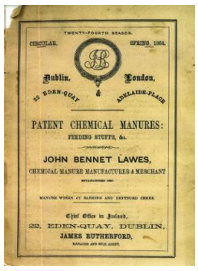
Circular: Patent Chemical Manures: Feeding Stuffs, Etc.



Full Table of Content

Patent Chemical Manures

James Rutherford

James Rutherford (1864) *Patent Chemical Manures ;* Circular: Patent Chemical Manures: Feeding Stuffs, Etc., pp 1 - 56 **- DOI: https://doi.org/10.23637/ERADOC-1-142**

SPRING CIRCULAR, 1864.

LAWES' MANURES.

FEEDING STUFFS, &c.

JAMES RUTHERFORD,

AGENT FOR J. B. LAWES,

22, EDEN-QUAY, DUBLIN.

In attempting to put a few sentences together in the form of a Manure Circular, at the opening of another season, the thought —as a kind of preliminary inquiry—arises, can anything new or interesting be stated regarding an article so well known to have been most extensively used throughout the United Kingdom during the last twenty-three years? It is but stating a simple fact, which will hardly be questioned by any one in the trade, that notwithstanding greatly-increased competition, every year shows a steady increase in the demand for Lawes' Manures. From various statistical returns, the total annual consumption of Phosphatic Manures is now tolerably well known, and the proportion which Mr. Lawes turns out yearly from his Factories places him not only ahead of all competitors in point of extent, but gives him a very large per-centage of the sum total. Nor will this appear so startling, when the reader is informed that Agencies are established, through which Lawes' Manures are supplied to almost every county in Ireland, England, and Scotland. Many facts could be mentioned to show how fairly this

https://doi.org/10.23637/ERADOC-1-142

enviable position has been attained. The Manure with which Mr. LAWES' name has been so long identified, has never changed its name, character, or composition; it has passed through every legitimate test, whether analytical or practical, with increased reputation, and a stronger hold on the public confidence. *Quack advertisements*, *cooked experiments*, and the *testimonial mania* have been alike studiously avoided; nor on its behalf has there ever been an effort made to influence the columns of Agricultural Journals, which, when so influenced, by whom or for whomsoever, instead of being reliable sources of instruction and information, and the independent organs of public opinion, are corrupt, and not to be depended on, even when publishing opinions honestly expressed.

Year after year LAWES' Manure has been placed in the hands of several of the leading Chemists of the day, the samples for analysis being always taken by the Chemists themselves, and from a bulk of several thousand tons. Every analysis thus made has been published, and has invariably shown that the Manure is perfectly uniform in quality—that it contains a high per-centage of those constituents which give value to a phosphatic manure, and (what is of very great importance to the farmer), that the condition of these constituents has always been found to be such as renders them most readily available as food for the growing plant.

The Analyses for 1864, by Professors APJOHN and CAMERON, of Dublin, will be found at page 6; and comparing these with Reports and Analyses by the same gentlemen for the two previous years (see p. 7), the reader will find confirmatory evidence of the accuracy of the foregoing remarks.

Under the auspices of different Agricultural Societies, extraordinary discussions on the subject of artificial manures have taken place during the past year, especially in England and Scotland, and it is at least questionable how far either agricultural interests or the progress of scientific investigation have been promoted by the apparent partizanship and violently conflicting opinions of Chemists regarding particular manures, on the one hand; or the unscrupulous tenacity with which an indefensible and anomalous position is maintained by certain manure vendors on the other hand. No wonder if the farmer, amid the misty productions periodically poured forth—sometimes chemical, sometimes editorial, and sometimes mercantile—finds it hard to discover anything that will clearly indicate the safe path, and finally takes refuge in the wholesome conclusion, that he may be safer in basing his practice in the selection and application of manures, on the correctly-ascertained results of his own matured experience.

