 4 7	2 13 4	7 17 11	5 18 2
20. Coarse pollard	8·0	280·0	4 7 6	168·00	4 18 0	2 17 9	7 15 9	5 12 10
21. Malt coombs	8·0	230·0	4 7 6	168·00	4 18 0	3 10 9	8 8 9	6 12 3
22. Bran	9·0	248·9	3 17 8	149·34	4 7 1	2 18 5	7 5 6	5 3 8
23. Clover hay	14·0	160·0	2 10 0	96·00	2 16 0	2 1 3	4 17 3	4 11 10
24. Meadow hay	15·0	149·3	2 6 7	89·58	2 12 3	1 8 7	4 0 10	4 5 2
25. Pea straw	16·0	140·0	2 3 8	84·00	2 9 0	0 18 10	3 7 10	2 15 0
26. Oat straw	18·0	124·4	1 18 9	74·64	2 3 6	0 11 7	2 15 1	2 6 7
27. Wheat straw	21·0	106·7	1 13 3	64·02	1 17 4	0 10 1	2 7 5	2 1 7
28. Bean straw	22·0	101·8	1 11 9	61·08	1 15 7	0 17 7	2 13 2	3 9 10
29. Barley straw	23·0	97·4	1 10 4	58·44	1 14 1	0 10 1	2 4 2	2 8 0
30. Potatoes	60·0	37·3	0 11 7	22·38	0 13 0	0 6 5	0 19 5	1 4 9
31. Parsnips	75·0	29·9	0 9 3	17·94	0 10 6	0 5 5	0 15 11	0 14 8
32. Carrots	85·7	26·1	0 8 1	15·66	0 9 1	0 4 3	0 13 4	0 14 4
33. Mangolds	96·0	23·3	0 7 2	13·98	0 8 2	0 5 0	0 13 2	0 11 6
34. Swedes	109·1	20·5	0 6 4	12·30	0 7 2	0 4 7	0 11 9	0 11 7
35. Yellow turnips	133·3	16·8	0 5 2	10·08	0 5 10	0 3 11	0 9 9	0 11 3
36. White turnips	150·0	14·9	0 4 7	8·94	0 5 3	0 4 0	0 9 3	0 8 7

Valuing Food by Units.

An attempt has been made to arrive at the value of any food substance by working it out at so much per unit of the constituents in the analysis, in a way similar to that followed with artificial manures. The prices usually adopted are 4s. for albuminoids, 3s. 6d. for fats, and 9d. for carbohydrates; but the values thus calculated only in a few instances approximate to market prices. As a guide for pointing out the comparative food value of the various materials, however, this system is very useful, and the theoretical food values per ton for 36 of the principal food substances are given in the final column of the table above.

In purchasing, preference should be given to those in which the "food value" is proportionally highest above the market value. Different unit prices are adopted by different authorities.

Essentials of a "Pure" Cake.

(Dr. A. J. Voelcker.)

(1) That it be made from sound seed of not less than 95 per cent. purity, subsequently well screened.

(2) That it contain no ingredients of a poisonous or deleterious nature.

(3) That it be entirely free from sophistication of any kind.

(4) That it contain not more than 2 per cent. of sand.

(5) That it be sold in good merchantable condition.

Mixing and Preparing Foods.

In addition to having food properly balanced as regards the albuminoid and other ingredients, it is necessary to have it of a mixed character—that is, with as great a number of kinds used to make up a ration as possible. There should be a moderate use of condimental preparations, but salt especially should be within reach. The reason appears to be that the digestibility is increased where there is a mixture, while the palatability is improved where condiments and salt are used. We find with ourselves that our food is much more agreeable when there is a variety, and where pickles, spices, &c., are used.

Besides this, the preparation of the food is of importance in lessening the work of digestion, and in furthering the assimilation of a greater amount of nutriment out of a given quantity of material. For this reason it pays to chaff the whole or a part of the fodder, slice or pulp the roots, bruise or grind up the grain, break the cake, and cook or steam various mixtures. An example will show the benefit thus derived. If a horse is fed with oats "neat," they will be found to pass through him more or less whole; if, however, they are bruised, or mixed with chaffed hay so as to compel him to masticate them thoroughly, then the digestive secretions (saliva, gastric juice, bile juice, &c.) can attack and dissolve every particle, so that there is no waste. Cooking or steaming does not increase the digestibility, but it improves the palatability, and thus allows of the use of tail corn, musty hay, &c.: while *warm* food is beneficial to live stock during cold weather, as it saves the waste of heat-producers, which must otherwise be used up in excess. Blood heat (say 100° F.) is the most suitable temperature.

Suitability of Foods.

Practical experience has shown that certain foods are more suitable to a given kind of stock than others. Thus, for horses, clover or mixture hay and oats are best, while wheat or barley are unsuitable or even dangerous; meadow hay, turnips, and cake for cattle and sheep; for milk cows, cotton cake rather than linseed cake, as the latter tends to make the butter rancid, soft, and oily,—and bean meal in preference to either; for fattening, linseed cake is superior, as the oil of it gives better results than an equal amount of any other kind of oil; for calves, linseed cake must be used, as cotton cake is dangerous; and pollards, maize, bran, and barley meal for pigs. Generally the kind of food given to farm animals has to depend on the kinds grown on the farm or most cheaply purchased in the market, but those selected should, as far as possible, be in accordance with the known suitability of each food to each class of animal.

Approximate Amount of Foods allowed to each head of stock during 200 days of winter half-year:—

Horse.

Mixture or clover hay	1 ton.
Oat straw	½ ,,
Oats	9 qrs.

Ox (fatting, per 1,000 lbs. live weight).

Oat straw	2 tons.
Roots	10 ,,
Cake	10 cwt.

Approximate Amount of Foods—*continued.*

Cow (milking, per 1,000 lbs. live weight).

Meadow hay	1 ton.
Oat straw	$\frac{1}{2}$,,
Meals	10 cwt.
Roots	5 tons.

Sheep (fatting, per 100 lbs. live weight).

Hay	200 lbs.
Roots	2 tons.
Cakes	200 lbs.

Pig (fatting, per 100 lbs. live weight).

Wheat meal	200 lbs.
Barley ,, ...	200 ,,
Maize ,, ...	400 ,,
Middlings	200 ,,

Water consumed per Head by each kind of animal per diem in summer:—

Horse at pasture	6 gallons.
Horse at work...	10 ,,
Bullock at pasture	6 ,,
Cow in milk	10 ,,
Sheep...	$\frac{1}{2}$,,
Pig	$1\frac{1}{2}$,,

The above estimates are only approximate, and will vary according to the wetness or dryness of the weather, the amount of exercise, the temperature of the air, and so on. Generally speaking, an animal requires 3 lbs. of water for every pound of dry food—more or less according to circumstances. In a damp climate sheep are able to absorb all the water they require through the wool and skin. In some experiments at Geneva, N.Y., it was found that cows required about 5 lbs. of water for every pound of milk yielded.

Daily Allowance of Salt.

(French Government Inquiry.)

Horse, Donkey, or Mule	1 oz.
Fatting Ox	2·5 to 4·5 ,,
Milch Cow or Store Ox	2 ,,
Sheep	0·5 to 0·75 ,,
Fatting Pig	...1 to 2 ,,

Some feeders have found that salt is injurious or even fatal to pigs, so that it must be used with care, and probably the above amount is too high for this country. With all kinds of stock the safest plan is to allow the animals access to rock salt both in stall and field, and they will then only take what they need.

Weight of some Foods per Bushel.

	Lbs.
Salt	65
Lentils	63
Maize	60
Dari	60
Millet	60
Potatoes	56
Linseed	52
Cottonseed meal	51
Bean meal	50
Decorticated cotton cake (broken)	50
Gluten meal (Paisley)	48
Maize meal	47
Mangolds	45
Swedes	45
Turnips	45
Linseed cake (broken)	43
Barley (ground)	42
Brewers' grains (wet)	40
Carrots	40
Undecorticated cotton cake (broken)	38
Beans and oats (ground)—equal parts	33
Middlings	32
Rye meal	32
Oats (ground)	30
Brewers' grains (dessicated)	20
Bran	17
Malt coombs	14½
Hay (chaffed)	8
Oat straw (chaffed)	5
Oat chaff	2½

TABLE for the conversion of the prices of the Principal Feeding Grains *per quarter*, into Values *per ton*:—

Kind of Grain.	Weight per Bushel.	Weight per Quarter.	Multiplier per Quarter.
	Lbs.	Lbs.	
English Beans	66·5	532	4·21
English Wheats as sold in London; Peas, Lentils, &c. ...	63·0	504	4·44
Pacific Coast Wheats, as imported	62·5	500	4·48
Foreign Wheats, as sold in London	62·0	496	4·51
Indian and Russian Wheats, and South Russian Maize, as imported	61·5	492	4·55
English Wheats (Imp.); United States, Colonial, La Plata, and Danubian Wheats, as imported: Maize, Beans, Rye, Dari, &c.	60·0	480	4·66
Russian Linseed and Rapeseed	53·0	424	5·28
Bombay and La Plata Linseed, Rapeseed, &c.	52·0	416	5·38
Calcutta Linseed	51·25	410	5·46
English and Foreign Grinding Barleys...	50·0	400	5·60
Foreign Oats	40·0	320	7·00
English Oats (Imperial) ...	39·0	312	7 17
Foreign Oats	38.0	304	7·36
English Flour: United States and other Foreign Flour ...	...	Sack. 280	8·00
United States and Hungarian Flour	...	Barrel. 196	11·42
Board of Trade rendering of Imported Grain, Flour, and Pulse, &c.	...	Cwt. 112	20·00
Custom of the Port of Liverpool	...	Cental. 100	22·40

Example:—Given Oats at 40 lbs. per bushel (320 lbs. per quarter) and 16s. per quarter, required price per ton. 16s. multiplied by 7·00 (the corresponding multiplier in above table) gives £5 12s., the price per ton. Or, again, maize at 17s. per quarter multiplied by 4·66 is equal to £4 per ton.

A Cheap Condimental Food.

	Lbs.
Indian meal	56
Locust-bean meal	30
Linseed cake meal	16
Sulphur	2
Saltpetre	2
Common salt	2
Fenugreek	$1\frac{1}{2}$
Gentian	$\frac{1}{3}$
Aniseed	$\frac{1}{2}$
Ginger (ground)	$\frac{1}{2}$
Carbonate of soda	$\frac{1}{2}$
Sulphate of iron	$\frac{1}{4}$
Levigated antimony	$\frac{1}{4}$
	112

The materials must be ground as finely as possible and intimately mixed.

Chemical Composition of Food Constituents.

Albuminoids—

Albumin	C_{72}	H_{112}	O_{22}	N_{18}	S
Casein	C_{144}	H_{228}	O_{45}	N_{36}	S
Chondrin	C_{36}	H_{9}	O_{16}	N_{9}	
Fibrin	C_{72}	H_{112}	O_{22}	N_{18}	S
Gelatin	C_{41}	H_{67}	O_{16}	N_{13}	
Gluten	C_{24}	H_{40}	O_{7}	N_{6}	
Ossein	C_{41}	H_{67}	O_{16}	N_{13}	
Protein	C_{18}	H_{27}	O_{6}	N_{4}	

Amides—

Asparagin	C_{4}	H_{8}	O_{3}	N_{2}
Glycocin	C_{2}	H_{5}	O_{2}	N
Leucin	C_{6}	H_{13}	O_{2}	N

Fats—

Margarin	C_{54}	H_{104}	O_{6}
Olein	C_{57}	H_{104}	O_{6}
Palmitin	C_{51}	H_{98}	O_{6}
Stearin	C_{57}	H_{110}	O_{6}

Carbohydrates—

Glucoses.

Dextrose	$C_6 H_{12} O_6 + H_2 O$
Glucose	$C_6 H_{12} O_6$
Lactose	$C_6 H_{12} O_6$
Lævulose	$C_6 H_{12} O_6$

Saccharoids.

Lactin (milk sugar) ...	$C_{12} H_{22} O_{11} + H_2 O$
Sucrose	$C_{12} H_{22} O_{11}$

Amyloids.

Arabin	$2(C_6 H_{10} O_5) + H_2 O$
Cellulose	$3(C_6 H_{10} O_5)$
Dextrin	$C_6 H_{10} O_5$
Glycogen	$C_6 H_{10} O_5$
Gum	$C_6 H_{10} O_5$
Mucilage	$2(C_6 H_{10} O_5)$
Starch	$C_6 H_{10} O_5$

DAIRYING.

Average Composition of Milk.

The following Table is based upon the reports of leading authorities :—

Authority.	Fat.	Solids not Fat.	Total Solids.	Water.
	%	%	%	%
Bell ; 181 cows	3·70	9·90	13·60	86·40
Cameron ; 42 cows at Glasnevin ; 1880	3·82	9·38	13·20	86·80
Cameron ; 100 cows at Russell Farm	4·40	9·00	13·40	86·60
Geneva, N.Y. ; 17,006 cows of various breeds	3·91	9·02	12·93	87·07
Fleischmann	3·40	8·85	12·25	87·75
Sheldon	3·50	9·25	12·75	87·25
Warington	3·90	9·10	13·00	87·00
Munro	3·70	9·30	13·00	87·00
Aikman (König)	3·69	9·14	12·83	87·17
Lloyd : B. & W. of E. Expts. ; 48 Shorthorns ; 1892	3·36	8·95	12·31	87·69
Average of above	3·73	9·19	12·92	87·08
Minimum of the Society of Public Analysts	3·00	8·50	11·50	88·50

Comparative Yield of different Breeds of Cows.

(Average of Milking Trials of the British Dairy Farmers' Association for Five Years.)

Breed.	Age.		Days in Milk.	Daily Milk Yield.	Fat.	Solids other than Fat.	Total Solids.	Water.
	Yrs.	Mos.		Lbs.	%	%	%	%
65 Shorthorns	6	1	42·8	49·2	3·91	9·08	12·99	87·01
100 Jerseys	6	3	90·3	28·9	5·29	9·40	14·69	85·31
23 Guernseys	7	0	108·1	29·0	4·77	9·13	13·90	86·10
14 Ayrshires	5	2	27·6	45·4	4·26	9·26	13·55	86·45
20 Kerries	6	0	81·7	28·0	4·15	9·05	13·19	86·81
19 Red Polls	6	7	88·0	37·2	3·76	9·02	12·78	87·22
7 Dutch	6	5	40·4	56·3	3·03	8·90	11·93	88·07
19 Cross-Breds... ...	6	6	49·5	50·4	3·94	9·11	13·05	86·95
267 Average	6	3	63·0	40·5	4·14	9·12	13·26	86·74

Annual Yield of Milk of the various Breeds.

The standards proposed for the respective breeds by the British Dairy Farmers' Association for entry in the "Dairy Cattle Register" are as under:—

Pedigree and Non-Pedigree.	Weight of Milk in the Milking Period not exceeding 11 months). Lbs.	Pure Butter Fat per Diem (average of two tests) as determined by Analysis. Lbs.
Shorthorn	8,500 ...	1·25
Jersey	6,000 ...	1·25
Guernsey	6,000 ...	1·25
Ayrshire	7,500 ...	1·00
Red Polled	7,000 ...	1·00
Kerry and Dexter Kerry	4,500 ...	0·75
Dutch	8,500 ...	1·00

The standard for crosses of either of the above will be the mean of the standards for the pure breeds. No animal will be admitted whose milk contains less than 12 per cent. of solids at any test.

Butter Tests of the British Dairy Farmers' Association.

(Average of Five Years.)

	47 Shorthorns.	98 Jerseys.
Age in years	6·16	5·75
Days in milk	42·34	87·90
Lbs. of milk in 24 hours ...	53·70	29·51
Lbs. of butter ,, ...	1·79	1·55
Butter ratio	30·00	19·08

Milking Trials of the British Dairy Farmers' Association.

Scale of Points allowed :—

1 point for each 10 days since calving, deducting the first 20 days, and with a maximum of 18.

1 point for each pound of milk yielded in 24 hours: average of two days taken.

20 points for each pound of butter fat contained in the milk.

4 points for each pound of solids not fat contained in the milk.

10 points deducted from the total score if the milk contains less than 3 % of fat.

Composition of various Milks.

	Fat.	Casein.	Albumin.	Milk Sugar.	Ash.	Total Solids.	Water.	Specific Gravity.
Human	3·78	1·03	1·26	6·21	0·31	12·59	87·41	1·0320
Cow	3·73	3·04	0·54	4·90	0·71	12·92	87·08	1·0310
Ewe	6·86	4·97	1·55	4·91	0·89	19·18	80·82	1·0400
Goat	4·78	3·20	1·09	4·46	0·76	14·29	85·71	1 0335
Mare	1·20	1·90	0·10	5·70	0·40	9·30	90·70	1·0374
Ass	1·64	0·67	1·55	5·99	0·51	10·36	89·64	1·0345
Mule	1·69	1·72		4·80	0·38	8·50	91·50	...
Sow	4·55	7·23		3·13	1·05	15·96	84 04	1·0380
Bitch...	9 57	6·10	5·05	3·08	0·73	24·53	75·47	1·0350
Cat	3·33	3·12	5·93	4·91	0·58	17·90	82·10	...
Buffalo	7·47	5·85	0·25	4·15	0·87	18·59	81·41	1·0340
Llama	3·15	3·00	0·90	5·60	0·80	13·45	86·55	1·0340
Elephant	19·57	3·09		8·84	0·65	32 15	67 85	1·0313
Camel	3·07	4·00		5·59	0·77	13·43	86·57	1 0420
Hippopotamus	4·51	...		4·40	0 11	9·02	90·98	...
Porpoise	45·80	11·19		1·33	0·57	58·89	41·11	...

Composition of First and Last Milk.

(Averages.)

	Water.	Casein.	Fats.	Total Solids.
First quart drawn ...	89·42	3·70	1·20	10·58
Last ,, ,, ...	83·37	3·48	7 88	16·63
Strippings	80·60	3·37	10·00	19·40

Percentages of Cream in First and Last Milk.

(Average of 7 Trials.)

First half-pint	5·1 %
Last ,, ...	32·9 %
Entire yield	15·7 %

Solids in One Gallon New Milk by Weight.

	12½ % Solids. Oz.	14 % Solids. Oz.
Butter fat	5·74	7·79
Sugar	7·87	7·87
Albumin	0·66	0·66
Casein	5·08	5·41
Ash	1·15	1·23
	20·50	22·96

Percentage of Products extracted in Manufacture of Butter and Skim Cheese.

	Lbs.		Lbs.
Cream	17·09	Butter	3·31
		Buttermilk	13·45
		Loss	0·33
Skim milk... ...	82·24	Cheese	6·10
		Whey	74·14
		Loss	2·00
Loss	0·67	Loss	0·67
	100·00		100·00

Constituents of Milk.

Water			87·750
Casein	3·000	Albuminoids...	3·500
Nuclein	trace		
Lactalbumin	0·500		
Globulin	trace		
Olein	1·430	Fats	3·400
Stearin ... ... / Palmitin	1·680		
Butyrin	0·143		
Caproin	0·085		
Caprylin ... ... / Caprin (Rutin) ...	0·061		
Myristin ... ... / Butin (Arachidin) / Laurin ... ... / Lecithin (N., P.)	traces		
Milk Sugar (Lactin) ...	4·43	Carbohydrates	4·600
Galactose (Lactose) ...	0·17		
Calcium citrate	0·1650	Ash	0·700
Monopotassium phosphate	0·0900		
Sodium chloride	0·0750		
Dipotassium phosphate ...	0·0610		
Potassium chloride ...	0·0645		
Tricalcium phosphate ...	0·0626		
Dicalcium phosphate ...	0·0523		
Potassium citrate ...	0·0385		
Calcium oxide in casein...	0·0365		
Magnesium citrate ...	0·0286		
Dimagnesium phosphate	0·0260		
Calcium carbonate / Calcium fluoride ... / Ferric oxide ... / Iodine ... ... / Silica	traces		
Urea			·0070
Fibrin			·0002
Sulphates ... ... / Sulphocyanates ... ... / Hypoxanthin ... ... / Cholestrin ... ... / Lactochrome ... ... / Odorous principle		... ...	traces
Bitter principle (tannin precipitate)			0·1000
			99·9672

Composition of Gas in Freshly Drawn Milk.

	Per Cent.
Oxygen	19·13
Nitrogen	77·60
Carbon dioxide	3·27
	100·00

Comparison of the Ash of various Milks.

	Human.	Mare.	Cow.	Ewe.	Goat.
Phosphoric anhydride ...	23·93	32·73	28·20	38·99	42·28
Potash	30·80	16·35	33·87	11·42	16·98
Lime	18·47	35·19	17·80	36·32	25·69
Soda	3·26	2·77	9·03	1·56	2·67
Magnesia	3·98	3·40	2·40	4·68	4·57
Chlorine	11·59	6·48	7·87	3·71	5 58
Sulphuric anhydride ...	7·97	3·08	0·83	3·32	2·23
	100·00	100·00	100·00	100·00	100·00
Total Ash percentage ...	0·29	0·39	0·70	1·09	1 00

Composition of Colostrum.

	Water.	Casein.	Albumin.	Butter Fats.	Milk Sugar.	Ash.
Ewe	73·2	7·5	7·9	2·0	8·0	1·4
Sow	70·1	7·6	8·0	9·5	3·8	0·9
Cow	71·7	10·2	10·5	3·4	2·5	1·8

Composition of Condensed Milk.

(Average of 8 Countries.)

Water	25·43
Casein	12·15
Fat	10·78
Milk Sugar	13·48
Cane Sugar	35·89
Ash	2·27
	100·00

100 Lbs. of Milk and 10 Lbs. of Sugar condense into :—

	Lbs.
Water	6·5
Casein	4·0
Fat	3 6
Milk Sugar	4·0
Cane Sugar	10·0
Ash	0·5
	28·6

Expansion and Contraction of Volume of Milk between Heating and Refrigeration.

			C°.		F°.
1,000·0	volumes	at	0·0	or	32
1,000·4	,, ...	,,	4 4	,,	40
1,001·3	,, ...	,,	10·0	,,	50
1,002·1	,, ...	,,	15·0	,,	59
1,003·8	,, ...	,,	20 0	,,	68
1,006·4	,, ...	,,	30·0	,,	86
1,014·3	,, ...	,,	50·0	,,	122
1,019·2	,, ...	,,	60·0	,,	140

Cream.

Analysis of Cream, &c.

	Rich Cream.	Separated Cream.	Skim Milk.	Separated Milk.	Separator Residue.
Water	55·0	66·1	90·0	90·8	67·3
Albuminoids ...	6·0	2·6	3·7	3·3	25·9
Butter fat ...	36·2	27·9	0·8	0 2	1·1
Milk sugar ...	2·5	3·0	4·8	5·1	2·1*
Ash	0·3	0·4	0·7	0·6	3·6
	100·0	100·0	100·0	100·0	100·0

* Organic material.

Yield of Cream from Milk of different Qualities.
(*Woll.*)

% of Fat in Milk.	Per Cent. of Fat in Cream.													
	14	16	18	20	22	24	26	28	30	32	34	36	38	40
	Pounds of Cream Yielded per 1,000 Lbs. of Milk.													
3·0	197	172	152	137	125	114	105	98	91	85	80	76	72	68
3·1	204	178	158	142	129	118	109	101	94	88	83	78	74	71
3·2	211	185	164	147	134	123	113	105	98	92	86	81	77	73
3·3	219	191	169	152	138	127	117	108	101	95	89	84	79	76
3·4	226	198	175	158	143	131	121	112	104	98	92	87	82	78
3·5	234	204	181	163	147	135	125	116	108	101	95	90	85	81
3·6	241	210	187	168	152	139	128	119	111	104	98	93	88	83
3·7	248	217	192	173	157	143	132	123	114	107	101	95	90	86
3·8	256	223	198	178	161	148	136	126	118	110	104	98	93	88
3·9	263	229	203	183	166	152	140	130	121	113	107	101	96	90
4·0	270	236	209	188	170	156	144	134	125	117	110	104	98	93
4·1	276	242	215	193	175	160	148	137	128	120	113	106	101	96
4·2	284	248	221	198	180	165	152	141	131	123	116	109	103	98
4·3	292	255	226	203	184	169	155	144	135	126	119	112	106	101
4·4	299	261	232	208	189	173	159	148	138	129	122	115	108	103
4·5	306	267	237	213	194	178	163	151	141	133	125	118	111	106
4·6	314	274	243	219	198	181	167	155	145	136	128	121	114	108
4·7	321	280	249	224	203	186	171	159	148	139	131	123	117	111
4·8	329	237	254	229	207	190	175	163	151	142	134	126	119	113
4·9	336	293	260	234	212	194	179	166	155	145	136	129	122	116
5·0	343	299	266	239	217	198	183	170	158	148	139	132	124	119

The above table is calculated on the supposition that there is 0·25 to 0·28 % of fat left in the skim or separated milk.

With the ordinary shallow-pan system of setting 3 inches deep, the cream will all rise in 24 to 30 hours with the dairy at a temperature of 58° to 60° F.

With the Cooley and Schwartz systems, the milk is set 20 inches deep in cold water (iced, if possible), and the cream rises in 12 hours.

With the "Jersey" or "Dorset" pans, the milk is also set warm (90° F.), and the water should not be higher than 58° to 60° F., nor lower than 45° F.: cream rises in 12 hours.

With a separator running at 2,000 to 4,000 revolutions per minute, the cream is procured instantaneously, but it is thinner than that from the other systems. The milk must be about 90° F.

For Devonshire scalded cream, the milk is set shallow at 60° F. for 12 hours, then placed on a stove and kept at 180° F. until the surface becomes wrinkled. More cream is raised and it is more easily churned by this system, while the scalding cures taints.

The specific gravity of cream varies from 1·017 to 0·947, according to the percentage of fat present; it may be taken at an average of 0·985, or equal to 9·85 lbs. per gallon.

Souring.

Souring is principally brought about by the action of an organism in the milk known as the *Bacterium lactis*. The germs of this are always floating about in the air, especially in that of dairies and cow-sheds, and infect the milk wherever exposed. The organism (which is one of the lowest forms of the vegetable world) lives on the casein and phosphates in the milk, and converts the milk sugar into lactic acid ($C_{12}H_{24}O_{12} = 4C_3H_6O_3$). Rancidity in butter is due principally to the life action of the *Bacillus butyricus*, which produces butyric acid. Besides these two organisms, there are many others which induce fermentive changes in milk, butter, and cheese, and the ripening of the latter is the result of the complicated action of various unorganised ferments, bacteria, and moulds. To keep milk "sweet," raising the temperature to over 167° F. is resorted to for the purpose of killing the organisms; and when raised to this temperature for 15 minutes in suitable utensils it constitutes "pasteurised" milk. "Sterilised" milk is that which has been heated in strong closed vessels to 266° F. for 30 minutes, or 230° F. for several hours: or otherwise to 150° F. for 2 hours daily for a week, and keeping closed from the air—the intention being, not only to kill the bacteria and other organisms, but also the spores of the same. Ordinary "pasteurising" is generally sufficient to kill all the dangerous pathogenic bacteria. Various antiseptics—such as borax, boracic acid, salicylic acid—are used, which either retard or wholly prevent the action of the various organisms, but their use is to be discouraged. Cooling the milk over a refrigerator to under 50° F. will preserve it sweet for 24 hours if the weather is not too warm: 3 gallons of water to every gallon of milk should be the minimum allowance for this purpose.

KOUMISS.

Koumiss was originally made from mare's milk in Eastern countries by the action of a ferment called "kephir." This has been found to contain three distinct organisms—the *Bacterium lactis*, above mentioned; the special ferment of koumiss, viz., *Bacillus Caucasicus;* and the yeast mould, *Saccaromyces lactis.* It is now, however, largely made from cow's milk by the combined action of the lactic acid organism and yeast. The sugar is partly converted into lactic acid, carbonic acid, and alcohol, while the nitrogenous matter is largely converted into peptones, which make the koumiss so digestible. The process is best carried on at between 54° and 60° F. The term "koumiss" is now usually applied to the product of mare's milk, and "kephir" to that of cow's milk. The following are two analyses:—

	Cow's Milk.	Mare's Milk.
Water	88·93	91·53
Casein	2·03	1·91
Fat	0·85	1·27
Sugar	3·11	1·25
Lactic acid	0·79	1·01
Carbonic acid	1·03	0·88
Alcohol	2·65	1·85
Ash	0·44	0·29
Loss	0·17	0·01
	100·00	100·00

If the average quantity of solids in the milk of cows is over 12 per cent., it is reckoned good quality.

The specific gravity of milk varies from 1028 to 1032—water being 1000.

The specific gravity of skimmed milk varies from 1034 to 1037, and contains from 10 to 14 per cent. of solids.

The average "albuminoid ratio" of the milk of different animals is about 1 : 3·4, reckoning 10 of milk sugar as equivalent to 9 of starch.

The average annual yield of a good dairy cow should not be under 600 gallons during 9 to 10 months of the year.

Milk leaves the cow at a temperature of "blood heat," but is generally cooled down to about 90° F. by the time it is taken into the dairy.

Comparison of Beef with Milk.

	Lean Beef.	Milk.
Water	72·0	87·0
Albuminoids	19·3	4·1
Fat	3·6	3·7
Sugar	—	4·4
Ash	5·1	0·8
	100·0	100·0

Two pounds of milk (less than a quart) thus contain the same amount of solid food as one pound of beef, while the cost is much less.

Specific Gravity of Milk by the Lactometer at 62° F

	Before Skimming.	After Skimming.
Pure Milk	1·0314	1·0337
,, + 10 % added water	1·0295	1·0308
,, + 20 % ,, ,,	1·0257	1·0265
,, + 30 % ,, ,,	1·0233	1·0248
,, + 40 % ,, ,,	1·0190	1·0208
,, + 50 % ,, ,,	1·0163	1·0175

Fleischmann's Formulæ for Calculating the Composition of Milk.

s = Specific gravity of sample of milk.
t = % of total solids.
f = % of butter-fat.
r = % of solids not fat.

$$s = \frac{1000}{1000 - [3{\cdot}75\ \{t - (1{\cdot}2 \times f)\}\ ]}.$$

$$t = (1{\cdot}2 \times f) + \left\{2{\cdot}665 \times \frac{(100 \times s) - 100}{s}\right\}.$$

$$f = ({\cdot}833 \times t) - \left\{2{\cdot}22 \times \frac{(100 \times s) - 100}{s}\right\}.$$

$$r = t - f;\ = \frac{(s \times 1000) - 1000}{4} + {\cdot}2\,f.$$

In these formulæ it has been assumed that the specific gravity of milk fat is 0·93, and of the solids not fat 1·6, as these figures are fairly constant.

Gerber's Babcock Fat Tester.

Sulphuric acid	10 c.c.
Amyl alcohol	1 ,,
Milk	11 ,,

Chemicals should be pure, and the acid of sp. gr. 1·82 – 1·84. Temperature of apparatus and materials not under 60° F.; temperature of mixture of milk and chemicals when reading off percentage of fat to be from 150° to 160° F. to keep the fat liquid.

Circumstances Influencing Milk Secretion.

Breed:—The breeds of dairy cattle recognised by the British Dairy Farmers' Association are:—Shorthorn among the larger breeds: Devon, Red Poll, and Ayrshire among the middle-sized; Jersey, Guernsey, Kerry, and Dexter Kerry among the smaller breeds; and Dutch among foreign breeds. The comparative yields of each have been shown above. Other breeds are more suitable for beef-production.

Age:—A cow in good health continues to improve in milk-yielding capacity up to her seventh or eighth year. The milk of a young cow is richer in fat, while that of an aged cow is reduced in total solids.

Period of Lactation:—A cow attains her highest yield, as regards quantity, about 6 to 8 weeks after calving; thence she declines till she goes dry about the 300th day, in average cases. The total solids in the milk increase as the quantity decreases, the increase being in the fat and casein, while the albumin and milk sugar may become reduced.

Period of Year:—The flush of young grass in early summer stimulates the milk yield of cows in whatever period of lactation they may be, while the dry, brown pastures and hot weather of autumn cause a shrinkage of the same. In the hot weather of summer there is an increase of olein in the butter fat, while in the cold weather of winter there is more stearin developed; thus butter is softer in summer and harder in winter, irrespective of temperature.

Food:—The food largely influences the quantity of the milk, and the proportion of cream and butter obtained therefrom. The result of investigations tends to show that, while the composition of the milk is little, if any, altered by a change in the nature of the food (or only temporarily altered), the "churn-ability"—*i.e.*, the proportion of butter which can be obtained from the milk produced by different foods—varies according to the nature of the food, as shown below (p. 328).

Water Supply:—A plentiful supply of good water is necessary in both summer and winter, but more especially in hot summer weather, to enable cows to milk well. According to the Geneva (N.Y.) experiments with seven different breeds, they require about 5 lbs. of water to every 1 lb. of milk yielded; every 1 lb. of dry food requiring 3 lbs. of water.

Temperature:—Cows give their largest yield when kept at a temperature of 63° F. This is often exceeded in summer; while in winter it is found impossible to keep the air of the cow-houses up to this from the natural heat of the animals alone, and at the same time have proper ventilation, while if they are turned out for exercise they are more liable to take chills in coming from a high temperature. All things considered, about 55° F. is the most suitable temperature.

Temperament:—An animal with a healthy, well-developed nervous organisation will milk better than one with a sluggish, phlegmatic temperament, *i.e.*, the most intelligent cow is the best milker. Such an animal requires very careful treatment, however, or otherwise she will degenerate into a nervous, fidgetty, restless animal—easily frightened—with a correspondingly adverse effect on the milk yield.

Œstrum:—The service heat affects some cows very little but in most cases the quantity of the milk is reduced, the specific gravity decreased, the percentage of fat reduced (to 1 % sometimes), and the butter made from the same is white (or nearly so) in colour. These changes disappear quickly—lasting from two to three days—immediately the œstrum is over.

Treatment:—Gentle treatment is of the utmost importance, as anything that ruffles the animal makes her unwittingly "hold up" her milk, and eventually largely decreases the daily yield; and it is thus of importance that she should never be hunted with dogs, struck, or harshly spoken to, but be petted as much as possible.

Milking:—Quick milking and clean milking largely increase both the quantity of milk and the percentage of butter fat therein, while slow and slovenly work reduces the yield in every way, and prematurely "dries up" the cow. Good milking will do more to increase the yield than any other circumstance, while an inferior milker will injure the animals more than all other good treatment will counteract. Babcock found as the average of several experiments that quick milking produced from 2 to 13 % more milk—which was 10 % richer in fat—than that produced by slow milking; and this superiority continued for several months, until the cows naturally began to decline.

BUTTER.

BUTTER FAT CONSISTS OF THE FOLLOWING TRI-GLYCERIDES:—

FATS.	Symbols.	Melting Points.	Group.	Corresponding Fatty Acids.	Symbols.	Melting Points.	Group.
		° C.				° C.	
Butyrin ...	$C_{15}\ H_{26}\ O_6$	...		Butyric ...	$C_4\ H_8\ O_2$	0	
Caproin ...	$C_{21}\ H_{38}\ O_6$	...		Caproic ...	$C_6\ H_{12}\ O_2$	–2	Volatile Fatty Acids.
Capryllin...	$C_{27}\ H_{50}\ O_6$	...	Liquid Fats (Oils).	Capryllic ..	$C_8\ H_{16}\ O_2$	16	
Rutin ...	$C_{33}\ H_{62}\ O_6$	...		Rutic ...	$C_{10}\ H_{20}\ O_2$	30	
Olein ...	$C_{57}\ H_{104}\ O_6$	0		Oleic ...	$C_{18}\ H_{34}\ O_2$	4·4	
Myristin ...	$C_{45}\ H_{86}\ O_6$	...		Myristic ...	$C_{14}\ H_{28}\ O_2$	53·8	
Palmitin ...	$C_{51}\ H_{08}\ O_6$	45·5–62·7	Solid Fats.	Palmitic ...	$C_{16}\ H_{32}\ O_2$	62·2	Real Fatty Acids.
Stearin ...	$C_{57}\ H_{110}\ O_6$	52–69		Stearic ...	$C_{18}\ H_{36}\ O_2$	69·2	
Butin ...	$C_{63}\ H_{122}\ O_6$	...		Butic ...	$C_{20}\ H_{40}\ O_2$	75	

Analyses of Butters.

