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ON THE
MANAGEMENT OF GRASS LAND,

WITH ESPECIAL REFERENCE TO

THE PRODUCTION OF MEAT.

BY

H. S. THOMPSON,

LATE PRESIDENT OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

LONDON:

PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET,
AND CHANCING CROSS.

1872.

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FROM THE
JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND,
VOL. VIII.—S.S. PART I.



ON THE MANAGEMENT OF GRASS LAND.

THE Journal for 1858 contained several articles on the Management of Grass Land, in one of which I gave an account of some experiments in laying down land to grass, and its subsequent management. These experiments have been repeated, under a considerable variety of circumstances, during the last fourteen years, and as this additional experience has, to some extent, modified my previous opinions, as well as furnished me with additional information, I am induced to revert to the subject now that the production of meat has assumed a degree of importance which cannot be fully appreciated without a brief reference to some of the public documents bearing on the subject.

Since the date of the abovementioned paper the number of mouths to be fed in Great Britain and Ireland has increased by more than three millions. A mere statement, however, of the increase of numbers, very inadequately expresses the whole additional call for animal food, the rapid development of the industrial resources of the country which has taken place of late having created a demand for labour at advancing wages, which has given the working classes unexampled command over the comforts of life, and greatly increased the frequency of their visits to the butcher's shop.

No reasonable doubt can, therefore, be entertained that the effective demand for fresh meat has risen rapidly during the last few years, and the next questions that suggest themselves are:—Have the supplies kept pace with the demand? And are they still increasing at such a rate as to satisfy the quarter of a million hungry souls which each successive year adds to the population of these islands? I will first deal with the supplies from abroad, and the accompanying Table (A) [see next page] shows the number of cattle, sheep, and swine imported into the United Kingdom in the years 1863–1871 inclusive, being a continuation of a return published in vol. xxv. p. 29 of the Society's Journal.

It thus appears that, though the foreign supply varies considerably in different years, it has never—even in the year of the Cattle Plague (1866)—reached a point at which it could materially affect the supply of meat for the million. It is satisfactory to find that the recent sanitary regulations, limiting the landing and removal of foreign cattle, sheep, and swine, have not diminished the importations; the average numbers of each kind of stock imported in the three last years—1869, 1870, 1871—having

materially exceeded the average of the whole nine years recorded in the Table.

We have next to consider our home resources, in which we are greatly assisted by the returns annually published by the Board of Trade. Unfortunately these returns were not, until 1867, sufficiently complete to be used as a basis for calculation. Table (B) gives the numbers of the live stock in the United Kingdom from 1867 to 1871; and by comparing tables (A) and (B) we learn the very small proportion which the imported flocks and herds bear to the *natives*. Even in 1871, when the prices of beef and mutton, and the numbers of the live stock brought into our ports, reached higher figures than ever before known, the number of cattle imported was only 2.66 per cent. of the home stock, the sheep 2.91 per cent., and the swine 2.07 per cent.

TABLE A.

CATTLE, SHEEP, AND SWINE imported into the United Kingdom during the years 1863 to 1871.

YEAR.	Cattle of all ages.	Sheep and Lambs	Swine.
1863	150,898	430,788	27,137
1864	231,733	496,249	85,362
Cattle Plague broke out in June, 1865	204,867	914,170	132,943
Cattle Plague ended with the year 1866	237,739	970,880	73,873
1867	177,948	539,716	48,079
1868	136,688	341,155	33,721
1869	220,190	709,843	69,067
1870	202,172	669,905	95,624
1871	248,911	916,799	85,622
	1,811,146	5,989,499	651,428
Average of 9 years	201,238	665,499	72,381
Average of 3 years, 1869, 1870, and 1871	223,757	765,515	83,437

TABLE B.

NUMBER of CATTLE, SHEEP, and PIGS in the United Kingdom, in each year from 1867 to 1871 inclusive, showing the increase or decrease from year to year.

YEARS.	Cattle.	Increase or Decrease from previous year.	Sheep.	Increase or Decrease from previous year.	Swine.	Increase or Decrease from previous year.
1867	8,731,473	..	33,817,951	..	4,221,100	..
1868	9,083,416	+ 351,943	35,607,812	+ 1,789,861	3,189,167	- 1,031,933
1869	9,078,282	- 5,134	34,250,272	- 1,356,540	3,028,394	- 160,773
1870	9,235,052	+ 156,770	32,786,783	- 1,463,489	3,650,730	+ 622,336
1871	9,347,789	+ 112,737	31,416,829	- 1,369,954	4,136,903	+ 486,173
Between 1867 and 1871.	Increase of Cattle	= 616,316	Decrease of Sheep	= 2,401,122	Decrease of Swine	= 84,197

Taking the average of the five years given in Table (B), the imported cattle, sheep, and swine bore to the home-breds the proportions of 2·17 per cent., 1·89 per cent., and 1·82 per cent., respectively. If, therefore by imposing moderate restrictions on the movement of our flocks and herds, both home and foreign, we can check the spread of disease sufficiently to save the lives of 2 per cent. of our sheep and cattle, we shall add to their numbers an amount equal to the whole of our foreign supply.

I will now endeavour to form an estimate of the amount of beef, mutton, and pork, which the animals recorded in Tables (A) and (B) may be expected to send annually to market. This calculation must, to a great extent, rest on estimate, and cannot approach in accuracy to an ascertained fact; but I have before me so considerable a number of opinions, supplied by some of the most eminent cattle salesmen in the metropolitan and several of the leading provincial markets, also by local cattle dealers and butchers, together with returns from some of the railway companies, who convey large quantities of meat weekly from all parts of the United Kingdom to London, that the figures founded on a careful comparison of these data can scarcely be very far from the truth. Beginning with Table (A), I estimate the weight of the foreign cattle brought to market for slaughter—exclusive of calves, young bulls, &c.—at 620 lbs. per head. A considerable deduction must be made for the number of calves, which, in 1871, were 40,189 = 16·12 per cent. of the cattle of all ages imported in that year. Taking the calves at 80 lbs. each; 16 per cent. at 80 lbs., and 84 per cent. at 620 lbs., give an average of 530 lbs. per head for cattle of all ages. There are, however, a certain number of young bulls and inferior cattle imported for which allowance must be made, and I therefore take the average weight of foreign cattle of all ages at 520 lbs. per head. In estimating the weight of meat derived from this source, it is, no doubt, overrating it to assume that the foreign cattle yield 520 lbs. of meat each as imported, many being milch cows, or store cattle for grazing; but, as there are no data for calculating their numbers or weights, I have preferred to assume that the whole are intended for immediate slaughter. The number imported in 1871 was the highest ever known, viz., 248,911. At 520 lbs. each, this would produce 57,783 tons of beef.

Foreign sheep and lambs I estimate at 50 lbs. per head: the 916,799 imported in 1871 would, therefore, produce 20,464 tons of mutton.

Foreign swine I estimate at 100 lbs. per head, and at this rate the 85,622 swine imported in 1871 would yield 3,331 tons of pork; so that the cattle, sheep, and swine, of all ages imported in 1871 would yield 81,578 tons of meat.

The next step will be to estimate the average supply of meat derived from the cattle, sheep, and swine shown in Table (B). For this purpose the United Kingdom may be treated as one gigantic farm, breeding, rearing, and fattening its own live stock; and the proportion of cattle, sheep, and swine sent to market may be approximately estimated by ascertaining how many head of each sort a farm maintaining a herd of 100 cows, 100 breeding ewes, and 20 sows can supply annually for sale. The stock must be self-sustaining, and must, therefore, contain animals of both sexes and of various ages. The following calculation proceeds on the assumption that 100 cows will produce annually 80 calves; that 10 per cent. of these will be killed for veal, and that, apart from any abnormal attack of disease, 3 per cent. will adequately represent the deaths.