https://doi.org/10.23637/ERADOC-1-142

So far as the Press is concerned, in connexion with the subject of manures, if our agricultural mediums wish to retain the respect and confidence of both buyer and seller, opinions expressed, and advice tendered, should be based alone upon practical experience and a thorough knowledge of the subject, not upon pecuniary advantage accruing from the profits of trading in any particular article of commerce. Suppose the case of a farmer in the provinces inquiring of a public officer, appointed in the metropolis for the purpose of giving information, as to the most approved construction of cart and harness, and discovering after acting on the information received, that though the public official had no pecuniary interest in the sale of the harness, he had a handsome commission on the price paid for the cart; the farmer may or may not be satisfied with his investment, but in either case, has he not reasonable grounds for concluding that the officer referred to is not a proper authority in such a case, and that even with the best intentions, his interested position is incompatible with that perfect impartiality which the public are entitled to receive at his hands. But further, should it happen that the said officer is interested in the profits of some periodical, through the columns of which the carts referred to are thereby unduly puffed, to the detriment of other honest traders, who make equally good implements, his position is still more anomalous and his motives more liable to suspicion; nor has he any reason to be surprised, if he finds himself denounced by every member of the craft, and by no inconsiderable portion of the general public.

The leaders of various political parties in the State, may, by different means and apparently opposite courses, be alike instrumental in successfully legislating for the promotion of the public weal, and evidence of political honesty and sincerity should protect their different lines of policy from being condemned, or their motives impugned; but there is nothing analogous in the case of, nor can the same beneficial results ever flow from the course pursued by, the manufacturers and agents connected with certain Manures, which, if not largely used, are at least extensively puffed in the present day; and the arrogant assumptions, as well as the position claimed by such parties, on behalf of their particular nostrum, can only expose them to the keenest criticism and severest censure of such of their competitors as wish to be fairly dealt by, and to the well founded suspicions of the Agricultural Community whom they wish to become their patrons.

Integrity, Skill, and Capital,—these are the great elements of success in every branch of trade, and exceptions but serve to

https://doi.org/10.23637/ERADOC-1-142

prove the rule. Firms of long experience and established reputation, will no doubt command public confidence and patronage, far beyond that accorded to younger aspirants of perhaps equal merit, but with a few such exceptional circumstances, so far at least as the manufacture of manures is concerned, there is nothing in the nature of things which can possibly give to any one article the pre-eminence unwarrantably attributed to some; no monoply exists as regards any of the various ingredients employed; the sources whence these ingredients can be best procured are well enough known to all in the trade; there is nothing very mysterious in the mode of apportioning the constituents of a chemical manure, so as to produce a certain agricultural value and analytical result; a particular mode of preparation is not now, as at one period, protected by patent, in the hands of a single manufacturer: it therefore follows, that if there exist on the part of manufacturers that Integrity which ever points to honesty as the best policy; that Skill which ensures the process of manufacture being completed without risk of failure as to the desired result, and the Capital which enables its possessor to buy and sell on the most favourable terms; we have that desirable combination which will not only command success both for principals and agents, but will be greatly conducive to the advancement of Agriculture, which, apart from all mere trading interests, is of such vast importance to the country at large; and there would be a comparative absence of those unseemly bickerings which have been of late so common on both sides of the Channel.

The Manure Manufacturer or Agent, whose special business it is to push the sales of the article with which his name is identified, while he may be daily questioned as to its character and value, occupies but slender footing, and merits little confidence, if he can only effect his purpose by, either negatively professing ignorance of—or positively, possessing only the knowledge which seems to warrant him in deprecating—all other competitors, many of whom it may be safely assumed, continue as in time past, to serve the public faithfully and well. A discreet and earnest advocacy on behalf of one's own goods is in no way incompatible with the respect which each owes to his neighbour, and though sometimes success is achieved by pursuing a less commendable course, yet as a rule, it is otherwise, nor need it be further enforced, that this is but in keeping with the indestructible principles of right and wrong.

It is much to be regretted that in connexion with the trade, there should exist circumstances fitted to call forth these somewhat critical observations; the circumstances referred to are every where the subject of discussion and remark, and need not therefore be more particularly alluded to.

https://doi.org/10.23637/ERADOC-1-142

PRICES OF LAWES' MANURES,

IN DUBLIN; INCLUDING BAGS,

And delivered at Railway or Canal.

		£	s.	d.	
Lawes'	Superphosphate, or Patent Turnip Manure	7	0	0	per Ton.
,,	Mineral Superphosphate ...	6	0	0	,,
,,	Grass Manure	8	10	0	,,
,,	Wheat Manure	8	10	0	,,
,,	Barley Manure	8	10	0	,,
,,	Mangold Manure	8	10	0	,,

OTHER MANURES, and FEEDING STUFFS.