	Sweet Cream.		Salt Butter, ½ oz. to lb.	Butter-milk.
	Fresh Butter, Unwashed	Fresh Butter, Washed.		
Water	10 0	11·3	12·0	91·24
Butter Fats	87·8	87·2	82·5	0·56
Albuminoids	1·0	0·5	1·0	3·50
Milk Sugar	0·3	0·2	0·3	4·00
Ash	0·9	0·8	4·2	0·70
	100·0	100·0	100·0	100·00

Comparison of the Percentage Composition of Real and Artificial Butter Fat.

Constituents.	Real Butter.	Artificial Butter.
Palmitin	20·33	22·32
Stearin	42·77	46·94
Olein...	27·71	30·42
Butyrin ... ... Caproin ... ... Capryllin ... ... Rutin or Caprin ... ... Butin or Arachidin ... ... Myristin	9·19	0·32
	100·00	100·00

The aroma and flavour of butter are due to the presence of the six last, probably to their incipient decomposition; while rancidity is excess of decomposition, butyric and formic acids being among the principal products—giving the bad taste and odour. This decomposition is hastened by the presence of casein acting as food to the butyric and other bacilli, so that butter which has been washed in the granular stage to remove the casein keeps longer and never becomes so rank in flavour as the unwashed. Six per cent. of the fatty acids—which are set free in decomposition from the glycerin with which they are combined—are soluble in water, and thus rancidity may be partly removed by reducing the butter to small particles and washing again. The fatty acids can also be distilled off.

Comparison of Butter with Margarine.

	Butter.	Margarine.
Melting point	29–35° C.	34–40° C.
Solidifying point	20–30° C.	18–38° C.
Specific gravity at 60° F.	·926–·95	·915
Do. 100° F.	·911 & over	·903–·906
Per cent. of fatty acids soluble ...	5–7	1–2

Butter fat exists as tiny drops or globules suspended in the serum of the milk, this serum being a solution of saccharine and albuminous substances. It is now acknowledged that there is no caseous membrane surrounding each globule, but that the molecular force of surface tension is sufficient to give the thin watery covering of serum the physical properties of a membrane. One pound of milk yielding 4 % of butter must contain 40,000 millions of them. The largest fat globules in cream are ·0005 to ·0006 in. in diameter, and the smallest 1-10th of this; size diminishes from the time of calving. The size varies in the milk of different breeds; thus Jersey cream globules are = ·00019 in. in diameter, and Ayrshire do. = ·00014 in. on an average. Large globules are most easily churned; thus cream with—

Size of globule.	May be churned in
·000225 in.	13 minutes.
·00019 ,, ...	30 ,,
·00018 ,, ...	34 ,,

Large globules are therefore best for butter-making (as Jersey), and small ones for cheese (as Ayrshire); the larger ones also rise more readily into cream; the smaller ones may never rise, and so tend to make an even, rich cheese

Sweet cream should be churned at 54° to 60° F., ripened cream at 50° to 55° F., and soured or "loppered" whole milk at 60° to 68° F. Sweet cream makes butter which will keep longest, but it takes longer to churn, yields less, and is deficient in flavour, owing to the almost complete removal of the casein. The temperature for churning is influenced by that of the air: the higher that of the air the lower for churning, and *vice versa*. The modern tendency is to churn at a lower cream temperature than formerly.

Temperature of Ripened Cream for Churning.

Temperature of Air.	Temperature of Cream.
66° Fah.	54° Fah.
64° ,, ...	55° ,,
62° ,, ...	56° ,,
60° ,, ...	57° ,,
58° ,, ...	58° ,,
56° ,, ...	59° ,,
54° ,, ...	60° ,,
52° ,, ...	61° ,,
50° ,, ...	62° ,,

Influence of Food on Churning Temperature.

Mr. Speir found in his experiments that the temperature of the air is of little account provided the temperature of the cream is right and it has been properly ripened, as the former can only affect the latter a degree or so up or down during the time of churning. He found, however, that it is necessary to vary the temperature of the cream at churning according to the nature of the food most freely used in the rations, and he has prepared the following table to illustrate this:—

	Degrees Fah.		
Fresh pasture	56	to	58
Dried grains, bran, and treacle ...	57	,,	59
Paisley (gluten) meal and grains ...	58	,,	60
Grey pea meal and grains	59	,,	61
B. sugar meal	60	,,	62
A. sugar meal and malt coombs ...	61	,,	63
Bean meal	62	,,	64
Meat meal and decorticated cotton cake	64	,,	66
Decorticated cotton cake	66	,,	68

The above figures are applicable where the cream has been sufficiently ripened, the churning done in an apartment where the temperature of the air ranges from 58° F. to 62° F., and the cows are neither recently calved nor approaching end of lactation period.

Ripening.

Time required.	Temperature.
12 hours	65 to 70° F.
24 ,, ...	60°
72 ,, ...	45°

24 hours at 60° F. is the best standard to aim at in natural ripening, but it may be hastened by raising to 97° F. and allowing to fall gradually, as the ferments work best at this

temperature. If the temperature is under 55° F. the process may be helped by adding some soured milk or cream, buttermilk, and even lactic or acetic acids. Creams of different ages should be well mixed during ripening. Pure "cultures" of the proper bacteria may now be had for adding to cream to give a fine flavour to the butter.

Average Butter Yield from Sweet and Sour Cream.

	Sweet.	Sour.
Minutes churning	32	29
Butter per 100 lbs. cream—lbs.	14·38	17·11
Percentage gain	—	18·98

Comparison with Cream artificially Soured with ·25 % of Lactic Acid.

	Sweet.	Acidified.	Sour.
Minutes churning	35	40	32
Butter, per 100 lbs.	14·85	17·19	18·94
Percentage gain over sweet cream ...	—	15·75	27 54

Churnability of Butter Fat.

Proportion of Total Butter Fat in Milk obtained by Churning, according to the Food used :—

	Per Cent.
Pasture and bran (June)	91·16
Pasture alone (May)	86·64
Hay, maize meal, and bran	84·18
Hay and bran	81·37
Ensilage (mixed)	81·25
Hay and maize meal	74 63
Ensilage and maize meal	65·69
Hay and starch refuse (gluten meal)	63·89

Variations in the Melting Point of Butter produced by the Use of various Foods —(*Speir.*)

Food.	Degrees F.		
Paisley meal or starch refuse from maize ...	87	to	88
Sugar refuse foods	87	,,	88
Brewers' and distillers' grains	88	,,	89
Malts coombs, bran	89	,,	90
Pasture, beans, oats	90	,,	91
Vetches	91	,,	92
Maize and barley, mixed	92	,,	93
Linseed cake, meat meal	94	,,	95
Decorticated cotton seed cake	100	,,	103

Good "grain" is given to butter if churned at the proper temperature: if too low, it will be long in coming and hard-grained; and if too high, it will come speedily, but be greasy.

The favourite churn is the end-over-end barrel, and plain inside—with the exception of perhaps a removable diaphragm. This style is most easily handled and kept clean.

In churning, never fill the churn more than half full; drive at 45 to 50 revolutions per minute; ventilate at first; stop when the butter "breaks," and add a little cold water; turn a little again till the grains gather as large as pin-heads; draw off the buttermilk and add clean cold water for washing; repeat the washing until the water runs off clear; allow the butter to drain before working up; keep in a cool place.

First-class butter contains from 10 to 15 per cent of water, and not more than 0·5 per cent. of casein.

The specific gravity of butter is from ·911 to ·930; while beef, mutton, and pork fats are from ·2028 to ·9045. Butter gets crumbly under 50° F.; soft at 68°; melts at 87° to 105°; and hardens again at 73°; but these points are all variable.

10 quarts of milk will yield 1 quart of cream with proper feeding (= 10 per cent.). 1 quart of cream will yield 12 oz. to 16 oz. of butter; or 3 lbs. of separated cream will yield 1 lb. of butter: cream churns best when yielding 3 lbs. per gallon, and should be diluted down to this. 1 quart of whole milk will yield 1½ oz. of butter. Average produce of a good cow is over 250 lbs. of butter per annum—two months dry.

Proportion of Butter yielded to the Percentage of Butter Fat in the Milk.

Average of the Butter Tests of the British Dairy Farmers' Association over Five Years.

(Sweet Cream.)

Shorthorn butter-yield ...	= % fat × 0·964
Jersey do. ...	= % fat × 1·077
Mixed breeds do. ...	= % fat × 1·008
Fleischmann's average (with butter = 84 % fat) for soured milk	= % fat × 1·06
Do. do. for soured cream	= % fat × 1·085

With average mixed milk in this country the butter-yield should just be about equal to the fat found by analysis, and on this basis the following table has been calculated. The water held by the butter about equals any loss of fat in the separation or in the churning.

PERCENTAGE OF BUTTER TO MILK.

Lbs. of Milk to 1 Lb. Butter.		Percentage of Butter Fat in Milk.	Lbs. of Milk to 1 Lb. Butter.		Percentage of Butter Fat in Milk.
10	...	10·00	26	...	3·85
11	...	9·09	27	...	3·70
12	...	8·33	28	...	3·57
13	...	7·69	29	...	3·45
14	...	7·14	30	...	3·33
15	...	6·66	31	...	3·17
16	...	6·25	32	...	3·12
17	...	5·88	33	...	3·03
18	...	5 55	34	...	2·94
19	...	5·26	35	...	2·86
20	...	5·00	36	...	2·78
21	...	4·76	37	...	2·70
22	...	4·54	38	...	2·63
23	...	4·35	39	...	2·56
24	...	4·17	40	...	2·50
25	...	4·00	41	...	2·44

Butter intended for immediate use requires only about $\frac{1}{4}$ oz. of salt per lb., or simply to be steeped in brine made with 1 lb. of salt to 1 gallon of water. for 10 to 20 minutes, while in the granular stage: for keeping, must have $\frac{1}{2}$ to $\frac{3}{4}$ oz. per lb., ground fine and worked in.

SCALE OF POINTS FOR JUDGING BUTTER.

Sheldon.	*Chicago Exhibition*, 1893.
25 Flavour: nutty, aromatic, sweet.	45 Flavour.
20 Moisture: as free from beads of water as possible.	25 Grain.
10 Solidity: firm, not melting easily, nor softening.	15 Colour.
25 Texture: closeness of grain—distinct fracture; not greasy.	10 Salting.
10 Colour: natural, even.	
10 Make: remaining points—cleanliness, salting, nicely put up. &c.	5 Packing.
100	100

Scale of Points for Butter-Making Competitions formerly adopted by the British Dairy Farmers' Association.

Preparation of the cream	4
Preparation of utensils	6
Ventilation of churn	4
Judgment and skill in churning	15
Use of strainer	4
Washing butter in churn	10
Use of thermometer...	7
Use of butter-worker	7
Salting	5
Making up	15
Rapidity and cleanliness of working	5
Flavour and colour of butter	7
Texture and freedom from moisture	7
Cleaning up utensils	4
	100

Scale of Points and Rules now Proposed by the British Dairy Farmers' Association.

Points.

Condition of butter in the churn	10
Condition of butter on the worker	10
Making up of butter	20
Smartness and cleanliness in work	20
Colour of butter	5
Texture of butter	20
Freedom from moisture	15
	100

Rules.

1. Two hours and a half will be allowed to competitors from the time cream is given out to them.
2. The Judges will require to see the butter in the buttermilk and in the brine; and also on the butter-worker before it is pressed.
3. The butter must be made up as follows:—
   1 lb. in a roll under 6 inches long;
   1 lb. in a plain brick under 6 inches long;
   1 lb. in an ornamental brick under 6 inches long; and the remainder in fancy designs.

CHEESE.

SYNOPSIS OF THE MANUFACTURE OF

	Evening's Milk cooled to	Renneted at	Time allowed for Coagulation.	Temperature in Cooking.	Breaking or Stirring.	Acid developed.	Salt added.
	° F.	° F.	Mins.	° F.	Mins.		
Cheddar	68	84	45	100	100	Much	1 : 56
Cheshire—							
Early Ripening	70	80	50	90	30	Very much	1 : 25
Medium do. ..	68	87	60	92	40	Medium	1 : 30
Late do. ..	63	90	70	94	40	Little	1 : 35
Stilton	65	86	45	None	Little	do.	1 : 40
Stilton	65	85	60-150	do.	Very little	do.	1 : 60
Gloucester (single and double)	65	80	60	84	do.	do.	Outside
Wilts Loaf... ..	65	80	60	90	Little	do.	1 : 56
Derby	63	80	60	None	do.	None	Outside
Leicester	65	82	70	84	20	Littie	1 : 160
Dunlop	65	80	60	None	60	None	1 : 56
Brie	...	83	240	do.	None	do.	Outside
Camembert ..	...	86	240	do.	do.	do.	do.
Cantal	...	75	60	do.	15	do.	Little
Coulommiers ...	...	78	720	do.	None	do.	None
Gervais (cream) ...	...	65	720	do.	do.	do.	do.
Gorgonzola ...	...	90	20	do.	do.	do.	Outside
Parmesan	...	92	45	130	40	Medium	do.

THE PRINCIPAL VARIETIES OF CHEESE.

Pressure applied.	Ripened at	Mould.	Shape of Cheese.	Weight of Cheese.	Remarks.
	° F.			Lbs.	
1 ton	60	...	Deep	60–80	
15 cwt.	60	...	do.	80	50 % more rennet used; skewered; sour whey added, 1 : 120.
Graduated	60	...	do.	80	Dried in oven at 70–80° F.
do.	60	...	do.	80	Do. do.
56 lbs.	60	Green	do.	20	Open flaky curd desired; extra rennet.
None	65	Blue	do.	15	Extra cream added, or $\frac{1}{6}$ skim drawn off.
Graduated	65	do.	Flat	15 & 30	Partly skim-milk; painted brown; differ only in thickness.
do.	65	...	Deep	30	Partly skim-milk.
do.	63	Blue	Flat	30	"Sweet curd."
do.	65	...	do.	40	
do.	60	...	Medium	56	No scalding; curd broken by hand.
None	50	Blue	Flat	4–5	Drained in open moulds.
do.	50	White	Deep	1	Drained in open moulds; ripe in six weeks.
Much	46	...	Flat	40–100	Ripe in two months.
None	...	Green	do.	2½	Drained in open moulds.
do.	...	...	Deep	¼	Drained in cloth; 1 cream to 2 milk; 1 drop rennet to quart of milk.
do.	46	Blue	do.	40–60	Drained in cloths.
Little	50	...	Flat	150	Ripens in three years.

Varieties and Analyses.

	Water.	Casein.	Fat.	Sugar.	Ash.
British, pressed—					
Caerphilli	...	...	...	...	...
Cheddar, 3 mos.	36·17	24·93	31·83	3·21	3·86
Do. 6 mos.	31·17	26·31	33·68	4·91	3·93
Do. average ...	34·38	26·38	32·71	2·95	3·58
Cheshire, new	36·96	24·08	29·34	5·17	4·45
Do. old	32·59	32·51	26·06	4·53	4·31
Cotherstone	38·28	23·93	30·89	3·70	3·20
Derby	31·68	24·50	35·20	4·38	4·24
Dorset (blue)	...	...	...	...	...
Dunlop	38·46	25·87	31·86	...	3·81
Gloucester (single) ...	32·50	28·51	28·23	2·85	4·66
Do. (double) ...	35·96	21·74	26·83	2·23	4·67
Lancashire	...	...	...	...	...
Liberton (Yorks) ..	...	...	...	..	...
Leicester	32·80	23·06	29·28	4·42	4·35
Skim	45·39	33·12	9·97	6·39	5·13
Warwickshire	33·61	29·70	30·04	1·95	5·60
Wensleydale	...	...	...	...	...
Wilts Loaf	34·44	29·00	28·71	3·60	4·25
British, soft—					
Cream	30·65	4·94	62·99	...	1·15
Colwick	...	...	...	...	...
New Forest	...	...	..	...	...
Slipcote	...	...	...	...	...
Stilton	30·35	28·85	35·39	...	3·82
York	...	..	...	..	...
French, soft—					
Brie	50·35	17·18	25·12	...	5·41
Camembert	50·16	21·85	21·13	...	3·89
Coulommiers	...	...	...	...	...
Gervais (cream)	52·94	11·80	29·75	2·53	2·93
Neufchatel	44·47	14·60	33·70	...	2·99
Poitiers (goat)	...	...	...	...	...
French, pressed—					
Cantal	44·2	25·7	24·0	...	...
Gruyère	34·87	25·87	28·91	...	3·84
Roquefort	31·20	27·63	33·16	...	6·01
Dutch—					
Edam (round)	36·28	24·06	30·26	...	4·90
Gouda (flat)	21·90	46·95	24·31	...	6·32
German—					
Backstein (soft skim) ..	73·1	19·8	2·8	2·2	2·1
Limburg	34·5	13·0	41·9	7·0	3·6
Swiss—					
Backstein	35·80	24·44	37·40	...	2·36
Belleiay (soft)	37·50	28·88	30·05	...	3·48
Emmenthaler or Gruyère	36·1	28·0	29·5	3·3	3·1
Zwiger	65·5	22·1	3·1	3·2	2·3
Italian—					
Gorgonzola	44·04	28·06	29·84	...	3·87
Parmesan	31·34	41·99	19·22	...	6·25
Rubiole (sheep)	...	...	...	...	...
Various—					
American Factory ...	25·93	38·12	31·55	...	4·38
Foreign Skim, average...	46·08	33·37	10·54	6·12	3·81
German Sour Milk ...	63·63	25·27	4·85	...	3·67
Separated Skim	50·50	43·10	1·20	...	5·20
Whey Cheese (cow) ...	24·21	9·06	20·80	41·01	4·92
Do. (goat) ...	25·29	9·10	20·98	29·21	3·88

Composition of Curd in the Vat before Cutting.

Liquid	92	Water	87 0
		Albumin	0·75
		Milk sugar	4·0
		Ash	0·25
Solid	8	Casein	3·75
		Fat	3·75
		Ash	0·50
	100		100 00

Chemical Composition of Casein.

Carbon	53·83
Hydrogen	7·15
Oxygen	22·52
Nitrogen	15·65
Sulphur	0·85
$C_{144} H_{228} O_{45} N_{36} S$	100·00

Analysis of Whey.

Water	93·0
Albuminoids	1·0
Fat	0·3
Milk sugar and lactic acid	5 0
Ash	0 7
	100 0

Curd and Cheese yielded by 100 Lbs. of Milk.

Purchased Milk.

	Curd. Lbs.	Green Cheese. Lbs.	Ripe Cheese. Lbs.	Shrinkage. %
May —	11·12	10·31	9·12	17·9
June 20	11·75	11·25	9·94	15·4
Aug 10	11·62	11·31	10·18	12·3
Sept. 19	13 00	12·12	11·18	15 0

Home-produced Milk.

	Curd. Lbs.	Green Cheese. Lbs.	Ripe Cheese. Lbs.	Shrinkage. %
July 17	12·94	—	10·00	22·7
Aug. 4	12 62	—	10·00	20·7
Aug. 17	12·50	11·25	9 81	21·5

A cow yielding 600 gallons of milk per annum should thus produce nearly 5 cwt. of cheese.

There are other albuminoids present in milk besides casein, principally albumin. Casein is coagulable by the addition of acids or rennet, but not by boiling; albumin is not coagulated by rennet or most acids, but is so by heat on the removal of the casein, as in whey. It preponderates in colostrum, which therefore coagulates by boiling, though it forms only $\frac{1}{9}$ of the albuminoids in ordinary milk.

Casein is not in solution in milk, but is chemically compounded with 1·25 % of calcium oxide in the form of a dilute jelly swelled up by absorption of water; it will not dialyse, but when curdled will dissolve in dilute hydrochloric acid or carbonate of soda.

There are three modifications of the coagulation of casein:—

1st. Natural coagulation by acidity of the milk. The milk sugar (lactin) is converted into lactic acid by the action of a ferment, *Bacterium lactis*; this, again, converts the neutral phosphates of the milk into acid phosphates, which in their turn act on the alkali of the casein (casein being an alkali-albuminate), causing coagulation of the pure casein. The formation of lactic acid from milk sugar takes place thus—

$$C_{12}\,H_{22}\,O_{11}\cdot\,H_2\,O = 4\,C_3\,H_6\,O_3$$
$$\text{Lactin} = \text{Lactic acid.}$$

2nd. Precipitation by acids other than lactic. Thus, dilute hydrochloric and acetic acids coagulate casein into flakes, but not in a state suitable for cheese-making; it is re-dissolved in excess of acids.

3rd. Coagulation by *rennet*. The process is not yet understood, but it appears to be one of fermentation caused by the unorganised ferment in the rennet. The casein is precipitated as *paracasein*, with all the di- and tri-phosphates as well as the butter globules mechanically enclosed. Rennet will not act if the milk is alkaline, or if there is a lack of soluble lime salts, while a slight acid reaction within narrow limits favours the process: thus "ripening" the milk by allowing time for the lactic ferment to develop, or adding a little soured whey, helps very much.

General Rules in Cheese-Making.

Ripen the milk by keeping an hour before rennetting at 84° to 88° F. in summer; in spring some add a little soured whey.

Allow one hour for coagulation before cutting.

Scald gradually up to 105° F.; in summer a little less.

Add salt at rate of 2 per cent

Unripe milk yields more curd, but the cheese does not keep afterwards so well.

Cheddar Cheese.

The evening's milk allowed to cool down to 68° F., and the morning's milk put in and the whole heated up to 84° F., or higher in cold weather. Rennet added to make the curd set in 30 to 45 minutes; the quicker it sets, the more quickly does the cheese ripen. About 4 oz. rennet extract used to 100 gallons milk. If evening's milk was cooled down below 64°, then some add 1 pint of sour whey to every 30 gallons of milk, to assist the action of the rennet, the object being to develop a certain amount of lactic acid before adding the rennet; though this practice is now considered objectionable in some districts. Annatto is added before the rennet if the cheese is to be coloured—1 to 2 oz. per 100 gallons. Curd is next cut slowly with a *sharp-edged* breaker, and stirring is then gently commenced. The whole is then raised to 100° F., or over (108° on clay soil, 105° on gravel, 100° on limestone), at the rate of 1° to 2° every five minutes, at which it must be kept until stirring is finished. The temperature of the scald must also be higher where the cows drink soft water, and lower where the water is hard. Heating is done by warming some whey separately and mixing again, or by steam or hot water in a jacketed vat. The effect of this "cooking" is to promote the separation of the curd from the whey. When curd has reached the proper consistency it is allowed to settle, the whey all run off, the curd broken in pieces and allowed to drain (and develop acidity) over a draining rack, put into vat and pressed for a short time with half a ton, taken out, sliced down, cooled (but not below 65° to 70° F.), ground in curd-mill, salted at rate of 1 lb of salt to 56 lbs. of curd, put into cheese-vats and pressed gradually up to 1 ton weight. The cloths are changed daily for four days, hood and bandages put on at last, and stored past in ripening room, which must be kept at a temperature of 60° to 65° F. The cheese must be turned daily, and are ready to eat in, say, two to three months.

Different varieties of cheese require different kinds of microbes and moulds to act in the process of manufacture. Lloyd has shown that in Cheddar cheese it is the *B. lactis* only that develops the "acidity," and in the whey there may be 1 per cent. of lactic acid.

Rennet.—In the dry form it is the salted stomachs of calves, but is best kept in liquid form. Four calves' stomachs to 1 gallon of brine (containing 2 lbs. of salt per gallon); add half a sliced lemon, and ½ oz. of saltpetre; ready for use in a month, and ½ pint of the liquor (strained) will coagulate 100 gallons of milk in one hour, but more must be used for speedy work. The ready-made "extracts" are now largely used, and are entirely satisfactory. The principle of rennet is an unorganised chemical ferment, developed by the secreting cells of the fourth stomach of the calf. It acts best for cheese-making between 85° F. and 95° F., but its maximum coagulative power is at 105° F.; becomes permanently inactive if heated over 140° F. or cooled below 65° F. Loses at least 25 % of its strength if kept over a year. Rennets differ in strength, but a standard sample should coagulate milk at the rate of 1 to 10,000 parts at 95° F. in 40 minutes. Samples coagulating under 1 to 6,000 parts should be rejected.

Analysis of Hansen's "Extract."

Water	78·86
Nitrogenous organic matter	2·00
Non-nitrogenous organic matter	0·24
Ash (chiefly salt)...	18·90
	100·00

Scale of Points for Judging Cheese.

Sheldon.		*Chicago Exhibition*, 1893.	
35	Flavour: nutty, buttery. ...	45	Flavour.
25	Quality: mellow, rich, melting on tongue.	20	Texture (and body).
15	Texture: solid, compact.	15	Colour.
15	Colour: natural-like, even.	10	Salting.
10	Make: remainder—due to good making, as cleanliness, salting, perfect rind, &c.	10	Make up (finish.)
100		100	

Plants which Affect Cows and their Produce if in the Pasture.

Ranunculaceæ.

Aconitum napellus ... ... Common Monk's Hood.
Anemone nemorosa ... ... Wood Anemone.
,, *Pulsatilla* ... ... Pasque Flower.
Helleborus fœtidus ... ... Stinking Hellebore.

PLANTS WHICH AFFECT COWS, &c.—*continued.*

Cruciferæ.

Sisymbrium Alliaria ...	Garlic Mustard.
Raphanus Raphanistrum ...	Wild Radish: Runch.

Umbelliferæ.

Æthusa Cynapium	Fool's Parsley.
Cicuta virosa	Cowbane.
Conium maculatum	Hemlock.
Hydrocotyle vulgaris ...	Marsh Pennywort.
Silaus pratensis	Pepper Saxifrage.

Araliaceæ.

Hedera Helix	Ivy.

Compositæ.

Anthemis arvensis	Corn Chamomile.
,, *Cotula*	Stinking Chamomile.
,, *nobilis*	True Chamomile.
Artemisia Absinthium ...	Wormwood.
Hieracium Pilosella ...	Hawkweed.
Matricaria Chamomilla ...	Wild Chamomile.
Tanacetum vulgare	Tansy.

Boragineæ.

Myosotis palustris	Common Forget-me-not.

Scrophularineæ.

Pedicularis palustris ...	Lousewort.

Lentibularineæ.

Pinguicula vulgaris	Butterwort.

Labiatæ.

Mentha arvensis	Corn Mint.

Euphorbiaceæ.

Euphorbia Helioscopia ...	Spurge.

Coniferæ.

Taxus baccata	Yew.

PLANTS WHICH AFFECT COWS, &c.—*continued.*

Liliaceæ.

Allium vineale	Crow Garlic.
,, *ursinum*	Broad-leaved Garlic, "Ramsen."

Junceæ.

Narthecium ossifragum ...	Bog Asphodel.

Alismaceæ.

Alisma Plantago	Water Plantain.

Equisetaceæ.

Equisetum arvense	Corn Horsetail.

The taste of turnips in milk and its products may be obviated by giving the turnips immediately after instead of before milking; by putting a little saltpetre in the milk, or one teaspoonful in every gallon of cream before churning; or by boiling or pulping the turnips before using.

Great cleanliness to be observed in all operations of the dairy: all vessels to be washed and scalded with hot water at over 150° F. (but as much higher as possible), to destroy adhering ferment; all sources of smells to be removed: otherwise no good butter or cheese can be made.

SYNOPSIS OF DAIRY FUNGI AND BACTERIA.

Organisms.	*Occurrence.*
A. FUNGI (Moulds).	
I. **Mucorini.**	
Mucor stolonifer ...	White mould: cheese.
II. **Ascomycetes.**	
Penicillium glaucum ...	Green mould: Stilton, Roquefort, and Gorgonzola cheese.
Aspergillus clavatus ...	Blue mould: cheese.
Oidium lactis	White mould: milk.
Saccharomyces lactis ...	Milk yeast: kephir and koumiss.

B. BACTERIA (Fission Fungi).

I. Coccaceæ.

a. Micrococci.

Micrococcus acidi lactici	Souring milk.
,, *casei amari*	Bitter-tasted cheese.
,, *lactis*	Souring milk.
,, *Weigmannii*	Ripening cream; good flavour.
,, *lactici amari*	Bitter-tasted milk.
,, *prodigiosus*	Red spots on milk.
,, *Freudeureichii*	Stringy milk.

b. Sarcinæ.

Sarcina rosea	Red surface on cream.

c. Streptococci.

Streptococcus acidi lactici	Souring milk.
,, *Hollandicus*	Edam cheese: "Taettemaelk" (Norwegian stringy milk).

II. Bacteriaceæ.

a. Bacteria.

Bacterium acidi lactici	Souring milk.
,, *limbatum acidi lactici* ...	,, ,,
,, *Hessii* ...	Stringy milk.
,, *lactis erythogenes* ...	Red skim-milk.
,, *coli commune*	Intestines: hoved cheese.
,, *butyricus* ...	Rancid butter.
Tyrothrix geniculatus...	Bitter-tasted soft cheese.
,, *catenula* ...	Ripening cheese.
,, *urocephalum*	Hoved cheese.
,, *tenuis*... ...	Ripening cheese.

b. Bacilli.

Bacillus acidi lactici (=*Bacterium lactis*)	Ordinary souring of milk; cheese-making "acidity."
Bacillus cyanogenus ...	Blue milk.
,, *synxanthus* ...	Yellow milk (after boiling).
,, *Guillebeau* ...	Inflammation of the udder: stringy milk.
,, *lactis pituitosi*	Slimy milk.
,, *lactis viscosus*	Viscid milk.
,, *viscosus*... ...	Slimy butter; greenish scum on cream.
,, *diatrypeticus casei* ...	Ripening Gruyère cheese (cavities).
,, *Caucasicus* ...	Kephir and koumiss.
,, *subtilis* ...	Dusty hay: ripening cheese.

LIVE STOCK.

HORSES.

Breeds.

The Shire Horse.—The most widely distributed work horse in England. Descended from the old English black cart horse native to the Fen countries. Bred chiefly in Cambridge, Hunts, Lincoln, Nottingham, Leicester, Derby, Northampton, Warwick, and Stafford. Black, brown, and bay are the most desirable colours; 17 hands high. Head long and lean, profile slightly arched, broad between the eyes. Shoulders oblique, sprung well into the back; very wide chest. Ribs wide and deep, with little space between last rib and hip. Feet large, with wide heels; legs short from knee to pastern, with long silky feather; pasterns rather short; tassel of hair at lip, knee, and hough. The animal generally is large and massive. Crosses well with Clydesdales, from which it differs in having the middles larger, the quarters shorter, the pasterns shorter, and hoofs more upright, and in being more sluggish in action. Held by Sir Walter Gilbey to be the lineal descendant of the "Old English War Horse." Supplies the greatest number of dray horses for London and other large towns.

The Clydesdale.—Native to the valley of the Clyde and the Glasgow district, but now the general farm horse over Scotland. Said to be descended from black stallions imported from Holland several centuries ago by a Duke of Hamilton. First improved in the Upper Ward of Lanarkshire. Prevailing colours are brown, bay, and black; chestnut and roan avoided. Height, 16 to 16·5 hands. The head is clean, eyes full and prominent, nose bones straight and slightly arched (not "dish-faced"), with wide nostrils; neck well arched; shoulders oblique, chest wide; back short and broad, and "well ribbed-up;" legs well under the body, flat and muscular, and with an abundance of straight, soft, silky feathering; ribs deep and widely sprung; houghs clean and strong; feet and knees large and broad; forelegs straight, with well-developed muscle on the forearm; sloping pasterns; flat leg bones. These horses have strong constitutions, free action, are high mettled but free from vice, and fast walkers.

The Suffolk Punch.—Native to Norfolk, Suffolk, and Essex. Said to be descended from horses introduced by the Norman invaders. From 15 to 16 hands high; colour, chestnut to dark sorrel, mane and tail often of a light or silvery shade. Finely arched necks, low shoulders, and thick on the withers; deep round barrels, well-developed quarters, but legs rather light, round in the bone, and very free from hair, and feet small: very suitable for work on clay soils, however. Very quiet and docile, and willing pullers.

The Cleveland Bay.—This breed is the descendant of the old coaching and pack-horse (the "Chapman Horse"), and is more of a carriage than a farm horse. It has lately come much to the front since the starting of a stud-book in 1884. It takes its name from the rich valley of Cleveland, on the river Tees. The prevailing colour is bay with dark legs, white not admissible; height, 16 hands and upwards. Good sloping shoulders, short back, powerful loins, long quarters, clean legs, good action. Suits tillage purposes on light sandy soils, and when crossed with the Thoroughbred produces most of the fine carriage horses of the country. The *Yorkshire Coach Horse* (or Howdenshire Cleveland) is an offshoot of the Cleveland, and is now developed into a distinct breed. More leggy than the original, but with the length and the level quarters. From these two are bred a large proportion of the carriage and hunting horses of the country, crossed the one with the other, or sired by the Thoroughbred.

The Thoroughbred.—Of Eastern origin, the famous sires *Byerley Turk*, *Darley Arabian*, and *Godolphin Arabian* (*Barb*) being introduced in the end of the 17th and the beginning of the 18th centuries, while the three most famous English-bred sires of a later period were *Herod*, *Eclipse*, and *Matchem*, from which all the best animals have descended. Fine head; tapering and finely-set-on neck; shoulders very oblique; well-bent hind legs; ample muscular quarters; flat legs, rather short below the knee; long elastic pastern. Used only for racing. Horses and ponies with some Thoroughbred blood in them have more spirit, action, and speed than others.

The Hackney or Norfolk Trotter.—Believed to be partly descended from the Norman horse, while there is some Thoroughbred blood in its ancestry. Essentially a riding and trotting animal. Must be over 14 hands in height; the shoulders rather thicker than in the Thoroughbred, and well-sloped back. Some varieties resemble the Suffolks in colour. Sound feet, good clean legs; tails usually cut short. A special variety is bred in Yorkshire.

Ponies.

(Under 14 hands in height.)

Exmoor.—Native to the district of that name. About 12 hands in height; hardy, nimble, thick-bodied, and well-formed. Of a buff-bay colour, some black-brown. The best strains said to be descended from *Katerfelto*, a sire that lived in the end of last century.

New Forest.—Native to the New Forest district, in Hampshire, where they run more or less wild. Hardy, safe, and of great spirit and speed. *Marsk*, the sire of the thorough-bred *Eclipse*, was allowed to run free in the New Forest before his quality was known, and is believed to have influenced this breed very much. Grey in colour, and about 12 hands in height.

Welsh.—A beautiful little animal about 12 hands high. Small head, high withers, deep round barrel, short joints, flat legs, and good round feet. Run semi-wild on the hills before being broken in. Dun-coloured, and about 12 hands in height.

Highland.—A hardy animal of Norwegian descent, running semi-wild while young. Large head, longish back, short legs, short pasterns, rough-haired; slow-paced. Dun-coloured, and over 11 hands high.

Shetland.—The smallest animal of the horse kind. Native to the northern Scottish islands. Sometimes not more than 7½ hands in height: 10 hands the largest. Small head, short neck, low thick shoulders, short back, powerful quarters, good feet. Dun- or black-coloured.

SYNOPSIS OF BREEDS.

	Height—Hands.	Prevailing Colour.
WORK HORSES.		
Shire	17·0	Black.
Clydesdale	16·5	Dark brown.
Suffolk Punch	16·0	Chestnut.
LIGHT HORSES.		
Yorkshire Coach	16·5	Dark bay.
Cleveland	16·0	Bright bay.
Hackney	15·0	Chestnut.
PONIES UNDER 14 HANDS.		
Exmoor	12·0	Buff bay.
New Forest	12·0	Grey.
Welsh	12·0	Dun.
Highland	11·0	Dun.
Shetland	10·0	Dun.

The four breeds of the eastern parts of England are all of a brownish or chestnut colour, clean-legged, and probably derived from a common ancestry—most likely the Norman horse. The two heavy breeds of the Shire and Clydesdale have Flemish ancestry, are black or dark brown in colour, and have large feet and long fetlocks.

The ponies are all found in the western districts, as they are derived from the native British horses of Cæsar's time, the descendants of which were crushed into the west by successive waves of invaders.

Names of Horses.

Horse.

During 1st year, Colt foal.
,, 2nd ,, Yearling colt.
,, 3rd and 4th year, Two- and three-year-old.
At 3 years off are Entires or Stallions; geldings if castrated.