SELF-MAINTAINING HERD OF 100 COWS.

<i>Total Herd.</i>		
Cows	100	It is assumed that 100 cows will produce 80 calves annually, of which 8 (= 10 per cent.) will be killed as veal. To maintain the herd, 20 cows and 1 bull must be supplied annually from the young stock between 2 and 3 years old, thus reducing the number available for market from 72 to 51.
Bulls	2	
<i>Young Stock—</i>		
Under 12 months old	80	
1 year old and under 2 years	72	
2 years old and under 3 } years	72	
	326	
Deaths = 3 per cent.	10	
	316	

Number available for Market.

Draught cows and bull	21
Calves	8
Young stock, 2 to 3 years old	51
	80
Less deaths 3 per cent.	2
	78

On these data a herd of 316 cattle of all ages will send to market annually 78 head = 24.68 per cent. In applying these figures to Table (B) allowance must be made for the calves not officially enumerated. Calves for veal are nearly always killed under eight weeks of age, and as the enumeration is only made once a year, and the consumption of veal is tolerably uniform through the year, $\frac{2}{3}$ ths of the veal calves are born and die without finding their way into the annual return. In the foregoing statement a herd of 326 animals contained 8 veal calves, and of these $\frac{2}{3}$ ths (= 6 $\frac{2}{3}$), which is equal to 2 per cent. of the whole herd, would be omitted from the official return. Two per cent. must therefore be added to the number of cattle in that return,

which would have the same result (within a very minute fraction) as raising the percentage given above of cattle available for slaughter from 24.68 to 25 per cent. It will therefore be assumed that 25 per cent. of the cattle of all ages in Table (B) will be annually available for slaughter.

A similar calculation applied to sheep shows that a self-sustaining flock will send to market 42 per cent. annually, if it be correct to assume that 100 ewes will produce 130 lambs, of which 32 (= 25 per cent.) will be killed under one year old. It is also assumed that, apart from any specific attack of disease, 5 per cent. per annum will represent the deaths.

SELF-MAINTAINING FLOCK OF 100 EWES.

<i>Total Flock.</i>		It is assumed that 100 ewes will produce 130 lambs, of which 32 (= 25 per cent.) will be killed under 1 year old. To maintain the flock, 33 ewes and 1 ram must be supplied annually from the shearing sheep, thus reducing the shearlings available for market from 98 to 64.
Ewes	100	
Rams	2	
Lambs	130	
Shearlings	98	
	330	
Deaths = 5 per cent.	17	
	313	

Available for the Butcher.

Culled ewes and ram	34
Lambs	32
Shearlings	64
	130
Less deaths	5*
	125

A flock of sheep numbering 313, of all ages, will thus send to market annually 125, = 40 per cent.

In applying these figures to Table (B), some adjustment must be made to compensate for the great number of lambs killed before the time of taking the agricultural census in June. April, May, and June are the great lamb-consuming months in the large towns, whereas in the country the greatest number are sent to the butcher in June, July, and August. It will probably be fair to assume that half the number destined to be killed as lambs are slaughtered by the middle of June, when the official enumeration is made. In the calculation given above, the lambs slaughtered (32) are about 10 per cent. of the whole flock, and if half of these are omitted from the Government return it would require an addition of 5 per cent. to the number of *sheep and lambs* shown in Table (B), in order to make good

* There are fewer casualties among the fattening than among the breeding stock.

the omission. This would have the same effect, so far as our calculation is concerned, as adding 2 per cent. to the numbers "available for the butcher." I shall therefore assume that our homebred sheep and lambs will send to market annually 42 per cent. of the entire number shown in Table (B).

Few farmers, probably, will find these figures precisely agree with the results of their own breeding and feeding operations, but they must bear in mind that an attempt is here made to strike an average of the productiveness of flocks and herds of different races, placed under the most varying conditions of climate, food, and shelter. One of the most likely points to be questioned is the average rate of increase of a flock of sheep, viz., 130 lambs from 100 ewes. It would no doubt be easy to name districts where the customary increase is much greater. In the flat lands, 150 lambs to 100 ewes is a common occurrence, but the hilly districts of the United Kingdom cover a great extent of country, and 130 lambs to 100 ewes would seem as extravagantly high to a breeder of mountain sheep as it would be thought below the mark by the owner of a sheep farm in the plains, who always provided succulent food for his ewes at the time of admitting the rams. From a number of letters on this subject I have selected two as representing the extreme views on this point. One is from an eminent Northumbrian farmer, who says that in the four years 1868-71, 1280 ewes produced him 2122 lambs, notwithstanding that in one of those years he had the bad luck to have 25 barren ewes. This is at the rate of 166 lambs per 100 ewes. The other extreme is described in a letter from a friend in Kent, who says, "Kent sheep, as a rule, do not twin much, and we much prefer they should not." . . . "I should say that if you were to put it at 105 lambs for 100 ewes, you would be about right as regards my district, though this year I have 400 lambs from my 350 ewes."

The proportion of pigs annually available for slaughter is far greater than that of either cattle or sheep, as a breeding sow will generally produce two litters per annum, which may be averaged at seven each. The sows themselves are seldom kept more than two years, and the bacon-pigs are killed at one year to one and a half year old—average fifteen months. There are no sufficient data for determining the proportion of porkers to bacon-pigs slaughtered. In the large towns great numbers of pigs are killed for pork, and comparatively few for bacon. In the country districts it is exactly the reverse; every well-to-do labourer kills his bacon-pig, and every farmer his two or three up to eight or ten; but the quantity of fresh pork consumed by either farmers or labourers is comparatively trifling.* The large production and

* Bacon-pigs here include all pigs killed for salting; porkers, all consumed fresh. A portion of a pork pig put into pickle for a short time would not prevent its being included in the latter class.

consumption of bacon in the agricultural districts is an important element in estimating the national supply of meat, and is liable to be underrated in consequence of its never being brought to market, or in any other way exposed to public view. I have had a careful enumeration made of the pigs in the two parishes immediately adjoining my residence, which contained, in 1871, a population of 1139 souls entirely dependent on agriculture for their support. In these two parishes 230 bacon-pigs and 35 porkers have been killed within the last twelve months, the whole for home consumption. The bacon-pigs averaged 306 lbs., and the porkers 86 lbs. each. Of the 230 bacon-pigs, 94 were killed by farmers, 113 by labourers, and 23 by small tradesmen and others not belonging to either of those classes. I have no reason to think that these parishes differ in any material respect from the average agricultural parish of the northern counties. In Ireland the proportion of bacon-pigs to porkers killed is much larger than in England.

From the best information I can obtain I am disposed to fix the proportion of bacon-pigs to porkers for the United Kingdom at two to three. The numbers will therefore stand as follows :—

SELF-MAINTAINING HERD OF PIGS.

<i>Total Number of Herd.</i>		
Sows	20	} 20 sows will annually produce 230 pigs. To replace breeding stock, 10 sows and 1 boar must be provided annually out of the young stock.
Boar	1	
Porkers	168	
Bacon-pigs	112	
	301	
Less deaths = 3 per cent. ..	9	
	292	

Annually available for Market.