Nitrate of Soda,	Linseed Cake,
Sulphate of Ammonia,	Linseed Meal,
Soda Ash,	Green Rape Cake,
Agricultural Salt,	Rape Meal,
Crushed Bones	Locust Beans,

Decorticated and Undecorticated Cotton Seed Cake,

All of the best quality, and at lowest market rates.

☞ Special offers to large Consumers, of all the above Manures and Feeding Stuffs.

PERUVIAN GUANO,

Supplied direct from the Depôt of the Peruvian Agents in Dublin, on the following terms:—

	Cash. £	s.	d.	Four Months. £	s.	d.	
Five Tons, and upwards, .	12	16	6	13	7	6	per Ton.
Over One, and under Five Tons,	13	0	0	13	10	0	,,
Small lots, under a Ton, .	0	13	6	0	14	0	per Cwt.

Guano over Four Months due, subject to Five per Cent. Interest.

https://doi.org/10.23637/ERADOC-1-142

ANALYSES AND CHEMISTS' REPORTS FOR 1864.

South Hill, Blackrock, March 14, 1864.

Having on Monday, the 7th instant, taken in person and without any selection, a sample of the cargo of LAWES' Superphosphate which had been just transferred to your store from a vessel lying in the Canal Docks, I have made it the subject of a careful analysis, and find it to have the following composition :—

Moisture, ...	14·40
Sand, ...	3·60
Bi-Phosphate of Lime, ...	14·34
(Equivalent to Phosphate of Lime made soluble 22·40)	
Phosphate of Lime	24·82
Hydrated Sulphate of Lime, with a little Carbonate of Lime	28·03
Organic Matter, ...	12·39
(Yielding Ammonia 0.61)	
Salts of Potash and Soda	2·42
	100·00

From these results I am enabled to say that this Manure is practically the same with the cargoes supplied you in 1863 ; and that as a fertilizer, particularly for land which is to grow green crops, it must maintain the reputation it has so long enjoyed. In the preparation of 100 parts by weight of this Superphosphate 47·22 parts of Phosphate of Lime were employed, and of this large amount of Phosphate 22·4 parts have been rendered soluble by the action of the sulphuric acid. The amount of bi-Phosphate (the most important ingredient) is the same as in the manure of 1863 ; but the total Phosphate of Lime used is appreciably higher, being in 1863 41·78, and in the article of the present year 47·22. I should not omit to add that the ammonia in the specimen to which this report refers is nearly the double of that found in the Lawes' Superphosphate of 1863. As a consequence of these differences the material at present in your depôt is in a slight degree more valuable than that of which you have made so extended a sale during the past season.

JAMES APJOHN.

I certify that I have analysed a specimen of LAWES' Superphosphate taken by me from a cargo landing at the depôt, and have found it to contain in 100 parts the following :—

Moisture, ...	12·28
Organic Matter, and Salts of Ammonia*	11·13
Bi-Phosphate of Lime	16·00
Phosphate of Lime	13·37
(Equal to Bone Phosphate rendered soluble by acid 25·40.)	
Sulphate of Lime	40·83
Alkaline Salts	2·24
Insoluble Matters	4·16
	100·00
* Capable of yielding Ammonia	1·30

This is a first-class Superphosphate. It contains 37 per cent. of Phosphate of Lime, of which about 26 per cent. is soluble. It also contains a fair proportion of ammonia.

CHARLES A. CAMERON, M.D., M.R.I.A.,
Analyst to the City of Dublin.

6, Waterloo-terrace, Upper Leeson-street, Dublin,
15th March, 1864.

https://doi.org/10.23637/ERADOC-1-142

ANALYSES AND CHEMISTS' REPORTS FOR THE YEAR 1862.

South Hill, Blackrock,
24th February, 1862.