Mare.

During 1st year, Filly foal.
,, 2nd ,, Yearling filly.
,, 3rd and 4th year, Two- and three-year-old.
At 3 years off are Mares.

Breeding.

The horse is bred for strength, endurance, and fleetness, so that the development of chest, brain, and nerves is of paramount importance. Crossing animals with extreme differences seldom answers. Both should be young, vigorous, and sound. The following diseases are generally considered hereditary:—Contracted feet, sidebones, ringbones, curbs, splints, spavin, founder and weakness of front legs, roaring, broken and thick wind, melanosis, specific ophthalmia and blindness, jibbing and ill temper.

Mares may be bred from at two years old, and liberal food and moderate exercise are needed for every pregnant animal; they may be worked safely up to a short period before foaling. They go with young from 10 to 12 months, 11 being about the average, and are usually timed to foal about the beginning of May. Premonitory symptoms of parturition are the swelling of the udder, and a waxy secretion issuing from and forming small drops at the ends of the teats, some three days to 24 hours previously; but false presentations sometimes occur. Mares must not be hard worked while suckling their foals, as the milk sours and induces diarrhœa, especially when the latter have to fast a while; it is better to let them run at the grass altogether. A mare takes the horse from 7 to 10 days after foaling, and is then most likely to conceive. She comes in season every three weeks, and remains in use from 5 to 7 days.

Rearing.

As soon as dropped, the umbilical cord should be secured, or the foal may bleed to death, and then dam and foal be left alone, as the young will usually find out the way to suck best by itself. Both mare and foal to be kept indoors at the first, and gradually acclimatised to outside life. Food should be given to mare which encourages flow of milk, such as boiled roots and bran mashes Foals are weaned at from 5 to 6 months old, and as horses are social animals there should be two or more together They should never be on short pastures, as they invariably suffer from worms. Best land for rearing on is the soft alluvial soil of valleys, where there is a profusion of grass, and where the moist spongy pasture encourages growth and expansion of hoof. They settle best where only two occupy the same field. Oats and bran must be given if the grass is not of first-rate quality. Winter out in fields with open sheds or yards. Usually castrated at 12 months old—to be in good condition at the time of the operation.

Breaking In.

Education should commence at birth: accustom to be handled, led by the forelock, and haltered; otherwise, if allowed to grow up half-wild, will be difficult to work with. Always treat gently and kindly: vicious habits are generally acquired from ill-treatment. Regular breaking in to work should begin at 2½ years old. The colt is usually yoked with a steady old horse at first, in the chain-harrow or plough. He should be accustomed to do without blinkers, as he is less liable to take fright when properly broken in. Work only for a few hours daily at first, and if shoulders chafe, clip off hair and bathe with a lotion made of 1 oz. sugar of lead and 1 oz. sulphate of zinc, dissolved in a quart of water. Care must be taken to frighten him as little as possible.

Feeding.

Horses have comparatively small stomachs, and must therefore receive nutritious food, and not be subjected to long fasts. Oats or other grains should be bruised or mixed with chopped hay to prevent "bolting" the food, and to assist digestion. They are very fond of raw potatoes, but these should be boiled, as they are apt to cause colic. Carrots are much relished. Soiling indoors with grass or forage crops is less expensive than turning out to graze during summer, and great regularity should be observed in feeding and watering. When in a heated state a horse should not be allowed to swallow a large quantity of water at a low temperature; river or pond water, if tolerably free from organic matter, is to be preferred to that from wells and springs. Salt should always be accessible.

The Stable.

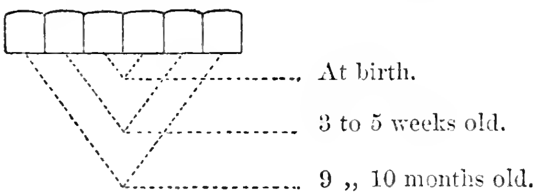
Should be on a dry situation, lofty, well ventilated, and well lighted. There should be no granaries over; and over-head racks are undesirable, as they put the horse into an unnatural position. The walls should be whitewashed, and the floor made of impervious material, with proper drainage. The building must be kept clean, otherwise poisonous gases are evolved which generate diseases, such as chronic cough, inflammation of the eyes, ophthalmia, impaired digestion, and affection of the lungs.

Dental Formula of a Full Mouth.

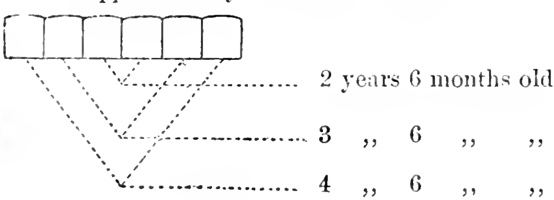
Permanent Molars.	Temporary Molars.	Canines.	Incisors.	Canines.	Temporary Molars.	Permanent Molars.
$\frac{3}{3}$	$\frac{3}{3}$	$\frac{1}{1}$	$\frac{3}{3} \mid \frac{3}{3}$	$\frac{1}{1}$	$\frac{3}{3}$	$\frac{3}{3} = 40$

Teeth as Indicative of Age.

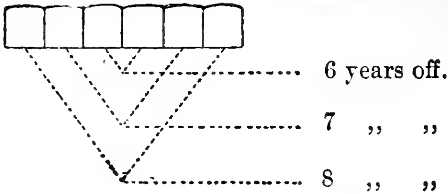
Appearance of Temporary Incisors.



Appearance of Permanent Incisors.

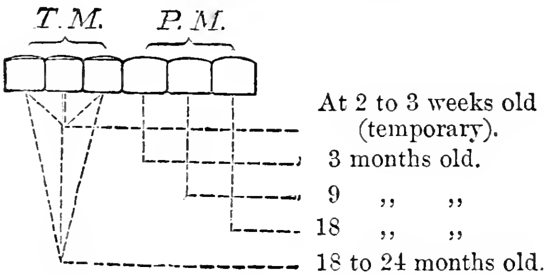


Wearing out of the Central Mark or Cavity.



Appearance of Molars.

(Temporary and Permanent.)



The tushes (*canines*) appear at 4 years 3 months. In the mare they do not usually come at all, and never before 8 or 9 years old. The foal incisors have a "neck," and are whiter and smaller than the permanent incisors. At 2 years old there is a full mouth of temporary teeth; at 5 years a full mouth of permanent teeth; and at 8 years the horse is "aged," with the "marks" gone.

Judging a Horse.

The weak points of a horse are best found while he is standing still. If he be sound, he will stand firmly and squarely on his legs without moving any of them, the feet planted flat upon the ground, with legs plumb and naturally poised. If one foot is thrown forward with the toe pointing to the ground and the heel raised, or if the foot is lifted from the ground and the weight taken from it, disease may be suspected, or at least tenderness which is a precursor of disease. If the horse stands with his feet spread apart, or straddles with the hind legs, there is weakness of the loins, or the kidneys are disordered. The examination should commence by watching him for a few minutes in the stall, and then paying great attention to his movements on being brought out, before he has time to be warmed up. A written warranty should be insisted on when purchasing.

Common Diseases.

Catarrh or *Common Cold.*—Characterised by sneezing, running at the eyes, discharge at the nose, and feverishness. Caused by exposure or sudden change of temperature. Clothe the body, give bran mashes and boiled linseed. Do not use purgatives unless constipated; in which case give 8 to 10 oz. of linseed oil. Nitrate of potash is sometimes given in the early stages as a febrifuge and diuretic; 1 to 2 oz. is the dose. If coughing, put mustard to the throat.

Strangles.—Most common among horses under 4 years old. A cold; cough, sore throat, yellow discharge from nostrils, swelling or tumour under the throat. Tumour bursts and discharges pus, and then heals up. Put poultice to tumour to hasten progress. Give in gruel 4 drachms of chlorate of potash, and then tonics. Feed on gruel and bran mashes; keep cool, but comfortable.

Influenza.—A contagious catarrhal fever. Evinced by dulness, shivering, loss of appetite, cough, inflamed eyes, watery discharge from nostrils. Swallowing difficult, intense weakness. "Pink-eye" is a violent form. Keep comfortable, give bran mashes and green food, steam the nose. Give 1 oz. saltpetre in the drinking water along with infusion of linseed. Give twice daily sweet spirits of nitre 1 oz., acetate of ammonia 3 oz., in a pint of water; afterwards a tonic.

Inflammation of the Lungs or *Pneumonia.*—Caused by cold or over-driving when out of condition. The breathing is quickened and laboured, nostrils widely dilated, the animal is restless, and the coat becomes staring. Keep comfortable, rub the legs with ammonia liniment, and also the sides of the chest. Feed on soft food, including bran mashes. Give draught every 4 hours, containing acetate of ammonia 3 oz., bicarbonate of potash ½ oz., tincture of aconite 3 drops, in ½ pint water; afterwards a tonic.

Broken Wind.—Evinced by the expiration of the breath taking two efforts, and the inspiration only one, as seen at the flanks, sometimes accompanied by a cough. The cause is due to a rupture of the air cells of the lungs, brought about by overfeeding with bulky food or musty hay and then over-working. No cure, but relieved by slow work and concentrated moist food.

Glanders.—A malignant, fatal, and contagious disease, due to some germ poison in the system. Most prominent symptom is a sanguineous and glutinous discharge from the nostrils, especially one nostril. No cure for it, and all animals affected by it must be destroyed, and the surroundings disinfected. Communicable to man. The police must be notified immediately.

Colic, Gripes, or *Batts.*—Spasm of the bowels, caused by food which easily undergoes fermentation—raw potatoes, green clover, new oats, &c.; or any improper food, sudden changes in diet, exhaustion from overwork, or a large draught of cold water when tired and heated. Intermittent paroxysms of great pain with excited countenance and perspiration are the prominent symptoms. Two varieties—"spasmodic," followed by "flatulent." Proper dieting will prevent it, but treatment consists in giving 5 to 10 drachms of aloes in a ball, 1 to 2 oz. of sweet spirits of nitre, or 1 to 2 oz. of laudanum, and enemas of warm water only. Flatulent colic requires ammonia, turpentine, or linseed oil; puncturing of the intestine with trocar is not recommended.

Inflammation of the Bowels or *Enteritis.*—Congestion of the mucous membrane of the intestines. Recognisable causes are—over-fatigue, cold from exposure, or sudden chill from washing, or drinking cold water. Symptoms are similar to those of spasmodic colic, but continuous, and abdomen is tender to pressure; the horse is careful in lying down, and there are no intervals of ease, but he kicks at his belly and whisks his tail. Administer 1 to 2 drachms of opium powder to relieve pain; hot fomentations to abdomen by fastening sacks round the body and pouring on warm water; enemas of warm water. Bran mashes and boiled linseed to be given on recovering. Very fatal.

Diarrhœa.—Frequent passing of fluid dung. Constitutional with some horses. Immediate causes are bad feeding, too succulent green food, raw potatoes, worms, &c. Keep comfortable, and give, in ½ pint of flour gruel, daily, tincture of catechu 1 oz., powdered chalk ½ oz., opium powder 1½ drachms. Improve the dieting.

Thrush.—A fœtid discharge from the frog, caused by a diseased condition of the sensitive frog, often due to the horse standing on foul litter, or going on wet pasture; sometimes caused by grease. Usually cured by cleanliness, and the application of carbolic acid 1 part to glycerine 6 parts.

Inflammation of the Feet, Acute Founder, or *Laminitis*—This is an inflammation of the sensitive parts of the foot, including laminæ, sole, and coffin-bone, caused by over-exertion, inordinate feeding, eating new hay, oats, wheat, or other unsuitable foods, drinking cold water when heated, sudden chills, or metastasis—the changing of seat of inflammation from some other organ into the foot. Evinced by great restlessness, lameness, and continual shifting from one foot to the other, followed by continuous lying down; forefeet are most affected, and animal tries to take its weight off them by putting hind feet as far forward as possible. Give gentle purgatives and small repeated doses of tincture of aconite; remove the shoes and apply warm poultices of linseed or bran, and also warm fomentations; cold applications after the crisis is past, and sometimes blisters to the coronet. Thin-heeled bar-shoes to be afterwards put on. Ribbed hoofs and pumiced soles are the results of this disease.

Mud-Fever.—Heat and swelling of the legs, and animal goes with a stiff gait. Due to the chilling and caustic action of mud, especially when the legs are tender from repeated washing and imperfect drying. Let the mud dry on and brush off. Dress the legs with a mixture of 1 of carbolic acid to 64 of glycerine and 8 of liquid acetate of lead.

Grease.—An inflammation of the skin at the back of the heels and fetlocks—oftenest in the hind feet—followed by an exudation of a greasy and fœtid nature. Some horses are predisposed to it, especially underbred cart horses and those with "washy" bodies. Exciting causes are sudden change of diet, and especially improper food—moist, inferior, or cooked—filth and neglect, too much corn without exercise; washing the feet and legs and leaving them to dry themselves is also apt to bring it on. Removal of the cause and giving alterative powder occasionally will usually be followed by its disappearance. Wash with soft soap and apply ointment made of zinc sulphate and vaseline.

Swelled Legs or *Weed (Lymphangitis).*—Mostly in horses of a coarse nature, and in hind legs. Caused by overfeeding and too little exercise. Seen most on Monday mornings after Sunday's rest. Gentle exercise and a purgative. Bathe part with lotion containing acetate of lead 1 part, tincture of arnica 3 parts, and water 8 parts.

Recipes.

Alterative Powder. — Equal parts of black antimony (sulphide), nitre, and sulphur. Dose, a tablespoonful.

Blister.— Red iodide of mercury ½ lb., mixed with lard 4 lbs.

Condition Powder.—Fenugreek 2 parts, carbonate of iron 1 part, nitre 2 parts, gentian powder 1 part, sulphur 2 parts. Mix and sift. 1 oz. daily in food.

Cooling Lotion.—Acetate of lead solution 1 part, tincture of arnica 3 parts, water 8 parts.

Embrocation.—Hartshorn 1 oz., turpentine 2 oz., spirit of camphor 2 oz., laudanum ½ oz., olive oil 6 oz.

Purgative.—Linseed oil (raw) 1 to 1½ pints. Or, powdered aloes 6 drachms, ginger powdered 2 drachms; made into a ball with meal and treacle.

Tonic.—Sulphate of iron 1½ drachms, sulphate of quinine 20 grs., sulphuric acid dilute 2 drs, water 10 oz. Give morning and night.

CATTLE.

Breeds.

Shorthorns.—Includes the Holderness and Teeswater or Durham breeds. The most cosmopolitan of all animals of the cow kind. Best variety for general purposes, as suit a wide range of localities, and cross well with nearly all local breeds, improving them in so doing. The improved pedigree strains are seldom good milkers, having generally been bred for beef, but ordinary kinds make good dairy cows, and both pedigreed and unpedigreed are being much improved in this respect. The frame is a parallelogram with meat evenly distributed over it; skin soft and mellow; colour, red or white, or these combined into roan, never black; tail hangs square; ribs full; horns small and neat, and not black-tipped, with short downward curl and creamy-white colour; prominent eyes; back straight and very wide between the hook-bones (*ilia*). A well-developed connective tissue gives the soft mellow feeling to the skin. Two principal beef families—Bates and Booth.

Longhorns or *Craven Breed.*—The largest British breed of cattle. Have long down-curving horns, sometimes touching the cheek or jaw, and from which they take their name. Deep red, roan, and dun colours, pied and brindled, with white streak along back. Straight back, long frame, hips broad in cows, fairly good milkers. Bakewell's favourite breed; crossed well with other breeds. Occupies a limited area in the Craven district in Yorkshire, and in Derby, Leicester, and Warwick. This breed is rapidly dying out, and the herd book and society have been formally wound up.

Herefords.—Dark red or roan colour, with white stripe along spine; white face, belly, and udder, and white tip to tail; red spot at eyes; muzzle flesh-coloured; white legs up to knees. Middle-horned breed; great beef-producers, but deficient in internal fat; cross well with other breeds. Calves usually run with dams. Not a good dairy breed; good working oxen; very hardy, grazing out the whole year. Found to largest extent in Hereford, Monmouth, and part of Gloucester. Widely distributed in America. "Smoky-faced Montgomerys" are a local variety.

Devons.—Medium-sized breed; fine dark-red colour, but udder or scrotum white, and white tip to tail; hardy constitution, and have been long used in native district for draught purposes; have large wide horns; good fatteners, as frame cylindrical; yield of milk is small, but very rich in cream. Yellowish nose, full eye, fine horns, and "self-coloured," are points required by breeders. Met with in Devonshire, South Hams, and Somerset. There are two varieties—the *North Devons*, and the *South Devons* or *Hams*. The latter are larger, coarser, and not so deeply coloured as the former, and have greater milking power; the former are the special type of the elevated region of northern Devonshire. In Somersetshire the North Devons are becoming differentiated into another distinct type—larger and coarser, with a tendency to developing drooping horns. There are separate herd books for the two varieties.

Sussex.—Bear a strong resemblance to the Devons, but are larger, stronger, and less proportionate, and of a darker red or plum colour and with white tail-tips; are most probably derived from same source. Long strong horns of irregular form. Have lengthy frames; defective at shoulders, as there is too much flesh laid on an unprofitable part. Yield good early meat on poor pastures, but are inferior milkers. Common in Kent, Surrey, and Sussex.

West Highlanders or *Kyloes.*—A large and very hardy race of cattle devoted to meat production, as milk small in quantity though of very rich quality. Black is the principal colour, though brown, brindled, grey, or dun, are common; covered with a very shaggy coat of thick glossy hair; very large horns, upright and wide-spreading, with black or red tips; shaggy-haired head; prominent piercing eyes. Body is massive and well fleshed, and carried on low, powerful limbs. Good meat-producers, but bullocks are three or four years in coming to maturity. Calves run with the dams. Is the principal breed of Argyle and the north-western parts of Scotland.

North Wales Black.—Includes the Anglesea Black, Carnarvons, and Welsh "Runts" or Cardigans. Wholly black is desired. Cows fairly good milkers. Have broad backs and good flanks and thighs. A tendency to a high rump, but this fault is being eliminated by selection. A medium-sized breed, with short legs, thick necks, thick short white horns, and silky coat of wavy hair. The bullocks are much appreciated throughout the Midlands as "Welsh Runts" (though "Runt" is a name often given to Welsh bullocks in general), and yield 50 to 60 imperial stones of meat at three to four years old.

South Wales Black.—Includes the Pembroke, Castle Martin Black, and Dewsland. Prevailing colour, black, but sometimes russet, chocolate, or brown-black appear; sometimes white markings appear on belly. Horns long, yellow, and black-tipped. Long straight hair. Good milkers.

Castle Martin White.—An old breed now being brought to the front by selection. Resemble the Pembrokes in everything but colour, which is nearly always white, or with black spots. Muzzles, eyes, ears, feet, and fetlocks should be black.

Glamorgans.—An old dairy breed being resuscitated. Colour, black, with white belly and white spine. Cows sometimes a deep brown or red. Tail-head is liable to be too high. Old Gloucester breed almost identical.

Shetlanders.—Not much larger than the calves of some breeds, and descended from the Norwegian race, being similar to those found in Iceland. Very hardy; good beefers; have abundant milk in comparison to size; rough shaggy coats of various colours—light, dark, and piebald. Though so small, will cross with Shorthorns, but are irregular in their points, though the best are quite shapely. Resemble the Kerries.

Orkney Cattle are distinguished from the above, but they are derived from the same source, have been crossed with them, and are similar in appearance and characteristics.

Red Polls.—A comparatively modern hornless breed, believed to be derived from crossing the old native Suffolk

Polls with imported Galloways. Colour, red, sometimes dun, with lighter coloured udders and white tail-tassels. Good beefers and excellent milkers: the old Suffolks are said to have yielded 6 and 8 gals. per day. Found in the Eastern Counties. The typical combined beef and dairy animal.

Aberdeen-Angus Polls.—The result of the amalgamation of two local breeds now merged into one—the "Angus" or "Doddie," and the "Buchan" or "Humlie." Black all over is the standard colour now, but sometimes used to come brindled red or pied white. Frame square, skin smooth, hornless, but tuft of hair on polls; hook-bones not too wide apart; flesh level and equal. Are hardy, and reach maturity early. Not a good dairy breed. Cross well with Shorthorn; form "Polled Scots" of Smithfield. Found principally in Aberdeen, Kincardine, and Forfar.

Galloways.—Black polled breed, sometimes red, brown, or dun. Similar in appearance to Polled Angus, but smaller, rougher in the coat (the hair being curly or woolly), and poll capped with knob on which is a rough tuft of hair. Head wide and short; ears set on rather back. Back is straight and legs short and strong. Not adapted for dairying purposes. Crosses well with the Shorthorns, the produce being a "blue-grey" much desired by feeders. Used to be sent in old times to fatten off in Norfolk and Suffolk, but since the introduction of the turnip are finished off at home. Found in Wigton, Kirkcudbright, and Dumfries.

Ayrshires.—Best general dairy breed. Subsist on inferior hill pasture, and are a hardy race; but do very well on rich soils, though sometimes tend to lose milking power and lay on fat. Are a medium-sized breed, and cross well with the Shorthorn bull—the progeny partaking of both the milking power of the dam and the fattening power of the sire. Are big-bellied, from being used to inferior pasture. Hind quarters broad and deep, fore quarters narrow and light—"wedge-shaped"—a good milking but bad fattening feature; udder very large, well forward under the belly and back behind, square, with flat-ended regular teats; well-developed "milk-veins;" horns wide apart, curved upwards and forwards. Colour brown, red, white, black, or these mixed in patches, but never roan, most common being red with white patches, but white animals are on the increase; black noses common. Of a lively and active disposition, but pay very well for fattening in native districts. Are met with in largest numbers in Ayrshire, Dumfries, Renfrew, and Lanark.

"Points" of an Ayrshire Cow.

1. *Head* short, forehead wide; nose fine between the muzzle and eyes; muzzle large; eyes full and lively; horns wide set on, inclining upwards 10

2. *Neck* moderately long, and straight from the head to the top of the shoulder, free from loose skin on the under side, fine at its junction with the head, and enlarging symmetrically towards the shoulders 5

3. *Fore quarters:* Shoulders sloping; withers fine; chest sufficiently broad and deep to ensure constitution; brisket and whole fore quarters light: the cow gradually increasing in depth and width backwards 5

4. *Back* short and straight; spine well defined, especially at the shoulders; ribs short and arched; body deep at the flanks 10

5. *Hind quarters* long, broad, and straight; hook-bones wide apart, and not overlaid with fat; thighs deep and broad (but thin of flesh on the inner thigh); tail long, slender, and set on level with the back 8

6. *Udder* capacious, and not fleshy, hinder part broad; the whole firmly attached to the body; the sole nearly level, and extending well forward; milk-veins well developed; teats from 2 to 2½ inches long, equal in thickness, and hanging perpendicularly; distance apart at the sides equal to one-third the length of the vessel, and across to one-half of the breadth (small teats considered objectionable) 33

7. *Legs* short in proportion to size; bones fine and joints firm 3

8. *Skin* soft and elastic, and covered with soft, close, woolly hair 5

9. *Colour*, red, of any shade, brown or white, or a mixture of these—each colour being distinctly defined; brindle or black and white is not in favour... 3

10. *Average live weight* in full milk, about 10½ cwts. ... 8

11. *General stylish appearance* and movement 10

Total 100

Jerseys.—Originally called Alderneys. Medium-sized and comparatively delicate, but celebrated for yielding milk very rich in butter and of a deep yellow tint. They are of a fawn or silver-grey colour, with sleek short hair, deer-like heads, and slender frames, and with black "points." The yellow tint is strong all over—on the horns, inside the ears, and on hide at root of the hairs. Native to the Channel Islands, but now kept largely throughout the southern half of England. The English Jersey is now of a distinct type and with a separate herd book. The Alderney as a special type is extinct; it was almost identical with the Jersey, but darker in colour.

"Points" of Jersey Cows and Heifers.

1. Registered pedigree		5
2. Head small, fine, and tapering...	Head 24	3
3. Cheek small, throat clean		4
4. Muzzle dark, encircled by light colour, with nostrils high and open...		4
5. Horns small, not thick at the base, crumpled, yellow, tipped with black		5
6. Ears small and thin, and of a deep orange colour within		5
7. Eye full and placid		3
8. Neck straight, fine, and lightly placed on the shoulders		3
9. Withers fine, shoulders flat and sloping, chest broad and deep		4
10. Barrel hooped, broad and deep, being well ribbed up		5
11. Back straight from the withers to the setting on of the tail		5
12. Back broad across the loins		3
13. Hips wide apart and fine in the bone, rump long, broad, and level		5
14. Tail fine, reaching the houghs, and hanging at right angles with the back		3
15. Hide thin and mellow, and covered with fine soft hair		4
16. Hide of a yellow colour		4
17. Legs short, straight, and fine, with small hoofs		3
18. Arms full and swelling above the knees		3
19. Hind quarters from the hough to point of rump, long, well apart, and well filled up		3
20. Hind legs squarely placed when viewed from behind, and not to cross or sweep in walking		3
21. Udder large, not fleshy, running well forward in line with the belly, and well up behind ...	Udder 14	5
22. Teats moderately large, yellow, of equal size, wide apart, and squarely placed		5
23. Milk-veins about the udder and abdomen prominent		4
24. Growth		4
25. General appearance		5
Total		100

Guernseys.—Allied to the Jerseys, but larger, longer in the body, and hardier animals; are nearly as good milkers and butter animals, and better flesh-formers. Prevailing colour is yellow, but are sometimes red and white, with flesh-coloured noses.

"Points" of a Guernsey Cow.

1. Head fine and long, muzzle expanded, eyes large, quiet and gentle expression	4
2. Horns yellow at base, curved, not coarse	3
3. Nose free from black markings	1
4. Throat clean, neck thin and rather long, not heavy at shoulders	7
5. Back level to setting on of tail, broad and level across loins and hips; rump long	10
6. Withers thin, thighs long and thin	4
7. Barrel long, well hooped, and deep at flank	10
8. Tail fine, reaching houghs, good switch	1
9. Legs short, arms full, fine below knee and hocks ...	2
10. Hide mellow and flexible to the touch, well and closely covered with fine hair. Yellow inside the ears, at the end of tail, and on skin generally	12
11. Fore udder large and extending forward, and not fleshy; udder full in form, and well up behind, with flat sole. Teats rather large, wide apart, and squarely placed	25
12. Milk-veins prominent, long, and tortuous	6
13. Escutcheon wide on thighs, high and broad, with thigh oval	5
14. Size, general appearance, and apparent constitution	10
Total	100

Kerries.—The only distinct breed of cattle peculiar to Ireland. A very small and hardy race, yielding an astonishing quantity of milk—devoted mostly to butter-making. Usual colour is black, with white streaks along the belly and udder, but they are sometimes black and white, also brown or red; skin soft and mellow and orange-coloured; horns wide and fine, with the black points turned up. Are allied to, or may have been crossed with, the Breton cattle. Found in the hilly districts of Ireland—Kerry, Clare, Galway, Mayo, and Donegal on the west side, and Antrim, Down, and Wicklow on the east side. "Dexters" are a heavier variety, with shorter legs, more compact body, and less milky looking.

"Points" of the Kerry Cow.

Colour, black (a little white on udder not being a disqualification).

1. Horns thin from base, tapering to fine point at top. "Cocked," or turning right upwards in a line with face, curving inwards, and gracefully turned back at top. Ivory white tipped with jet black, smooth and hard 15

2. Head and neck: Head small, lean, and tapering to a black muzzle. Large, prominent, expressive eye. Neat, thin ear, and clean face, cheek, and throat (10). Neck rather long and fine (5) 15

3. Body: Shoulders fine, thin, and sloping (5). Hips and quarters long (5). Back straight, with spine terminating prominently (5) in a high tail, which should be long (bone reaching hough, at least), thin, with flag at end (5). Ribs deep at heart, though rather flat (5). Chest deep but narrow (5) 30

4. Udder moderately-sized, not fleshy, well formed, with good fore udder, and well-developed milk-vessels, good escutcheon, skin being thin, elastic, and abundant; equally divided quarters; well-shaped teats of equal size, and well separated 10

5. Limbs rather long, light-boned, clean cut, and muscular, with the sinews standing out, and small, sound, hard hoofs; fore legs straight and rather close, hind legs well under body, houghs well hooked and chiselled out 10

6. Hide and Hair: Skin thin, soft, yellow, and loose, "handling well," and coming up freely from ribs and "pins" (like a dog's neck) (5). Hair short, thick, fine, and wiry (in short, horse hair) (5) 10

7. Movements, character, and general appearance: Quick, active movements, deer-like expression and pose; picturesque appearance 10

Total 100

"Points" of the Dexter Kerry Cow.

Colour, black or red (a little white no disqualification).	
1. Horns: Kerry horns	15
2. Head and neck: Head rather larger than the Kerry, short, with broad forehead, and larger muzzle, mouth, and ear, and full soft eye (10). Neck shorter and thicker than the Kerry (5)	15
3. Body shorter, broader, and more compact than the Kerry. Shoulders flat, sloping, and well filled in behind (5). Hips wide, and quarters thick (5). Back flat, level, and wide across loins (5). Barrel deep, well rounded and ribbed up (5). Chest wide (5). Tail smooth and set on like a Shorthorn, but with flag at end (5)	30
4. Udder larger and coarser than the Kerry, of correct shape, and showing good milking developments	10
5. Limbs shorter, thicker, with coarser bone and larger joints and hoofs than the Kerry, well shaped, and set wide apart	10
6. Hide and Hair: Skin rather thicker than the Kerry, but soft and mellow, with good "touch," and yellow tinge (5). Hair soft and silky, showing a beautiful feather in the season	10
7. Size and general character: Not so tall as the Kerry, more thick-set and dwarf-like, but symmetrical, slower in movements, and more domestic in appearance	10
Total	100

There was at one time a native breed of Longhorns in Ireland, another Middle-horned kind, and also a polled breed called "Moylès;" but these have mostly now become mixed up with others, and the largest proportion of the cattle now consists of various broken breeds and crosses in which Shorthorn and Ayrshire strains predominate.

Wild White Cattle (Bos primigenius or Urus).—There were about a dozen herds of these in various parts of the country at the beginning of the century, but only some five now remain—the Wild Cattle of Chillingham, of Cadzow (Hamilton), the semi-domesticated herd at Vaynol Park, Bangor (transferred from Kilmory, Argyleshire, in 1886), the long-horned herd at Chartley (Staffordshire), and the polled herd at Somerford (Cheshire). Descendants of the original wild cattle of Britain and Western Europe, which had a common origin with some of our domestic breeds. Were extinct in Britain in the Roman period, and re-introduced by the Norse and other invaders. Medium-sized; of a white or cream colour; the muzzle, eyebrows, inside of ear and one-third of outside, the feet, and the tip of the tail are black or brown; the horns white with black tips. The occasional appearance of a white animal with black points among our domesticated breeds seems to show a common origin or connection with these wild varieties. Professor McKenny Hughes, however, considers that all our British breeds are derived from the *Bos longifrons*, or small "Celtic ox"—which was about the size of the Kerry—crossed with Roman cattle, and in mediæval times crossed again with animals from the Low Countries, and differentiated into the existing breeds during the succeeding centuries as the country became more settled. The Roman cattle, he considers, "must have been in form not unlike the modern Ayrshire." Cross readily with the Shorthorn. The average dead weight of the Chillingham cattle over 27 years has been—For bulls, 560 lbs.; cows, 420 lbs.; steers, 570 lbs.

Names of Cattle.

Male.

At birth: Bull calf; bullock calf if castrated.
1st year. Year-old bull; stott (castrated).
2nd year: Two-year-old bull; stott, steer, ox, or bullock.
3rd year: Three-year-old bull; stott, steer, ox, or bullock.

Female.

At birth: Quey calf, heifer calf, or cow calf.
1st year: Year-old quey or heifer.
2nd year: Two-year-old quey or heifer,
3rd year. Three-year-old quey or heifer: becomes a cow on bearing a calf.

"Stott" is sometimes applied to a bull of any age, and sometimes to an ox or steer after the fourth year. "Segg" is applied to a bull castrated after service.

"Stirk" is limited to males and females under two years in Scotland, while it is usually applied to females only in England, the males being "steers."

"Heifer" is almost universally applied in England to a young cow in calf, but in some places, especially in Scotland, it is limited to speyed animals.

A cow after being served with bull should be an "in calver." If she proves barren, is "eild" or "farrow;" when she stops yielding milk, is "yeld" or "dry." When a bull and quey calf are dropped at one birth, the latter is generally a "free-martin"—that is, barren.

A "six-quarter-year-old" is an animal of either sex eighteen months old.

Synopsis of Breeds of Cattle.

(Partly compiled from the results of the Smithfield Club and the British Dairy Farmers' Association over 4 years.)

Breed.	Prevailing Colour.	Horns. Large.	Horns. Medium.	Horns. Polled.	Weight of Bullock, 2 yrs.	Daily Gain in Lbs.	Weight of Fat Cow, 4 yrs.	Weight of Cow in Milk.	Dairy Breeds.	Annual Milk Yield.	Butter Yield per Diem.
					Lbs.		Lbs.	Lbs.		Lbs.	Lb.
Shorthorn	Red, white, roan ...	...	×	...	1,415	1·93	1,970	1,350	×	8,500	1·25
Hereford	Dark red ; white face	×	...	...	1,350	1·85	1,780	...	...	...	...
Devon	Red	×	...	...	1,100	1·50	1,530	...	×	...	...
Sussex	Plum-red	×	...	...	1,430	1·95	1,910	...	...	...	...
Red Poll	Red	...	...	×	1,165	1·59	1,740	1,100	×	7,000	1·00
Aberdeen-Angus	Black	...	...	×	1,400	1·91	1,720	...	...	...	...
Highland... ...	Black	×	...	...	1,030	1·41	1,470	...	...	...	...
Galloway ...	Black	...	...	×	1,160	1·58	1,560	...	...	...	...
Ayrshire	Red and white ...	×	...	...	1,150	1·57	1,680	1,100	×	7,500	1·00
Shetland	Piebald	...	×	...	...	...	...	...	...	...	...
Welsh	Black	×	...	...	1,290	1·76	1,690	...	×	...	...
Jersey	Fawn	...	×	...	...	...	...	830	×	6,000	1·25
Guernsey ...	Yellow	...	×	...	...	...	...	1,100	×	6,000	1·25
Kerry	Black	×	...	...	860	1·17	...	700	×	4,500	0·75
Dexter Kerry ...	Black	×	...	...	800	1·09	1,030	700	×	4,500	0·75
Cross-bred ...	Various	×	×	×	1,410	1·93	...	...	×	...	...

Breeding.

Cattle are bred for beef-producing or milking purposes, or both combined. There is little power inherent in any breed of cattle by reason of which they are specially good milkers or beefers, or the reverse. but from a long course of artificial selection specialities in these respects have been developed. If anyone, however, chooses to be at the trouble and expense, they could convert any one of the beef-producing breeds into one suitable for dairy purposes, and *vice versa*, provided always that soil and climate were suitable, and that they keep on selecting long enough. Cows are usually bred from at 3 years old, but may be at 2 to 2½ years without any bad results. A cow comes in season every 14 to 21 days. They must not be allowed to get too fat before breeding commences, as they are liable to be barren, and for this reason it is sometimes advisable to put early to the bull. High-bred cattle are especially subject to barrenness. As one bull will be the sire of many animals, great care must be exercised in his selection. It is the custom in some parts where the constitutional vigour of a certain strain of cattle has become deteriorated, to cross the virgin heifers with a bull of a different breed, and more especially with a Shorthorn bull. The fœtus transmits some of the vigour of the sire to its dam, and this beneficially affects *future* calves without interfering with their pureness of blood. Average period of gestation is 40 weeks, but if exceeding the ordinary time there is a greater probability of male produce. Approaching parturition is shown by the enlargement and firmness of the udder; the thin fluid which may be drawn from the teats; the loosening or "slipping" of the hinder parts—relaxation of the pelvic ligaments; and the restlessness of the animal. The cause of abortion is obscure, but evidence seems to point to the germ theory as a feasible explanation, and careful handling and the use of disinfectants are advised.

Rearing.