Sows (half)	10
Boar	1
Bacon-pigs ($\frac{2}{3}$ ths killed yearly)	90
Porkers (all)	168
	269
Less deaths 3 per cent.	8
To replace breeding stock	11
	250

A herd of 292 pigs of all ages, will therefore supply annually for slaughter 250, = 87½ per cent. This will require considerable modification, in consequence of the number of young pigs necessarily omitted from the June census. Roasting pigs are

seldom more than a month old, so that eleven out of every twelve are born and die after one census day and before the next. Similarly, porkers whose average life does not exceed five months, would more than half of them be unrecorded, even if the consumption of pork were tolerably uniform through the year; but, as the great pork-consuming months are November, December, January, February, and March, I cannot estimate the number omitted at less than $\frac{2}{3}$ ths of the whole porker class. The pork-pigs are estimated above at 168 out of a herd of 301, = 56 per cent., and of this 56 per cent. $\frac{2}{3}$ ths are omitted from the census; $\frac{2}{3} \times 56 = 33$. It will therefore be necessary to add 33 per cent. to the number of pigs in the Government return. It has been already shown that $87\frac{1}{2}$ per cent. of our whole stock of pigs are slaughtered annually, and $87\frac{1}{2}$ per cent. of the number of pigs in the Government return, with 33 per cent. added, is equivalent to rather more than 116 per cent. of the number as it originally stood. Hence it appears that the number of homebred pigs annually slaughtered in the United Kingdom amounts to about one-sixth more than the whole number recorded in Table (B).

Up to this point the calculation has been confined to determining the *numbers* of the different kinds of homebred live-stock annually slaughtered, and these have been fixed at 25 per cent. for cattle, 42 per cent. for sheep, and 116 per cent. for pigs, of the number given in Table (B). The next step must be to ascertain their respective weights. The average weight of homebred cattle, of all ages, I fix at 600 lbs. per head. This is below the weight given me by the leading salesmen, but I am disposed to think that the great dealers who are more conversant with prime animals than with inferior stock, do not attach sufficient importance to the effect the light weights have in pulling down the average, and the railway returns confirm me in this view. I shall therefore proceed on the assumption that the average dead weight of cattle of all ages is 600 lbs.

The average weight of sheep I fix at 72 lbs. per head, and of lambs at 24 lbs. per head. It will be seen by the figures relating to a self-sustaining flock of sheep that there were 98 sheep sent to market for every 32 lambs: 98 at 72 lbs. each, and 32 at 24 lbs. each, give an average of 60 lbs. for the whole. The average weight, therefore, of the sheep and lambs slaughtered will be taken at 60 lbs. each.

The average weight of bacon-pigs I estimate at 250 lbs. each. For many of the northern counties this will be below the mark. The large breed is in high favour among the artisans in the manufacturing towns and villages, many of whom pride themselves on feeding their pigs up to 700 or even 800 lbs. each.

On the other hand, in some of the midland and southern districts there is a tendency to patronize the small short-nosed breeds, which frequently do not exceed 140 to 160 lbs. when killed for bacon. But the fancy breeds, either large or small, exercise comparatively little influence on the average of the whole country. By far the largest portion of the pig stock of the United Kingdom is composed of moderate-sized animals, of which the Berkshire and the Yorkshire pigs may be taken as types of the black and white breeds respectively. The average weight of these, when slaughtered, is about 280 lbs. There are, however, large numbers of pigs killed for salting, especially in the south of Ireland, which fall short of the usual weight of the regular Christmas bacon-pig. In October, 1869, I visited one of the large pig-killing establishments in Waterford, and found a goodly row of 700 pigs slaughtered that morning. There were 12,000 carcasses of pigs on the premises, the proceeds of the previous three weeks' operations. The weights of these were from 150 to 250 lbs., and would, I think, scarcely reach an average of 200 lbs. These weights would probably be somewhat increased as the season advanced. On the whole, I think 250 lbs. fairly represents the average weight of a bacon-pig.

I estimate the porkers at 65 lbs. each. The professional opinions all incline in favour of 70 lbs. or more, on the ground that comparatively few are killed below 70, whilst there are a fair number of heavy weights killed even up to 140 lbs. each, not only for consumption as pork, but to be worked up into sausages, and other forced-meat compounds. No doubt this is true as regards the large towns, but in the country districts and small towns a few roasters and a good many young porkers are killed; and as the large breeds are unsuited for early slaughtering, the small breeds are generally selected for the purpose, and only reach light weights. I therefore assume the average weight of porkers killed to be 65 lbs.

It has been already shown that, out of 269 pigs of all ages available for market, 101 would be killed for bacon, and 168 for pork; and applying to these numbers the weights of 250 lbs. and 65 lbs. respectively, we arrive at an average of 134 lbs., which will represent the average weight of homebred pigs of all ages killed in the United Kingdom.

We are now in a position to apply these numbers and weights to Table (B). Beginning with the year 1871:—25 per cent. of the 9,347,789 cattle recorded in that year = 2,336,947, and multiplying this number by 600 lbs., gives us 625,968 tons of beef and veal as the produce of our cattle last year. Similarly 42 per cent. of the 31,416,829 sheep and lambs recorded = 13,195,068, which, at 60 lbs. each, would yield 353,439 tons of mutton and lamb. And lastly, 4,136,903 pigs, at 116 per



cent. = 4,798,807, which, multiplied by 134, gives 287,071 tons of pork and bacon. These figures give us a total of

	Tons.	Per cent.
Beef and veal	625,968	
Mutton and lamb	353,439	
Pork and bacon	287,071	
Produce of meat from homebred flocks and herds in 1871	1,266,478	= 87·51
Produce of meat from imported flocks and herds in 1871 (see p. 5)	81,578	= 5·64
Imported provisions, fresh, salted, or otherwise preserved (see Board of Trade Returns for 1871)	99,125	= 6·85
Total supply of meat, home and foreign, in 1871	1,447,181	100

The same calculation applied to the returns for 1870 shows that 1,240,603 tons of meat were supplied by our homebred cattle, sheep, and pigs, in that year. Similarly the imported animals in 1870 furnished 66,556 tons, and the imported provisions of all sorts—fresh, salted, and otherwise preserved—57,743 tons.

	1870.	1871.	Increase.	Proportion of Increase.
	Tons.	Tons.	Tons.	
From Homebred Animals	1,240,603	1,266,478	25,875	= 31·44
„ Imported Animals..	66,556	81,578	15,022	= 18·27
„ Imported Provisions	57,743	99,125	41,382	= 50·29
	1,364,902	1,447,181	82,279	100

Comparing these with the figures for 1871, we find that, in the latter year, there was an increase in the supply of meat from all sources of 82,279 tons, of which nearly one-half was in the form of salted or preserved meat, the quantity of fresh meat imported being small. It also appears that, even under the stimulus of extraordinarily high prices, there was little elasticity in the import trade, so far as live animals were concerned; the importations in 1871 being very little in excess of those in 1866, when there were 11,172 head of cattle and 11,749 pigs less, but 54,081 more sheep imported than in the first-named year.

An elaborate and very valuable article on this subject appeared in the 'Chamber of Agriculture Journal' of May 29, 1871, which, unfortunately, did not come into my hands until after the foregoing statement respecting our meat-supply was prepared. Had it been otherwise, I should have been spared the labour of collecting the data on which the calculations are founded. Though differing in many matters of detail from the article in

question, the only considerable divergence is in the average weight of the pigs slaughtered in the United Kingdom; and on this point the best-informed opinions differ so widely, that it would have been strange, indeed, if two independent calculations, both founded on estimate, had arrived at any close coincidence. As regards sheep and cattle, the substantial agreement of the main results obtained by two distinct modes of handling the subject is a strong confirmation of both.