I have just concluded my analysis of Mr. Lawes' Superphosphate, which I undertook at your desire, and I have now to report to you the results at which I have arrived. In 100 parts by weight I find it to include the following constituents:—

Moisture, expelled at 212°	13·80
Organic matter and Salts of Ammonia	6·65
Sand	3·60
Phosphate of Lime	12·20
Biphosphate of Lime	15·00= 23·04 of Phosphate of Lime.
Hydrated Sulphate of Lime	46·95
Alkaline Salts	1·80
	100·00
Ammonia	0·51

This is a superphosphate of first quality, for 36 per cent. of phosphate of lime has been employed in its manufacture, and of this two-thirds have been rendered soluble by the action of sulphuric acid. Using the data which I am in the habit of employing, I find that its money value is £8 14*s.* 6*d.* per ton. I should not omit to mention that the sample to which this report refers was got by taking at your store, at the Canal Docks, a shovelful from several bags of a large cargo just imported, mixing these well, and then separating for analysis about a pound weight from the mixture. This method of ensuring an average specimen for experiment was adopted at my instance, and carried out in my presence, and I am therefore enabled to state with confidence that the results above given are true of the entire cargo. The purchaser, therefore, of this valuable manure, in applying it to his crops as a fertilizing agent, need not apprehend any disappointment.

JAMES APJOHN.

6, *Waterloo-terrace, Upper Leeson-street,*
24th February, 1862.

At the request of Mr. Rutherford I have visited the depôt of Mr. Lawes' Artificial Manures, Canal Docks, and selected from a large cargo of superphosphate of lime, just delivered from the ship, a specimen of that manure; this specimen, on being submitted to analysis, gave the following results:—

100 parts contained.

Moisture	13·23
Nitrogenous Organic matter (Yielding 2 per cent. of Ammonia.)	12·46
Biphosphate of Lime	16·40
Phosphates of Lime & Magnesia	12·24
Hydrated Sulphate of Lime	39·34
Alkaline Salts	2·06
Insoluble matters	4·27
	100·00

The above figures prove this superphosphate to be of the very best description. It contains about 40 per cent. of phosphates, of which nearly 26 per cent. are soluble. The insoluble phosphate being derived from bone, is consequently of great value, and will aid in prolonging the growth of tubers and roots late into the autumn. I cannot too highly recommend Mr. Lawes' Superphosphate.

CHARLES A. CAMERON.

ANALYSES AND CHEMISTS' REPORTS FOR YEAR 1863.

South Hill, Blackrock,
23rd February, 1863.

Underneath you have the composition of the specimen of Lawes' superphosphate, or patent manure, which I selected at your stores on the 16th inst.

Moisture	13·60
Sand	3·80
Biphosphate of Lime (Equivalent to phosphate of lime made soluble 22·82.)	14·62
Phosphate of Lime	18·90
Hydrated Sulphate of Lime	39·14
Organic matters (Yielding ammonia 0·34.)	7·14
Salts of Soda and Potash	2·80
	100·00

In the preparation of this artificial manure, which is found, particularly in the case of green crops, so energetic a fertilizing agent, 41 per cent. of phosphate of lime must have been employed, and of this amount more than one-half has been rendered soluble. Its money value is, by my method of estimation, £8 12*s.* 11*d.* per ton, a sum I understand considerably higher than that at which it is sold.

To what precedes, I may add that the sample, whose composition is given above, was selected by myself from a cargo which was being unshipped at the canal docks, in the immediate vicinity of the depôt, in which Mr. Lawes' Manures are stored; from several bags equal portions were taken, and these, when well mixed, constituted the specimen submitted to analysis, the results obtained corresponding closely with those at which I arrived in February, 1862, in analyzing for you the superphosphate of the same manufacturer; and having had this manure repeatedly under examination, I can state with confidence that the method of manufacture employed by Mr. Lawes is most complete, and that the product of his process does not, at least practically, vary in composition.

JAMES APJOHN.

6, *Waterloo-terrace, Upper Leeson-street,*
23rd February, 1863.

I certify that I have made a careful analysis of a specimen of Mr. Lawes' Superphosphate, and have found it to contain the following:—

Moisture	12·98
Nitrogenous organic matter (Yielding ammonia 1·23)	8·05
Biphosphate of Lime	16·32
Phosphate of Lime	10·80
Hydrated Sulphate of Lime	45·03
Alkaline Salts	2·00
Insoluble matters	3·92
	100·00

This is a very superior superphosphate, well prepared, and very dry. It contains nearly one and a-half per cent. of ammonia, and about 36 per cent. of phosphates, nearly three-fourths of which are in a soluble, and therefore immediately available condition. I may mention that the sample analyzed by me was selected from a large stock by Dr. Apjohn, sealed and sent to me by that gentlemen, as I was unable to comply, as intended, with Mr. Rutherford's request, that I should visit the stores and select a sample from the bulk.