As soon as a calf is dropped the cow should be milked, and some of this milk (colostrum or "beastings") given to the calf. This acts as a gentle purgative to clear the *meconium* out of its intestines; and if there happens to be none at hand some medicine should be given, care being taken not to overdo it. Should be fed three times a day, getting 6 to 8 quarts of new milk daily at first, but which is to be gradually replaced by skimmed milk, and linseed and barley meal porridge, and even whey towards weaning time; buttermilk is very good for the purpose. Some of the "calf meals" in the market are very good substitutes for milk: cotton cake is to be avoided. Weaned at 4 to 6 months old. Four or five calves may be easily reared on one cow. Bulls may be castrated at from 2 to 3 weeks old. Condimental food is sometimes of great use if not overdone; but no animal should be too much coddled up in the house, as it is apt to fall off in condition when put out to graze. Sucking the mother is an expensive and wasteful plan where people to milk can be got. Young animals intended for breeding must get exercise, but others which are only for beef may be reared and finished off entirely under cover.

A fairly good calf of the larger breeds weighs 60 lbs. at birth.

Feeding.

Cattle grazing outside ought to have as much shelter as possible from hedges and sheds, as comfort and quietness are essential to either fattening or milking animals, and while indoors to be kept from draughts. Great regularity must be observed in feeding, and food to be given at least three times a day, but oftener if possible. Any change in food must be made very gradually, otherwise disorders are apt to be engendered; milk cows especially are very sensitive in this respect, and show it in the decrease of milk at first, though the flow will return if the change is to better food. Oilcake for fattening, and bean meal and Indian meal (or crushed oats) mixed for milking cattle, have established a reputation for themselves above all other feeding stuffs. Cotton cake (decorticated) is so rich and nitrogenous that it should only be used in limited quantities. Warm and slushy food is desirable for cows in milk. Special richness of milk in any of the constituents separately cannot be induced by any special feeding, but the continuous use of rich food stimulates a cow to yield the most and richest milk she is constitutionally capable of giving. Brewery by-products are found to lower the percentage of fat very considerably. Salt must be allowed at the daily rate of 2 to 4 oz. per head, but if hay salted before, none will be necessary.

The cow gets a "nick" in her horn for every calf she bears; but good feeding and shelter tend to counteract the strain of pregnancy on the system, and the nick or ring may not show distinctly.

Cattle in health when on grass will keep along with the others; will stretch themselves on being quietly raised; will have their hair covered with lick-marks and not standing on end or "staring;" will feed and chew the cud; will not be thin from want of food, or distended from accumulation of gas or from stoppage; and have no cough or other peculiarity of condition or manner.

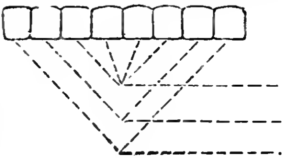
Dental Formula for a Full Mouth.

P.M.	T.M.	INC.	T.M.	P.M.		
$\frac{3}{3}$	$\frac{3}{3}$	$\frac{0}{4} \mid \frac{0}{4}$	$\frac{3}{3}$	$\frac{3}{3}$	=	32

The corner incisors are sometimes looked upon as canine teeth, but are shed like the others.

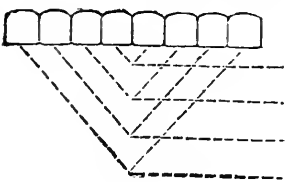
Teeth as Indicative of Age.

Appearance of Temporary Incisors.



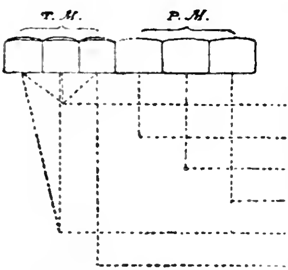
At birth.
12 to 14 days.
3 to 4 weeks.

Appearance of Permanent Incisors.



1 year 10 months.
2 years 6 ,,
3 ,,
3 ,, 6 ,,

Appearance of Molars.



3 to 4 weeks.
6 months.
15 ,,
2 years.
2 ,, to 2½ years.
2½ ,, ,, 3 ,,

The ox has no incisors in the upper jaw.

Regulations of the Smithfield Club regarding Dentition.

Cattle having their central permanent incisors cut will be considered as exceeding one year and six months.

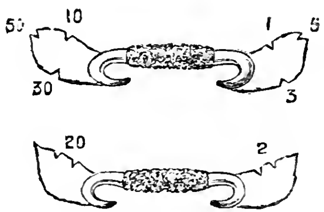
Cattle having their central permanent incisors fully up will be considered as exceeding one year and nine months.

Cattle having their second pair of permanent incisors fully up will be considered as exceeding two years and three months.

Cattle having their third pair of permanent incisors cut will be considered as exceeding two years and eight months.

Cattle having their fourth pair (corner) permanent incisors fully up and their anterior molar showing signs of wear will be considered as exceeding three years.

Ear-Marking Cattle for Purposes of Registration.



By adding together the figures represented by each "nick," any number up to 99 is obtained, excepting 2 and 7 or 20 and 70, but these are formed by extra notches, as shown in the lower diagram. A very good method is to have a metal button with a number on it, fastened through a hole in the ear; it sometimes gets torn out, however.

Calving Table.

Bulled		Will Calve		Bulled		Will Calve	
January	1	October	13	July	1	April	12
,,	7	,,	19	,,	7	,,	18
,,	14	,,	26	,,	14	,,	25
,,	21	November	2	,,	21	May	2
,,	28	,,	9	,,	28	,,	9
,,	31	,,	12	,,	31	,,	12
February	1	,,	13	August	1	,,	13
,,	7	,,	19	,,	7	,,	19
,,	14	,,	26	,,	14	,,	26
,,	21	December	3	,,	21	June	2
,,	28	,,	10	,,	28	,,	9
March	1	,,	11	,,	31	,,	12
,,	7	,,	17	September	1	,,	13
,,	14	,,	24	,,	7	,,	19
,,	21	,,	31	,,	14	,,	26
,,	28	January	7	,,	21	July	3
,,	31	,,	10	,,	28	,,	10
April	1	,,	11	,,	30	,,	12
,,	7	,,	17	October	1	,,	13
,,	14	,,	24	,,	7	,,	19
,,	21	,,	31	,,	14	,,	26
,,	28	February	7	,,	21	August	2
,,	30	,,	9	,,	28	,,	9
May	1	,,	10	,,	31	,,	12
,,	7	,,	16	November	1	,,	13
,,	14	,,	23	,,	7	,,	19
,,	21	March	2	,,	14	,,	26
,,	28	,,	9	,,	21	September	2
,,	31	,,	12	,,	28	,,	9
June	1	,,	13	,,	30	,,	11
,,	7	,,	19	December	1	,,	12
,,	14	,,	26	,,	7	,,	18
,,	21	April	2	,,	14	,,	25
,,	28	,,	9	,,	21	October	2
,,	30	,,	11	,,	28	,,	9

Measuring of Cattle for Weight.

Each cubic foot of living carcase is equal to 3 stones Imperial, and therefore 576 cubic inches = 1 stone, so that the solid contents of the body $\left(\text{length} \times (\text{diameter}^2 \times \cdot 7854)\right)$ in cub. in. and $\div$ 576 gives the weight in Imperial stones.

The length of an animal is taken straight along the back from the square of the shoulder to the square of the buttock, and the girth immediately behind the shoulder.

Rule I.—Girth^2 $\times$ 5 lengths $\div$ 21 gives weight in Imperial stones. Measure in feet.

Rule II.—Girth^2 $\times$ length $\div$ 7344. Measure in inches.

Rule III.—Girth^2 $\times$ length $\times$ ·07958 $\div$ 576. Measure in inches.

Rule IV.—Girth^2 $\times$ length $\times$ ·00013816. Measure in inches.

Rule V.—Girth $\times$ length $\times$ 23 $\div$ 14. Measure in feet (23 is the number of lbs. to each superficial foot of exterior of body—within limits).

Rule VI. — Girth^2 $\times$ length $\times$ one of the following decimals: strike off to the right as many points as are contained in the decimal; result is Imperial stones. Measure in feet.

Decimals Applicable to Beasts of various Classes in Rule VI.

Moderately fat beast	·23
Fat	·24—·25
Prime fat	·26
Very fat	·27

Live stock are now, however, generally weighed to find out their saleable value, and this is a much more satisfactory system.

Six-fourteenths ($\frac{3}{7}$) of live weight of butchers' beasts is offal, that is, every Imperial stone of 14 lbs. of live weight will yield a Smithfield stone of 8 lbs. of dead weight. On this basis the following table is calculated :—

Table of Proportion of Live and Dead Weight of Fat Cattle.

(In Imperial stones of 14 lbs.)

Live Weight.	=	Dead Weight.	Live Weight.	=	Dead Weight.	Live Weight.	=	Dead Weight.
50		28·57	75		42·85	100		57·14
51		29·14	76		43·42	101		57·71
52		29·71	77		44·00	102		58·28
53		30·28	78		44·57	103		58·85
54		30·85	79		45·14	104		59·42
55		31·42	80		45·71	105		60·00
56		32·00	81		46·28	106		60·57
57		32·57	82		46·85	107		61·14
58		33·14	83		47·42	108		61·71
59		33·71	84		48·00	109		62·28
60		34·28	85		48·57	110		62·85
61		34·85	86		49·14	111		63·42
62		35·42	87		49·71	112		64·00
63		36·00	88		50·28	113		64·57
64		36·57	89		50·85	114		65 14
65		37·14	90		51·42	115		65·71
66		37·71	91		52·00	116		66·28
67		38·28	92		52·57	117		66.85
68		38·85	93		53·14	118		67·42
69		39·42	94		53·71	119		68·00
70		40·00	95		54·28	120		68·57
71		40·57	96		54·85	121		69·14
72		41·14	97		55·42	122		69·71
73		41·71	98		56·00	123		70·28
74		42·28	99		56·57	124		70·85

Proportion of Beef to the Live Weight of Oxen.

Live Weight in Stones of 14 lbs. Avoirdupois.	Per Cent. of Beef, according to "Condition" of Animal.			
		Class 1.	Class 2.	Class 3.
Under 180	Heifers	70 to 72	66 to 69	— —
„ 180	Steers	69 „ 71	66 „ 69	— —
From 120 to 150	Steers	66 „ 68	63 „ 65	63 to 66
100 „ 120	Heifers	66 „ 68	63 „ 65	63 „ 66
100 „ 120	Steers	62 „ 65	60 „ 62	57 „ 62
90 „ 100	Heifers	62 „ 65	60 „ 62	57 „ 62
90 „ 100	Steers	57 „ 61	54 „ 59	51 „ 56
80 „ 90	Heifers	57 „ 61	54 „ 59	51 „ 56
80 „ 90	Steers	53 „ 56	50 „ 53	48 „ 50
70 „ 80	Heifers	53 „ 56	50 „ 53	48 „ 50
Under 70		— —	— —	45 „ 47

Live Weights of Cattle at the Smithfield Club Show.

(Average of four years.)

Breeds.	Steers under 2 Years.	Steers under 3 Years.	Steers over 3 Years.	Heifers under 3 Years.	Cows over 3 Years.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Devon	1,100	1,530	1,800	1,300	1,530
Hereford	1,350	1,820	2,115	1,595	1,740
Shorthorn ...	1,415	1,835	2,250	1,735	1,910
Sussex	1,430	1,850	2,040	1,720	1,920
Red Poll	1,165	1,590	1,855	1,470	1,745
Aberdeen-Angus	1,400	1,835	2,170	1,705	1,820
Galloway	1,160	1,665	1,990	1,455	1,560
Welsh	1,290	1,695	1,985	1,700	1,690
Highland	—	1,455	1,645	1,290	1,410
Kerry	860	980	1,165	935	—
Dexter Kerry ...	800	1,010	—	950	1,035
Cross-Bred ..	1,410	1,810	2,045	1,560	—

Proportion of the various Parts of Bullocks, Live and Dead.

Weight Alive.	Lean.	Half Fat.	Fat.	Weights in Pounds.
	%	%	%	
Four quarters, with kidneys and kidney fat ...	47·4	55·7	60·3	560 — 900
Fat of omentum and intestines	2·3	2·9	4·5	27 — 67
Head	2·8	2·7	2·6	33 — 42
Tongue and gullet ...	0·6	0·6	0·5	7 — 9
Heart	0·4	0·5	0·5	6 — 7·5
Lungs and windpipe ...	0·7	0·7	0·6	9 — 10
Liver and gall-bladder...	1·5	1·3	1·3	19 — 20
Diaphragm	0·5	0·5	0·4	6 — 7·5
Spleen	0·2	0·2	0·2	3 — 3·5
Stomach, without contents	4·5	3·0	2·7	30 — 56
Intestines, ,,	2·0	1·5	1·4	20 — 25
Contents of stomach and intestines	18·0	15·0	12·0	180 — 220
Legs to gambrel joint ...	1·9	1·7	1·6	24 — 28
Skin and horns	8·4	7·4	6·0	90 — 100
Blood	4·7	4·2	3·9	42 — 56
Loss—shrinkage	4·1	2·1	1·4	21 — 50
	100·0	100·0	100·0	
Carcase.				
Dressed weight, including fat.				
Flesh, without fat & bones	36·0	38·0	35·0	428 — 522
Bones	7·4	7·3	7·1	87 — 166
Fat in flesh	2·0	7·9	14·7	23 — 220
Fat on kidneys	2·0	2·5	3·5	22 — 52
Fat on omasum and intestines	2·3	2·9	4·5	27 — 67
	49·7	58·6	64·8	587 — 967

The hide alone in the case of 2-year old steers shown at Smithfield averaged one year about 6·25 % of the live weight, and 6·6 % in the case of the 3-year olds; the weights ranging from 70 to 112 lbs., with an average of 93 lbs. (calculated from figures supplied by butchers). Sometimes, though rarely, the weight of the hide and horns reaches 10 stones, and that of the tallow 20 stones. The total weight of offal, according to the foregoing table, ranges from about 25 stones to 50 stones, and in rare instances to nearly 60 stones; but as the minimum of every item of offal is never—and the maximum very rarely—to be met with in any case, the variation of the weight of offal will, perhaps, be from 30 to 55 stones—a difference of 25 stones between the offal of the smallest and leanest and that of the largest and fattest animals.

Live Weight Gain in Lbs. per Day since Birth of Cattle at the Smithfield Club Show.

(Average of 4 years.)

Breed.	Steers under 2 Years.	Steers under 3 Years.	Steers over 3 Years.	Heifers under 3 Years.
	Lb.	Lb.	Lb.	Lb.
Devon	1·50	1·39	1·23	1·18
Hereford	1·85	1·66	1·42	1·45
Shorthorn	1·93	1·67	1·53	1·58
Sussex	1·95	1·68	1·38	1·57
Red Poll	1·59	1·45	1·27	1·34
Aberdeen-Angus ...	1·91	1·67	1·48	1·55
Galloway	1·58	1·52	1·36	1·32
Welsh	1·76	1·54	1·35	1·55
Highland	—	1·33	1·12	1·17
Kerry	1·17	0·89	0·79	0·85
Dexter Kerry	1·09	0·92	—	0·86
Cross-Bred	1·93	1·65	1·40	1·42

Common Diseases.

Hoose or *Husk.*—Due to threadworms (*Strongylus micrurus*) in the windpipe, causing a husky cough. Attacks calves and yearlings in autumn when kept too long on some pastures, especially damp meadows or flooded land. A change of ground and extensive run generally cures it; or give two table-spoonfuls of turpentine in a little linseed oil, or inhalations either of sulphur fumes or chlorine gas.

Pleuro-Pneumonia Contagiosa.—A contagious disease affecting the lungs of cattle, and having an incubative stage of from two weeks to three months. In the second stage the most prominent symptom is a peculiar cough, with quickened breathing, dulness, and loss of appetite. No curative treatment can be adopted, as it is nearly always fatal. Is an imported disease, and only to be kept down by preventing the bringing in of live stock from infected districts abroad. Police must be notified and the animals slaughtered. A place is not declared "free" until 56 days after the cessation of the disease.

Tuberculosis.—The same as consumption in the human subject. Due to the presence of the *Bacillus tuberculosis* in the lungs and other organs, and may be aggravated by bad treatment. Infectious, and, through predisposition or generalised tuberculosis in the mother, may be hereditary. Symptoms are a wasting of flesh, cough, and offensive excreta. Prevent by breeding from healthy animals, by removal of infected individuals after testing with Koch's "tuberculin," and by having thorough ventilation and sanitation. Fatten off for butcher in early stages. Most common in cows after seven years old.

Tympanitis or *Hoven.*—Impaction of the rumen with undigested food, which ferments and yields gas, causing great distention. Puncture the rumen with trocar on the left loin, midway between the last rib, the spine of the ilium, and the transverse processes of the lumbar vertebræ. Give carbonate of ammonia in water if not an urgent case. Use of probang will also give instant relief. Very often caused by a quick change on to succulent food, such as clover. If rumen engorged, then flank must be opened and food removed by hand. Give purgative on recovery.

White Scour.—Diarrhœa in calves. Caused by crowding together, and surroundings not kept clean and sweet. Sometimes from the cows being fed on very rich food, their milk causing scouring. Keep clean and give sparing milk diet, but use meals. The best medicine is common rennet—give a table-spoonful after the calf has taken its milk—or some calf "cordial" (as below).

Red Water.—Evinced by the red or dark colour of the urine, accompanied by diarrhœa and then constipation. Most common on moorland soils (hence called "muir-ill") and wet subsoils, and in cows 10 to 15 days after calving. Prevent by draining and liming, and limiting supply of turnips. Give purgative, followed by oil of turpentine 1½ oz., twice daily, with nourishing food.

Blackquarter.—A variety of anthrax disease which attacks young cattle under 18 months old, and believed to be due to the presence in the blood of the *Bacillus anthracis.* Animal is struck suddenly, the limbs or back swelling, and giving a rustling or crackling sound under pressure. No treatment of much use, as it is usually very quick and fatal. Preventives are setoning through dewlap, periodical doses of salines, and no sudden changes in food. Moderate use of linseed cake in preference to cotton cake or any kind of cotton meal. It is a common disease on some farms, and unknown on many others.

Mammitis, Garget.—Inflammation of the udder. Induced by "hefting," or exposure to cold and wet. One or more quarters become hot and red, and afterwards engorged with diseased milk or matter; sometimes the quarter is hard and swelled—catarrh of the udder or "weed." It may end in suppuration and sloughing of the part. Keep the udder empty; foment with warm water; iodine ointment, or a liniment composed of oil of turpentine 1 oz. and tincture of camphor 3 oz., well rubbed in, is the most ordinary treatment; give Epsom salts and treacle internally. Most common on damp, low-lying land.

Milk Fever or *Parturient Apoplexy.*—Cows in high condition at calving, and especially after the third calf, are liable to it. Reduce the keep if too plethoric, and give a dose of 1 lb. Epsom salts, 2 lbs. treacle, and 1 oz. ginger before parturition; milk the cow a little if udder very full. First symptoms (within three days after calving) are loss of milk and restlessness: may afterwards become quite frenzied. Apply cold water to the head; stimulate the spine with ammonia liniment, and keep the animal bolstered up in a natural position. Give chloral hydrate 2 oz., potass. bromide 1 oz., tinct. of aconite 15 minims, all in water; then every 4 hours after, chloral hydrate 6 drs., tinct. of aconite 1 dr., all in a little treacle and water. Stop as soon as better. Allow calf to suck if possible. The "Red Drenches" sold by chemists are good preventives given before calving.

Foot-and-Mouth Disease or *Murrain.*—An inflammatory eruptive fever, characterised by the appearance of vesicles on mouth, tongue, and elsewhere. First prominent symptom is salivation and champing of mouth, but not always manifested. Very contagious. Not very fatal if properly taken care of. No special cure, as the disease must run its course. Give a mild purge, and use lotion of sulphate of zinc—2 drachms to 1 pint water—for raw exterior surfaces. The milk yielded by affected cows is extraordinarily rich in butter fats, and quite fit for use if the udder is not diseased. Salicylic acid has lately been found to be a specific, given internally: $\frac{1}{4}$ oz. given in drink. Disinfect with carbolic acid in water, 1 to 20. Police must be notified.

Inversion of the Uterus.—Cows sometimes, after calving, continue pressing until the womb itself is squeezed out Carefully clean and wash with warm milk, then anoint with carbolic oil (1 to 7), squeeze with shut fist into its proper place, and put on the truss or "breeches." Let the cow stand with hinder end elevated.

Ringworm.—Loss of hair in circular patches, leaving a dry and scaly eruption on the face, neck, back, and root of tail. Caused by a parasitic fungus *(Trichophyton tonsurans)* growing in the skin. Wash parts with soft soap and apply mercurial or iodine ointment.

Warbles.—The maggots of the Warble or Bot-Fly *(Œstrus bovis)*—the eggs of which are laid on the backs of the cattle in July and August—pierce the skin and live in the tissue below during winter, and cause the unsightly lumps on the backs of the cattle in spring-time. An air-hole may be seen in the middle of each lump, and when "ripe" the maggot may be squeezed out. The attack may be prevented by applications of train oil, or with sulphur and spirit of tar mixed with it. during the fly-time, and applications of McDougal's "smear" in spring will kill those already in the hides. These applications will also prevent annoyance from the Cleg *(Tabanus bovinus)* and other flies in summer-time.

Recipes.

Calf Diarrhœa Cordial.—Prepared chalk 2 oz., powdered catechu 1 oz., powdered ginger $\frac{1}{2}$ oz., powdered opium 1 drachm, peppermint water 1 pint. Dose, $\frac{1}{2}$ oz.

Drench for a Cold, &c.—Powdered digitalis 1 dr., liquid acetate of ammonia 3 oz., sweet spirits of nitre 2 oz., belladonna extract 2 drs. Given in a pint of water.

Mild Blister.—For udder, &c. Oil of turpentine 8 oz., liquid ammonia 3 oz., soft soap 4 oz.; or, oil of turpentine 1 oz., tinct. of camphor 3 oz.

Purgative.—Epsom salts 16 oz., treacle 1 lb., ground ginger 1 oz. Given in a quart of warm water.

Tonic.—Powdered gentian $\frac{1}{2}$ oz., powdered ginger $\frac{1}{2}$ oz., carbonate of soda $\frac{1}{2}$ oz. Given in a pint of water twice daily.

Blackleg Preventive.—Potassium chlorate 1 dr., sodium sulphite ½ oz. Dose for a yearling.

Teat Dressing.—Carbolic acid 1 oz., glycerine 1 oz., linseed oil 10 oz.

SHEEP.

Long-woolled Breeds.

Leicester.—The most extensively distributed breed in Britain, and a general favourite. Comparatively large in size; head small and generally bare, face white, nose rather large, hornless, legs white. Neat frame, fine in the useless parts, good fleece of long soft wool, very firm mutton, and a great aptitude to fatten, but lay on too large a proportion of pure fatty tissue with little inside fat. Will cross with and improve almost all native breeds, being analogous to the Shorthorn in this respect. Wethers reach 25 lbs. per quarter at 15 months old in the Border variety, and over 20 lbs. in the Improved English or Bakewell's variety. The principal varieties are the Border Leicester, a larger white-faced sheep; the Yorkshire Leicester or Wensleydale; the Dishley or Bakewell's improved variety: the Teeswater, the largest of all, and of which the "Mugs" were a local type now almost extinct. Leicesters are the prevailing sheep of the lowland parts of Northumberland, Cleveland, southern half of Yorkshire, and on downs through the Midlands, and up into Cheshire and South Lancashire. In Ireland they have been successfully introduced into the northern half of Connaught, West Meath, Kildare, Tipperary, Cork, and Down. Wool oiled at shows.

Border Leicester.—Recognised as a distinct breed only since 1860. Head well set on, long, broad between the eyes; muzzle large, black; ear not too large; belly rather light; appears "leggy" when shorn: hair on head and legs white and hard—no streaks; wool long, soft, and in little "pirls." Weighs up to 25 lbs. per quarter. Bred mostly for the sake of the rams, which are used to cross, especially with the Cheviot, producing "Half-Breds," and with the Blackface, producing "Cross-Breds."

Yorkshire Leicester or *Wensleydale.*—A large, high-standing animal with characteristic blue colour in the skin of the face and ears, and sometimes over the whole body. Nose slightly arched. Sometimes called "Mashams" in South Yorks and Lincolnshire. Yield a large number of twin lambs. The favourite ram for crossing with Blackfaces in Scotland, producing "Cross-Breds." Wool open and "pirly" on the forehead, round the ears, and on belly, and downy on back of hind legs down to hoofs. Descended from the Teeswater, and the hardiest animal of the Leicester type.

Lincolns.—The foremost long-woolled breed, on account of the lustrous character and great weight of the fleece, which is broad in the staple, and which has reached 30 lbs. in some instances, ram hogg fleeces often averaging 14 and 15 lbs. each. The largest breed of sheep in the British Islands. The old breed was greatly improved by crossing with the New Leicester, to which type the Lincoln belongs. Faces and legs are always white. Wethers reach 30 lbs. per quarter. Restricted to Lincoln Heath and Wolds, and the adjoining parts of the country. Wool coloured with dark brown ochre at shows. Very free from foot-rot.

Cotswolds.—One of the largest breeds of sheep in Britain, and of the same type as the Leicesters. Majority have white faces and legs, the head covered with tuft of wool almost down to the muzzle, and hornless. Large handsome frames, great propensity to fatten, handle soft, but mutton rather coarse-grained. Cross well with the Southdown sheep. Wethers sometimes reach 30 lbs. per quarter. Wool long and fine, and staple curly; well woolled on belly; tendency to accumulate fat on back. Restricted to the Cotswold hills, and that neighbourhood.

Devon Long-Wool.—The improved form of the Devonshire or Bampton Notts: known generally as Devon sheep. White faces and legs, no horns, long fine wool, with tuft on forehead and woolled on the cheeks. Found in the valleys of Devon and Somerset. The *Devon South Hams* are a variety which resemble the Romney Marsh; had brown faces and legs, but improved by introduction of Leicester blood, and are in favour in the Vale of Honiton and the lower valleys in Cornwall. Coloured with brown ochre at shows.

Romney Marsh or *Kentish.*—A breed peculiar to the land reclaimed from the sea on the coast of Kent, but now spread over a large area of country. Related to the Cheviot, and somewhat larger than the Leicester. Has been improved of recent years by crossing with the Leicester, which reduced the size but raised the value. Wool long, of good combing quality, and very close. Faces and legs white, noses coal-black, no horns, but with small tuft of wool on heads. Lambs are usually fattened on the uplands. Hardy constitution and good fatteners.

Roscommon.—The principal native Irish breed, met with largely in Connaught. It has been developed by crossing a native variety with the Leicester, and is as large as the Cotswold or Lincoln, and somewhat ungainly in form. Fleece of long, heavy, silky wool, while the mutton is of fine quality.

There was an old breed of short-woolled sheep known as the *Cottagh*, peculiar to the hilly districts, especially of Ulster and Leinster. These resembled the Welsh sheep very much; had no horns, possessed of white faces and legs, and with coarse, hairy wool. They were at one time in great request in Dublin, but are mostly extinct, or the bulk of them now merged in various crosses of Leicesters, Southdowns, &c.

Short-woolled Breeds.

Sussex or *Southdown.*—Brown or grey-faced; rather small, but true form; very fine, close, curled wool, and finest mutton. No horns, but thick close wool between the ears; belly well defended with wool; short-legged. Have a greater proportion of meat to offal than many others, and more internal fat than Leicesters. Crosses well with Cotswold; reaches 22 lbs. per quarter; native to the chalk Downs of Sussex, but has spread over a large tract of south-eastern England, and improved many of the native breeds; not hardy enough, however, for wet or northern districts; but has been introduced into western Ireland. Coloured with brown ochre at shows.

Suffolk Downs.—Large heavy variety; head and legs clear of wool, and of a deep coal-black colour. Resemble the Hampshires, but finer head. Prevail in the Eastern Counties, and most probably have some of the blood of the old Norfolk sheep in them, crossed with the Southdown. Large proportion of twins. Coloured with yellow ochre at shows.

Oxford Downs.—A variety originated comparatively recently by using a half-bred Leicester and Cotswold ram with Hampshire Down ewes. The largest variety of the Down type: a lighter coloured brown face and narrower shoulder than the Hampshire Down. The wool is more open and loose than other Downs, with tuft on head. Lambs reach 70 to 90 lbs. dead weight at 12 to 15 months old. The principal breed found on the clays of the Midlands. Coloured with red, brown, or yellow ochre at shows.

Hampshire Down.—A result, most likely, of crossing the old original Wiltshire white-faced horned breed and the the "Berkshire Knot" with the Southdown. Have now almost black faces and legs, Roman noses, and no horns. Heavy-looking heads. A large but refined type of the Down sheep, lower set than the Shrops; weigh from 80 to 100 lbs. carcase at 8 to 14 months old. Found largely throughout the southern parts of England. Good crosser. Very liable to foot-rot on clay soils. Coloured with yellow ochre at shows.

Shropshire Down.—Dark-faced, without speckles; short dark ears; skin pink; head and cheeks covered with short wool; legs black; heavier than pure Southdown in both fleece and carcase, and mutton nearly as good. Resulted from crossing the original *Morfe Common* breed with Leicester, Cotswold, and lastly with Southdown. Probably also the *Cannock Heath* breed was one of the original progenitors. Are very hardy, comparatively easily acclimatised, and are the variety of Down sheep most suitable for Scotland, though the crosses are smaller than the Leicester cross. Ewes very prolific; rams in demand for crossing, owing to their more general adaptability. Coloured with yellow ochre at shows.

Somerset and Dorset Horned.—A hardy breed of medium-sized sheep found on uplands of Dorset and Somerset. White-faced and horned, the horns of the ram long and convoluted; tuft of wool on forehead, and pink skin at nose. Wool is of intermediate length and fineness. A little larger than the Southdown. Ewes are peculiarly forward, sometimes taking the ram as early as April, thus yielding fat lambs at Christmas, and often yielding two crops of lambs in one year. Crossed with the Southdowns. Varieties of this breed are found in Dean Forest, and on the Mendip Hills. Coloured with yellow ochre at shows.

Ryeland.—A small, compact sheep, found in the district of that name in Hereford, and in neighbouring localities. Short white wool, with small tuft of hair on forehead; white faces and no horns. Mutton delicate and juicy; 15 to 20 lbs. per quarter. Wool next in quality to Merino for carding purposes; known as Leominster wool or "Lemster ore." Does not cross satisfactorily with any other breed, but is one of the longest standing in England. Very restricted in numbers, though still appearing at shows, and being bred up again. Free from foot-rot.

Mountain Breeds.

Cheviots.—A middle-woolled breed with very white clean faces and legs, Roman noses, and no horns, but horns in ram not objected to if "clean;" nostrils black; full dark bright eye; cocked ears; shoulders high and sharp; wool close, fleece averaging 5 lbs. in weight; carcase 70 lbs. at $1\frac{1}{4}$ years old. Longer bodied than Blackfaces, but compact sheep now desired. Cross well with the Leicester, giving "Half-breds," or "White-faces," and also with Shropshire, but the latter cross is deficient in hardiness. Are of medium size; tails left long. Found on the lower grounds throughout the North of England, the Lowlands of Scotland, Aberdeen, and the North of Scotland.

Blackfaces.—A breed pre-eminently suitable for high upland pasturage, on account of its hardiness. Small-sized; long, open, coarse, and shaggy wool: faces and legs black or mottled—the white in patches and not diffused—all black preferred; black or blue spots on wool-bearing portion of skin objectionable: horns large and spiral; tails left long; mutton of very fine flavour—60 lbs. to the carcase. Are wintered mostly on the low grounds. Require a large range of pasture, as will not do with confinement. Blackfaces are a native and natural breed not due to crossing. Breed well with Leicesters, however, giving "Cross-breds" or "Grey-faces." Occupy the high ground in Northern England, and from Lanarkshire in Scotland on through the whole of the Highlands: various old names are *Heath*, *Linton*, *Short*, and *Forest* breeds.

Hardwicks.—A local breed peculiar to the hills of Cumberland and Westmoreland, said to be descended from sheep cast ashore from the wreck of a vessel of the Spanish Armada. Very hardy breed: males only sometimes horned, with long, coarse, open hairy wool, well covered on the poll and forehead; lambs have black heads and legs when dropped, but become gradually white by the third year. White hoofs. Show great sagacity in foreseeing the approach of snowstorms. Smaller than Cheviots, weighing 60 lbs. in carcase.

Limestone.—Good-sized white sheep, with large curled horns (ewes also horned), white faces, and fine quality of wool—7 lbs. to the fleece. Ewes sometimes weigh 25 lbs. a quarter, and rams 30 lbs. Suit the high-lying limestone hills in the central districts of North England, and said to live where the Blackfaces refuse to thrive.

Lonks.—The largest of the mountain breeds; yields excellent mutton, and as much as 8 lbs. of rather coarse wool. Black-faced and horned: much resembling the Blackface, but larger and coarser, though not so hardy. Occupy a restricted area in the hills in the west of Yorkshire and that neighbourhood.

Penistone.—Occupy a restricted area of heathy land, about 25 miles square, in the neighbourhood of the town of the same name. Faces and legs white; rams much larger than ewes, and with close projecting horns. Silky wool of medium length, averaging 4 to 5 lbs. per fleece. Wethers 16 lbs. per quarter. Feet large, limbs bony; the tail is singularly long and muscular.

Exmoors and *Dartmoors.*—The latter are a medium-sized hardy breed, with soft long wool and white faces and legs. Horns going out. Reach 15 lbs. per quarter: yield fine-flavoured mutton. Have great power of resisting wet. The *Exmoors* are the smaller of the two, and the males have slight beards like goats, and horned. Sometimes crossed with Leicester. Found on the mountainous parts of Devon and Cornwall, but usually fattened on the lower grounds.

Soft-woolled Welsh Mountain.—White-faced, with long fine soft wool; very hardy. Deer-like hind quarters; small-sized, and males only having horns, which are curved backwards like those of the goat; some hornless; weigh 10 lbs. per quarter; mutton very highly flavoured, and fine in the grain. Found in the Welsh valleys and in Anglesea.

Clun Forest.—Native to the Clun district, in Shropshire. Sometimes called the *Radnor Forest* or *Kerryhill* sheep. Bred from the old tan-face of that region crossed with Shrops and Longmynd. Faces speckled with fawn under-colour. Horns going out. Wool coarser than Shrops, especially at the breech. Tails left long. Wether mutton sold as "Welsh" in London, dressed with tuft of wool left on the tail; not too fat.

The Radnor or *Tan-Face.*—Is an improved variety of the Welsh mountain breeds; black hair on face and legs, with fleece of a black, brown, or grey colour. Rams horned. Crosses well with the Shropshires.

Shetland.—Little wild animals, very hardy and active. Have somewhat the appearance of goats, with backward curving horns; fleece of a black, brown, grey, or white colour, and much mixed with hair. On account of the hair, the wool, which is celebrated for its fineness and softness, is never clipped, but pulled off when it separates in summer. "Short-tailed" breed, and weigh only 9 lbs. per quarter.

SYNOPSIS OF BREEDS.