In that article it is shown that during the four years, 1867-71, the annual consumption of meat in the United Kingdom was slightly under 7 stone per head of the population. The rate of increase of the nation is 252,463 per annum, and the supply of meat from all sources has been shown to have been greater by 82,279 tons in 1871 than in 1870. This would be at the rate of $52\frac{1}{4}$ stone for each additional individual, or more than seven times the average consumption; so that the national stock of animal food, if equally divided amongst the population, would, even after filling the 252,463 additional mouths, supply a larger allowance to each individual in 1871 than in 1870. Consequently, meat might have been expected to have been cheaper, whereas, in point of fact, the price of butcher's meat was higher in 1871 than ever before known; showing that the increased demand for meat is not to be measured solely by the increase of population, but that, so long as the country continues to make progress, the increasing ability of the whole nation to buy will require a more rapid increase of supply than even the large additions which have been made in the last few years.

The most probable mode of accomplishing this important object is to improve our grass land. The land under "Permanent Pasture" in the United Kingdom was returned in 1870 at 22,085,295 imperial acres.* This is exclusive of 31,336,215 acres partly occupied by towns, roads, and inland water, but chiefly consisting of wild moor and mountain, furnishing but scanty herbage, yet, in the aggregate, supplying large numbers of hardy sheep and cattle, to be fattened on better land. The United Kingdom in 1870 contained also 6,320,126 acres of *clover and grass under rotation*. Of these three great divisions of land devoted to the maintenance of live stock, the first is the only one which holds out much promise of speedy improvement, as moors and mountains are costly to improve, and precarious in their returns; and the clovers and rotation-grasses, being preparatory to the growth of corn, are, for the most part, as well managed as the skill and means of the occupiers permit. I propose, therefore, to limit my suggestions for improvement to the twenty-two millions of permanent pasture above mentioned. The great bulk of this large area is in England

* Agricultural Returns, 1870.

and Ireland, as in Scotland grass is generally grown as a rotation crop; so that in 1870 England, Ireland, and Wales, contained 21,098,828 * out of the 22,085,295 acres of permanent pasture in the United Kingdom.

Within the last three years I have endeavoured to ascertain by personal observation the general state of the grass land of the two former countries. In 1869 I spent a few months in visiting every county in Ireland, and in 1870 and 1871 I travelled many hundred miles to make myself acquainted with some of the most famous grazing districts in England. The following are three of the general conclusions at which I arrived.

1st. That although very excellent management is to be met with in parts of our best grazing districts in Leicestershire, Northamptonshire, Gloucestershire, Somersetshire, and several other counties, this must be considered quite exceptional, and the treatment of the bulk of the grass land of the country is very unsatisfactory.

2nd. That our grass lands, if properly managed, would be easily able to meet the demand made upon them for an increased production of meat, even if the supply required were greatly in excess of the present rate of consumption.

3rd. That money judiciously laid out in improving grass land makes a better return than money laid out on arable land.

With reference to the first assertion, though 9s. per stone for beef and mutton is causing considerable stir amongst grass-land farmers, the efforts to improve are very desultory, and entirely without method or system. If corn or roots are to be grown, pains are taken to give a dressing of the most suitable tillage, and to remove the interloping weeds which rob and threaten to smother the crop; and if any tenant tries to grow successive crops without manure, or systematically allows his fields to be red with poppies or yellow with charlock, the neighbours shake their heads, and hint that he is getting near the end of his tether. But if he totally neglects his pastures, never giving himself the trouble to consider whether bad grass might not be improved, or whether the docks and thistles might not be destroyed at very small cost, no surprise is excited, because, unfortunately, improved management is the exception and not the rule. It is, however, not my object to dwell on the deficiencies of our present practice, but rather to call attention to the great opportunity afforded by the present high prices of meat to improve our grass land and our banker's balances by one and the same operation.

The problem before us is how to improve 22 millions of acres of grass land, so as materially to increase the production of meat

* Agricultural Returns, 1870.

and leave a safe profit to the improvers. These 22 millions of acres contain every variety of land, and are placed under an equal variety of management, and the value of the gross annual produce may be said to vary between the extreme limits of 10*l.* and 5*s.* per statute acre. It may be well to define at the outset what is meant by first-rate grass land, that we may have before us a standard of excellence towards which improvers may strive to approach as nearly as circumstances will permit. The rent actually paid is clearly no guide at all. The amount obtainable at annual lettings by public competition approaches much more nearly to the value; but as annual letting is seldom practised, and cannot be recommended except under very exceptional circumstances, I prefer to take as my standard of excellence land which, in a good grazing year, will produce 20 imperial stone of meat per acre without artificial assistance.

Unfortunately the quantity of such land is extremely small, and is for the most part confined to the alluvial flats which have accumulated near the existing or former outlets of some of our tidal rivers. The far-famed pastures along the banks of the Axe, the Brue and the Parret, in Somersetshire, are of this character, and constitute probably the most extensive flat of first-rate grass land in the United Kingdom. Here may be seen 1000 acres let annually for grazing by the trustees of one estate, which bring in between 5000*l.* and 6000*l.* per annum. The land is let annually in 54 fields of various sizes, and clear of all rates, taxes, and tithes. In 1870 the 54 lots let for 5948*l.*, and in consequence of the extreme drought of that summer the lettings in 1871 were reduced to 5664*l.*; but it is a striking proof of the intrinsic excellence of the pasture that, after 1870, one of the worst grazing years on record, this estate should still have let in 1871 for 5*l.* 13*s.* 3*d.* per acre!

The residents in the most noted grazing districts are each confident that their own is the best in the kingdom, and I have repeatedly been challenged to express an opinion as to their comparative merits. In the Eastern Counties the district around Boston is believed to be unrivalled in Great Britain, and doubtless amongst the old enclosures in that neighbourhood are to be found fields which, from their depth of soil and the richness of their herbage, are acre for acre as good as any; but when speaking of grazing districts, the great uniformity of character which prevails over an extensive area in the Bridgwater Level, and the mildness of the western climate, give Somersetshire advantages which are unequalled in any other part of Great Britain.

Next to the alluvial soils the best pastures are to be found on the carboniferous or mountain limestone, and especially on the beds of drift gravel, partly composed of the *débris* of these

rocks. In Ireland a considerable portion of the flat country is overlaid by these drifts, which grow sweet wholesome pasture on which either horses, cattle, or sheep thrive well. It is too much the habit in Ireland to plough out the grass at short intervals, but where it has been left undisturbed for a sufficient period, it improves in quantity and quality of produce until it reaches a point very little below the first-class alluvial land already mentioned. This may be seen to advantage in the County Meath, and portions of the adjoining counties. In several counties of England, too, very good grass land is found on the mountain limestone. The valleys of the Dove and Derwent in Derbyshire, and those of the Wharfe and Ribble in the West Riding of Yorkshire, may be especially mentioned; and according to the dictum of Hudibras, that "the worth of a thing is what it will bring," some of this land might claim to be ranked amongst the very first. Probably no higher bid was ever made for land for agricultural purposes than one which was mentioned to me in November, 1871, when walking over a ten acre field in the immediate neighbourhood of the small town of Settle in the West Riding. It formed part of a farm of about 100 acres, which had recently been offered for sale. My informant was cognizant of the fact that a *bonâ fide* offer of 3000*l.* had been made and REFUSED for this field, the vendor being advised that the sale of the remainder of the farm would be prejudiced to a greater extent than even 3000*l.* by the loss of these 10 acres. No reasonable calculation of produce could justify such a price, but its convenient position, and the great advantage of having a field where grass of the best quality was always growing when the thermometer was above freezing-point, made its estimated worth to the owner of an adjoining farm from 7*l.* to 8*l.* per acre.