CHARLES A. CAMERON,
Public Analyst to the City of Dublin

https://doi.org/10.23637/ERADOC-1-142

LAWES' SUPERPHOSPHATE, OR PATENT TURNIP MANURE.

Reference has already been made to the analyses for this and former years, shewing that the uniformity and high character of this Manure are fully maintained, and the repeated tests applied by Professors Apjohn and Cameron, in Ireland, are corroborative of the reports by Professors Voelcker and Way in England, in which they state, after visiting Mr. Lawes' Works, and drawing samples from a bulk of 7,000 tons—"The Soluble Phosphates obtained by *separate* analyses of the *seven different samples* taken by us, did not vary from the average more than one per cent., showing the manure to be of very uniform composition."

The dry and fine condition in which this and all other manures are sent out from Mr. LAWES' Works render them easy of application, and certain in their action on the crop. Some manures analyze well, and yet are very seldom found to produce satisfactory results in the field, because the constituents of the manure are rendered inactive and comparatively valueless by that adhesiveness and excess of moisture which generally characterise either inferior or badly made manures.

QUANTITY TO APPLY, PER IRISH ACRE.

If Superphosphate is used alone for the Turnip crop, the usual quantity is from 8 to 10 cwts. per Irish acre; if half dung and half superphosphate, from 4 to 6 cwt. per acre, of the latter; if dung, guano, and superphosphate are applied, about *equal money value* of the two artificial manures; and if guano and superphosphate are applied without any dung, the same proportions, but in greater quantity. Superphosphate acts most beneficially on light and medium soils, and guano is more effective on damp or stiff clay soils; but on all heavy land where roots are grown, dung should form at least a portion of the manures used, as, among other advantages, its effects are to lighten the land, rendering it more porous, and thus permitting freer action to artificial manures and atmospheric influences.

Superphosphate may be applied close to the seed, and in this way the growth of early-sown turnips is rapidly promoted, putting the crop soon beyond the power of the fly—thick sowing of seed, however, being the best preventive of this pest. Guano, whether by itself or mixed with Superphosphate, should have a covering of soil before the seed is sown, in order to prevent the loss of ammonia by evaporation, and also to protect the seed

https://doi.org/10.23637/ERADOC-1-142

from injury caused by its immediate contact with guano. One of the most important points in green cropping is *the thorough tilling and cleaning of the land*, and better have the sowing rather late than this imperfectly attended to. The speedy action of artificial manures enables the farmer to devote more time to the plough and harrow, and thus to some extent compensates for those delays which, though often inexcusable, are sometimes unavoidable.

MINERAL SUPERPHOSPHATE.

This Manure is prepared as formerly, and the price is £1 per ton under the patent Manure, but the demand is so limited, a stock of it would not be kept unless to show that if a low priced manure is wanted it can be supplied. The chief merit of this purely mineral manure is its soluble phosphates, the insoluble portion not possessing any agricultural value; and even at a lower figure than £6 per ton, it would not be such good value as the £7 manure.

MANGOLD MANURE.

This manure contains about 5 per cent. ammonia, and 12 to 15 per cent. soluble phosphates. A manure of this composition has been found most suitable for the Mangold crop. The usual quantity, with a liberal supply of dung, is from 4 to 6 cwts. per Irish acre, spread in the drill, on the top of the dung. Some recent experiments show that salt, as a manure, is not so beneficial to the Mangold crop as is generally supposed, better results having been obtained where no salt had been applied, as compared with the addition of salt, where soil and other manuring were the same. While in some cases salt seems to produce good effects, yet enough has been ascertained to warrant in drawing attention to the subject, and cautioning against its indiscriminate application.

GRASS MANURE.

The constituents of Lawes' Grass Manure include nitrogen, ammonia, and phosphates, and it has been found most suitable as a spring top-dressing for pasture and meadow. The usual quantity per Irish acre is from 4 to 6 cwts. For further information on this subject the reader is referred to the annexed Paper by Mr. Lawes and Dr. Gilbert, on the "Effects of different Manures on the Mixed Herbage of Grass-Land."

https://doi.org/10.23637/ERADOC-1-142

WHEAT MANURE.