——	Average Weight of Wool per Fleece.	Average Weight of Wethers per Quarter.	Years Old when Killed.	Weight of Lambs under 12 Months: Smithfield.	Daily Gain of Lambs in Oz.	Horns. Both Sexes.	Horns. Rams only.	Horns. Horn-less.	Weight of Fat Ewe over 3 Yrs. Smithfield.
	Lbs.	Lbs.		Lbs.					Lbs.
LONG-WOOLS.									
Leicester	8	23	2	144	8·5	...	...	×	280
Border Leicester	9	25	1¼	135	8·0	...	...	×	...
Yorkshire Leicester	9	27	2	...	...	...	...	×	...
Cotswold	10	30	2	187	11·2	...	...	×	290
Lincoln	12	30	2	183	11·1	...	...	×	340
Romney Marsh	9	25	2	161	9·2	...	...	×	290
Devon Long-Wool	9	27	2	170	9·4	...	...	×	...
Devon South Hams	9	25	2	...	...	...	...	×	..
Roscommon	8	25	3	...	...	...	...	×	...
SHORT-WOOLS.									
Southdown	4½	22	2	148	8·2	...	...	×	175
Oxford Down	7	23	1¼	184	10·0	..	...	×	300
Shropshire Down	7½	22	1¼	151	8·6	...	...	×	245
Hampshire Down	5	24	1¼	196	10·2	...	...	×	275
Suffolk Down	6	25	1¼	190	11·0	...	...	×	275
Dorset Horned	5	20	1¼	194	8·8	×	...	...	255
Ryeland	7	20	2	...	...	...	...	×	...
MOUNTAIN BREEDS.									
Cheviot	5	20	3	112	8·0	...	×	...	190
Black-faced	4½	18	3	...	...	×	...	...	180
Herdwicks...	4½	16	4	...	...	...	×	...	...
Limestone...	7	20	3	...	...	×	...	...	...
Lonks	6	20	3	...	...	×	...	...	...
Penistone	5	16	3	...	...	...	×	...	...
Exmoor and Dartmoor...	5	12	2½	...	...	...	×	...	175
Welsh Soft-Wools	5	10	4½	...	...	...	×	...	150
Clun Forest	8	18	2	...	...	...	×	...	...
Radnor	5	16	3	...	...	...	×	...	...
Shetland	2	9	4½	...	...	×	...	...	...
Irish	2½	10	4½	...	...	...	...	×	...

The "weights per quarter" in the above table represent the average of ordinary sheep, but of recent years lambs of the more artificial varieties have been bred to fatten off at from 12 to 18 months, so that in these cases the Smithfield figures are above the average of the country. The following table exemplifies this, in the case of the live weight of some of the heaviest pens of sheep at the Smithfield Show :—

	Lambs 9 to 10 Months.	Lambs 12 to 24 Months.
	Lbs.	Lbs.
Leicester...	154	273
Cotswold	194	322
Lincoln	193	312
Southdown	181	214
Shropshire	143	254
Hampshire	233	282
Oxford	183	277
Suffolk	179	290

Names of Sheep.

Age of sheep dates from the "shearing."

Male.

1. Tup lamb till weaned.
2. Tup hogg; wether hogg, hogget, or tegg, if castrated —from weaning till first shearing.
3. Tup, shearling or diamond tup; shearling wether or dinmont—from first to second clip.
4. Two-shear ram and two-shear wether from second to third clip.

Female.

1. Ewe lamb.
2. Ewe hogg.
3. Gimmer or threave.
4. Ewe, if in lamb, barren gimmer if not: if not put to tup, is a yeld gimmer.

Sheep are aged after being "three-shear."

Breeding and Rearing.

Sheep are bred for mutton and wool—the mutton not to be too fat, but "marbled;" the wool to be as fine and free from hair as possible: hair is the natural covering, and its absence is only to be secured by "artificial selection" and good treatment. Ewes of a breeding flock must be kept young, with good mouths, udders, fleeces, and conformation; it is usual to draft them out at 3 to 4 years old. As early and quick fattening is now the system adopted, the ram is put to ewes in August and September in the South of England, October in the Midlands, but not till November in the North, and allowed to run with them for six weeks; 50 ewes is the average allowed to each tup. The ewes ought to be in store condition, not having previously got too many roots; go in lamb from 20 to 22 weeks.

In the South the early lambing is usually carried on in sheds for shelter. Ewes should be fed liberally at lambing time, and afterwards with, say, $\frac{1}{2}$ to 1 lb. linseed cake or oats. Will generally lamb themselves without assistance. Weaned at three months; males castrated at 10th to 16th day after birth.

The weight of a lamb at its birth is to its dam as 1 : 10 or 12. The lambs of smaller breeds weigh 7 to 10 lbs. and upwards; of larger breeds, 12 to 18 lbs.; ram lambs slightly the heaviest; twin lambs do not always weigh less, though usually do so. Some lambs increase from 3 to 4 lbs. in weight per week, some nearly 1 lb. per day.

Feeding.

Sheep of all kinds are normally fed on grass only, summer and winter. Of recent years, however, feeding off forage crops, and even under cover, has become general. In Scotland, in winter-time, turnips, with hay and cake, is the usual food for hoggs: but in England large breadths of tares, sainfoin, &c., are sown in autumn and ready for folding purposes in spring and during summer. Dry land is most suitable, as foot-rot is troublesome. On wet pastures fluke (liver rot) is very destructive. Shelter is as necessary for sheep as for other animals, though their wool enables them to stand cold, and the mountain breeds are very hardy. Any sudden change in the food—especially if on to worse food—produces a corresponding check and deterioration in the fibre of the wool, which is quite perceptible under the microscope.

Shearing is usually begun in May in the South country, and later on in summer further north: much depends on climate and weather. The greater number of breeds naturally cast their wool once a year, and advantage is taken to clip them when it is well "risen." The sheep are usually washed 10 days or so previously, but there is an increasing tendency to shear them "in the grease," owing to the harm the washing does them, and the trouble it necessitates.

Dipping is practised to ameliorate or prevent the attacks of parasites, and is usually done twice a year. Where a large flock is kept it is best to have a long, narrow, and deep bath in which the sheep can walk or swim through the mixture on to the dripping platform, as this does away with the risk from straining in handling.

The following are recipes for a dipping composition:—

I.—3 lbs. white arsenic (boiled with washing soda).
8 lbs. sulphur.
1 gal. carbolic acid.
30 lbs. lard, butter, or various pure oils.
100 gals. water.

II.—1 gal. carbolic acid.
2 lbs. arsenic.
3 lbs. soda.
3 lbs. soft soap.
100 gals. water.

III.—1 gal. pitch oil.
3 lbs. soda.
4 lbs. soft soap.
100 gals. water.

Each is sufficient for 100 medium-sized sheep, but more must be put in for heavy varieties. The water should be kept warm by adding fresh supplies, and the mixture added in small quantities as the dipping proceeds. The mixtures must first be melted in boiling water.

It is generally better and much more convenient, however, to use some of the dips in the market, and there are both winter and summer varieties to be had.

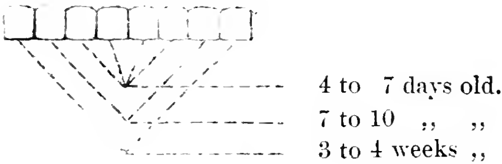
Smearing is now going out of practice: it was done mostly with hill breeds on the approach of winter. The wool was shed down the back, and a mixture of Archangel tar with butter or any grease was rubbed in: this melted and worked down over the skin. A man could do 20 sheep in a day; about 1½ gallons of tar and 1½ of melted butter, mixed, being sufficient for this number

Dental Formula for a Full Mouth.

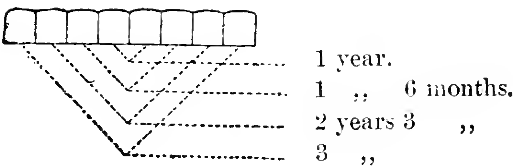
P.M.	T.M.	INC.	T.M.	P.M.		
$\frac{3}{3}$	$\frac{3}{3}$	$\frac{0}{4} \mid \frac{0}{4}$	$\frac{3}{3}$	$\frac{3}{3}$	=	32

Teeth as Indicative of Age.

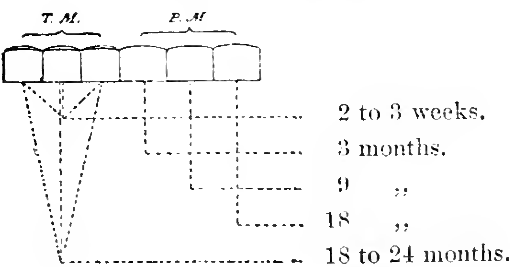
Appearance of Temporary Incisors.



Appearance of Permanent Incisors.



Appearance of Molars.



Regulations of the Smithfield Club regarding Dentition.

Sheep having their central permanent incisors cut will be considered as exceeding 10 months.

Sheep having their central permanent incisors fully up will be considered as exceeding 12 months.

Sheep having their third pair of permanent incisors cut will be considered as exceeding 19 months.

Sheep having their third pair of permanent incisors fully up and the temporary molars shed will be considered as exceeding 24 months.

Sheep having their corner permanent incisors well up, and showing marks of wear, will be considered as exceeding three years.

Lambing Table.

Tupped		Will Lamb		Tupped		Will Lamb	
Jan.	1	May	24	July	1	Nov.	21
,,	14	June	6	,,	14	Dec.	4
Feb.	1	,,	24	Aug.	1	,,	22
,,	14	July	9	,,	14	Jan.	4
Mar.	1	,,	22	Sept.	1	,,	22
,,	14	Aug.	4	,,	14	Feb.	4
April	1	,,	22	Oct.	1	,,	21
,,	14	Sept.	4	,,	14	Mar.	6
May	1	,,	21	Nov.	1	,,	24
,,	14	Oct.	4	,,	14	April	6
June	1	,,	22	Dec.	1	,,	23
,,	14	Nov.	4	,,	14	May	6

Live Weights of Sheep at the Smithfield Club Show

(Average of four years.)

	Lambs under 12 Months.	Wethers 12 to 24 Months.	Ewes over 3 Years.
	Lbs.	Lbs.	Lbs.
Leicester	144	259	290
Border Leicester	135	254	—
Cotswold	187	297	287
Lincoln	183	306	343
Kent	161	260	278
Devon	163	253	—
Cheviot	112	200	194
Blackface	—	185	180
Southdown	148	204	187
Hampshire	196	261	272
Suffolk...	190	281	274
Shropshire	151	245	240
Oxford	184	276	288
Dorset	194	270	272
Exmoor	—	170	175
Welsh	—	145	150

Proportion of Mutton to Live Weight of Wethers.

Live Weight in Lbs.	Per Cent. of Mutton. In Wool.	Per Cent. of Mutton. Newly Shorn.
280 to 300	71 to 72	74 to 75
260 ,, 280	69 ,, 70	73 ,, 74
240 ,, 260	67 ,, 68	71 ,, 73
220 ,, 240	65 ,, 66	69 ,, 70
200 ,, 220	63 ,, 64	67 ,, 68
180 ,, 200	61 ,, 62	65 ,, 66
160 ,, 180	59 ,, 60	64 ,, 65
140 ,, 160	58 ,, 59	63 ,, 64
120 ,, 140	56 ,, 57	62 ,, 63
100 ,, 120	55 ,, 56	60 ,, 61
80 ,, 100	53 ,, 54	58 ,, 59
60 ,, 80	50 ,, 52	56 ,, 57

PROPORTION OF THE VARIOUS PARTS OF WETHERS, LIVE AND DEAD.

WEIGHT ALIVE.	Lean.	Half Fat.	Very Fat.	Weights in Pounds.
	%	%	%	
Four quarters, with kidneys and kidney fat ..	43·3	49·4	52·8	50 —140
Fat of omentum and intestines	3·0	4·9	8·0	3·3 — 20
Head, tongue, and gullet	4·6	3·7	2·8	5 — 7
Heart	0·4	0·4	0·3	0·5 — 0·7
Lungs and windpipe ...	1·5	1·2	1·0	1·7 — 2·5
Liver and gall-bladder ...	1·4	1·3	1·0	1·4 — 2·5
Diaphragm	0·3	0·3	0·2	0·4 — 0·5
Spleen	0·2	0·2	0·1	0·2 — 0·3
Stomach, without contents	2·4	2·3	1·5	2·6 — 3·7
Intestines, ,,	2·3	1·9	1·3	2·5 — 3·2
Contents of stomach and intestines	16·0	14·0	10·0	19 — 25
Horns, skin, and legs to gambrel joint	9·6	8·0	6·5	10 — 16
Wool, washed	5·0	4·3	3·6	6 — 9
Wool dirt	4·8	4·0	3·2	5 — 8
Blood	3·9	3·6	3·2	5 — 8
Loss—shrinkage	1·3	0·5	0·3	0·7 — 1·5
	100·0	100·0	100·0	
CARCASE.				
Dressed weight, including fat.				
Flesh, without fat and bones	33·2	33·1	27·0	37 — 67
Bones	7·1	5·9	5·2	8 — 13
Fat in flesh	2·0	8·0	20·5	2·8 — 50
Fat on kidneys	1·0	2·4	4·4	1·5 — 10
Fat on omentum and intestines	3·0	4·9	8·0	3·9 — 20
	46·3	54·3	65·1	53·3 —160

In round figures, and with ordinary sheep, the proportion of live to dead weight will be:—Hoggs or teggs in a lean condition will yield one half of weight as carcase—one half offal. Shorn sheep, fat for the market, will yield 56 lbs. carcase to 100 live weight, and 7 to 14 lbs. of loose or offal fat: Long-Wools yielding least, and Downs most.

Average Live Weight Gain in Ounces per Day since Birth of Sheep at the Smithfield Club Show.

(Average of four years.)

	Lambs under 12 Months.	Wethers under 24 Months.	Ewes over 3 Years.
Leicester	8·5	6·9	4·2
Border Leicester ...	8·0	6·8	—
Cotswold	11·2	7·4	4·2
Lincoln	11·1	7·8	4·9
Kent	9·2	7·0	4·0
Devon	9·4	6·5	—
Cheviot	8·0	5·3	2·8
Blackface...	—	5·2	2·6
Southdown	8·2	5·0	2·7
Hampshire	10·2	6·6	3·9
Suffolk	11·0	7·1	3·9
Shropshire	8·6	6·2	3·5
Oxford	10·0	6·6	4·2
Dorset	8·8	4·8	3·9
Exmoor	—	4·5	2·0
Welsh	—	3·8	2·2

Order of the Deposition of Fat on a Sheep.

1st. On the net enveloping the intestines.
2nd. Around the kidneys.
3rd. On the end of rump at tail-head.
4th. Along back to neck, and around ribs.
5th. Between muscles: round below ribs and flanks.
6th. Up to breast in front, and scrotum behind: on stomachs inside at same time.
7th. The above receive more fat in same order, and back becomes "nicked," *i.e.*, divides into two portions along spine: thus the presence of the "nick" shows there is much fat elsewhere.

Wool.

There are three kinds of wool in every fleece—*prime* or *mother-wool* from the neck and back, *seconds* from the tail and legs, and *thirds* from the breast and belly.

Under the microscope it shows a finely serrated structure, the teeth all pointing outwards and upwards from root to top. The finer the wool, the greater the number of serrations to the inch.

Saxony wool has	2,720	serrations	per inch.
Merino	2,400	,,	,,
Southdown ...	2,080	,,	,,
Leicester ...	1,860	,,	,,
Cheviot	1,440	,,	,,

Fineness also due to smallness of fibre; coarse wool is $\frac{1}{450}$ of in., and fine wool $\frac{1}{1500}$ of in. in diameter. The "felting" property is due to the power of the serrations to hold fibres together. Wool consists of "suint," fat, and pure wool hair. Suint is an excretion of the perspiration glands of the skin; consists of a compound of potassium with an organic acid containing nitrogen, of which little is known. Suint is soluble, and therefore washes out: in the Merinos it is over half the weight of unwashed fleece, in ordinary sheep exposed to weather it is about 15 %. Fat varies in washed fleece from 30 % to 8 %, or less; short fine wool has most fat. Pure wool hair contains 16 % of nitrogen. In ordinary wool the potash salts amount to 10 %, and which must be withdrawn from the soil on which they graze. Sulphur is also present in some quantity.

Sheep in grazing will feed on and keep down Ragwort *(Senecio Jacobæa)*, Ribgrass *(Plantago)*, and several other weeds.

Common Diseases.

Diarrhœa.—Excessive purging and loss of flesh, weakness. Give shelter and dry nourishing food, or a change of pasture. Give repeated doses of same cordial as for calves.

Garget or *Inflammation of the Udder.*—Hardness and tenderness of udder, same as in cows. Foment with warm water, keep vessel empty of milk, and apply a mild blister.

Straining after Lambing—Inflammation of the Womb.—Spasmodic pains arising from the violent contraction of the womb, with pressing, followed by swelling, inflammation, and mortification of the parts, probably the result of blood-poisoning. Two table-spoonfuls of a mixture of 1 part of Calvert's best carbolic acid to 7 parts of Gallipoli olive oil, to be injected into the uterus; for milder cases 1 to 15 will do. This "carbolic oil" is useful for applying to all wounds and diseased surfaces among the domestic animals.

Liver Rot.—Due to the presence of "flukes" (*Fasciola hepatica*) in the biliary ducts; manifested by a falling off in condition, and the white of the eye turning yellow. These parasites pass one stage of their existence in fresh-water snails, so that the disease is most prevalent on marshy or damp land, or when there is excessive rainfall. No perfect cure, though salt and dry foods may check, and allow the sheep to fatten. Prevention consists in draining, getting stock from sound flocks, using salt and dry food—as cakes—liberally, and fattening off as quickly as possible.

Louping-Ill or *Tremblings.*—Most common among upland sheep. Animal seems dull and heavy at first, head is convulsively turned towards the back, has tremors, grinds the teeth and froths at the mouth, with hurried breathing; generally fatal. Due to the presence of a fungoid parasite in the tissues of the spinal cord, and which passes one stage of its existence in the tick, so that prevention must take the form of exterminating this latter. Keep down all roughness of pasture in which it breeds, by liming, burning, or heavy stocking; keep the sheep clean by dipping.

Sturdy.—Hydatid in the brain (*Cœnurus cerebralis*), one stage of a tapeworm in the dog (*Tænia cœnurus*). Can sometimes be extracted from the head of the sheep, but usually better to kill the animal at once. Prevention consists in giving powdered areca nut—from 15 grains to 2 drs.—to dogs, to expel the worms and prevent them from dropping the segments full of ripe eggs on the pastures.

Scab.—Due to presence of a minute acarus (*Dermatodectes ovis*), which burrows into the skin. Very contagious; shown by sheep rubbing or biting infected parts, and wool coming off. Dip the healthy sheep, and dress infected spots with tobacco juice, mercurial ointment, spirit of tar, or sulphur ointment, several times, to kill each brood in turn. Police must be notified of outbreak.

Foot-Rot.—A disease due to sheep pasturing on wet land among succulent herbage; two forms—contagious and non-contagious. The hoof softens and allows dirt to lodge; this breaks down the horn, exposes the sensitive tissues, and sets up inflammation, suppuration, and fungoid growths. Prevention consists in grazing on dry, sound land, as damp or clay soil is conducive to development of the disease. Paring away the loose horn, and driving the sheep through quicklime, or applying butter of antimony to the diseased surfaces, acts as a check to the disease. Walking the sheep, after paring the feet, through a shallow trough containing 4 parts of crude carbolic acid to 100 of water, or a solution of sulphate of copper, is also a good cure. An arsenical solution is applied in the same way to harden the horn—1 lb. of arsenic boiled with equal quantity of washing soda to dissolve it, and added to 5 gallons water, and this solution put $1\frac{1}{2}$ in. deep in the trough.

Maggots.—The larvæ of several varieties of the blue-bottle fly. Attack the dirty parts of sheep in warm showery weather. Prevent by dipping in spring, and keeping the hinder parts clean. Treat by dressing the affected spot with spirit of tar or other strong-smelling mixture. Paraffin oil, or a mixture of equal parts of paraffin, turpentine, and colza oil, is a good dressing.

Braxy.—Believed by some to be a variety of anthrax disease. First symptom is the affected animal going with a short step and arched back, the bowels having a tendency to swell; the disease is usually rapidly fatal. After death the blood and tissues quickly decompose, the flesh is very dark red in colour, and bowels are distended with gas. No treatment of much use, as it is usually quick and fatal. Errors in dieting, or sudden changes in the weather, determine the production of many cases of braxy. Prevent by changing on to sound pasture if possible, avoid too succulent food, and give access to rock salt.

Recipes

Carbolic Oil.—Carbolic acid 1 part, olive oil 7 or 8 parts.

Purgative.—Epsom salts 3 oz., ground ginger 1 dr. Give in gruel.

Lotion.—Carbolic acid 1 part, water 50 parts.

Foot-Rot Dressing.—Butter of antimony 1 part, tincture of myrrh 8 parts.

Fly Dressing.—Spirit of tar 1 part, olive oil 4 parts; or, bichloride of mercury $\frac{1}{4}$ oz., paraffin 2 oz., turpentine 2 oz., soft water 1 pint; dissolve the bichloride first.

PIGS.

Breeds

Large White or *Yorkshire*.—Largest variety in the British Isles. Colour, nearly all white, but largest varieties have sometimes blue spots or patches. Head rather long, with drooping ears; light neck, good shoulders, long narrow back with flat ribs, good hams, fairly long legs, and covered with thick bristly coat. Useful as scavengers in courtyards, and require a long time to grow before fattening, but sometimes reach enormous weights.

Small White or *Yorkshire*.—A useful variety for pure stock and crossing purposes. Short upturned nose, lower jaws dished, prick ears, heavy cheeks; neck long and well padded, so that head appears as if hung at lower level than shoulders; legs short and well apart, loins wide, hind quarters long and square, soft silky curly hair over the whole. Supposed to have originated from crosses with Chinese pigs. Are small. and indifferent breeders, so that not so profitable as some varieties, except for improving other breeds.

Middle White breed originated as a cross between the large and small kinds. Is the most widely distributed white pig, and useful for crossing purposes.

Black Suffolk or *Essex*.—Resemble the Small White breed very closely, except that they have coal-black skins and fine black hair, longer and lighter carcases, and longer head. Common in Devon and Cornwall, as well as in native district. Resulted from crossing the old native breed with that known as Neapolitan. Fatten early, but not so hardy as others.

Berkshires.—One of the hardiest and most widely distributed varieties. Colour, black; head moderately short; nose slightly dished and not *retroussé* or turned up, and with a little white on it; and feet and tip of tail white. Neck muscular, shoulders wide, ribs rather flat, and bone of the legs rather coarse; covered with longish fine hair. Never are of the dead black colour of the Essex. Have a larger proportion of lean meat when fat than other breeds. The cross with Small White breed is best.

Dorsets.—A variety of the black Essex specially developed in this locality, but not so shapely as the original. Of a rusty black colour, with pendant ears. Are good mothers, and yield a heavy carcase of good quality. Other black varieties of same type are Devons and Shrops.

Tamworths.—A comparatively local breed, predominating in Staffordshire and Warwickshire. Are of a red or dark brown colour, with dark spots on skin. The most direct descendant of the aboriginal pig of the country Large proportion of lean mixed with fat in the bacon, and for this reason have come much into favour of late years. Have long head, body, and legs, with deep flat ribs. A good hardy, practical sort.

Synopsis of Breeds of Pigs.

	Colour.	Dead Weight, 1 Year Old.	Markings.	Ears.
Large White	White ...	350	Blue Spots ...	Droop.
Middle White	White ...	300	—	Cock.
Small White	White ...	250	—	Cock.
Essex Small Black	Dead Black	280	—	Cock.
Berkshire ...	Glossy Black	300	White Points	Cock.
Tamworth ...	Red	400	Dark Spots ...	Droop.
Dorset	Rusty Black	350	—	Cock.

General Scale of Points of Pigs adopted by the National Pig-Breeders' Association.

Head wide and deep, lower jaw well sprung	10
Neck muscular and rather long	5
Shoulders wide, but not open	10
Fore legs straight, and well placed outside the body ...	7
Ribs well sprung and deep	12
Loin wide, not slack	8
Flanks deep and full	7
Quarters long, and straight from hip to tail	13
Hams wide, with meat down to the hocks	10
Hind legs placed well outside, and not too much under the body	5
Bone flat and not coarse	6
Hair long and silky, but without mane or bristles along the neck and shoulders	7
	100

Names of Pigs.

The newly born of both sexes known as sucking pigs, porkers, or porklings.

Male.

1st. Boar pig.
2nd. Castrated after weaning is a "shott" or "hog."
3rd. Entire male after weaning is a "boar" or "brawn."

Female.

1st. Sow pig.
2nd. Spayed female is a cut sow pig.
3rd. Female uncut is an open sow or "yelt," or "gilt."
A boar cut after service is a "brawner."
A sow after having taken the boar is "lined" and becomes a brood sow. When she has young, is said to have "littered" or "farrowed."

Management.

Sows for breeding to be chosen with good wide hips, and at least 12 teats; a good compactly built boar to be used. The sow must not be too fat, else she will go barren; may be bred from at any age from 6 or 8 months upwards. Comes in season every three weeks. May be put to boar in October or April, and as she goes from 113 to 120 days with young, will farrow in February or August. The early time is the best, as it gives the young pigs the benefit of the summer. Exercise is good for them. Must have short litter, and a spar fixed all round the wall of apartment a short distance from the floor, otherwise the little pigs are apt to get entangled and overlain. Keep dry and comfortable, but well ventilated. Weaned at from 6 to 8 weeks, and males may be castrated shortly after.

Feeding.

Pigs exist specially to manufacture fatty tissue, and will consume almost anything eatable. Milk, barley and wheat meal produce the finest pork: whey, buttermilk, and meals give white meat; peas and beans give a certain amount of hard stringiness to the flesh, and it is yellow and flabby if maize only is used: therefore a mixture must be given. A pig should give about 1 lb. of pork for every 5 or 6 lbs. of meal supplied, and increase at the rate of from $1\frac{1}{2}$ to 2 lbs.

daily. Fattening should commence immediately after weaning; exercise should be reduced to a minimum, and the animals kept warm—covered-in houses being preferable to those with open pens attached. Potatoes and roots when cooked make very good food along with meals of various kinds. Give turf or small coals as a tonic.

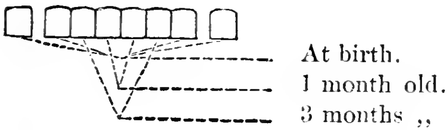
Sucking pigs are killed at 18 or 20 days old. Others pay best at from 4 to 6 months old, and will weigh from 8 to 14 Imperial stones.

Dental Formula of a Full Mouth.

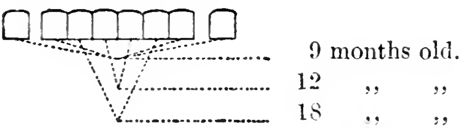
P.M.	T.M.	C.	I.	C.	T.M.	P.M.	
$\frac{3}{3}$	$\frac{3}{3}$—$\frac{1}{1}$	$\frac{1}{1}$	$\frac{3}{3}$ | $\frac{3}{3}$	$\frac{1}{1}$	$\frac{1}{1}$—$\frac{3}{3}$	$\frac{3}{3}$	= 44

Teeth as Indicative of Age.

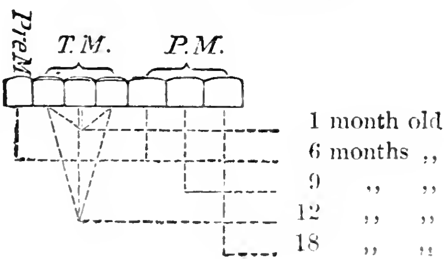
Appearance of the Temporary Incisors and Tusks.



Appearance of Permanent Incisors and Tusks.



Appearance of the Molars.



Regulations of the Smithfield Club regarding Dentition.

Pigs having their corner permanent incisors cut will be considered as exceeding six months.

Pigs having their permanent tusks more than half up will be considered as exceeding nine months.

Pigs having their central permanent incisors up and any of the first three permanent molars cut will be considered as exceeding twelve months.

Pigs having their lateral temporary incisors shed and the permanents appearing, will be considered as exceeding fifteen months.

Pigs having their lateral permanent incisors fully up will be considered as exceeding eighteen months.

The weight of pigs may be approximately found by measuring in the same way as that for cattle, but in this case the length along the *curve* of the back must be taken to the tail-head—one-sixth being added on for head and neck; but weighing live is much the better plan.

The dead weight of an ordinary pig is about $\frac{7}{9}$ of the live weight.

A carcase of pork includes head, feet, skin, and leaf fat inside, so that the offal is a comparatively small proportion. The following table will pretty accurately represent different weights of well-fed swine:—

Live Weight in Stone of 14 Lbs.		Per Cent. of Pork.
Above 40	... ...	87 to 88
From 35 to 40	... ...	84 ,, 86
30 ,, 35	... ...	83 ,, 84
25 ,, 30	... ...	81 ,, 82
20 ,, 25	... ...	79 ,, 80
15 ,, 20	... ...	78 ,, 79
Under 15	... .	75 ,, 77

Proportion of the various Parts of Swine, Alive and Dead.

Weights Alive.	Half Grown.	Fat.	Weights in Pounds.
	%	%	
Four quarters, with head, kidneys, and kidney fat	72·8	82·1	145 —410
Fat of omentum and intestines	1·7	2·5	3·4— 12·5
Tongue and gullet	0·5	0·4	1 — 2
Heart	0·5	0·3	1 — 1·5
Lungs and windpipe	1·4	0·9	2·8— 4·5
Liver and gall-bladder	2·6	1·7	5 — 8·5
Spleen	0·2	0·2	0·4— 0·5
Stomach, without contents ...	1·2	0·7	2·5— 3·5
Intestines, ,, ...	3·9	2·2	10 — 11
Contents of stomach and intestines	7·0	5·0	14 — 25
Blood	7·3	3·6	12 — 14·5
Loss—shrinkage	0·9	0·4	1·8—· 2
	100·0	100·0	
Carcase.			
Dressed weight, including fat.			
Flesh, without fat and bones...	46·4	40·0	92 —200
Bones	8·0	5·8	16 — 30
Fat in flesh	16·5	32·4	33 —160
Fat on kidneys...	1·9	3·9	3·8— 20
Fat on omentum and intestines	1·7	2·5	3·4— 12·5
	74·5	84·6	148·2—422·5

Wiltshire Bacon.

For a pig of 200 lbs.: When the meat is cold and cut up, have it salted lightly and left on the stones for the night. Next morning brush off this salt, and well rub in a layer of salt and half a pound of saltpetre for each side of bacon of this weight, and have the saltpetre mixed with 1 lb. of coarse brown sugar for each side. Have it rubbed every day for three weeks, and then wash it all off, and have it sent to be smoked for a week or a little more. It is then fit for use A pickle is generally made for the head, legs, &c., and any other small bits. Six lbs. of salt, 1 lb. of saltpetre, 1 lb. of treacle, boiled for half an hour in six gallons of water, when cold to receive the pieces.

Common Diseases.

Typhoid or *Swine Fever*.—A fatal and infectious disease. There is loss of appetite and dulness in the early stages; the animal grunts plaintively; appears sensitive to the cold; purple spots appear on the belly and thighs; it refuses all solid food, and cares for drink only. Costive in early stages, followed by offensive diarrhœa. Must be slaughtered. Police to be notified. Disinfect premises; freedom declared only after 28 days' cessation.

Enlargement of the Spleen.—Animal wrings and twists itself about, and bends to ground as if in great internal pain. The cause is over-feeding with too rich food. Clear out the bowels with 4 to 6 oz. of Epsom salts. Reduce the quantity and quality of food.

Inflammation of Lungs or *Hearings*.—Brought about by exposure or lying on hot manure. Seldom curable, and best to kill if fat. If carefully fed and kept comfortable, may be fattened out with only one sound lung. Nitre $\frac{1}{4}$ oz. twice daily in the food, and mild blister on the chest will help the animal.

Rheumatism or *Cramp*.—Dulness, with lameness of hind quarters especially. Brought about by lying on damp bedding or cold brick floors, and especially by lying on fermenting horse-manure. Keep dry and comfortable. Rub the limbs with a mixture of turpentine 4 parts, mustard 1 part, and olive oil 2 parts.

Measles.—Red patches appear on the skin, pustules under the tongue, with fever. Give 1 oz. sulphur in food, and repeat dose. Keep warm.

Mange.—Due to the presence of the mange acarus (*Sarcoptes suis*), and analogous to scab in sheep; is transmissible to man, and very infectious; fostered by want of cleanliness. Appears as blotches or small pustules on different parts of the body. Wash with soap and warm water; give 2 oz. Epson salts in food; apply mixture of oil 3 parts and sulphur 1 part to the spots until killed out.

Trichinosis.—Due to the presence in the adipose tissue of the encysted form (*Cysticercus cellulosus*) of the tapeworm which infests mankind (*Tænia solium*). Produces "measly pork." It is dangerous to eat such pork unless in a thoroughly cooked condition.

Lice.—Due to want of cleanliness. Wash the animal with water saturated with petroleum.

POULTRY.

Breeds of Hens.

White-fleshed Varieties.

Creve Cœur.—A French breed of great size; great breast development; carries a medium-sized crest of feathers; legs black, but clean—*i.e.*, not feathered; plumage entirely green metallic black. Fine white eggs; non-sitters. Flesh delicate, white, and fine; requires mild climate, grass land; develops rapidly; fattens easily.

Dorking.—Full rose comb with posterior "peak" in white variety, single in dark kinds; body large and deep, and, when viewed sidewise, almost forming a square; breast well forward; neck short, and head medium; legs clean, white in colour, and carrying a fifth toe; four varieties—darks, silver-greys, whites, and cuckoos. The white-feathered is the finest variety. Best chickens for market. Good layers and setters. Will not roost high, and require broad perches. Flesh of silver-grey is exceedingly fine. Requires dry grass soil and mild climate; develops very rapidly. Best for table and for crossing.

Game.—Not so good as the old-fashioned fighting type, which were close, compact, and hard-feathered; bodies medium in size, broad in breast; legs clean and rather long; abortive comb; several varieties, of which the white-legged black-red plumaged are preferred for table purposes. Lay tinted eggs; good for crossing; good sitters and mothers. Flesh excellent; develops quickly; suitable for most climates; hardy.

Houdan.—Of French origin; large size, broad and massive; clean legs, pale or speckled in colour, carrying a fifth toe; head crested; plumage, mottled black and white; rose-combed, and large-tailed. Hardy, plump; flesh very fine; suitable to all climates, especially on calcareous ground; develops rapidly with crossing. Non-sitters; good summer layers, but will not do to be confined.

La Fleche.—Large French fowls; massive in body, deep in breast; clean black legs; neat head, with forked comb; plumage entirely black. Large white eggs; non-sitters. Flesh very fine; requires mild climate and dry soil; develops slowly; fattens easily.

Scotch Grey.—Most nearly like the Dorking in shape, and has white or speckled legs: plumage, black and white; five-toed. Flesh good: develops slowly; requires dry grass soil; delicate breed. As a rule a non-sitter; lays fairly well, and good on table.

Yellow-fleshed Varieties.

Brahma.—Large, full-feathered birds, feathers extending down the legs and yellow feet: small, neat heads, with pea combs; two varieties—darks and lights. Flesh moderate; hardy, all climates. Good sitter and mother; develops slowly. The best winter layers (buff-coloured eggs), and, being very tame, endure confinement best. Do not care to roost on perch at all, but prefer to squat on ground.

Buff Cochin.—Very tame: heavily-feathered yellow legs; suitable to all climates: develops slowly: excellent sitter, but too unwieldy. Colour, a rich soft golden buff. Good winter layers; hardy.

Indian Game.—Large, upstanding, somewhat heavily-boned fowls, but carrying a large amount of flesh on the breast; partridge or black in plumage, which is very rich in colour; clean, yellow legs; long neck and legs, small tail. Flesh excellent, cream-coloured; develops rapidly; suitable to most climates.

Langshan.—Large Chinese fowls, on rather long legs; full tails, carried high; slightly feathered on the legs, comb single, plumage entirely black. Flesh excellent, cream-coloured; suitable to all climates; hardy; develops moderately; good sitter and mother. *Orpingtons* are clean-legged crosses.

Leghorn.—Of the Mediterranean type; active fowls, of great precociousness; legs clean and yellow; several varieties, whites and browns being oldest and best known; other colours are cuckoo, black, pile, duckwing, and buff. Browns are single-combed, with long drooping tail-feathers, and an abundance of yellow, orange, and red feathers on neck and back. Not good sitters, but very profitable summer layers. Flesh indifferent; develops moderately; suitable to all climates.

Plymouth Rock.—A breed of American origin; large in body, rather big in bone; single comb; clean, yellow legs; three varieties—grey (speckled), whites, and blacks, the first-named being the most popular. Good winter layers; buff-coloured eggs. Flesh moderate; suitable for all climates; good sitter and mother; develops quickly.

Wyandotte.—Another breed of American production, and one of the most recent; rose comb; legs clean and yellow; large-sized body; plumage laced, and in two colours or varieties—silvers and golds; also whites. Flesh moderate; suitable for all climates; good sitter and mother; develops quickly.

Dark-fleshed Fowls.