In many other parts of England first-rate grass land may be found in isolated patches, where accumulations of silt brought down by successive floods have in the course of ages formed alluvial soils of great depth and richness. It may seem a work of supererogation to make suggestions for the improvement of pastures which already produce great results, but the holders of first-class land may learn something by observing the practice of those skilful and experienced graziers who find it worth their while to give such extreme prices for the occupation of land as some of those already quoted. In order to reimburse themselves it is necessary that every yard of land should be productive, and the greatest care is taken to mow the thistles whilst still young and succulent, in which state they are (when mown) readily eaten by all kinds of stock. Coarse patches of grass, too, are occasionally switched over by the scythe, or, if necessary, an old horse is tethered in the worst places, until they are cropped

down sufficiently to be again grazed regularly by the feeding stock. The loss of grass caused by neglecting to mow thistles and other large weeds would never be permitted if farmers would only consider how largely the fertility of the soil is taxed to nourish these intruders, and how cheaply they may be kept down. An old man and a hard-worn scythe, neither of them fit for regular work, will keep a large acreage of grass free from this constant source of loss.

In addition to these preservative measures, something may be done to increase the produce on even the best land. If the question be asked why such and such a field is worth more to the occupier than the adjoining ones, the reply will frequently be that the field in question *grows early and late*, and even the most unobservant are occasionally struck with the brilliant green of some favoured fields, or portions of fields, when all the rest are brown. But a closer inspection will show that even the brown pastures have green patches in them. Wherever the droppings of cattle have fallen in spring the grass is green in autumn, even after a moderate amount of frost and biting winds, showing that it is not the fault of the soil or the climate that the grass is not still fresh and succulent, but that want of condition produces a feeble vitality, easily affected by cold, which stops the growth of the herbage much earlier in the winter than is at all necessary. There are also patches of land in most pastures where the stock do not like the grass, the deficiency in this case not being in bulk but in quality of herbage. Unless this is caused by defective drainage, a dressing of the mixture to be subsequently described will generally restore the quality and cause these neglected parts to be as well eaten as the rest.

I have ventured to define first-class grass-land as that which will produce 20 imperial stone of meat per acre without artificial assistance. Next in order must be placed the land which will produce about the same quantity of beef and mutton, with the aid of a moderate allowance of cake or corn. This quality of land may be found to a greater or less extent in almost all parts of the country, with the exception of the *chalk*, the *light sands*, and the *strong clays*. The practice of giving artificial food to cattle at grass is rapidly gaining ground. It is already apparent that 9d. a lb. for beef and mutton will produce a perfect revolution in the management both of live stock and of grazing land, and the advantages of the improved system are such that it may be safely expected to outlive any reasonable decline in the price of meat. The easiest kind of food to give in the field is linseed or cotton cake. The mixture I prefer to any other is linseed and decorticated cotton-cake in equal quantities. Bean-meal, too,

moistened and rolled into balls is easily given and very effective. Many other kinds of feeding-stuffs, either singly or in combination, will recommend themselves according to their relative prices in the market. Where mixed linseed and cotton cake are given, the cost of the mixture at present prices would be about 1s. 4d. per stone; and supposing it to be unnecessary to commence its use during the first ten weeks of the grazing season, whilst the grass is at its best, if 5 lbs. be given daily to each fattening bullock at the commencement of the last ten weeks, increasing the allowance to 6 lbs., and for the last few weeks to 7 lbs. per day, averaging 6 lbs. for the whole ten weeks, the cost of the artificial food would be 40s. per head. If the land will carry a beast per acre, this will add 40s. per acre to the farmer's expenses, and reduce correspondingly the value of the land when compared with that which will fatten the same number of beasts without artificial aid. Hence, if the very best grass land be supposed to be worth a rent of 5*l.* per acre, the land which requires cake for finishing the beasts ought not to be rented at more than 3*l.* per acre. These general figures will, of course, require adapting to each individual case to suit the great variety of qualities of land and other modifying circumstances.

One of the advantages of giving cake to finish beasts, which, on the unassisted grass, would come out in October only half beef, is that the grazier is thus enabled to send his beasts to the butcher at full prices, instead of fattening them in the yards at great cost; or, of selling them as store beasts when many others are doing the same, and the markets are crowded and depressed. In cases where farmers occupy land not well suited for the growth of roots, and do not attempt to fatten beasts in the winter, but give cake in the strawyards to improve the manure, and bring out their beasts in spring in a forward state, it often answers well to give cake in the early part of the grazing season, and so push on their cattle as to get them to market in June and July, when beef is the dearest, to be followed by younger beasts to eat up the rough grass in the autumn and early winter. This is excellent practice, as there is no time when cattle make such rapid improvement, and when the expense of tending them is so light, as when they are having cake or corn on a good pasture. The grazier, too, who has fat cattle in June, has the command of the market, and is to a great extent independent of season, as should the weather be drouthy and his stock heavy, he can at any time lighten his pastures by draughting a few forward beasts for sale.

Another advantage which arises from giving artificial food to grazing cattle, is that the pastures themselves are gradually improved, until land that is only fit for rearing store cattle becomes

capable of fattening stock with a moderate amount of help towards the end of the season.

Hitherto I have spoken of good land only, but unfortunately the larger portion of the pasture land of the United Kingdom may be classed either as *moderate* or *inferior*. I will not attempt to describe the various gradations by which land descends from the highest quality to that which requires some acres to keep a yearling steer, and which was once described by a disheartened occupier, as of that kind on which the grass only began to grow on Midsummer Eve, and gave up growing on Midsummer Day. The various shades of land worth from 40s. per acre downwards require very similar measures for their improvement, and, before making any special suggestions respecting them, it is necessary to declare open war against the time-honoured fallacies that pasture land can be profitably occupied by leaving it to itself, and that a farmer consults his own interests by allowing the arable land to rob the grass. Any one who mows his grass without return robs his land quickly, and he who pastures it without return robs it slowly; but the process is sure as well as slow, and when persevered in long enough produces the splendid variety of thistles, ragwort, scabious, and other flowering weeds, very charming to a botanist in July, but extremely disheartening to the hungry cattle, who are doomed to wander amongst them seeking for grass.

Since the days of Jethro Tull, there have been two recognized methods of keeping up the fertility of land, viz., either manuring at short intervals, or thorough disintegration, produced by frequent stirrings of the soil. It cannot be too strongly urged that as grass-land is necessarily deprived of the advantage received by arable land from frequent exposure to the atmosphere, it ought to be furnished in some other way with the minerals required to produce good crops of nutritive herbage. The use of artificial manures has given the grass-land farmer complete command over the supply of nitrogen, but a perfect restoration of the mineral ingredients removed by grazing, and still more by mowing, cannot be effected without an occasional application of farmyard-manure or of compost, in which farmyard-manure holds an important part; so that it would really be better practice, so far as farmyard-dung is concerned, to let the grass starve the arable land, than the arable land starve the grass, since the arable land can receive its mineral supply from other sources, viz., deep cultivation and thorough aeration. The slovenly management of grass land, which a few years ago was general, and is still too common, would never have been seen if the quality of grass could be appraised as easily and certainly as that of corn. But it is notorious that even the most experienced

farmers and graziers can only distinguish between good, moderate, and bad; no man living can distinguish by the eye the subtle difference in the quality of the herbage which makes one very good field worth 1*l.* an acre more rent than another very good field, or one bad field worth less than another equally bad-looking field. So long as a grass field grows about the usual quantity of grass, and the cattle eat it, the occupier is too apt to rest content with the good or bad reputation earned by particular fields, without any attempt to alter it for the better, or even to ascertain whether it is not gradually getting worse.