The Wheat Manure is specially prepared for this crop, and contains from 9 to 10 per cent. of ammonia, in the form of salts of ammonia and organic matter, yielding ammonia by decomposition. Apply from 4 to 5 cwt. per Irish acre, sown broadcast, and harrowed in with the seed. A mixture of about equal parts of Peruvian Guano and Superphosphate of Lime, applied as above, at the rate of from 5 to 6 cwts. per Irish acre, is also a very good manure for wheat.

OATS.

The manure suitable for wheat may also be applied to oats, but rather lessening the quantity. When corn crops require some artificial top dressing late in the Spring, nothing will act so beneficially as nitrate of soda; but the most economical system is, to give a sufficient supply of manure when the seed is sown.

BARLEY MANURE.

The liability of the barley crop to fall renders it rather a critical matter to decide the proper quantity of manure. Previous cropping and the condition of the land should be considered. If the barley succeed a corn crop, 5 to 7 cwts. per Irish acre will not be too much; if after roots, all of which have been removed, 4 cwts. will be sufficient. The manure should be sown and harrowed in at the same time as the seed.

POTATOES.

The mineral matter in the acreage produce of a root crop is very large indeed; the following is the amount contained in a moderate crop of wheat-grain and of potatoes:—

	Mineral Matter.
28 Bushels Wheat-grain, ...	28 lbs.
8 Tons Potatoes	180 „

Of potash alone, the 8 tons of potatoes will contain about eight times as much as the 28 bushels of Wheat. The exhaustion of

https://doi.org/10.23637/ERADOC-1-142

mineral constituents by the sale of potatoes, may be compensated for by bringing upon the farm a sufficient quantity of stable-dung, or other town manures, sea-weed, or even fern or brake from neighbouring wastes for litter. It is the general practice to dung heavily for potatoes. Although the crop might not be so large, it is probable that if the potatoes were taken after some other crop well dunged, instead of the dung being applied directly for their growth, they would be less liable to disease. Supposing this plan adopted, 5½ cwts. per Irish acre of an equal mixture of Peruvian Guano and Superphosphate of Lime, or 7 to 8 cwts. Superphosphate of Lime alone, should be used for the potatoes. Or, in case of dung being employed, the best mode of application would be to plough it into the land in the Autumn, the potatoes being set in the following Spring.

NITRATE OF SODA.

For several years past Nitrate has been sold at from £14 to £15 per ton, according to quality, and a largely increasing demand attested its value. There is no scarcity this season, but the stocks in the English market are held by speculators, and the result to consumers is an advance in price of upwards of £2 per ton; this must seriously check the demand, if not for chemical, at least for agricultural purposes, yet there seems not the least indication of any decline in price.

PERUVIAN GUANO.

There is no alteration in the price of Peruvian Guano, nor does the laboured and biassed efforts of its detractors seem to have any other effect than to confirm its merits as one of the most valuable of all our agricultural fertilizers. To the farmer, the great point in connexion with Guano is to *procure it genuine and apply it judiciously;* but this hint applies equally to Superphosphates and other manures which are now so largely used *in conjunction with* Guano, the highly ammoniacal and nitrogenous character of the latter being thus modified, in various degrees, as may be considered necessary for different soils and crops. As a mixed system of cropping is likely to ensure the most profitable results, *on the average of seasons*, so a mixed system of manuring, if properly carried out, will with equal certainty produce the same effect.

https://doi.org/10.23637/ERADOC-1-142

LIST OF AGENTS FOR LAWES' MANURE.

From the following List, as compared with former Circulars, it will be observed that an increased number of Agencies have been established; and as the principal seaports in Ireland are supplied by cargo direct from the Works, parties living in districts the most remote from Dublin can have these manures delivered in their respective localities (with some exceptions) at or about the Dublin prices.