Andalusian.—A member of the Mediterranean family, which has been described as having a smallish-sized body, placed upon legs of a good length; the neck rather long, with a fine head; a large, upright single comb in the cock, and in the hen also large, but falling over on one side; and the cocks have large sickle-shaped tails. They are clean-legged; colour, slate, except on the cock's neck and back, where it is dark purple, nearly black. Good layers; white eggs; non-sitters. Flesh indifferent: requires dry soil and mild climate; develops slowly.

Hamburgh.—Small-sized, well-shaped bodies on longish legs; large sickle tail; full hackle, with neat head, and rose comb; five varieties—blacks, gold-spangled, silver-spangled, gold-pencilled and silver-pencilled, all very rich in colour, save blacks. Lay too small eggs to be of marketable value. Suitable to all climates; requires large run; inferior sitter and mother.

Minorca.—Also of the Mediterranean family; two varieties—namely, black and white, but the latter seldom seen. A medium-sized but very hardy breed. Single-combed, and with large tail-feathers; dark legs; large amount of white on wattles. Non-sitters, but one of the most valuable breeds we possess as egg-layers; eggs large and white. Flesh indifferent; suitable to all climates; develops quickly.

Synopsis of Breeds.

Breeds.	Eggs laid per Annum.	Weight per Dozen Eggs.	Live Weight of Hens.	Weight of Meat at 6 Months.	Weight of Bones and Offal.	Food consumed Daily.
		Oz.	Lbs.	Lb. oz.	Lb. oz.	Oz.
Andalusian ...	150	$29\frac{1}{4}$	5 – 6	3 1	2 15	$6\frac{3}{4}$
Brahma (light) ...	120	$28\frac{1}{2}$	8 – 10	4 11	5 0	$9\frac{1}{2}$
Cochin (buff) ...	115	24	8 – 10	4 9	5 $4\frac{3}{4}$	$17\frac{1}{2}$
Creve Cœur ...	122	33	8 – 9	4 $9\frac{1}{8}$	4 $14\frac{1}{4}$	$7\frac{1}{8}$
Dorking (silver-grey)	130	$27\frac{1}{2}$	7 – 10	5 $4\frac{1}{2}$	4 14	$6\frac{3}{4}$
Do. (dark) ...	130	$27\frac{1}{2}$	6 – 9	5 4	3 12	$6\frac{1}{2}$
Game	100	24	5 – 6	3 $15\frac{1}{2}$	2 $7\frac{3}{4}$	$4\frac{1}{2}$
Hamburgh (silver-spangled)	239	$20\frac{1}{4}$	4 – 5	2 $3\frac{1}{2}$	2 $7\frac{3}{4}$	$4\frac{1}{4}$
Do. (golden-pencilled)	225	$19\frac{1}{2}$	$3\frac{1}{2}$ – 4	1 $15\frac{3}{4}$	2 $7\frac{1}{2}$	$4\frac{1}{4}$
Houdan	125	26	6 – 7	3 7	2 $10\frac{1}{4}$	$6\frac{3}{4}$
La Fleche ...	140	$29\frac{1}{2}$	6 – 7	3 $5\frac{3}{4}$	2 $9\frac{3}{4}$	$6\frac{3}{4}$
Langshan ...	115	27	7 – 10	4 $14\frac{3}{4}$	5 $1\frac{1}{4}$	$7\frac{1}{8}$
Leghorn (brown)	190	22	5 – 6	3 $15\frac{1}{2}$	2 $10\frac{1}{4}$	$4\frac{3}{4}$
Minorca (black)	180	$28\frac{1}{2}$	$5\frac{1}{2}$ – 7			
Plymouth Rock...	120	$27\frac{1}{2}$	6 – $7\frac{1}{2}$			
Scotch Grey ...	140	29	5 – 6	3 $4\frac{1}{2}$	2 12	$6\frac{3}{4}$
Wyandotte ...	140	25	$5\frac{1}{2}$ – 7			

Breeds of Ducks.

Aylesbury.—Large white variety, with pink or flesh-coloured bills and feet; body long and deep and "keeled." Weighs 9 to 12 lbs. Dozen eggs weigh 34 oz. The breed most suitable for eggs and confinement; rarely sit.

Pekin.—White variety, with orange yellow bills and feet; not "keeled" like Aylesburys. Weighs 8 to 11 lbs. Dozen eggs weigh 39 oz.

Rouen.—A descendant of the wild duck, and coloured like it; in drake head and neck a lustrous bottle green; white ring round neck; body claret and green; a cinnamon colour in duck. Can be kept profitably only when at large. Weighs 9 to 12 lbs. Dozen eggs weigh 39 oz.

Turkeys.

Native to America; still retain wild instincts, and will not bear confinement. Three principal varieties—the *Cambridge* (black and white), *American* (bronze), and the *Black Norfolk*. The Black Norfolks are the hardiest and best for general purposes. Are watchful mothers, but young ones difficult to rear. A peculiarity is that one copulation at beginning of season renders fertile all the eggs in the ovarium. Hens weigh 10 to 12 lbs.; cocks, 15 to 20 lbs.

Geese.

Require ground to graze over as well as water to swim in. Bred for flesh and feathers only, as eggs are too large for ordinary use: dozen weigh 80 to 87 oz. There are three varieties—the *Toulouse*, or grey, which lays well in spring, but does not hatch often; the *Embden*, or pure white, which usually only produces one brood; and the parti-coloured or common breed, which is smaller but more prolific, rearing two and sometimes three broods in a year. This latter is most likely the produce of the large white gander with the grey goose. Reach maturity at 3 to 4 years old.

Management of Poultry.

All fowls for laying purposes must be young, and killed off at two years and a half old. Not more than 50 should be kept in one stock, as they are apt to develop diseases and die if more are together. Must have freedom to wander and pick up grit, green food, flies, worms, &c. Give access to lime, sand or gravel, and water. The house must be dry and warm, and they must have shelter outside. Access to a pond is necessary for ducks and geese. If unconfined, two feeds will do in the day: barley meal is the best food, and wheat also is good; maize produces more fat than eggs; house scraps, potatoes, and vegetables chopped up and mixed with meal and skim-milk, are very good food—given warm and not soured. Use pure cocks, as a pure variety is generally more profitable than the ordinary mongrels. Good feeding and comfort are to be preferred to giving pepper for the production of eggs. Hens do not usually lay an egg every day, but miss one in three, and lay about 2 dozen at one period, stop for two or three weeks, and begin again—from March to October. Hatch from 12 to 14 at a time. The heat of the breast is about 104° F., and incubators should be adjusted to this. A hen requires

21 days to hatch eggs, and the duck, goose, and turkey 30. To drive away the broodiness it is best to shut up in the dark and deprive of food for a day or two. Moulting takes place in the autumn and winter.

Hens when old have hard spurs, scales on legs rough, under bill stiff, and comb thick and rough.

One male allowed to about ten females.

Specific gravity of eggs:—

Average	1088
Brown-shelled	1087
White-shelled	1092

Common Diseases.

Roup.—A species of catarrh, manifested by a swelling round the eyes and a discharge from the nostrils. Keep clean and warm, and give a little sulphur or iron in soft food.

Diarrhœa.—Due principally to a sudden alteration of the food: a drop or two of tincture of opium checks it.

Gapes.—Due to the presence of a parasite (*Sclerostoma syngamus*) in the air passages, and characterised by gaping, gasping, and sneezing. A feather, stripped of all except the top barbs, dipped in a weak solution of tobacco, is to be carefully introduced, turned round, and withdrawn with the worms adhering to it. Apply turpentine externally to the throat.

Crop-bound.—Due to over-feeding. Pour warm water or oil down throat into crop, and knead to get away the food; if this fails, then must cut open and stitch up again.

Egg-bound.—Obstruction in the egg passages or too large an egg. Oil or steam the vent and parts around, and give some treacle. Stop forcing food.

GENERAL LIVE STOCK NOTES.

Estimate of Stock required per Acre on a Farm.

	Sheep.	Cattle.	Horses.
1 acre of very good land will maintain	5	1 to 1½	2
1 acre good average land	3	1	1
1 acre poor land	2	½	½

Periods of Gestation of Domestic Animals, and of Incubation of Poultry.

	Shortest Period. Days.	Mean or usual Period. Days.	Longest Period. Days.
Mare	322	347	419
Ass	365	380	391
Cow	240	283	321
Ewe	146	154	161
Sow	109	115	143
Goat	150	156	163
Bitch	55	60	63
Cat	48	50	56
Rabbit...	20	28	35
Turkey sitting on the eggs of the Hen ...	17	24	28
Turkey sitting on the eggs of the Duck ...	24	27	30
Turkey sitting on the eggs of the Turkey...	24	26	30
Hen siting on the eggs of the ... Duck ...	26	30	34
Hen siting on the eggs of the ... Hen ...	19	21	24
Duck	28	30	32
Goose	27	30	33
Pigeon	16	18	20

Number of Females to each Male.

Mares	80	Hens	6 to 10
Cows	50	Ducks	6 ,, 10
Ewes	50	Turkeys	8
Sows	10	Geese	4

Periods of "Season" (Œstrum).

	Time that "Heat" Lasts.	First "Heat" after Birth of Young.	Periodical Return of "Heat."
Mare	5–7 days	7–10 days	2–3 weeks
Cow	2–3 ,,	21–28 ,,	3–4 ,,
Ewe	2–3 ,,	4–6 months	17–20 days
Sow	2–4 ,,	5–6 weeks	20–21 ,,

Pulse, Respiration, and Temperature.

	Pulse		Respiration per Minute.	Temperature. ° F.
	Beats per Minute.	Where Felt.		
Horse	36–40	Jaw	8–10	100·2
Cow...	45–55	Jaw	15–25	101·4
Sheep	70	Thigh	25–35	104
Pig	70	Heart	15–25	102·6

These figures vary with different animals, and in the same animal at different times, even while in perfect health. The temperature, for instance, is higher immediately before and after parturition.

Medical Substances and Instruments which a Farmer should have Always at Hand.

Epsom Salts: Treacle:
Raw Linseed Oil and Meal:
Carbolic Acid: Jeyes' Fluid;
Carbolic Oil (say 1 to 12):
Saltpetre: Ginger: Mustard:
Laudanum; Turpentine:
Sheep Dip; McDougal's "Smear:"
Ammonic Carb.;
Gentian; Spirits;
Nitric Ether;
Bluestone; Tar;
Calcic Chloride;
Ferrous Sulphate;

And a clinical thermometer, trocar, injection tube, teat-bistoury, and probang.

Contagious and Infectious Diseases which come under the Contagious Diseases (Animals) Acts.

Glanders and Farcy.
Pleuro-Pneumonia Contagiosa.
Cattle Plague (Rinderpest).
Foot-and-Mouth Disease (Murrain).
Anthrax.
Sheep Scab.
Small-Pox in Sheep.
Swine Fever.
Rabies.

An outbreak of any of the above must be notified to the police, and the local authorities will deal with the case.

Disinfection.

An infected building can be purified by washing mangers, racks, &c., with a 5 % solution of carbolic acid and water, squirting it into the crevices with a garden syringe. Afterwards the walls, &c., to be limewashed, the wash to contain 1 pint of carbolic acid to the gallon. Floors, gutters, &c., to be kept sprinkled with carbolic disinfectant.

BREEDING.

The perfection of any particular breed of animals is most nearly arrived at by "in-and-in breeding"—that is, pairing two animals nearly related, or at least belonging to the same strain; but when this is carried out to too great an extent, it has many drawbacks. For instance, many hereditary diseases, loss of reproductive power, and general delicacy are induced, so that an occasional cross, or the introduction of new blood, if judiciously done, is likely to be followed by improvement. The influence of an animal on its offspring is in proportion to the antiquity of its particular kind, and "pedigree," as registered in stud or herd books, is simply a list of the ancestors of particular animals for the purpose of showing their long descent from, and adherence to, pure types. "Atavism," or "Reversion," is the occasional appearance of an animal with points denoting the ancestry of an ancient or native breed, as, for instance, black muzzles, ears, hoofs, &c., seeming to show descent from the Wild Cattle. "Prepotency" is the analogue, limited to the power which one particular sire seems to have over others, as exemplified in some of the calves subsequently born showing the peculiarities of the male first paired with the dam. On account of this latter result it is always advisable to use the best male possible with a young female, in order that her subsequent progeny may not be inferior, and also (as explained on p. 363) that fresh vigour may be transmitted to the dam from the sire through the fœtus, and thus beneficially influence the future young. By crossing two cross-bred animals it is sometimes possible to etablish a new breed, as exemplified in the Oxford Down Sheep. The following conclusions have been arrived at by breeders:—

1. Man has the power of controlling and modifying the forms of all animals.

2. Such modified forms can be handed down to the progeny; but, being departures from the primitive or natural type, this form can only be maintained by "artificial selection."

3. It is best to seek for improvement through the male, both on account of his own special endowments, and also because one male can serve many females.

4. Qualities of form and character become hereditary in proportion to the frequency of repetition in past generations, but high pedigree will not make up for important defects.

5. Animals closely related may be paired, provided that they are healthful, well-formed, without hereditary taint, and that the practice be not continued through many generations.

6. Young females should be placed to the best of their own kind at the first, to avoid reappearance of stain in future progeny.

7. Science has not revealed any rule by which the proportion of the sexes can be pre-determined and secured.

8. The sire exercises most influence on the size, muscular power, and general conformation of, while the dam influences the nervous system and constitution of, and is more likely to impart hereditary diseases or weakness to, the offspring.

LIVE STOCK SOCIETIES.

Horses.

Shire Horse Society.
Clydesdale Horse Society.
Suffolk Horse Society.
Cleveland Bay Horse Society.
Yorkshire Coach Horse Society.
Thoroughbred General Stud Book.
Hackney Horse Society.
Association for Improvement of the Breed of New Forest Ponies.
Shetland Pony Stud Book.

Cattle.

Shorthorn Society.
Lincolnshire Red Shorthorn Association.
Hereford Herd Book Society.
Hereford Cattle Breeders' Association.
Devon Cattle Breeders' Society.
South Devon Herd Book Society.
Sussex Herd Book Society.
Highland Cattle Society.
North Wales Black Cattle Society.
Red Polled Society.
Polled (Scots) Cattle Society.
Galloway Cattle Society.
Ayrshire Cattle Herd Book Society.
English Jersey Cattle Society.

Jersey Herd Book.
English Guernsey Cattle Society.
Kerry and Dexter Cattle Society.
Kerry and Dexter Herd Book.

Sheep.

National Sheep Breeders' Association.
*Leicester Sheep Breeders' Association.
*Wensleydale Long-Wool Sheep Breeders' Society and Flock Book Association.
Incorporated Wensleydale Bluefaced Sheep Breeders' Association and Flock Book Society.
*Lincoln Long-Wool Sheep Breeders' Association.
*Cotswold Sheep Society.
Devon Long-Wool Sheep Society.
Kent Sheep Breeders' Association.
Roscommon Sheep Breeders' Association.
*Southdown Sheep Breeders' Association.
Southdown Club.
*Suffolk Sheep Society.
*Oxford Down Sheep Breeders' Association.
*Hampshire Down Sheep Breeders' Association.
*Shropshire Sheep Breeders' Association and Flock Book Society.
*Dorset Horn Sheep Breeders' Association.
Cheviot Sheep Society.

* Affiliated with the National Sheep Breeders' Association.

Pigs.

National Pig Breeders' Association.

Life of Animals.

	Years.		Years.
Horse	35	Dog	13
Ox or cow	20	Goose	80
Sheep	10	Hen	14
Pig	25	Cat	12
Ass	30	Hare	8
Goat	15	Rabbit	7

Weight of Men and Horses.

A Crowd of Men—packed	=	84 lbs. per square foot.
A Light Horse, about	=	8 cwt.
A Cavalry Horse, ,, ...	=	11 ,,
A Strong Cart Horse	=	14 ,,

List of Principal Animal Parasites.

Scientific Name.	Common Name.	Attack.
A—Scolecida		
I. Tæniada or Cestoda (Tape or Bladder Worms)—		
Cysticercus cellulosus...	"Measles" in pork...	Tapeworm in man. (*Tænia solium.*)
Cœnurus cerebralis ...	"Sturdy" in sheep...	Tapeworm in dog. (*Tænia cœnurus.*)
II. Trematoda (Flat Worms)—		
Fasciola hepatica ...	"Fluke" or "Rot"	Liver of sheep.
III. Acanthocephala (Thorn-headed Worms)—		
Echinorynchus gigas...	—	Intestines of pig; rare.
IV. Nematoda (Round Worms)—		
Trichina spiralis ...	Flesh worm	Muscle of man, pig, &c. Cause of "trichiniasis."
Strongylus filaria ...	"Husk" in lambs ...	Bronchial tubes.
Strongylus micrurus..	"Husk" in calves ...	,, ,,
Strongylus cervicornis	"Lamb disease" ...	Cause of gastro-enteritis.
Sclerostoma syngamus	"Gapes" in fowls ...	Bronchial tubes.
Oxyurus curvula... ...	"Maw-worm"	Intestines of horse.
Ascaris megacephala...	"Worms" in horse...	,, ,,
Ascaris marginata ...	"Worms" in dog ...	Intestines of dog.
B—Aracnida.		
Acarida (Mites)—		
Sarcoptes scabiei... ...	"Itch"	Man, &c.
Sarcoptes equi	—	Horse.
Sarcoptes ovis	—	Sheep.
Sarcoptes suis	"Mange"	Pig.
Sarcoptes canis	,, ...	Dog.
Dermatocoptes equi ...	,, ...	Horse.
Dermatocoptes bovis ...	,, ...	Ox.
Dermatocoptes ovis ...	"Scab"	Sheep.
Ixodes ricinus	True "Tick"	,,
Ixodes reduvius	,, ,, ...	,,
C—Insecta (Insects).		
I. Anoplura—		
Hœmatopinus eurysternus.	Sucking louse	Ox.
II. Mallophaga—		
Tricodectes scalaris ...	Biting louse	Ox.
Mallophagus ovinus ...	"Ked:" Sheep louse	Sheep.
III. Diptera—		
Œstrus equi	"Bot"	Stomach of horse.
Œstrus bovis...	"Warble"...	Under skin: ox.
Œstrus ovis	Sheep "Bot"	Nostrils.
Musca vomitoria... ...	"Maggot-flies," "Blow-flies" or "Bluebottle flies"	Skin of sheep.
Musca cadaverina ..	,, ,,	,, ,,
Tabanus bovinus... ...	"Gadfly or "Cleg"	Sucks blood.

Zoological Classification of the Domestic Animals.

Class :—Mammalia.

Order :—Ungulata (Hoofed).

Sub-order A :—PERISSODACTYLA (Odd-toed).

I. Solidungula (Solid-hoofed).

Equidæ—

Equus caballus (HORSE).

Asinus vulgaris (ASS).

Sub-order B :—ARTIODACTYLA (Even-toed).

II. Ruminantia (Ruminant).

Bovidæ—

Bos taurus (OX).

Ovidæ—

Ovis aries (SHEEP).

Capra hircus (GOAT).

III Omnivora (Omnivorous).

Suidæ—

Sus scrofa (EUROPEAN PIG).

Sus Indicus (CHINESE PIG).

FORESTRY.

Nat. Ord. *Cupuliferæ.*

OAK—*Quercus Robur.*—Two varieties, the sessile fruited (*sessiliflora*) and the peduncled (*pedunculata*): the latter the most common, and considered by some to yield the best timber. Thrives best on a strong, deep, rich clay, and does not like a light open soil. Grows well with Larch, as it is deep-rooted, while the Larch is shallow-rooted. Stumps yield good coppice wood. Yields best tanning bark—one ton to four tons timber on average—and is felled after the sap rises in spring for this purpose. Timber straight-grained, hard, and heavy.

BEECH—*Fagus sylvatica.*—Suits light, dry, calcareous soils. Makes good shelter hedges. Reaches maturity at 70 to 80 years, and grows to over 100 feet high. The timber is hard and rather brittle, but suits well for woodwork under water.

HORNBEAM—*Carpinus Betulus.*—Very similar in appearance to the Beech, but not so valuable timber, though it will stand great strain. Reaches 80 feet in height. Makes good shelter fences. Yields a very hot fire as faggot-wood, and good charcoal. Timber white, and of fine texture. Requires good soil, and will not thrive on chalk.

SPANISH CHESTNUT—*Castanea vulgaris.*—Suits deep, dry, sandy loam. Reaches 80 feet high. Timber hard and durable, resembling the Oak, but it is most valuable when felled young, as it becomes brittle when old. Is ornamental, and shoots well from the stool.

BIRCH—*Betula alba.*—Very hardy, and suitable for northern districts. Will grow on wet or mossy land, and thrives after the Scots' Pine Grows to 60 feet in height, and matured at 70 years old. Timber white and firm, and bark used for tanning nets and cordage. Good coppice wood. The Weeping Birch (*B. alba pendula*) is another common variety.

ALDER—*Alnus glutinosa.*—Thrives best on damp alluvial land: the most aquatic tree in Britain. Grows to 70 feet high, and matures in 50 to 60 years. Timber resembles Willow, and is good for charcoal for powder-making.

HAZEL—*Corylus Avellana.*—The most suitable for underwood and copsewood. Grows best on good dry, sandy loams, and in sheltered situations, but is very hardy. Does not suit Pine woods. Wood esteemed for gunpowder charcoal.

Nat. Ord. *Urticaceæ.*

ENGLISH ELM—*Ulmus campestris.*—Suits a rich clay loam best, and reaches maturity in 70 to 80 years, after which it tends to rot in the centre. Branches grow upwards, leaving a good bole. Rarely seeds in England, and is propagated by layers from the stools: the plants may be planted out of large size, as the roots are very fibrous. Wood is brown, hard; and of fine grain, much used for weather-boarding and rough inside work.

Wych or Mountain Elm—*Ulmus montana.*—The species common in Scotland. Suits a wide range of soils. Reaches 80 feet in height, with the branches wide and drooping; short bole. Tough, elastic timber.

Nat. Ord. *Oleaceæ.*

Ash—*Fraxinus excelsior.*—Suits damp, rich, hazelly loams. Timber grown in poor sandy or gravelly soil is brittle. Should be tough and elastic. Sap is very fermentable, therefore the timber is best felled in autumn. Bad hedgerow tree, as roots ramify near the surface and impoverish the soil. Good coppice tree.

Nat. Ord. *Salicineæ.*

Poplar: Lombardy Poplar—*Populus fastigiata.*—Tall spire-like variety, with the branches gathered closely round the stem. Suits low-lying damp situations. A quick grower, and will stand the smoke of towns. Propagated by layers. Timber white, soft, and yielding.

Black or Italian Poplar—*P. nigra* or *monilifera.*—Branches more widespread than the former; twigs darker; profusion of scarlet catkins in spring before the leaves appear; leaves pale green, and smooth on both sides. Timber yellowish-white. Grows large timber. No suckers. Quick grower.

Aspen or Trembling Poplar—*P. tremula.*—Very hardy; native to hilly districts; suits various soils. Round-headed and tall in growth, and a quick grower. Roots near the surface.

Willow—*Salix.*—Many species. The most common are the White Willow (*S. alba*) and the Goat Willow or Saugh (*S. Caprea*). The former has white downy leaves, which are narrow and acute in shape, and the tree is of a tall habit of growth—50 to 80 feet high. Most frequently planted of any Willow for timber. Good for coppice, pollarding, and wickerwork. Timber white and soft. The latter has very broad leaves, wood "red-hearted," and tree of a more spreading habit. Suits swampy land; will grow on sea-shore; and also good for coppice and pollarding. Will grow after Scots' Pine and Larch. Timber light and soft.

Nat. Ord. *Sapindaceæ.*

SYCAMORE—*Acer Pseudo-platanus.*—Very hardy, and suits soft, deep, dry soil, and will grow on the sea-shore. Reaches 60-80 feet in height. Timber white, fine-grained, and hard.

MAPLE—*Acer campestre.*—A small tree; suits sheltered situations. Some varieties of the timber beautifully grained, yielding "bird's-eye maple." Good coppice wood.

HORSE CHESTNUT—*Æsculus hippocastanum.*—Suits a rich, deep, damp loam. Reaches 60 feet, and matures in 50 to 60 years. Timber very soft and worthless. Tree planted mostly for ornamental purposes, as the flowers are conspicuous in spring.

Nat. Ord. *Tiliaceæ.*

LIME—*Tilia Europœa.*—Requires shelter and good alluvial soil. Propagated by cuttings. Timber is soft and yellowish; used for carving. Planted mostly for ornament in avenues. Inner bark forms bast for tying. Suitable for pollarding.

Nat. Ord. *Juglandaceæ.*

WALNUT—*Juglans Regia.*—Suits poor, dry, sandy soil, as on river banks; vigorous tap-root. Often grown for its fruit: bears at 12 years old. The most ornamental timber of European growth.

Nat. Ord. *Coniferæ.*

SCOTS' PINE—*Pinus sylvestris.*—Requires heathy, open, exposed situations: suits poor, dry soils. Grows well where Birch is the natural tree. Timber resinous. Mature at 80 years.

CLUSTER PINE—*Pinus pinaster.*—Suits sandy sea-shores; strong tap-root. Reaches 80 feet on Norfolk coast. Cones grow in a cluster. Timber white and soft. Good shelter tree.

NORWAY SPRUCE—*Abies excelsa.*—The most common Spruce in Britain. Suits low-lying alluvial soils. Habit of growth, a regular cone. Matures in 70 to 80 years. Reaches 120 feet in height. Roots ramify near surface. Timber white and soft; no true "heart."

DOUGLAS SPRUCE—*Abies Douglasii.*—Species introduced from North America. Reaches 150 feet in height. Rich foliage like the Yew. Thrives in ground with moist subsoil, as alluvium. Timber white and soft; no true "heart."

SILVER FIR—*Picea pectinata.*—Suits rich, friable, moist loam, and thick planting. Tender when young, and unsuited to exposed situations. Will grow in the shade. Reaches 120 feet in height. Timber of a pale yellow, and does not warp; no true "heart."

LARCH—*Larix Europæa.*—The only deciduous conifer. Suits the shattered stony soils of hillsides. Needs much room to develop properly, but will stand close planting at first in bleak situations. Two varieties—white and red blossoms—the red being the best. Thrives best in a mixed plantation, especially if interspersed with Oak. Timber reddish, hard, and most valuable of the conifers.

Trees for Damp and Low-lying Situations.

Alder	Poplar	Horse Chestnut
Willow	Lime	Birch
Maple	Spruce	Silver Fir

Trees for High-lying, Exposed Situations.

Birch   Mountain Ash   Scots' Pine   Larch

Trees for the Sea-Shore.

Willow   Sycamore   Elder   Cluster Pine

Trees for Poor Soils.

Birch   Poplars   Willows   Rowan   Alder   Scots' Pine

Trees for Good Soils.

Oak   Elm   Ash   Sycamore   Beech   Silver Fir

Trees for Deep Soils.

Oak   Lime   Ash   Larch   Silver Fir

Trees for Shallow Soils.

Birch   Rowan   Spruce

Trees for Coppice or Pollarding.

Oak	Beech	Hornbeam	Hazel
Birch	Poplar	Willow	Ash
	Maple	Lime	

Hard Woods.

Oak	Beech	Hornbeam
Spanish	Chestnut	Elm
Birch	Ash	Sycamore
	Maple	Larch

Soft Woods.

Alder	Poplar	Willow
Horse Chestnut	Lime	Scots' Pine
Cluster Pine	Spruce	Silver Fir

Suitable Mixtures of Trees.

Oak with Ash, Elm, Beech, or Hornbeam.
Oak with Alder and Birch.
Oak with Scots' Pine, Larch, or Silver Fir.
Elm with Beech or Hornbeam.
Ash with Beech.
Beech with Hornbeam.
Beech with Larch, Silver Fir, or Spruce.
Sycamore with Beech, Silver Fir, or Spruce.
Larch with Silver Fir or Spruce.
Silver Fir with Spruce.
Scots' Pine with Larch or Silver Fir.
Scots' Pine with Beech or Hornbeam.

Influence of Geological Formations on Trees.

Rocks. (Figs. = Relative values.)	Apple.	Pear.	Oak.	Elm.	Beech.	Pine.
Chalk	2	0	2	4	8	5
Greensand	3	1	3	7	0	3
Gault	4	1	6	6	0	0
Oxford Clay ...	6	0	10	8	0	1
Oolite Freestone ...	2	0	1	4	10	5
Lias	10	3	5	10	0	1
New Red Sandstone (Marl)	8	0	7	12	0	2
Mountain Limestone	1	0	2	2	3	1
Old Red Sandstone...	15	8	8	10	0	1

Trees should be felled in winter, and seasoned from two to five years, being stacked in the shade butt downwards, but not in contact with the damp soil. Soaking the timber, when thoroughly dry, in creosote will preserve it from decay for a very long time, especially where exposed in outside work. The creosote should contain at least 10 per cent. of crude carbolic and cresylic acids.

Tree Seed Data.

	Seeding Maturity.	No. of Seeds in a Lb.	Weight of Bushel of Seed	Seeding per Acre.
	Years.		Lbs.	Lbs.
Alder	30–40	300,000	24	15
Ash	40–50	6,500	12	35
Beech	60–70	2,000	36	150
Birch	25–30	800,000	8	30
Chestnut, Spanish ...	50–60	115	58	600
,, Horse	30–40	110	58	600
Elm	40–50	70,000	4	25
Fir, Silver	70–80	10,000	25	40
Hornbeam	40–50	14,000	40	35
Larch	30–40	75,000	30	14
Lime	30–40	5,000	—	—
Maple	40–50	5,000	12	35
Oak	70–80	130	60	550
Pine, Scots'	40–50	70,000	30	6
Spruce, Norway	50–60	65,000	35	10
Sycamore	40–50	5,000	12	30

Tree Growth Data.

	Limit above Sea Level.	Average Height.	Timber Maturity at	Extreme Age.
	Feet.	Feet.	Years.	Years.
Alder	1,600	70	50–60	100
Ash	1,350	100	40	300
Beech	1,200	100	70–80	500
Birch	2,500	60	70	100
Chestnut, Spanish ...	800	80	50	500
Elm, English	1,500	120	70–80	500
,, Wych...	1,300	80	40	500
Fir, Silver	1,200	120	70	300
Hazel...	2,000	30	10	80
Hornbeam	600	80	40	300
Larch	2,000	130	30	300
Lime	800	100	30	1,070
Maple	1,200	20	35	520
Oak	1,500	110	70	1,600
Poplar, Black	1,600	90	50–60	100
,, Lombardy ...	1,600	150	—	100
Pine, Scots'	2,2[illegible]0	110	80	200
Spruce, Norway ...	2,000	120	70–80	300
Sycamore	1,500	70	40	720
Willow, Goat	2,000	70	—	100

Timber Data.

	Specific Gravity: Air-dried.	Weight of a Cubic Foot.	Cubic Feet in a Ton.	Order of Transverse Strength	Order of Durabilty.
		Lbs.			
Alder	·53	33	67	13	12
Ash	·75	46	48	2	6
Beech	·74	46	48	4	9
Birch	·64	40	56	14	14
Chestnut, Horse ...	·57	35	64	15	17
.. Spanish	·66	41	54	3	4
Elm, English ...	·69	43	52	10	5
Fir, Silver	·48	30	74	9	8
Hazel	·63	39	57	18	19
Hornbeam	·72	45	50	5	10
Larch	·62	38	58	7	2
Lime	·45	28	80	16	15
Maple	·67	42	50	11	13
Oak	·86	53	42	1	1
Pine, Scots	·52	32	70	8	3
Poplar	·48	30	74	17	16
Spruce, Norway ...	·47	30	74	6	7
Sycamore	·66	41	54	12	11
Willow...	·53	33	68	19	18

TIMBER MEASUREMENT.

Take the average girt in inches, divide by 4, deduct 1 inch for bark for each foot of circumference, and square the result: this gives mean sectional area. Multiply this by length of tree in feet and divide by 144: the quotient = contents in cubic feet.

Timber less than 26 inches round the bark is not included in the length.

To cut the best beam from a log, divide the diameter on a cross section into three, and erect perpendiculars from the two dividing points: the places where the diameter and the perpendiculars cut the circumference give the corners of the log.

To cut the stiffest beam, divide the diameter into four, and draw the perpendiculars from the two outer dividing points.

Generally, the more nearly the saw-cuts approximate to the medullary rays, the better will the timber stand tear and wear.

Comparative Values of different Timbers per Cubic Foot.

	s. d.		s. d.		s. d.		s. d.
Alder	1 0	to	1 6	Larch	0 10	to	1 3
Ash...	1 3	,,	2 6	Lime	2 0	,,	3 6
Beech	0 8	,,	1 0	Maple	0 6	,,	1 6
Birch	1 0	,,	1 6	Oak...	2 0	,,	3 0
Box	3 0	,,	5 0	Poplar	0 6	,,	1 0
Cherry (wild)	0 8	,,	1 0	Scots' Pine and Spruce Fir	0 4	,,	0 8
Chestnut (horse)	1 6	,,	2 0	Sycamore ...	1 6	,,	2 6
,, (Spanish)	1 6	,,	2 0	Walnut	2 0	,,	3 0
Elm	1 0	,,	1 9	Willow	1 6	,,	2 0
Holly	2 0	,,	4 0	Yew	2 0	,,	3 0
Hornbeam ...	2 0	,,	2 6				

Number of Trees to an Acre.

2 ft. apart	each way,	10,890	12 ft. apart	each way,	302
3 ,,	,,	4,840	15 ,,	,,	200
4 ,,	,,	2,722	18 ,,	,,	135
5 ,,	,,	1,742	20 ,,	,,	110
6 ,,	,,	1,210	22 ,,	,,	90
8 ,,	,,	680	25 ,,	,,	70
10 ,,	,,	435	30 ,,	,,	50

Hedges.

Where the soil is deep and dry or well drained, hedges should be planted on the flat. Land should be trenched in autumn along the site, 4 feet wide and 20 inches deep, placing the surface soil at bottom. If the soil is bad at places, it should be dug out and good soil filled in. Plant before winter or early in spring, and set the plants upright, and not horizontally, in a notch or small trench made along the surface. One line of plants at 6 inches apart is best. A dressing of farmyard manure acts very beneficially. The Common Hawthorn (*Cratægus Oxyacantha*) is the best plant, but others suitable for special situations are Beech, Hornbeam, Holly, Sloe, Crab-Apple, Elder, Privet, Yew, and Gorse. A hedge is never now made on a raised bank, but the earth taken from the ditch (where such is necessary in wet or retentive ground) may be put on one side and sloped down fieldwards, and the row of plants set in on the top as the work proceeds.

TABLE SHOWING THE COMPOSITION OF THE ASHES OF TREES.

Name of Plants, or of their Parts.	Potash.	Soda.	Magnesia.	Lime.	Phosphoric Acid.	Sulphuric Acid.	Silica.	Peroxide of Iron.	Chloride of Sodium.	Chloride of Potassium.
Beech (Fagus sylvatica), Wood	11·80	2·04	8·42	47·25	3·29	1·01	1·09	0·60	0·16	...
,, ,, Seeds	22·82	9·50	11·64	24·50	20·81	2·20	1·88	2·67	0·87	...
Elm (Ulmus campestris), Wood	21·92	13·72	7·71	47·80	3·33	1·28	3·07	1·17	...	...
,, ,, Bark	2·22	10·09	3·19	72·70	1·59	0·62	8·77	0·82	...	...
Larch, Wood	15·24	7·27	24·50	26·97	1·79	3·60	3·60	4·25	0·92	0·92
Lime (Tilia Europaea), Wood	35·80	5·23	4·15	29·93	4·85	5·30	5·26	7·97	1·49	...
,, ,, Bark	16·14	4·53	8·03	60·81	4·02	0·75	2·27	1·24	2·21	...
Oak (Quercus Robur), Wood	5·65	3·77	3·01	50·58	2·32	0·78	0·52	0·38	0·02	...
,, ,, Seeds	64·64	...	5·57	6·86	19·19	...	0·96	1·89	0·98	...
Pinus sylvestris, Wood	7·17	6·26	9·19	31·50	2·07	5·72	5·72	2·33	0·81	0·81
,, ,, ,, ...	2·79	15·99	19·76	31·74	1·93	3·04	3·04	3·51	1·48	1·48
,, ,, Seeds	22·37	1·26	15·09	1·86	...	10·44	10·44	3·01	...	...