In early life I learnt a lesson on this point which I have never forgotten. A neighbouring gentleman mowed about 50 acres of his park annually, and, not being a farmer, he believed that grass was grass, and made equally good hay, whether he went to the expense of manuring it or not. He was also remarkably indifferent on the subject of quantity, saying that he kept a fixed number of horses and cows, and if, in a good season, he had a large crop they ate it all, and in a bad season they made it do; so that he stuck to his system as long as he lived, and the land got no manure but what the horses and cows made. I was thoroughly acquainted with this land, and much interested in watching the result. The produce grew gradually less, not year by year, or the owner would have taken the alarm; but each drouthy year that came produced a worse crop than the preceding dry season, until I have seen the produce of the 50 acres carried home in 19 cart loads! The quality, too, had fallen off quite as much as the quantity. In one part of the park, where the land was light, one kind of grass (*Avena flavescens*) had taken almost exclusive possession of the land, and neither cattle nor sheep would graze on this portion, except in the most desultory way; a mouthful here, and another five yards further on, picked up on the move, showed what they thought of the system, and even the hay was sorted over rather than eaten by the cows, a large portion being deliberately rejected and trodden under foot. This is an instructive instance, showing that the produce of grass land restored to it annually, less the value abstracted from it by the animals fed on it, will not, when continued for a length of time, prevent ordinary grass land from gradual but steady deterioration. It also shows how much more rapidly light land deteriorates than that which is stronger. The park in question, after being mown for many years, was certainly not worth more to let than 20*s.* per acre on the lighter, and 30*s.* on the stronger land; but after ten years' continuous pasturing, with occasional manurings and top dressings, it became worth 50*s.* per acre all round.

Having endeavoured to lay it down as an established fact that no grass land will maintain itself unimpaired without the

farmer's aid, I will venture to prescribe a mode of treatment which aims higher than mere maintenance.

On first-rate grass land there is comparatively little to be done. Deep alluvial soils contain such store of the elements of plant-growth, and are for the most part so easily penetrated by the roots of the grasses, that many years' successive pasturing seems to produce but little change in the quality of the herbage. But even here there are gradations of goodness. If the occupier carefully scrutinizes his fields in early spring, he will find backward patches, and in early autumn places that turn brown before the rest. These evidently want helping up, and in mid-summer he will generally meet with places more or less avoided by the cattle, when making their regular grazing rounds. In all these cases a slight dressing of the mixture hereafter mentioned may be put on at any time, being perfectly harmless to the cattle if accidentally taken up with their food. No dressing, however, should ever be applied in drougthy weather. Where a piece has grown coarse from not being eaten, it should be switched over with the scythe, in order that the tillage may quickly reach the roots of the grass. In this way the land may be kept up to its full producing power.

There is in the country a large quantity of grass land, which is not considered feeding-land, but yet will fatten young heifers or small Irish beasts, if the occupier is not in a hurry, and does not put them too thick on the ground. This kind of land is the most inviting to the improver; and if the occupier cannot screw up his courage to face the whole at once, he should till 10 acres well rather than 20 in a half-and-half way. Let him give a sufficient dressing to change the character of the herbage at once, so that he may have one field at least on which he can finish off his forward beasts. Mr. Lawes, on his experimental grass plots at Rothamsted, first taught the world that on a piece of old pasture, neither very good nor very bad, different kinds of tillage, repeated on the same ground for a few successive years, will produce as many different kinds of crop as there are kinds of tillage used, the character of the plants in the different plots varying as much as the quantity and quality of the produce. It is quite safe to assert that any occupier may, if he pleases, convert his grass into feeding-land; and though it will not always pay to do so, there are very many thousand acres on which it will pay well at the present price of meat. If any one wishes to satisfy himself whether what he has done in the way of improvement is in the right direction, and whether he has carried it far enough, let him watch his cattle when grazing. If they take the grass as it comes, heartily and contentedly, merely rejecting foiled portions, so that they are quickly satisfied and lie down to rest, the

occupier may be sure that he is on the right tack, and may leave well alone; but if they pick one bit and leave another, take the top off one kind of plant and nibble a few leaves off another, he may be equally sure that the pasture is unpalatable to the cattle, and that without change they will not give a satisfactory account of themselves at the end of the season.

The three worst kinds of pastures are generally supposed to be those on *light sands*, on *strong clay*, and on *black peaty soils*. The light sands I give up to the plough, unless in parks or ornamental grounds, where it is important to preserve the turf; ammoniacal dressings will produce a sudden appearance of improvement on light sandy land; but the effect is not lasting, and the dry bent grasses soon re-assume their sway. A mixed top-dressing will, for a time, increase the clovers, but a heavy dressing of compost, containing road-scrapings, or any other tolerably strong soil, is the most permanently useful. Improving pasture on really light sand is, however, one of the most thankless and ceaseless of agricultural operations, and ought to be the next task for Sisyphus, if ever his rolling stone should wear out.

The strong clays are much more promising. Most clay contains an abundant supply of the minerals which make a soil fertile, but they are in a crude state, and require air to make them fit for plant-food. The cracks caused by drought and worm-holes partially effect this, but the mineral supply from clay land that has been long in pasture is not sufficient to support heavy crops, and it should be a fundamental maxim with all clay-land farmers that their grass should never remain long without a dressing of farmyard-manure. Even the poorest, worst-made manure, which is little better than straw, is of great value, as it furnishes the requisite minerals, and, though deficient in ammonia, that can be supplied in soot, nitrate of soda, guano, &c. The grass grown on clay is wholesome and nutritive, unless the drainage is defective, or the land has been robbed; and, with a little extra tillage, clay pastures may be made to get moderate-sized beasts fit for market, especially if helped with cake or corn in the latter end of summer. All tillage should be applied to strong-land pastures early in winter. Many weeks are required to wash in the various mineral salts, and, from the retentive character of the soil, there is no fear of their washing out again. All operations on clay land require more time than on lighter soil. Soluble matters make their way more slowly down, and plants extend their roots with greater difficulty. It is, therefore, a great object to put on farmyard-manure, compost, and even mineral applications, soon after the grass is eaten bare in autumn, so as to have the full benefit of the winter rains. The roots of grass are always growing when the thermometer is

above freezing-point; and if by means of tillage applied in early winter the roots of the grass strengthen and extend themselves before the growing season arrives, a good foundation is laid for the increased development above ground which is sure to follow. If, on the other hand, the application of tillage be delayed till March or April, and a droughty spring follow, the application loses great part of its effect for that season.

When grass on clay is very unproductive, it sometimes becomes a question whether it would be better to plough it out and relay it. In such a case much ought to depend on whether the form of the land can be much improved by taking it out, whether high ridges require levelling, awkward watercourses filling up, old banks removing, &c. This is landlord's work, and requires both time and money to do it well. Those who set about it deliberately, knowing the difficulty of restoring the fertility of the old ridges after ploughing down, and prepared to go on paying until the object is accomplished, will ultimately reap their reward; but tenant-farmers or landlords who do not mean to do it thoroughly would be wise to confine themselves to making the best of the old turf. If properly drained, it will yield an immediate return for all tillage bestowed upon it; and, on the whole, I incline to the opinion that grass on clay, being let low, will generally pay an improving farmer better than any other kind of pasture land.