Abbeyleix	David Mercier.
Athy	Mark Cross.
Ardee	Mrs. M. Dolan.
Ballinasloe	Harpur & Rutledge.
Ballina	Little & M'Culloch.
Belfast	Shaw & Finlay.
Carlow	S. Haughton & Son.
Castledermot	S. B. Cope.
Coleraine	John Lusk.
Cork	Thos. M'Kenzie & Son.
Dundalk	James Shekleton.
Durrow	David Mercier.
Edenderry	B. J. Williams.
Ennis	John Leech & Son.
Enniscorthy	John Hinton.
Galway	Rutledge & Harpur.
Gorey	Joseph Bates.
Limerick	John Abraham.
Londonderry...	Robert Henderson & Co.
Maryborough	David Mercier.
Mountmellick	Edward Murphy.
Newry	M'Blain & Co.
New Ross	Dawson A. Millward.
Parsonstown	B. W. Fayle.
Portumna	J. T. Grier.
Rathangan	John Murphy.
Rathdowney	David Mercier.
Sligo	Thos. Little Robinson.
Tinahely	Joseph Murphy.
Tralee	R. Walpole & Co.
Tullamore	T. P. & R. Goodbody.
Westport	J. & W. Pinkerton.
Wexford	John Hinton.

Many of the above have numerous Sub-Agencies in their respective districts. All are supplied with Circulars, containing prices and other particulars, which they will forward on application.

https://doi.org/10.23637/ERADOC-1-142

REMARKS ON EXPERIMENTS.

On the subject of experiments a few remarks have appeared in my former circulars, and I preface these few sentences with the following extract from last year's.

"It would be quite fallacious to conclude, that because in a *single* experiment with, say twelve different manures, *one* exceeded all the others, it was the best of the dozen; as a different season, and a change of soil, or even on the same soil, the result might place No. one five or six steps down the scale. This has been fully verified by many experiments which have come under my notice since then; Peruvian guano and various phosphatic manures are found changing their places up and down the scale, to the extent of from six to eight tons per acre, while in many cases at least, there would be no variation in the quality and composition of the manures used; this anomaly is capable of explanation, but is too formidable a task to enter upon here, and the disturbing elements are familiar enough to many who may glance at these remarks. Some particulars of a few experiments might be introduced as examples of the changes and variations referred to, but this would involve the use of names, which, while agreeable to a few, would be displeasing to many, and tend to prevent that harmony and good feeling which should exist in the trade. When manures are purchased specially for experiment, the seller should be kept in ignorance of the buyer's intention. The importance of this is obvious, from the fact that parties have been known to give small quantities of manure for experiment, greatly exceeding in quality and value, such as would under ordinary circumstances be supplied. The practice so much adhered to in experiments, of using nothing in conjunction with the artificial manures, might be to some extent departed from, with advantage both to agriculturists and manure manufacturers. All artificial fertilizers should be tested in conjunction with a certain portion of farm-yard dung. It is not considered good practice to apply phosphatic manures alone in growing root crops, for although the produce on some soils may be all that could be desired in point of quality and yield, yet the soil is excessively exhausted of certain constituents, the want of which, especially if the roots are not consumed on the field, will seriously affect succeeding crops. In experimenting with 'turnip manure,' 'bone manure,' 'superphosphate,' 'nitrophosphate,' or by whatever name they may be called, regard should be had to the composition (as shown by analysis) of manures vended by different makers, as the care taken merely to try equal money value of each, though fair enough *so far*, is not *altogether* a fair test; some phosphatic manures are prepared so as to contain a