PRINCIPAL INSECTS INJURIOUS TO TREES.

NAME.	Destructive Stage.	Trees Affected.	Part Affected.	Remarks and Treatment.
COLEOPTERA:				
Hylesinus fraxini—Ash-bark Beetle	Beetle and larva	Ash	Under the bark	Drain land and thin out; wash trunks with soft soap if attack circumscribed.
Hylobius abietis—Pine Weevil	Do.	Pines and Firs	Young shoots	Remove thinnings and rubbish; set pieces of pine logs round trunks to act as "beetle traps."
Hylurgus piniperda—Pine Beetle	Do.	Pines	Under the bark&young shoots	As with the weevil above.
Scolytus destructor—Elm-bark Beetle	Do.	Elm	Inside bark	Scrape off rough bark, so as to cause an extra flow of sap if not numerous.
HYMENOPTERA:				
Cynips kollari—Marble-gall Fly	Larva	Oak	Bud	Cut off in small trees while galls are young.
LEPIDOPTERA:				
Cossus ligniperda—Goat Moth	Do.	Oak and others	Timber	Soft soap rubbed on bark and over the tunnellings, if trees not too numerous.
Tortrix viridana—Oak Leaf-roller Moth	Do.	Oak	Leaves	Encourage wild birds.
HOMOPTERA:				
Chermes laricis—Larch Aphis	Do.	Larch	Buds	Spray with lime-water or soap-wash.

Fungoid Diseases of Trees.

Trametes radiciperda—Root-Rot.—Worst on conifers. Mycelium grows between the cortex and wood, living on the cambium, and eventually grows into and through the timber, and appears as flat silky bands when the cortex is stripped off. The fructification appears below ground, breaking through the cortex in patches, and appearing as a yellowish white mass of felt-like substance. Leaves of tree turn pale and yellow and die off, and then the lower part of the stem begins to die and rots.

Agaricus melleus.—Tawny yellow toadstool, with ring round the stem. Grows from dark shining stringy mycelium (rhizomorphs) which penetrates the roots of many trees, especially those of Beech and Spruce. The leaves grow pale and drop off, while the timber rots from below upwards. Dig ditches round affected tree to check spread of rhizomorphs.

Polyporus sulphureus.—Bracket-like yellow fungus which grows from the side of trees. Attacks trees at wounds, and rots the timber. Mycelium fills up spaces between cells and rings and cracks, as dense corky sheets. Timber becomes reduced to a powdery condition. Prevent by dressing wounds with coal tar, &c.

Peziza Willkommii—Larch "Canker."—Grows below the bark, causing cracked and diseased patch, with flattened deformed stem. Prevents the growth of wood layers at affected part, and eventually kills the tree by "ringing." Small cup-like fructification appears outside the bark, and resin flows from the diseased part. Spores will germinate on and penetrate bark of trees or branches under 4 years old, and crowded plantations favour it. May be treated by cutting out the diseased part while young. Drain the land and keep thinned.

Peridermium pini—Pine "Blister."—Needle-like leaves become affected in April and May with yellow vesicles, forming a fungus. The mycelium is in the tissues of the leaf, and a variety affects the twigs. It prevents the formation of wood layers in a way similar to that of the "canker" on Larch. Passes a stage of its life as the *Coleosporium Senecionis* on the ragweed. Remove affected parts or trees, and keep down the above weeds in the neighbourhood.

Anything which interferes with the healthy growth of a tree encourages the attacks of insects and fungi. If the kind of trees suitable to a given situation be planted, the superfluous moisture removed by surface drains, thinning properly carried out, wounds dressed with an antiseptic like coal tar, dead branches and other rubbish removed and burnt, then the trees are likely to continue in a healthy growing state, and are less likely to succumb to the attacks of their enemies.

HORTICULTURE.

Market Gardening.

Plant.	Seed per Acre.	Distance between Rows.	Distance apart in Rows.	Yield per Acre.
Artichoke	7 cwt. of setts	36 inches	18 inches	200–300 bush.
Asparagus	4 to 5 lbs. ...	36 to 48 in.	12 ,,	...
Bean, Broad	1½ bushel ...	36 inches	9 ,,	75–120 bush.
,, Runner ...	1 ,, ..	48 ,,	12 ,,	100 bushels.
,, French ...	1 ,, ...	30 ,,	12 ,,	100 ,,
Brussels Sprouts ...	3 to 4 lbs. ...	30 ,,	18 ,,	...
Buckwheat	1 bushel ..	12 ,,	...	25–30 bushels
Cabbage, Early	1 oz. = 2,500 plants ...	24 ,,	18 ,,	25 tons.
,, Late ...	,, ,,	36 ,,	24 ,,	30 ,,
Carrot	3 to 4 lbs. (dressed) ..	24 ,,	3 ,,	400–700 bush.
Cauliflower ...	1 oz. per 1,000 plants ...	30 ,,	24 ,,	...
Celery	1 oz. per 2,000 plants ...	36 ,,	9 ,,	...
Cress, Garden ...	2 to 3 lbs. ..	18 ,,	3 ,,	..
Cucumber	2 lbs.	48 ,,	48 ,,	50,000 fruits.
Kail	1 oz. = 2,500 plants ...	28 ,,	18 ,,	...
Lettuce	1 oz. = 1,000 plants ...	18 ,,	12 ,,	...
Leek	5 to 6 lbs. ...	12 ,,	3 ,,	...
Mustard	¼ bushel ...	18 ,,	3 ,,	...
Onion	5 to 6 lbs. ...	12 ,,	3 ,,	300–600 bush.
Parsley	,, ...	12 ,,	3 ,,	...
Parsnip	4 to 6 lbs. ...	24 ,,	6 ,,	500–800 bush.
Pea	1 to 2 bushels	36 ,,	3 ,,	100–150 ,,
Potato	12 cwt. of setts	28 ,,	12 ,,	100–300 ,,
Radish	8 to 10 lbs. ..	12 ,,	3 ,,	...
,, Horse ...	7,260 setts ...	36 ,,	24 ,,	3 to 5 tons.
Rhubarb	3,630 ,, ...	48 ,,	36 ,,	...
Salsafy	8 to 10 lbs. ...	18 ,,	6 ,,	200–300 bush.
Shallot	90,000 setts ...	12 ,,	6 ,,	...
Spinach	10 to 12 lbs. ..	30 ,,	6 ,,	...
Tomato	1 oz. = 700 plants ...	48 ,,	48 ,,	8 to 16 tons.
Turnip	3 to 4 lbs.	24 ,,	9 ,,	600-1,000 bush.

Average Weights of One Peck Vegetables, &c.

Apples	10 lbs.	Pears	12 lbs.
Broad Beans	9 ,,	Plums and Stone Fruit	14 ,,
Currants	14 ,,	Potatoes	14 ,,
Filberts	7 ,,	Raspberry	12 ,,
Green Peas	8 ,,	Strawberry	12 ,,
Gooseberries	14 ,,	Swede Turnips ...	12 ,,
Kidney Beans... ...	10 ,,	White ,, ...	12 ,,
Onions	16 ,,		

Fruit-Growing.

Plant.	Distance apart of "Standards" each way.	Time to Fruiting.		Annual Yield.	Profitable Life.
Apple ...	30 × 20 ft.	3 yrs.	Good in 6 — 8 yrs.	20 — 30 bushels in alternate years per tree	40 — 50 yrs.
Cherry ..	20 × 16 ,,	3 ,,	,, 8 — 10 ,,	3 — 5 ,, ,,	30 — 40 ,,
Currant ...	6 × 4 ,,	1 yr.	,, 2 — 3 ,,	100 bushels per acre ...	15 — 20 ,,
Gooseberry	6 × 4 ,,	1 ,,	,, 3 — 4 ,,	100 ,, ,, ...	15 — 20 ,,
Peach ...	20 × 16 ,,	2 yrs.	,, 3 — 4 ,,	5 — 10 bushels per tree	8 — 12 ,,
Pear	30 × 20 ,,	3 — 4 yrs.	,, 6 — 12 ,,	25 — 35 ,, ,,	50 — 60 ,,
Plum	20 × 16 ,,	3 yrs.	,, 8 — 10 ,,	5 — 8 ,, ,,	30 — 40 ,,
Raspberry ...	6 × 3 ,,	1 yr.	,, 2 — 3 ,,	50 — 100 ,, per acre	8 — 12 ,,
Strawberry	3 × 2 ,,	1 ,,	,, 2 — 3 ,,	75 — 250 ,, ,,	4 — 5 ,,

MISCELLANEOUS.

WEIGHT OF PLOUGH HARNESS

Collar	15	lbs.
Haims—iron-plated and straps ...	7	,,
Bridle	5	,,
Backband	3	,,
Chains...	8	,,
Total	38	lbs.

DUBBING.

2 lbs. black resin, 1 lb. tallow, 1 gallon train oil.

AXLE GREASE.

$1\frac{3}{4}$ parts tallow, $1\frac{1}{4}$ part palm oil: boiled and stirred, then strained into solution of $\frac{1}{2}$ part of soda and $\frac{1}{4}$ part water: mixed well.

PAINT MIXTURE.

6 pints raw linseed oil, 1 pint boiled oil. 1 pint turpentine (total 1 gallon), takes 12 to 14 lbs. of dry paint, and will cover 50 sq. yds. of timber-work, 25 of stone or brick, and 80 of iron. Gas tar will cover 12 sq. yds. per gallon at first coat, and 16 sq. yds. at second coat.

Weights of a Few Common and Useful Things.

	Specific Gravity. Distilled Water = 1.		Weight of a Cubic Foot in Lbs.
Gases.			(At one atmosphere)
Air	·00129		·0807
Ammonia	·00076		·0474
Carbonic acid	·00197		·123
Nitrogen	·00125		·078
Oxygen	·00143		·089
Steam	·00061		·038
Liquids.			
Water, distilled ...	1·00		62·425
,, rain	1·0013		62·506
,, sea	1·027		64·110
Oil, linseed	·94		58·0
,, olive	·915		57·0
,, petroleum, crude	·885		55·25
,, ,, refined	·910		60·55
Sulphuric acid, stand'd	1·825		115·0
Urine, horse	1·03 to 1·06		64·3 to 66·2
Timbers.	Fresh Felled.	Dry.	Dry.
Alder...	·857	·53	33
Ash	·903	·69 to ·76	43 to 47
Beech...	1·000	·69 ,, ·74	46
Birch	·901	·64	40
Chestnut, Horse ...	·900	·57	35
,, Spanish ...	·960	·66	41
Deal	...	·689	43
Elm	·947	·55 ,, ·69	34 ,, 43
Fir. silver	·870	·48	30
Hornbeam...	1·085	·72	45
Larch...	·920	·54 ,, ·62	34 ,, 38
Lime	·817	·45	28
Maple	·960	·675	42
Oak	1·075	·77 ,, ·86	48 ,, 53
Pine, red	...	·57 ,, ·657	36 ,, 41
,, white	·785	·43 ,, ·553	27 ,, 34
,, yellow	...	·508	32
,, Scots'	·912	·52	32
Poplar (Italian) ...	·963	·48	30
Spruce (Norway) ...	·735	·47	30
Willow	·715	·529	33

Weights of a Few Common and Useful Things—*contd.*

	Specific Gravity. Distilled Water = 1	Weight of a Cubic Foot in Lbs.	
Roots.		(As solid cubes.)	
Swede: December	1·035	64·61	
,, June (after flowering)	·994	62·05	
,, white	1·022	63·80	
Turnip, purple-top yellow...	·98 to 1·000	61 to 62·42	
,, yellow bullock ...	·940	58·68	
,, globe	·840	52·40	
Carrot	1·018	63·50	
Potato	1·120	70·00	
Rocks, &c.			
Basalt	2·75 to 2·95	172 to 184	
Chalk	2·33 ,, 2·62	145 ,, 162	
Flint	2·54 ,, 2·74	162 ,, 170	
Granite	2·5 ,, 2·67	160 ,, 167	
Limestone	2·60	162	
,, Blue Lias	2·46	154	
Oolite, Bath stone	1·98	123	
,, Portland stone ...	2·42	151	
Quartz	2·65	166	
Sandstones, various	2·15 ,, 2·63	157 ,, 165	
Slate, Welsh...	2·88	180	
Trap	2·72	170	
Rock salt	2·25	140	
Granular salt	...	46	
		(In natural state.)	
Earths, &c.	(As solid masses.)	Dry.	Wet.
Arable soil	2·40	84·5	119·1
Calcareous sand	2·72	113·6	141·3
Carbonate of lime (fine) ...	2·46	53·7	103·5
Clay, pure grey	2·53	75·2	115·8
,, brick (stiff)	2·56	80·3	119·6
,, loamy	2·58	88·5	124·1
,, pipe	2·44	47·9	102·1
,, sandy	2·60	97·8	129·7
Earth, common	1·48	78·0	98·0
,, and gravel	2·02	83·0	90·0
Garden mould	2·33	68·7	102·7
Gypsum powder	2·33	91·9	127·6
Humus	1·37	34·8	81·7
Peat	1·30	32·0	70·0
Sand, silicious	2·65	111·3	136·1
Slaty marl (fine)	2·63	112·0	140·3

Weights of a Few Common and Useful Things—*contd.*

	Specific Gravity. Distilled Water=1	Weight of a Cubic Foot in Lbs.
Metals.		
Iron, cast	7·0 to 7·6	437 to 474
,, wrought	7·6 ,, 7·8	474 ,, 486
Lead, sheet	11·4	711
Steel	8·0	500
Zinc, rolled	7·2	450
Miscellaneous.		
Asphalte	2·5	156
Beef bones	1·65	70
Brick, various	1·6 to 2·00	100 to 125
Cement, Portland	3·1 ,, 3·15	86 ,, 94
Coal	1·27 ,, 1·29	79 ,, 80
Coke	·74	46
Concrete (cement)	2·2	137
Glass	2·53	158
Gypsum...	2·28	143
Ice	·92	57·4
Lime (quick, fine)	·84	53
Mortar	1·4 to 1·90	86 to 119
Pitch	1·15	69
Snow, loose	...	5 ,, 12
,, moist	...	15 ,, 20
Tallow	·94	59
Tar (gas)	1·02	63
Tiles, common	1·81 ,, 1·85	112 ,, 115

The specific gravities of the "Earths, &c.," given above are for these reckoned as solid bodies in the usual way. Thus sand appears with the same specific gravity as quartz or sandstone rock. This is very misleading for practical purposes, and therefore the weight of a cubic foot in the ordinary loose state must be noted and compared with a cubic foot of water for correct results. The actual specific gravity of these in the natural state (dry) will range from 1·2 to 2·0.

Average Yield of Wheat per Acre in different Countries.

	Bushels.		Bushels.
Austria	16	Greece	13
Australasia	12·62	Germany	18·7
New South Wales	14·93	Holland	23
Queensland	11·33	Hungary	13
South Australia ...	7·99	India	14
Victoria	12·52	Italy	12
West Australia ...	11·36	New Zealand	26·28
Tasmania	18·19	Norway	23
Bavaria	16	Portugal	9
Belgium	23	Prussia	17
Canada—		Russia	6
Ontario	20	Sweden	20
N. W. T.	22·5	Spain	23
Denmark	26	Wurtemburg	25
Egypt	15	United States	12
France	16	United Kingdom ...	29·25

Average Yield of Potatoes per Acre in different Countries. (Four seasons, 1884–87.)

(Sir H. J. Gilbert.)

	Tons per Acre.		Tons per Acre.
England and Wales ...	6·23	Australasia	3·81
Scotland	5·90	Germany	3·31
Great Britain	6·14	Sweden	3·21
Ireland	3·90	Russia in Europe ...	2·93
United Kingdom ...	4·82	France	2·80
Norway	6·01	Austria	2·76
Belgium	4·54	Hungary	2·62
Holland	4·09	Denmark	2·59
Italy	4·09	United States	1·87

Estimated Average Yield of the Principal Crops of the United Kingdom over Ten Years.

	Corn Crops.					Green Crops.			Other Crops.	
	Wheat. Bush.	Barley. Bush.	Oats. Bush.	Beans. Bush.	Peas. Bush.	Potatoes. Tons.	Swedes. Tons.	Mangolds. Tons.	Hay of all sorts. Tons.	Hops. Cwts.
1884	29·96	34·08	37·52	25·78	24·64	6·62	13·35	16·98	—	—
1885	31·31	35·11	36·85	20·49	18·76	5·83	10·18	15·43	1·41	7·14
1886	26·89	32·17	37·84	27·04	27·31	5·72	14·97	20·84	1·36	11·07
1887	32·07	31·32	34·74	22·49	24·43	6·37	10·01	15·04	1·15	7·18
1888	28·05	32·84	37·24	28·68	24·21	5·18	12·69	17·27	1·41	4·81
1889	29·89	31·78	39·27	28·81	26·28	6·19	14·63	18·76	1·53	8·62
1890	30·74	35·02	41·40	32·65	28·71	5·31	14·25	18·25	1·40	5·26
1891	31·26	34·14	38·77	29·66	28·23	5·73	13·24	19·03	1·26	7·78
1892	26·38	34·61	38·80	22·19	25·85	5·80	14·12	18·49	1·06	7·35
1893	25·95	28·69	35·59	19·30	22·61	6·59	13·30	12·84	0·73	7·21
Average	29·25	32·97	37·80	25·70	25·10	5·93	13·07	17·19	1·13	6·64

Average Prices of LIVE MEAT at the Metropolitan Cattle Market.

Beef, per Stone of 8 Lbs.

	Inferior.		Second.		First.	
	s.	d.	s.	d.	s.	d.
1878	4	6	5	5	6	0
1879	4	1	4	11	5	6
1880	4	6	5	5	5	11
1881	4	5	5	1	5	6
1882	4	4	5	7	6	0
1883	4	4	5	7	6	1
1884	4	1	5	4	5	9
1885	3	11	4	9	5	3
1886	3	3	4	3	4	10
1887	3	0	3	8	4	5
1888	2	4	4	2	4	11
1889	2	4	4	5	4	10
1890	2	4	4	4	4	10
1891	2	9	4	4	4	11
1892	2	10	4	2	4	10
1893	2	10	4	1	4	9
1894	2	5	3	11	4	6
1895	2	8	3	11	4	6

Mutton, per Stone of 8 Lbs.

	Inferior.		Second.		First.	
	s.	d.	s.	d.	s.	d.
1878	5	4	6	4	6	10
1879	5	5	6	1	6	7
1880	5	6	6	4	6	10
1881	5	8	6	4	6	9
1882	6	1	6	9	7	2
1883	6	2	6	9	7	3
1884	5	6	5	11	6	5
1885	4	6	5	2	5	8
1886	4	2	5	5	6	0
1887	3	7	4	8	5	3
1888	3	3	4	11	5	10
1889	3	6	5	7	6	4
1890	4	6	5	6	6	3
1891	3	9	5	3	5	10
1892	3	9	5	1	5	8
1893	3	8	4	8	5	5
1894	3	7	5	2	5	10
1895	3	11	5	4	5	11

Pork, per Stone of 8 Lbs.

	Inferior.		Second.		First.	
	s.	d.	s.	d.	s.	d.
1878	3	10	4	6	4	10
1879	3	9	4	4	4	8
1880	4	1	4	10	5	3
1881	4	6	5	0	5	4
1882	4	3	4	8	5	0
1883	4	0	4	5	4	9
1884	3	8	4	2	4	7
1885	3	3	3	10	4	3
1886	2	6	3	9	4	6
1887	2	5	3	6	4	4
1888	2	5	3	6	4	1
1889	2	6	3	10	4	5
1890	2	5	3	8	4	1
1891	2	7	3	3	3	9

Average Prices of DEAD MEAT at the London Central Meat Market.

Per Lb. Carcase.

	Beef.	Mutton.
	d. d.	d. d.
1878	4¼ to 8¼	4¾ to 9¼
1879	4 ,, 7¼	4½ ,, 8½
1880	4¼ ,, 7¾	4¾ ,, 8¾
1881	4½ ,, 7¼	5 ,, 9
1882	4¾ ,, 8	5½ ,, 9½
1883	5 ,, 8	5¾ ,, 9¾
1884	4¼ ,, 7¾	5 ,, 8¾
1885	3¾ ,, 6¾	4¼ ,, 7½
1886	3½ ,, 6¼	4 ,, 8
1887	3 ,, 5¾	3¼ ,, 7
1888	3¼ ,, 6¼	3¾ ,, 7¾
1889	3½ ,, 7¼	5 ,, 9
1890	3½ ,, 7¼	6¾ ,, 9½
1891	4¼ ,, 7½	5½ ,, 8¾
1892	3 ,, 6¼	3⅛ ,, 7⅛
1893	3⅛ ,, 6⅜	3 ,, 6⅞
1894	2¾ ,, 6¼	2¾ ,, 7⅜
1895	2⅞ ,, 6¾	2⅞ ,, 7⅝

PRICES OF WOOL. (Average Prices per LB.)

	Lincolns.	Half-Breds.			Leicester.			WhiteCheviot			Southdown.			
	d.	d.		d.	d.		d.	d.		d.	d.		s.	d.
1885	10	8¾	to	9½	8½	to	9	11¼	to	13	9	to	1	0¼
1886	10	9½	,,	10¾	9	,,	9¾	11½	,,	13¾	9½	,,	1	0½
1887	10½	10	,,	11¼	9¾	,,	10¼	11½	,,	14	10¼	,,	1	0¾
1888	10¼	9½	,,	10½	9¼	,,	10	11½	,,	14	9¾	,,	0	11¾
1889	11	10¼	,,	11	9¾	,,	10½	12	,,	14	10¼	,,	1	0½
1890	11	10¾	,,	11½	9¾	,,	10½	12	,,	14	11	,,	1	1
1891	9¾	10	,,	10¾	9½	,,	10	11	,,	14	10½	,,	1	1
1892	8¾	9¾	,,	10¼	8½	,,	9	10	,,	14	10½	,,	1	0½
1893	10¼	9½	,,	10¼	8½	,,	9¼	10	,,	18½	10½	,,	1	0
1894	10	9	,,	10¾	9	,,	10	10	,,	13	9¾	,,	1	0
1895	12	9¼	,,	11	9¼	,,	10½	10	,,	12½	9½	,,	0	11½

AVERAGE PRICES OF WHEAT, BARLEY, AND OATS PER IMPERIAL QUARTER FROM 1785 TO 1835 INCLUSIVE.

Yrs.	Wheat.		Barley.		Oats.		Yrs.	Wheat.		Barley.		Oats.	
	s.	d.	s.	d.	s.	d.		s.	d.	s.	d.	s.	d.
1785	43	1	24	9	17	8	1810	106	5	48	1	28	7
1786	40	0	25	1	18	6	1811	95	3	42	3	27	7
1787	42	5	23	4	17	2	1812	126	6	66	9	44	6
1788	46	4	22	8	16	1	1814	74	4	37	4	25	8
1789	52	9	23	6	16	6	1816	78	6	33	11	27	2
1790	54	9	26	3	19	5	1817	96	11	49	4	32	5
1791	48	7	26	10	18	1	1818	86	3	53	10	32	5
1792	43	0	27	7	16	9	1819	74	6	45	9	28	2
1793	49	3	31	1	20	6	1820	67	10	33	10	24	2
1794	52	3	31	9	21	3	1821	56	1	26	0	29	6
1795	75	2	37	5	24	5	1822	44	7	21	10	28	1
1796	78	7	35	4	21	10	1823	53	4	36	6	22	11
1797	53	9	27	2	16	3	1824	63	11	36	4	24	10
1798	51	10	29	0	19	5	1825	68	6	40	0	25	8
1799	69	0	36	2	27	6	1826	58	8	34	4	26	8
1800	113	10	59	10	39	4	1827	58	6	37	7	28	2
1801	119	6	68	6	37	0	1828	60	5	32	10	22	0
1802	69	10	33	4	20	4	1829	66	3	32	6	22	9
1803	58	10	25	4	21	6	1830	64	3	32	7	24	5
1804	62	3	31	0	24	3	1831	66	4	38	0	25	4
1805	89	9	44	6	28	4	1832	58	8	33	1	20	5
1806	79	1	38	8	27	7	1833	52	11	27	6	18	5
1807	75	4	39	4	28	4	1834	46	2	29	0	20	11
1808	81	4	43	4	33	4	1835	39	4	29	11	22	0
1809	97	4	47	0	31	5							

The highest price of wheat was in 1812—126s. 6d.; the lowest in 1743–44—22s. 1d. per quarter.

Tithe Commutation.

Table giving the average actual prices per Imperial quarter of Wheat, Barley, and Oats since the passing of the Tithe Commutation Act, with the corresponding Tithe Rent-Charge. The average of each previous seven years is computed annually to the Thursday before Christmas in fixing the amount of Tithe. The normal average price per quarter was fixed at: Wheat, 56s. 2d.; barley, 31s. 8d.; oats, 22s.—being the average of the seven years preceding 1836.

Years.	Wheat.		Barley.		Oats.		Tithe Rent-Charge.		
	s.	d.	s.	d.	s.	d.	£	s.	d.
1836	48	6	32	10	23	1	100	0	0
1837	55	10	30	4	23	1	93	13	9¾
1838	64	7	31	9	22	5	97	7	11
1839	70	8	39	6	25	11	95	7	9
1840	66	4	36	5	25	8	98	15	9½
1841	64	4	32	10	22	5	102	12	5¼
1842	57	3	27	6	19	3	105	8	2¾
1843	50	1	29	6	18	4	105	12	2¼
1844	51	3	33	8	20	7	104	3	5¼
1845	50	10	31	8	22	6	103	17	11¼
1846	54	8	32	8	23	8	102	17	8¾
1847	69	9	44	2	28	8	99	18	10¼
1848	50	6	31	6	20	6	102	1	0
1849	44	3	27	9	17	6	100	3	7¾
1850	40	3	23	6	16	5	98	16	10
1851	38	6	24	9	18	7	96	11	4¾
1852	40	9	28	6	19	1	93	16	11¼
1853	52	3	33	2	21	0	91	13	5¾
1854	72	5	36	0	27	11	90	19	5
1855	74	8	34	9	27	5	89	15	8¾
1856	69	2	41	1	25	2	93	18	1¼
1857	56	4	42	1	25	0	99	13	7¼
1858	44	2	34	8	24	6	105	16	3½
1859	43	9	33	6	23	2	108	19	6¼
1860	53	3	36	7	24	5	110	17	1⅓
1861	55	4	36	1	23	9	112	3	4¾
1862	55	5	35	1	22	7	109	13	6

Tithe Commutation—*continued.*

Years.	Wheat.		Barley.		Oats.		Tithe Rent-Charge.		
	s.	d.	s.	d.	s.	d.	£	s.	d.
1863	44	9	33	9	21	2	107	5	2
1864	40	2	29	11	20	1	103	3	10¾
1865	41	0	29	9	21	10	98	15	10½
1866	49	11	37	5	24	7	97	7	9¼
1867	64	5	39	11	26	0	98	13	3
1868	63	9	43	0	28	1	100	13	8
1869	48	2	39	5	26	0	103	5	8¼
1870	46	11	34	7	22	10	104	1	0¼
1871	56	8	36	2	25	2	104	15	1
1872	57	0	37	3	23	2	108	4	0¼
1873	58	8	40	5	25	5	110	15	10¼
1874	55	9	44	11	28	10	112	7	3
1875	45	1	38	5	28	8	112	15	6¾
1876	46	2	35	2	26	3	110	14	11
1877	56	9	39	8	25	11	109	16	11½
1878	46	5	40	2	24	4	112	7	5¼
1879	43	10	34	0	21	9	111	15	1½
1880	44	4	33	1	23	1	109	17	9¼
1881	45	4	31	11	21	9	107	2	10½
1882	45	1	31	2	21	10	102	16	2
1883	41	7	31	10	21	5	100	4	9¾
1884	35	8	30	8	20	3	98	6	2¼
1885	32	10	30	1	20	7	93	17	3¼
1886	31	0	26	7	19	0	90	10	3½
1887	32	6	25	4	16	3	87	8	10
1888	31	10	27	10	16	9	84	2	8¾
1889	29	9	25	10	17	9	80	19	8½
1890	31	11	28	8	18	7	78	1	3½
1891	37	0	28	2	20	0	76	3	3¾
1892	30	3	26	2	19	10	75	18	3¾
1893	26	4	25	7	18	9	74	15	2¾
1894	22	10	24	6	17	1	74	3	9½
1895	23	1	21	11	14	6	73	13	0½
1896	26	2	22	10	14	8	71	9	6¾

Average for the first 50 years—£102 9s. 9½d.

Average of 60 years—£98 8s. 9¼d.

Prices in England since A.D. 1201, by Centuries

Actual Price in weight of Silver (Mulhall).

	13th.	14th.	15th.	16th.	17th.	18th.	19th.
Ox	43s.	45s.	42s.	40s.	106s.	107s.	280s.
Cow	30s.	35s.	30s.	30s.	80s.	100s.	200s.
Horse	...	...	84s.	80s.	106s.	275s.	440s.
Sheep	3s.	4½s.	4s.	4s.	8s.	19s.	25s.
Pig	6s.	9s.	6s.	6s.	9s.	23s.	30s.
Wheat, quarter ...	...	16s.	12s.	21s.	45s.	53s.	56s.
Wine, gallon ...	3s.	3s.	2s.	4s.	6s.	17s.	20s.
Beer	3d.	5d.	4d.	4d.	4d	8d.	18d.
Goose	9d.	12d.	12d.	11d.	12d.	25d.	50d.
Rabbit	6d.	6d.	6d.	4d.	6d.	8d.	12d
Hen	3d.	6d.	6d.	5d.	9d.	12d.	18d.
Pigeons, dozen ...	9d.	12d.	12d.	12d.	13d.	18d.	36d.
Beef, 8 lbs. ...	6d.	12d.	10d.	8d.	25d.	38d.	64d.
Butter, lb. ...	...	4d.	3d.	3d.	4d.	5d.	12d.
Eggs, dozen ...	3d.	6d.	6d.	4d.	4d.	8d.	12d.

Retail Prices of Articles of Food, &c.

		1815.		1836.		1850.		1887.		18[illegible]1.	
		s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Bread ...	per 4 lbs.	1	4	0	7½	0	7¾	0	4½	0	6¼
Butter ...	...per lb.	1	2	1	0	1	0	1	5	1	4
Cheese ...	... ,,	0	8½	0	7½	0	7¼	0	6	0	6
Bacon ...	... ,,	0	8½	0	7	0	9⅜	0	7	0	7
Butcher's meat ...	,,	...		0	6	0	7¾	0	7	0	7¼
Tea ...	... ,,	6	0	5	0	4	0	2	3	2	0
Sugar ...	... ,,	0	9½	0	7	0	4¾	0	2½	0	2
Candles ...	... ,,	0	7½	0	6	0	6	0	4	0	3½
Paraffin ...	per quart	...		...		...		0	2½	0	2¼

Table of Agricultural Wages in England.

Divisions and Counties	Average Weekly Wages of Men.											
	1824.		1836.		1860.		1870.		1881.		1891.	
Eastern—	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Bedford	8	7	9	6	10	3	12	0	13	0	13	6
Cambridge	...		9	6	10	0	11	0	...		13	6
Essex	9	4	10	4	11	3	11	0	13	6	14	0
Hertford	9	0	9	6	10	0	12	6	13	0	13	6
Huntingdon	...		9	6	10	9	10	6	...		...	
Lincoln	10	2	12	0	13	0	14	0	13	6	14	0
Norfolk	9	1	10	4	10	7	11	6	13	6	14	0
Suffolk	8	3	10	4	10	7	11	0	13	6	14	0
Average	9	1	10	1	10	9	11	7	13	4	13	9
South-Eastern and East Midland—												
Berks	...		...		10	0	9	6	12	0	12	6
Bucks	...		8	0	...		...		14	0	14	6
Hants	8	6	9	6	12	0	10	9	...		12	6
Kent	11	9	12	0	12	0	14	0	14	0	14	6
Leicester	...		10	0	13	0	13	0	13	0	13	6
Middlesex	...		10	6	...		...		...		15	0
North Hants	8	1	9	0	11	0	11	6	13	0	13	6
Notts...	10	3	12	0	12	9	13	3	13	6	14	0
Oxford	..		9	0	...		...		13	3	13	6
Rutland	...		9	0	...		12	6	...		...	
Surrey	10	8	10	6	12	9	13	0	16	0	16	6
Sussex	9	7	10	7	11	8	12	0	16	0	16	6
Warwick	8	10	10	0	10	9	12	6	16	0	16	6
Average	9	8	10	0	11	9	12	2	14	0	14	5

WAGES—*continued.*

Divisions and Counties.	Average Weekly Wages of Men.											
	1824.		1836.		1860.		1870.		1881.		1891.	
WEST MIDLAND AND SOUTH-WESTERN—	s.	d.	s.	d	s.	d.	s.	d.	s.	d.	s.	d.
Cornwall	...		10	0	11	0	11	6	...		...	
Devon	7	6	8	0	9	2	10	9	13	6	14	6
Dorset	6	11	7	6	9	4	11	0	12	6	13	0
Gloucester	9	3	9	0	9	5	10	9	12	6	13	0
Hereford	7	1	8	0	9	0	10	3	14	0	14	6
Monmouth	10	1	10	6	11	8	13	6	12	0	12	6
Somerset	8	2	8	8	10	0	10	6	13	0	13	6
Wilts...	7	7	8	6	9	6	10	9	12	0	12	6
Worcester...	8	2	9	6	10	0	11	0	...		...	
Average	8	1	8	9	9	10	11	0	12	9	13	3
NORTH AND NORTH-WESTERN—												
Chester	10	8	13	0	11	8	13	6	15	6	16	6
Cumberland	12	3	12	0	15	0	15	9	18	0	19	0
Derby	10	10	12	0	12	0	14	0	13	6	15	6
Durham	11	6	12	0	14	3	16	0	18	0	19	0
Lancashire	...		...		...		15	9	17	6	18	6
Northumberland ...	11	5	12	0	14	0	16	0	18	0	19	0
Shropshire	8	10	9	0	10	0	11	9	14	6	16	0
Stafford	10	8	12	0	12	6	13	0	...		17	0
Westmoreland	12	0	12	0	14	3	16	4	...		...	
Yorks—East Riding	11	8	12	0	13	6	...		17	6	18	6
,, North ..	10	3	12	0	13	6	14	6	17	6	18	6
,, West ..	12	6	12	0	13	6	16	0	17	6	18	6
Average	11	1	11	9	13	1	14	9	16	9	17	9
Average of all England	9	6	10	2	11	4	12	4	14	2	14	9

These figures do not include payments for piece or task work, allowances, harvesting, &c., which generally raise the average to from 30 to 35 per cent. over the above.

Table for calculating Rent-Charges to be paid off in less time than 22 years.

Reduced Period.	Annual Rent-Charge for such Period for each £3 10s. of Rent-Charge.			
		In Sterling Money.		
Years.	£ decimals.	£	s.	d.
Annual Rent-Charge if it has to last 21	6·7091	6	14	2¼
20	6·9398	6	18	9½
19	7·1958	7	3	11
18	7·4812	7	9	7½
17	7·8013	7	16	0¼
16	8·1626	8	3	3
15	8·5734	8	11	5½
14	9·0441	9	0	10½
13	9·5887	9	11	9¼
12	10·2256	10	4	6¼
11	10·9801	10	19	7¼
10	11·8874	11	17	9
9	12·9984	12	19	11½
8	14·3895	14	7	9½
7	16·1808	16	3	7½
6	18·5724	18	11	5½
5	21·9244	21	18	5¾
4	26·9574	26	19	1¾
3	35·3520	35	7	0½
2	52·1508	52	3	0¼
1	102·5666	102	11	4

Note.—The above table is calculated on the assumption that a yearly rent-charge of £6 10s., continuing for a term of 22 years (but payable half-yearly), is equivalent to the sum of £100 in ready money.

Estimated Farm Capital of the United Kingdom on June 4th, Based approximately on an Average of Three Years, 1891–93. (Rew.)