The third kind of inferior pasture mentioned above is that on black peaty soils. Where the depth of peat is considerable, or where it lies on white or yellow sand, it is very unpromising; but, even in these cases, I have seen instances where nitrate of soda or soot had a striking effect, and made the cattle eat the rough herbage greedily. The varieties of peaty soils are so numerous, and the results of applying tillage differ so widely, that it is generally advisable to try it experimentally in the first instance, putting a heavy dressing of the tillage intended to be used, on a very small portion of land. Where the peat lies upon clay it can always be made good land if the situation is such as to admit of efficient drainage. Should the thickness of peat be inconsiderable, so that the roots of the grass can reach the clay, a dressing of the tillage already mentioned will almost always succeed in making black land very useful for rearing young stock, with which it seems to agree remarkably well. Should a few acres be contiguous to a feeding pasture on higher land, I have found it answer well to let even fattening cattle have the run of the whole. They highly relish the variety of the herbage thus afforded them, and in dry seasons the black-land pasture will often keep its colour and freshness when the other burns. Should there be three or more feet of

peat upon the clay, it answers best to break it up and give the land a substantial dressing of clay before laying it down again, either by throwing it over the land from trenches, as practised in some of the eastern counties, or, if too deep for spade-work, then by carting it from pits. When this expense has been incurred it will probably become doubtful whether to lay it down again to grass, or to keep it under the plough, for which, after claying, it is extremely well suited.

Frequent mention has been made of a mixed top-dressing which has been found to be a valuable application to grass land. It has been gradually arrived at after many trials and modifications, and consists of *nitrogen*, *phosphoric acid*, and *potash*. These substances may be supplied in the form in which they can be most readily and cheaply obtained at the time and place required. The nitrogen may be furnished in guano, soot, nitrate of soda, or in the more specific form of muriate or sulphate of ammonia. The phosphoric acid may be obtained from bones, mineral superphosphate, or some of the poorer guanos. The potash similarly may be applied in the form of kainit, sulphate of potash, &c. The particular substances I am employing this season (1872) are nitrate of soda, mineral superphosphate, and kainit, in the following proportions: 1 cwt. of nitrate of soda, 2 cwt. of mineral superphosphate, and 3 cwt. of kainit per acre for pasture. At present prices this costs about 42s. per acre. For mowing land, where no manure is used, I should add to the above quantities $\frac{1}{2}$ cwt. of nitrate of soda, making the whole outlay about 50s. per acre. Where land is annually mown a dressing of this manurial value is required every year to prevent deterioration, except in exceptional cases, such as deep alluvial land, waterside meadows subject to flooding, &c. The best practice is, no doubt, to manure mowing land regularly with good farmyard-dung; but in the numerous instances in which this cannot be done, the meadow may be maintained in full productiveness by a good manuring once in three or four years, and a dressing of the above mixture in the intermediate seasons. For pastures it is not contended that a dressing of this character is required year by year, but after laying down a field to permanent grass it is absolutely necessary to till hard for three or four years in order to keep it steadily progressive, and when grass land has been long neglected, and is thoroughly out of condition, one dressing will not suffice. It requires following up for two or three successive years before the traces of long neglect will be completely obliterated.

My first attempt at top-dressing grass was in 1841, on a field of young seeds which showed a want of condition, and I applied a liberal dressing of nitrate of soda in the month of April.

This salt had been only recently introduced to the notice of agriculturists, and I watched the result with considerable interest. The field soon assumed a deep green colour, and showed unmistakable signs of vigorous growth. It was stocked with sheep, which, coming from turnips, ate it well; but, to my surprise, they were seized with scour, and did not thrive. I had not then become aware that agricultural products raised by heavy dressings of nitrogenous manure are always of inferior quality, and unwholesome for stock. As this is a point of importance in the management of either grass or arable land, I shall take some pains to establish the fact. When Peruvian guano was first brought to this country, and used freely for the growth of corn and roots, it was not uncommon to meet with instances where its liberal use was followed, in the case of wheat, by a gross broad flagged plant, which produced a large crop of soft dingy straw, and a small yield of lean dark-coloured grain. The cattle disliked the straw, and the millers disliked the grain. Nitrate of soda, soot, or any other ammoniacal dressing too freely used, produces a similar result. If too much nitrogen be applied to turnips the result is rapid growth and speedy decay, and stock fed on them do not thrive without a considerable admixture of other food. In 1846 I saw white turnips that had been grown by a heavy dressing of guano without other manure. They were as big as a man's head the first week in August, were rotten at heart by the end of the month, and collapsed altogether by the middle of September. On grass land the effect of heavy nitrogenous dressings may be observed in most pastures at places where the stock are accustomed to congregate for shade or shelter. The dark-coloured coarse grass grown under such circumstances is familiar to every farmer, and it is equally well known to him that cattle refuse to eat such grass, except under the pressure of absolute want. A still more instructive illustration is to be found when heavy rains in July or August follow a period of drought. At such a time fields of clover and young grass, which have carried a heavy stock of sheep for some months, become absolutely poisonous to lambs, and unwholesome for stock of any kind. Even rabbits and hares from an adjoining cover frequently die in numbers from eating the luxuriant herbage which immediately springs up. This is clearly due to the droppings of the sheep, both solid and liquid, which have, during the dry weather, accumulated on or near the surface of the land. A warm July rain suddenly washes down to the roots of the plants an overdose of manure, rich in ammoniacal salts, and the rank herbage so produced is unwholesome food. My first lesson, therefore, in manuring grass was that nitrogen, though most valuable in

increasing the produce, and indispensable in restoring the condition, of exhausted land, cannot be used in large doses without materially diminishing the quality of the herbage. If called upon to explain this fact, I would suggest that plant-food, to produce really healthy vegetation, should consist of a due admixture of several ingredients, of which ammonia, phosphoric acid, and potash, are the most important. As the roots of plants cannot select the substances they require, but suck up all soluble matters with which they come in contact, if ammonia, which is extremely soluble, be presented to them in excess when compared with the other elements of their growth, the result is that sap is circulated through the plant of too stimulating character, and produces in the vegetable organisms results somewhat similar to those too often observed in the human subject who imbibes *too much soluble matter of a stimulating kind*: viz., high colour and vigorous vitality, but with a tendency to premature decay: in short, plants so treated are on the *high-road to gout*. If soils commonly contained a considerable amount of soluble phosphoric acid and potash, a reasonably large dressing of ammonia would probably produce unmixed benefit, such as we see to result from a liberal application of manure from the yard, which supplies all these substances to the growing plant in the exact proportions required; but, as the potash and phosphates contained in the soil itself are, for the most part, very slowly soluble, it is necessary to provide them in a more available form, in order to prevent ammonia from greatly predominating over the other ingredients, and thus injuring the quality of the produce.

Next to nitrogen, the most important manurial substance is phosphoric acid, and, after being disappointed with the result of ammoniacal dressings, I made various trials of the phosphates in different combinations. The great success which attended the use of bones on the dairy-lands in Cheshire, and the experience of all observant shepherds that turnips, manured with bones, bore more hard weather, and were better sheep-meat, than more showy crops grown with other tillage, led me to anticipate great advantage from a liberal use of bones or superphosphate on grass. In this, however, I was again disappointed. Bones improved the quality of the pasture, and somewhat increased the proportion of clovers and fine grasses to the coarser kinds, but I could not satisfy myself that the improvement was sufficient to pay the bill. Lesson the second therefore taught me that bones alone could not be depended upon for the renovation of grass land in general.

Having arrived at the point that neither nitrogen nor phosphoric acid alone was to be recommended, I tried them in combination with good results; but there was still something wanting to give the agriculturist complete command over the

growth of herbage suited to his wants, and the next substance I thought likely to be of use was potash. It was suggested by the luxuriance of the vegetation produced wherever vegetable matters had been burnt, and the strength of the clover-plant where kelp, wood-ashes, or other manure containing potash had been applied. After several minor experiments with encouraging results, in 1867 I took in hand a field which was notoriously clover-sick, and where it was important to have a good plant of young seeds for sheep-feed, and the top-dressing specified above was specially compounded to meet the case. The result was a magnificent crop of clovers and trefoil, which carried ten head of ewes and lambs per acre through the very dry season 1868. This success encouraged me to try it largely the following year, and after five years' trial, on strong clay as well as on light land, on newly-laid grass and on old inferior pasture, I have had no instance of even partial failure. In the extraordinarily dry season of 1870, my seeds carried a full stock of sheep without the slightest appearance of giving way, and some old pastures so treated were full of clover and vetches, although previously conspicuous for the absence of the whole trifolium family. I will give one more instance, which was striking in its way. In the autumn of 1868 I applied the top-dressing to 40 acres of very bad old grass on strong clay. It had been mown frequently, but rarely manured, and the herbage was dry and coarse. The effect was remarkable. White clover, trefoil, and vetches, sprang up in abundance in the following spring, and both hay and aftermath were greedily eaten by all kinds of stock. In 1871 I gave this land a dressing of 40 bushels of soot per acre. Within three months the clover and trefoil had disappeared as if by magic. The crop of grass was a heavy one, but coarse, and the hay, though well got, met with a very doubtful reception even from the milch cows, although, as is well known, milking cattle accept gratefully any amount of hay of any kind, unless mouldy or mow-burnt.

In 1858 I recommended that newly-laid grass should be mown the first season. I was well aware that, by so doing, not only was the condition of the land much reduced, but by allowing the stronger grasses to attain their full growth the first year, a tufty, irregular surface was given to the pasture, and the formation of the close even turf, which is so great a desideratum, was much retarded. Grazing with sheep was, however, so injurious to the clovers and finer grasses, that I considered mowing the lesser evil of the two. When, in 1858, I found that I had obtained the clue to the growth of clover, I immediately adopted a *revised code* for laying down land to permanent pasture. In 1869 and 1870 I had 50 acres to lay down. Three fields, containing together 40 acres, were dressed twice with the mixture above recom-

mended: 1st, when the barley and seeds were sown, and 2ndly, a few months after the barley-crop was harvested. Another field of ten acres, of better quality than the other three, I sowed down in good condition, but without the potash and superphosphate dressing. The whole four fields were grazed with sheep the first season. The three first-mentioned remained as full of clover and fine grasses at the end of the season as at the beginning, whereas the ten acres not so dressed, though carrying a good stock of sheep, gradually lost their plant of clover, and began the following spring to show indications of the dry, bent appearance, which I had previously found to supervene so generally in the second, and still more in the third, year after laying down. I mean for the future, therefore, to graze newly-laid grass for permanent pasture with sheep until firm enough to carry cattle, relying on the top-dressing to maintain the quality of the young grass against all comers.

The two men most competent to advise on scientific questions affecting British agriculture are undoubtedly Mr. Lawes and Professor Voelcker, and I am happy to be able to quote them both in support of the recommendations here given for the treatment of grass land. The experimental plots at Rothamsted (the produce of which is annually mown and removed) show conclusively that any application to grass land which does not contain potash, if repeated for several successive years, results in a decline, and eventually an extinction of the clovers, vetches, and finer grasses; and though Mr. Lawes is not yet satisfied that for general use potash can be recommended as a paying application, I am authorised to state that within the last few months his advice to a gentleman asking him to prescribe for some old pasture land which required renovation, was to apply $1\frac{1}{4}$ cwt. of nitrate of soda, $2\frac{1}{2}$ cwt. of superphosphate, and $\frac{3}{4}$ cwt. of kainit per acre, which it will be observed differs very slightly from the mixture advocated above.

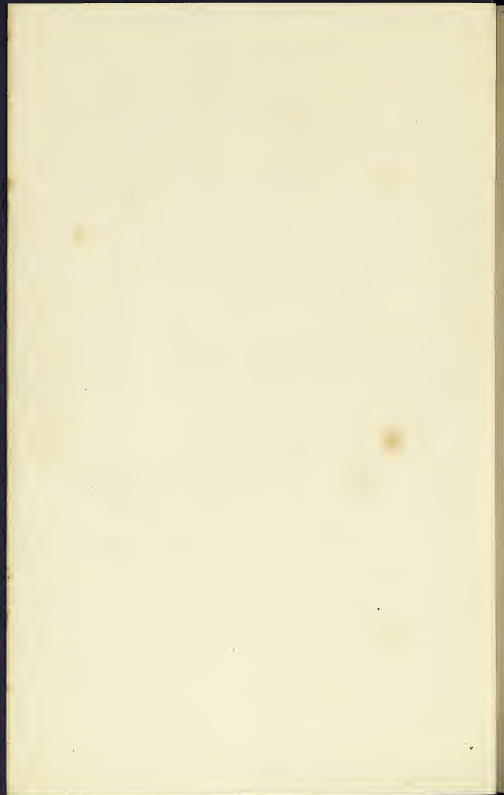
Professor Voelcker, in articles published in the 'Journal of the Royal Agricultural Society,' has pointed out the excellent effect produced on clover by the use of superphosphate and potash salts on light land. He was, however, until very recently of opinion that no corresponding benefit was produced by this combination on clay; but I quote from a letter received from him within the last few weeks, which shows that he has somewhat modified that opinion: "More than twelve months ago you brought to my knowledge the fact that potash salts gave you a satisfactory result on your heavy land. From all the experiments which I had tried with potash salts for a number of years upon heavy soils, no appreciable result was produced on the grass or root crops to which these salts were applied. Your experience, however,

induced me last season to try a mixture of superphosphate with potash salts on some poor clay land in Kent, and the accounts which I received from several farmers who tried this mixture upon clover seeds on heavy land, and I may add also upon potatoes, are very satisfactory. I have myself seen the good effects which potash salts and superphosphate produced on clover and grass on moderately stiff land in the neighbourhood of Bromley, in Kent, and I believe this mixture will probably be found beneficial for grass land on the poor clays in Staffordshire, and, generally speaking, on the bad clays of the Coal Measures. A close examination of these clays, if I am not mistaken, will show that there are some clays which are greatly deficient in potash, and on such poor clay soils the application of potash salts no doubt will be attended with beneficial results. I am glad to have this opportunity of modifying to some extent the opinion which I expressed on the strength of a more limited experience than I now possess, namely, that salts of potash are likely to be useful only on light land, for the experience I had last year fully confirms your own that there are clay soils as well as light land which are benefited by the application of potash salts and superphosphate."

It will have been observed that throughout this article the means principally relied on for increasing our home production of meat are, *an extended use of artificial manures on pasture land and of feeding-stuffs for cattle at grass.* At the present prices of fat and lean stock, it will pay the farmer to adopt both systems simultaneously. The great difficulty is in making a beginning. The routine of years, possibly handed down for generations, cannot be broken through without a pang; but such pangs seldom outlive the first favourable balance-sheet, and it may be confidently stated that for some time past the farmers who have made most money are those who have paid as much attention to the improvement of their grass as to the growth of fine crops of corn or roots.

Kirby Hall, February, 1872.

1/4	2.50	Soda	-	17-6
2 1/2	Superphosphate			7 1/2
3	Kainit			12 1/2
				47 1/2
6 3/4				



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