	Description.	Quantity.	Price.	Value.
I.	Live Stock :	No.	Each.	£
	Cattle and Calves	11,356,886	£8	90,855,088
	Sheep and Lambs	32,983,873	30s.	49,475,809
	Horses	2,057,768	£20	41,155,360
	Pigs	3,605,564	42s. 6d.	7,661,823
	Mules and Asses...	700,000	£3	2,100,000
	Goats	1,000,000	10s.	500,000
	Poultry	32,000,000	1s. 6d.	2,400,000
II.	Growing Crops (Seed, Manure, Labour, and half-year's Rent):	Acres.	Per Acre.	
	Corn	9,314,463	60s.	27,943,389
	Green Crops ...	9,169,697	50s.	22,424,242
	Potatoes	1,278,757	130s.	8,311,920
	Meadow Hay ...	5,931,602	30s.	8,897,403
	Hops	56,656	160s.	453,248
	Flax	72,419	70s.	253,466
	Bare Fallow ...	490,848	50s.	1,227,120
III.	Corn in Stock	Qrs. 4,000,000	Per Qr. 25s.	5,000,000
IV.	Hay unconsumed ...	Tons. 2,000,000	Per Ton. 70s.	7,000,000
V.	Straw ,, ...	1,000,000	25s.	1,250,000
VI.	Wool in Stock ... ... (The whole of one clip and 10 per cent. of previous year's clip.)	Lbs. 140,000,000	Per Lb. 9d.	5,250,000
VII.	Cheese in Stock ... ($\frac{1}{6}$th of year's make.)	Cwt. 333,000	5½d.	855,000
VIII.	Implements, Machinery, Tenants' Fixtures, Harness, &c.	—	—	36,000,000
				319,013,868

Estimate of the Apportionment of Farming Capital in Great Britain (June).

(Wrightson.)

	Percentage.
Live stock	67·85
Implements and harness	14·25
Seed corn... ... ... / Seed potatoes .. ... / Clover and grass seeds / Turnip, mangold, &c., seed	2·10
Manure, and hay and straw unconsumed	7·25
Value of manual labour on growing crops, and rent paid by farmers who entered at Michaelmas	8·55
	100·00

Number and Size of Farm Holdings in England and Wales.

Area in Acres.	Number of Farms.	
50 to 100	54,937	121,961
100 ,, 300	67,024	
300 ,, 500	11,841	16,608
500 ,, 1,000	4,194	
Over 1,000	573	
	138,569	138,569

Acreage of Crops in United Kingdom, including the Channel Islands.

Acreage under each Crop, and Fallow, and Grass, upon the 4th June in the years 1880, 1890, 1895, and 1896:—

Description of Crops.		United Kingdom (Total Area, 77,671,319 Acres).			
		1880. Acres.	1890. Acres.	1895. Acres.	1896. Acres.
Cultivated Area		47,586,700	48,045,161	47,873,333	47,882,099
Corn Crops.					
Wheat		3,065,895	2,483,595	1,456,200	1,734,118
Barley or Bere		2,695,000	2,300,994	2,346,367	2,285,933
Oats		4,191,716	4,137,790	4,527,741	4,303,967
Rye		47,937	64,458	80,293	88,634
Beans		436,361	362,242	245,128	252,983
Peas		235,177	220,170	269,609	196,973
Total		10,672,086	9,574,249	8,865,338	8,862,408
Green Crops.					
Potatoes		1,339,578	1,321,272	1,262,766	1,281,310
Turnips and Swedes		2,336,499	2,251,220	2,237,653	2,199,864
Mangolds		385,348	378,313	387,252	392,591
Cabbage, Kohl-Rabi, and Rape		204,016	213,165	198,465	212,46[illegible]
Vetches or Tares ...		439,852	239,510	170,369	182,898
Other Green Crops, except Clover or Grass ...			130,865	143,423	100,125
Total		4,746,293	4,534,145	4,399,927	4,429,264
Other Crops, Grass, &c.					
Flax		166,521	99,326	97,247	74,098
Hops		66,698	53,961	58,940	54,249
Small Fruit		...	...	74,920	76,797
Bare Fallow or Uncropped Arable Land		828,778	524,112	494,505	450,940
Clover, Sainfoin, and Grasses under Rotation	For Hay ..	...	2,938,680	2,952,636	2,840,372
	Not for Hay	...	3,158,530	3,108,503	3,120,077
Total		...	6,097,210	6,061,139	5,960,449
Permanent Pasture, exclusive of Heath or Mountain Land	For Hay ...	...	6,248,352	6,327,228	6,193,988
	Not for Hay	...	20,867,073	21,503,889	21,779,700
Total		...	27,115,425	27,831,117	27,973,688

Number of Live Stock in United Kingdom and Channel Islands.

Description of Live Stock.	1880. No.	1890. No.	1895. No.	1896. No.
Horses used solely for agriculture, Mares kept solely for breeding, and unbroken horses	1,929,680	1,964,911	2,112,207	2,115,557
Cattle	9,871,153	10,789,858	10,753,314	10,942,423
Sheep	30,239,620	31,667,195	29,774,8[illegible]3	30,853,809
Pigs, exclusive of those kept in towns and by cottagers	2,863,488	4,362,040	4,238,870	4,301,329

Values of Corn, Meat, Food Products, and Articles affecting Agriculture, Imported into the United Kingdom in the Year 1896, with the Corresponding Figures for 1894 and 1895.

[*From Trade and Navigation Returns.*]

	Values.		
	1894.	1895.	1896.
Animals, Living (for food):--	£	£	£
Oxen and Bulls	8,225,067	7,150,812	9,241,455
Cows	59,298	31,049	62,231
Calves	679	1,179	1,369
Total Cattle	8,285,044	7,183,040	9,305,055
Sheep and Lambs	804,823	1,782,544	1,133,634
Swine	16	668	10
Total Value	9,089,883	8,966,252	10,438,699

VALUES OF CORN, MEAT, FOOD PRODUCTS, &c.—*continued.*

	Values.		
	1894.	1895.	1896.
Corn:—	£	£	£
Wheat	18,760,565	22,531,176	21,678,704
Wheat Meal and Flour	7,994,673	7,679,013	9,216,048
Barley	7,090,579	5,538,405	5,703,318
Oats	3,900,096	3,723,465	4,225,576
Peas	647,194	693,828	852,465
Beans	1,346,096	1,079,780	837,417
Maize	7,952,238	7,808,860	9,423,554
Maize Meal	40,968	75,523	123,313
Other kinds of corn and meal	487,876	593,243	732,302
Total Value	48,220,225	49,723,293	52,792,697
Meat:—	£	£	£
Beef, Salted	342,814	286,511	303,433
,, Fresh	4,213,688	4,275,548	5,028,828
Mutton, Fresh	4,341,227	4,595,678	4,718,576
Bacon	8,083,887	7,925,979	7,854,515
Hams	2,771,828	2,898,018	3,136,089
Pork, Salted (not Hams) ...	335,556	269,829	291,966
,, Fresh	436,546	664,946	687,241
Meat, unenumerated—Salted or Fresh	410,724	490,650	555,562
Meat preserved otherwise than by Salting ...	1,490,902	2,040,006	1,775,178
Rabbits	297,818	315,594	401,614
Total of Dead Meat ...	22,724,990	23,762,759	24,753,002
Dairy Produce:—	£	£	£
Butter	13,456,699	14,245,230	15,344,083
Margarine	3,044,810	2,557,170	2,498,425
Cheese	5,474,940	4,675,130	4,900,428
Total	21,976,449	21,477,530	22,742,936

VALUES OF CORN, MEAT, FOOD PRODUCTS, &c.—*continued.*

	VALUES.		
	1894.	**1895.**	**1896.**
POULTRY, &c. :—	£	£	£
Poultry & Game, alive or dead	480,884	605,160	605,458
Eggs	3,786,329	4,003,446	4,184,567
Total Value	4,267,213	4,608,606	4,790,025
FRUIT, VEGETABLES, &c. :—	£	£	£
Apples	1,389,421	960,273	1,582,471
Cherries	168,899	96,017	105,811
Plums	302 105	166,045	241,782
Pears	411,316	166,696	206,674
Grapes	470,428	486,981	442,830
Oranges and Lemons	2,206,217	2,476,510	2,369,675
Unenumerated	563,859	513,261	590,826
Onions	765,040	696,428	6[illegible]1,879
Potatoes	1,030,091	1,169,922	907,875
Vegetables, unenumerated (raw)	1,090,370	1,277,266	1,284,634
Hops	774,378	644,505	591,582
Total Value	9,170,124	8,653,934	9,006,039
OTHER ARTICLES :—	£	£	£
Lard	2,758,416	2,941,941	2,268,029
Wool, Sheep and Lambs' ...	24,791,160	26,025,960	24,958,346
Wood and Timber :			
Hewn	4,187,763	4,181,436	4,889,393
Sawn or Split, Planed or Dressed	11,899,533	10,695,916	13,380,660
Staves	541,797	594,615	655,243
Oil-Seed Cake	1,707,358	1,603,650	1,588,214
Seeds: Clover and Grass ...	825,155	855,524	787,764
,, Cotton	2,052 085	1,750,437	1,729,322
,, Flax and Linseed ...	3,941,995	3,366,113	4,022,676
,, Rape	319,189	307,348	196,237
Bones (whether burnt or not)...	412,529	320,051	251,866
Guano	146,361	392,309	104,554
Cotton, Raw	32,944,341	30,429,428	36,272,039
Hemp	1,807,943	2,087,667	1,951,486
Flax	2,525,195	3,270,840	3,117,316
Hides untanned : Dry	988,912	1,153,757	905,427
,, ,, Wet	1,242,168	1,650,369	1,319,501
Petroleum...	2,184,976	3,368,904	3,722,056

CLIMATE.

Every rise of 300 ft. above sea level gives a decrease of 1° F. in the average temperature.

Wheat will not ripen in this country above 1,000 ft., and barely at that; while barley, oats, and hardier cereals may ripen up to 1,500 ft.

The west side of the country is warmer than the east, and the sea is warmer than the land in winter: this explains why the coast is not so subject to frosts as land further inland.

The isothermal lines show that the coolest part of the British Islands in July is the Orkney and Shetland Islands (54° F.), and the warmest Land's End and the Eastern Midlands (64° F.) On the other hand, in January the whole western coast from north to south averages 39° F., and the eastern 37° F., while the lowest average is in the central parts of England. In Ireland the south-west averages 45° during the same period.

Average rainfall of the west coast = 36 in.
,, ,, east ,, = 26 ,,

The highest rainfall is $224\frac{1}{2}$ in. at Stye, in Cumberland; the lowest, 18 in. in Lincolnshire.

1 in. of rainfall = 3,630 cubic ft. per acre = 22,622·523 Imperial gallons = 101·28 tons

Seasonal rainfall :—

20	per cent	of rain	falls in	spring.
23	,,	,,	,,	summer.
31	,,	,,	,,	autumn.
26	,,	,,	,,	winter.

The atmosphere always contains moisture—the warmer it is, the more it holds—and any lowering of temperature is followed by a condensation of the moisture, which appears as clouds, and eventually as rain. *Fogs and mists* are clouds close to the surface of the ground, caused by vapours rising from a warm moist soil and immediately condensing. *Dew* is the moisture of the air (or that evaporating from vegetation) condensed on cold bodies on the surface of the ground: a calm clear night requisite. *Frosty nights* can only exist when the sky is clear; the presence of clouds prevents the heat of the soil radiating into space

Greenwich Meteorological Data.

	Temperature of the Air. Average of 46 Years.	Daily Range of Temperature. Average of 46 Years.	Rainfall. Average of 72 Years.	Humidity of Air. Saturation = 100.
	Degs.	Degs.	Ins.	
January ...	38·4	9·5	1·89	87
February ...	39·5	11·1	1·57	85
March... ...	41·6	14·7	1·52	81
April	46·0	18·4	1·74	80
May	52·5	20·4	1·98	79
June	58·9	21 0	1·96	75
July	62·3	21·0	2·50	75
August ...	56·5	19 9	2·35	76
September ...	57·0	18·2	2·43	81
October ...	49·9	14·5	2·76	89
November ...	43·4	11 4	2·36	90
December ...	39·8	9·3	1·99	90

Fitzroy's Barometer Instructions.

The words on scales of barometers should not be so much regarded for weather indications as the RISING or FALLING of the mercury; for if it stand at CHANGEABLE (29·50) and then rise towards FAIR (30·00) it presages a change of wind or weather, though not so great as if the mercury had risen higher; and, on the contrary, if the mercury stand above FAIR and then fall it presages a change, though not to so great a degree as if it had stood lower; beside which the direction and force of wind are not in any way noticed.

It is not from the point at which the mercury may stand that we are alone to form a judgment of the state of the weather, but from its RISING or FALLING; and from the movements of immediately PRECEDING days as well as hours, keeping in mind effects of change of DIRECTION, and dryness or moisture, as well as alteration of force or strength of wind.

It should always be remembered that the state of the air FORETELLS COMING weather rather than shows the weather that is PRESENT—(an invaluable fact too often overlooked)—that the longer the time between the signs and the change foretold by them the longer such altered weather will last; and, on the contrary, the less the time between a warning and a change the shorter will be the continuance of such foretold weather.

If the barometer has been about its ordinary height, say near 30 inches at the sea level, and is steady on rising, while the thermometer falls and dampness becomes less, north-westerly, northerly, north-easterly wind, or less wind, less rain or snow, may be expected

On the contrary, if a fall takes place with a rising thermometer and increased dampness, wind and rain may be expected from the south-eastward, southward, or south-westward. A fall with low thermometer foretells snow.

When the barometer is rather below its ordinary height, say down to near 29½ inches (at sea level), a rise foretells less wind, or a change in its direction towards the northward, or less wet; but when it has been very low, about 29 inches, the first rising usually precedes or indicates strong wind—at times heavy squalls—from the north-westward, northward, or north-eastward, AFTER which violence a gradually rising glass foretells improving weather; if the thermometer falls, but if the warmth continues, probably the wind will back (shift against the sun's course), and more southerly or south-westerly wind will follow, especially if the barometer rise is sudden.

The most dangerous shifts of wind, or the HEAVIEST northerly gales, happen soon after the barometer first rises from a very low point; or if the wind veers GRADUALLY, at some time afterwards.

Indications of approaching change of weather and the direction and force of winds are shown less by the height of the barometer than by its falling or rising. Nevertheless, a height of more than 30 inches (at the level of the sea) is indicative of fine weather and MODERATE winds, except from east to north, OCCASIONALLY.

A rapid rise of the barometer indicates unsettled weather, a slow movement the contrary; as likewise a STEADY barometer, when continued and with dryness, foretells very fine weather.

A rapid and considerable fall is a sign of stormy weather, and rain or snow. Alternate rising and sinking indicates unsettled or threatening weather.

The greatest depressions of the barometer are with gales from S.E., S., or S.W.; the greatest deviations, with wind from N.W., N., or N.E., or with calm.

A sudden fall of the barometer, with a westerly wind, is sometimes followed by a violent storm from N.W., N., or N.E.

If a gale sets in from the E. or S.E., and the wind veers by the south, the barometer will continue falling until the wind is near a marked change, when a lull MAY occur; after which the gale will soon be renewed, perhaps suddenly and violently, and the veering of the wind towards the N.W., N., or N.E. will be indicated by a rising of the barometer, with a fall of the thermometer.

After very warm and calm weather a storm or squall, with rain, may follow; likewise at any time when the atmosphere is HEATED much above the USUAL temperature of the season.

To know the state of the air not only the barometer AND THERMOMETER, but appearances of the sky, should be vigilantly watched.

Signs of Weather.

Whether clear or cloudy, a rosy sky at sunset presages fine weather; a red sky in the morning, bad weather, or much wind, perhaps rain; a grey sky in the morning, fine weather; a high dawn, wind; a low dawn, fair weather. A high dawn is when the first indications of daylight are seen above a bank of clouds A low dawn is when the day breaks on or near the horizon, the first streaks of light being very low down.

Soft-looking or delicate clouds foretell fine weather, with moderate or light breezes; hard-edged, oily-looking clouds, wind. A dark, gloomy blue sky is windy, but a light, bright blue sky indicates fine weather. Generally, the softer the clouds look, the less wind (but perhaps more rain) may be expected; and the harder, more "greasy," rolled, tufted, or ragged, the stronger the coming wind will prove. Also a bright yellow sky at sunset presages wind; a pale yellow, wet; and thus, by the prevalence of red, yellow, or grey tints, the coming weather may be foretold very nearly—indeed, if aided by instruments, almost exactly.

Small inky-looking clouds foretell rain; light scud clouds driving across heavy masses show wind and rain, but if alone may indicate wind only.

High upper clouds crossing the sun, moon, or stars in a direction different from that of the lower clouds, or the wind then felt below, foretell a change of wind.

After fine, clear weather, the first signs in the sky of a coming change are usually light streaks, curls, wisps or mottled patches of white distant clouds, which increase, and are followed by an overcasting of murky vapour that grows into cloudiness. This appearance, more or less oily or watery as wind or rain will prevail, is an infallible sign.

Light, delicate, quiet tints or colours, with soft, undefined forms of clouds, indicate and accompany fine weather; but gaudy or unusual hues, with hard, definitely outlined clouds, foretell rain, and probably strong wind.

When sea-birds fly out early and far to seaward, moderate wind and fair weather may be expected. When they hang about the land, or over it, sometimes flying inland, expect a strong wind, with stormy weather. As many creatures beside birds are affected by the approach of rain or wind, such indications should not be slighted by an observer who wishes to foresee weather.

Remarkable clearness of atmosphere near the horizon, distant objects such as hills unusually visible, or raised (by refraction), and what is called a "good HEARING day," may be mentioned among signs of wet, if not wind, to be expected. Much refraction is a sign of easterly wind.

More than usual twinkling of the stars, indistinctness or apparent multiplication of the moon's horns, haloes, "wind-dogs" (fragments or pieces of rainbows, sometimes called "wind-galls") seen on detached clouds, and the rainbow, are more or less significant of increasing wind, if not approaching rain with or without wind.

Lastly, the dryness or dampness of the air, and its temperature (for the season), should ALWAYS be considered WITH OTHER indications of change or continuance of wind and weather.

THE GENERAL LAWS OF CLIMATE ARE:—

1. The temperature falls from the Equator to the Poles.

2. There is an equable seasonal temperature at the Equator, but a greater variation as we go north.

3. There may be a hot summer in high latitudes, but with a correspondingly severe winter.

The modifying influences are:—

1. *Elevation and Aspect.*—The temperature is higher the nearer the sea level, and the soil with a southern exposure is more genial than equally good soil facing away from the sun.

2. *Geological Structure.*—Some soils absorb heat much more quickly than others, and thus some districts are earlier than others, and less subject to frosts. Dark colours absorb heat best, and light or white worst; but, again, the dark gives it up most rapidly: thus the white chalky soils are always late and cold, while brown and black varieties are better. As to texture, sand retains its heat longest, clay next, and humus or peat the shortest time: this is one reason why the dark brown sandy soils of the Old and New Red Sandstones are among the best. Wet soils are cold, because the sun's heat is wasted in heating up and evaporating the water they contain, as on clays; where, for a like reason,

spring frosts are worst. High hills chill the wind, and cause a precipitation of its moisture as rain.

3. *Geographical Position with respect to Seas and Continents.*—The Gulf Stream is the great cause of our mild winters and cool summers. In the interior of a continent the difference of the seasonal temperatures is greater than on an island such as Britain, which is subject to the influence of the ocean currents. Thus it is that the temperature of Britain during the winter is the same from north to south.

4. *Prevailing Winds and Humidity.*—In the spring-time the east wind prevails over Britain; this is cold and dry, from blowing over Russia and Germany. In the autumn, again, the south-west wind is the most common, and as this comes from the equatorial region of the Atlantic, it is hot and charged with moisture, which it yields up when chilled by contact with our shores; and thus our largest rainfall is in autumn.

CALENDAR OF FARM WORK.

January.

Arable Farm.—Finishing stubble ploughing. Commence ploughing lea land for oats. Carting manure from yards and boxes either on to stubble to be ploughed in at once or to the manure heap. Road-mending. Grubbing, mending, and making fences. Carting lime; digging and spreading marl. Threshing corn of all kinds for market, or as straw is needed for use or sale. Executing works of drainage, road-making, building.

Live Stock.—Feeding sheep in fold on swedes, or scattered over the pastures. Fattening cattle in boxes or in feeding stalls and houses or yard, or in fields with open sheds.

Stock Farm.—There is still generally more milk from long-calved cows than from the few already come to the pail. Feeding is regulated by the produce required or obtained from the cow. When milk-selling prevails the cow receives succulent or sloppy foods in addition to fodder. Steers or down calvers receive chaff of hay and straw, with a few turnips and mangold-wurzels. Cows as they calve sometimes get meals mashed up with their straw and hay chaff. They get better food as their produce comes on and increases.

Hop Garden.—The work is carting dung on to the field; collecting old bine and carting it into yards for litter; moving the poles, &c., re-sharpening them, and setting them up in conical piles for use when needed; grubbing old abandoned gardens: attending to plantation for hop-poles.

Exceptional Crops. — Osiers may be planted. Water meadows are "drowned" at intervals, with periods of rest.

Marketing includes sales of wheat and other grain, straw, hay, and potatoes; also sales of fat cattle, sheep, pigs, milk, &c.

FEBRUARY.

Arable Farm.—Carting and ploughing are still the chief occupation of the horses. In some districts, however, they are at work with the sowing machine and harrow. Spring wheat may be sown either after beans, if the stubble was not ready two or three months ago, or after clover if for any reason they have been kept standing so long, or after the earliest sheep-fold. Beans may be sown. Peas may be sown on the lighter lands. Purchases of seeds may be made according to the proposed cropping of the farm. Manure may be purchased. Dung heaps may be turned.

Stock Farm.—Cows now are coming more rapidly to the pail; but it is still better to sell the milk than to make cheese. The calves are now kept for rearing. The ewe flock occupies attention. Lambing in the southern counties is in full swing. Fattening stock are being sold as they are fit for the butcher.

Hop Gardens.—Men may be engaged in the coppice woods, or in draining, or in making ready manures and composts.

Marketing.—Includes sales of milk, butter, grain, straw, hay, possibly roots, calves, pigs, &c.

Water Meadows which have been "drowned" at intervals during winter will now be beginning to show signs of growth.

Exceptional Crops.—Canary seed may be sown this month.

MARCH.

Arable Farm.—One of the busiest months of the year. The horses must have improved rations, for they are working full hours and hard. All spring corn may be got in this month, and the nearer this work is completed the better. Oats should be sown after either sheep-fold, or lea ploughed up in winter. Barley is sown close up to the sheep-fold, or after wheat stubble ploughed in winter and receiving a dressing afterwards. Grass and clover seed may be sown in

March over the young wheat after harrowing, or over the barley either now or later on. Potatoes should be planted towards the end of March: early sorts in early places. Carrots may be sown this month. Spring tares may be sown in portions for use in July. A plot for cabbage seed should be sown to provide drumhead plants for transplanting in May and June Land must be got ready for mangolds; ploughed in autumn, it may be scarified now and ribbed up to receive the dung, and a dressing of guano and superphosphate may be sown broadcast, and the whole covered by splitting the drills ready for the seed next month.

Stock Farm.—Cows are calving, and cheese-making has begun. The lambing season is at its height all over Southern and Midland England.

Hop Garden.—Young hops are being planted.

Exceptional Subjects.—Water meadows are now productive for ewes and lambs. Farm accounts ought to occupy attention. The year, if it began at Lady-Day, terminates then, and valuations of stock and crop are required to complete the year's accounts. Chicory may be sown for forage. Teazels may be sown, one acre for every four intended for next year's crop, to provide plants for transplanting.

April.

Arable Farm.—All spring-sown grass should be got in this month at latest. Potato-planting, too, should be finished in April. Kohl-rabi may be sown. Beans may be horse-hoed, and wheat, when the land is dry, may be hoed or harrowed and rolled. Mangolds are sown or dibbled during the latter weeks of March and April. Land is being got ready for turnips. Carrots may be sown on the flat. Lucerne may be sown this month. Sainfoin is sown in April, drilled or sown across the barley as that is coming up. Flax is sown in April. Onions may be sown this month. Artificial manures, superphosphate, nitrate of soda, and soluble manures of all kinds may be applied broadcast in the growing weather of April over grass lands and over such wheat as wants them. Liquid manure may be taken over the grass lands.

Stock Farm.—Dairy work is in full swing, most of the calves have come, and cheese-making is at its busiest. Fatting beasts are still in stalls or boxes receiving mangolds and hay, with meal and cake. Sheep-folds are overtaking the turnips, and the plough follows immediately, and the last barley is sown. Young grass is available for ewes and lambs in the water meadows, and mangolds may be taken to them in the pastures. Sheep-dipping with "summer dip."

Exceptional Crops.—Teazels in the second year should be dug between the plants. Gorse may be sown this month.

May.

Arable Farm.—The principal work of the early part of the month still is getting in the last crop of mangolds, and in the later weeks the earliest sown swedes and turnips. In the Northern counties swedes are all got in this month. Wheat receives its last weeding. Beans will require horse-hoeing; and the earliest sown mangolds and kohl-rabi also will want horse-hoeing and singling by hand hoe. Top dressings may be applied to the young corn crops which need it.

Stock Farm.—Cows are out at grass during May: they may be brought in, perhaps, for the first week or so at night. Rye, vetches, and even mangolds may help out a late season. The earlier calves are getting weaned. Cows are now fully at pail, and dairy work is heavy. The pig-sties ought to be full on dairy farms, young pigs bred or bought receiving the whey. Sheep-shearing in full swing.

Special Crops.—Buckwheat may be sown on light poor soil. Hemp sown.

Hop Farm.—Poling and subsequent hoeing of the hop ground are now complete, and the tying is commenced; two or three bines are tied to each pole. A second digging of the hop ground proceeds. Nitrate of soda and other soluble manures may be applied with advantage if growth is backward or stunted.

Exceptional Subjects.—Silos may be got ready, or stacks arranged to receive green rye and trifolium and other forward green stuff, under pressure.

June.

Arable Farm.—Turnip cultivation is the chief work in June in Southern and Midland counties. Other forward green crops will need horse and hand hoeing, and singling out to fitting distances. Cabbages may be transplanted either into well-prepared land, so as to yield a full crop of drumheads in December and late autumn, or between the rows of the ripening early crop of potatoes, so as to provide a catch crop after they have been removed. Clovers and sainfoin are mown for hay and for forage, for which also the late vetches are still available. They are finishing turnip-hoeing in the North already, at the same time as they are only beginning in the South, where too early sowing makes them liable to mildew.

Stock Farm.—Grass lands must be grazed according to the season, and thistles spudded and droppings spread about. Any cattle being soiled in stalls or boxes during the summer receive clover and vetches brought to them along with cake and meal; but grazing beasts are now generally at grass, receiving, it may be, cake—decorticated cotton cake—with which they are supplied in movable troughs. Cleanse out and lime-wash all cattle sheds. Hay-making begins in June; and cows should have as frequent change of pasture as possible. Sheep are washed and shorn in June, if not before; the shepherd must look carefully daily for any attacks of fly.

Hop Garden.—Where bine is weak, shorter poles may be supplied in place of long ones; and where land needs it, additional supplies of artificial manure are supplied.

Exceptional Crops.—Teazels receive their last cultivation, a shallow spading. White mustard may be sown after tares as food for sheep, or for ploughing in as green manuring. Hemp may be singled out.

July.

Arable Farm.—Peas will be ready for harvesting towards the end of the month in Southern counties, also winter beans. Any rye that has not been cut for forage, or for silage, is now ripe, and will be ready for harvest. Turnips must be horse and hand hoed, probably for the last time. Carrots and parsnips receive their last hoeing. Flax may be pulled as soon as the bolls get brown in July, and the land may be easily got into tilth for later turnips or mustard. Haymaking of the clover and sainfoin will be finished, and meadow haymaking begun in July. Silos may be filled, or silage stacks built.

Stock Farm.—During this and the previous month cows continue to receive the bull, especially the earlier heifers at 16 months, and 17 and 18 months old. Lambs are weaned in July, the ewes being taken from them and put into poorer pastures. The horse-work of July is not so heavy as that of other months, and they may be turned to grass at night. They will be employed in carting lime from the kilns for spreading on the stubble after harvest. Drain tiles, too, may be fetched against needing them in winter-time, and be placed in the fields to be drained. This is a suitable month for clearing out ditches and river-courses. When bare fallows are necessary a good deal of work is done in July in cross-ploughing and scarifying, collecting or burning weeds, and another cross-ploughing may be accomplished.

Hop Garden.—If weather be dry, the space between the rows cannot be moved too frequently, the horse-hoe or "midget" being kept going.

Exceptional Crops.—Teazels must be kept clean with the spade if they require it.

August.

Arable Farm.—This is the principal harvest month over all the Southern and Midland counties. Wheat is cut before it becomes dead ripe. Oats are cut while still a little green in the straw; they generally shake out in the wind if left till ripe. Barley is permitted to stand till dead ripe. Winter beans are ripe, and will be harvested in August. Spring-sown beans are also ripening. Early tares left for seed will ripen in August. Mangolds and carrots, if running to seed, should be pulled or cut down. Clovers are now over, or folded by sheep. Lucerne also provides forage. Cabbages may be available for cattle at pasture in drought. Fallow work proceeds, and if the land is still foul advantage must be taken of dry weather to collect or burn weeds. *Trifolium incarnatum* may be sown over wheat stubble.

Stock Farm.—Cheese and butter making proceed as in June and July. Milk yields more cheese per gallon in the autumn months. Cows at grass must have extra green food carried to them in the fields in droughts. Sales of fatting stock may be effected this month, when food for cattle in the fields is at its lowest. Swine will be bringing forth their second litters. The first litters are now strong young porkers, fit to go on the stubbles. The sows will want drafting; those intended for future breeding put on better pastures.

Exceptional Crops.—Buckwheat may be cut in August as soon as the majority of blossoms have ripened their seed. Hemp: as soon as the seed has set on the female plants, the male plants may be pulled and tied in bundles, and carried to the steeping-pond. Mustard may be sown for ploughing in or for feeding off. Teazel harvest begins in August, and the cutting of the heads continues for a week or two.

September.

Arable Farm.—Harvest work proceeds, finishing in the Southern counties and being the chief work in the North.

Corn ricks should be thatched as soon as they are built. Ploughs are busy in the stubbles as soon as cleared, before the end of the month; bean stubbles for wheat, and in other stubbles for beans, or winter tares, or rye. Lime may be applied broadcast, 80 to 100 bushels per acre. Marl and chalk and clay may be hauled out on land intended to receive them. Where harvest is early, and weeds can grow, it is well to pare the stubbles, harrow, and gather the rubbish together and burn it before ploughing. Clover for seed is ready to cut towards the end of September. The ploughing of clover lea for wheat proceeds. Bare fallows receive their last ploughing as a seed furrow, and may be sown.

Stock Farm.—Cattle at grass should be fat and ready for sale; they may have some early turnips or cabbages to help the green stuff of the fields along with their cake, scattered in the pastures. Sheep may be put on rape, and ultimately on the earliest turnips. Breeding ewes should be put on better fare than they have had since weaning time. They should be dipped with "winter dip" towards the end of September, to free their wool and skins from vermin. Pigs may be put up to fatten, the larger stores for bacon, the smaller for porkers. Dairy operations are gradually shrinking.

Exceptional Crops.—Hemp is ripe this month, and may be pulled and tied in bunches to dry. Hops ripen in September, and as soon as fully ripe should be gathered quickly. Canary seed is ready for the sickle after wheat harvest, being cut as soon as the top ears are ripe. In the orchard, pears, apples, and plums may be gathered. Put rams with the ewes in September or earlier, the earliest lambs coming in December and January.

OCTOBER.

Arable Farm.—Wheat-sowing is one of the principal operations of the month. Clover and bean stubbles having been ploughed are ready for the seed. Winter beans may be sown in October on any stubble that has been prepared by ploughing and manuring to receive them. Winter vetches may be sown during October; some having been sown during September also for successions in May and June. Potatoes may be harvested in October, either by the plough or spade. Turnip and mangold storing commences. Stubble-ploughing is October work, and, if clean, those fields may be manured before ploughing which are to receive spring beans, early peas, carrots and parsnips, and mangolds. Carting manure on to meadows.

Stock Farm.—Feeding cattle are brought into their stalls or yards, and fed on cut turnips, along with hay chaff and oil-cake or meal. Cows should be brought in at night, receiving prepared food in their mangers. Cheese-making is drawing to a close. Cows are calving for winter milking. Store pigs may be fed in yards or sties on mangolds or carrots that have run to seed, along with a little meal and steamed turnips. Fatting pigs get the small potatoes from the field, steamed, along with 5 or 6 lbs. of meal. Sheep may be folded on turnips or rape, or receive them in the meadows: and lambs, too, may be put on turnips by the middle of the month, receiving some chaffed hay and a small allowance of cake. Horses are on full work, and must receive their full allowance of corn. The rams may be put with the ewes in October.

Exceptional Subjects—It is well to begin in October, and maintain throughout the year, a strict record of all receipts and payments. Farm accounts, therefore, are a special subject for October. Hop-picking is completed in October. Young teazels may be transplanted from the seed beds. Gorse, cutting every alternate row in successive winters, may be cut and crushed for cattle food. Water meadows are being prepared for winter flooding by making fit all surface furrows.

November.

Arable Farm.—Wheat-sowing is carried on as fast as swede and mangold fields are cleared, and it should be finished this month. Carrots and parsnips should all be dug and housed or pitted in November. Horses may still be ploughing among the corn stubbles this month, those fields intended for beans and peas being ploughed first, and those intended for swedes and turnips last. It is well, too, to select the stiffest soils for early ploughing. Some of the labour of November may be spent in carrying clay or marl or chalk on such lands as would be benefitted by them. Threshing of all kinds of grain, as straw or corn is needed either for use or sale, is carried on in November and other winter months.

Stock Farm.—Cattle in the feeding stalls and sheep in the folds are being fed liberally where beef or mutton is the end in view. In the dairy, as the grass fails, cows may receive hay as fodder in the fields, or be tied up in cow-houses, receiving cabbage or roots along with hay and straw chaff. Cheese-making comes to an end, and the milk of any lately calved cows, or cows purchased for their winter milk, is sold directly to the consumer, the yield being stimulated by good feeding of all kinds. Store pigs are fed on turnips and bran, and fatting pigs on turnips, potatoes, and barley meal.

Exceptional Subjects.—Fences are planted, mended, cut, and laid this month; posts and rails should be repaired. Work in the hop grounds includes draining, sorting and re-pointing poles, and planting. Osiers may be cut this month. The teazel land receives a shallow digging between the rows of young plants. In water meadows, furrows, surface drains, hatches, &c., are all completed, and irrigation commenced by those who have water at command.

DECEMBER.

Arable Farm.—Horse-labour includes ploughing stubbles, carting lime from the kiln, and marl from pits or trenches, to the fields where these are to be applied; also in carting stones to roads, tiles to drains, manure to fields, and grain to market; also in carting from market such feeding stuffs as your stock require. Drainage work goes on in December, the lowest field on the farm being first done, and a good outfall for the whole area being secured. Roads should be made and mended.

Stock Farm.—Cattle in stalls are kept warm and dry and clean, and well fed, cow stock being treated as to food according to their condition, whether dry or yielding milk, and fatting stock being fed better and better as they are getting fat. Sheep folded on turnips should receive ample dry food along with the cut turnips in the troughs, and ewes scattered over the grass fields require additional food, especially dry food, along with a few turnips or cabbages Pigs should be sold as they fatten, and the larger stores with the sows, after their third litter, should be put in to fill up the blanks. On dairy farms the production of milk for sale is almost the only work going on. Some butter-making may be continued, and the earliest calves may be coming; but as a rule, where cheese-making is the ordinary industry, cows are dry, and fed, either in fields or in houses, on turnips, with hay and straw. Yards and byres and boxes are cleaned out, and the manure carted during frosty weather, when the dung-cart can be worked without injury to the land, heaps of manure being made on properly prepared layers of absorbent earth in the fields intended for green crops next year. The carts are driven over the heaps as they bring their additions, so as by condensation to check any premature fermentation.

Exceptional Crops.—Planting and pruning may be carried on in the orchard; and digging in the hop grounds, to which manures and poles may be carried in frosty weather.

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