https://doi.org/10.23637/ERADOC-1-142

certain per-centage of ammonia, but may be deficient in soluble phosphates, as compared with a different manure, which again may not yield so much ammonia. *In manuring the turnip crop, a large proportion of phosphates is all important, and artificial manures which are found to excel in this particular element, but do not yield ammonia except in minute traces, can have this valuable constituent supplied most cheaply by the addition of a certain portion of Peruvian guano, and in using a manure of this composition for experiment, regard still being had to equal money value against others, the farmer is not only proceeding upon the same basis as he would in more extended practice, but is ascertaining more accurately how he can get the greatest result at the smallest cost," and will find, as the result of repeated experiments, that as a manure for the turnip crop, on average medium soil, nothing will equal a combination of farm-yard dung, Peruvian guano, and Superphosphate of lime.* During the autumn and winter months of the past year I visited various parts of the four provinces, and the most careful inquiry and observation amply confirm what I now state; in some cases an abundant yield was seen where the manuring for the growing crop was exclusively Superphosphate; in others, not less favourable results from Guano alone; again, still greater success from Guano and Superphosphate mixed; but the general result gives emphatic testimony in favour of the trio above mentioned: the artificial portion of the mixture gives a much better result in the growing crop than dung alone, and in green cropping, the dung and artificial together leave the soil in a much healthier condition for future operations. It may be further stated that this (modified by particular or exceptional circumstances) is the general practice of nearly all farmers of experience and advanced intelligence, men who, while by no means despising the valued results of scientific research in connexion with agriculture, are guided by the doctrines of chemists, or mere theorists, only in so far as they find them to accord with the practical results of their own observation and experience. It is to be feared that amateurs and inquirers are very much misguided by the class of experiments which generally find their way into print, and are still further astray in so far as they are influenced by the testimonials which are so ingeniously got up and so prodigally and industriously circulated; it is a well known fact, that the largest collection of testimonials ever vended on behalf of any manure, was in connexion with the most worthless article ever offered to the public, and now happily extinct. The great majority of experiments are on much too limited a scale, to ensure accuracy, either in the application of the manures, or in testing the produce, and their ever varying results prove that they are of very little practical value.

https://doi.org/10.23637/ERADOC-1-142

If our Registrar-General, Mr. Donnelly, C.B., would devise some means of combining with his "Agricultural Statistics" a series of tables, embracing, under certain technical headings, the Manures applied to Green Crops, Cereals, and Grass Lands in Ireland, he would be giving fresh proof of the indefatigable zeal and ability which characterize his labours, and would furnish the public with an amount of information which would produce most beneficial results to agricultural interests. Assuming that the collectors of these statistics are supplied with printed forms, containing queries, the answers to which are given verbally by the farmer, and taken down in writing by the public officer, these queries could very simply be extended so as to embrace the particulars above alluded to; holdings could be divided into, say four sections, viz., 10 and under 40 acres; 40 and under 100 acres; 100 and under 200 acres; 200 acres and upwards; and the four provinces could also be distinguished. Manures might be classified into—1st, Farmyard Dung; 2nd, Dung from Towns; 3rd, Ammoniacal Manures, viz., Guanos; and 4th, Phosphatic Manures, viz., Superphospates and Bones; the results year by year as to the state of the crops, could be sufficiently indicated by "Good," "Bad," or "Middling." On some such basis as this there could be no possible motive on the part of farmers, for either erroneous or evasive replies, nor could any one engaged in the manufacture or sale of manure have a grievance to complain of; and a synopsis of the whole returns, which could be further improved by distinguishing between Landlords and Tenants, would furnish valuable data for most important deductions, on a subject of paramount interest to a country, the prosperity of which depends so much on its yearly produce in Beef and Corn.

FEEDING STUFFS.

Notwithstanding the low price of grain, there has been a large consumption of Linseed Cakes and Rape Cakes as Cattle Food during the past year, and these, partly as the result of corn being so cheap, have been sold at lower rates than for many years previous. I have been at very great pains to secure the best qualities of feeding cakes, having visited, during last autumn, both the home and foreign markets, and procured stocks which have met with the highest approval, and secured a large demand from all parts of the country. In this branch, as in the manure trade, no effort has been made to *force* a trade by "testimonials" or squibs of that nature; my aim is to supply a genuine article at a fair price, avoiding inferior and low priced cakes, which, if they enhance profits, decrease reputation, and have no tendency to

https://doi.org/10.23637/ERADOC-1-142

secure the steady patronage of those who not only wish a cake of uniform good quality, but are willing to give full value for such. Every advantage is given to cash buyers, and favourable arrangements entered into, to meet the convenience of parties prefering a current account, and paying at fixed periods.

Cotton Seed Cakes, though not much in demand in Ireland, are extensively used both in England and Scotland; supplies, however, have been uncertain during the American troubles, nor is there any prospect of matters mending much in this respect for some time. The undecorticated Cotton Seed Cake, which contains the husk of the seed, and is so much cheaper than the other, is very seldom found to produce injurious effects on the animal; in fact, there seems no risk of this unless the quantity given per day be excessive. Perhaps the most advantageous mode of feeding with Cotton Seed Cakes, is on grass-lands, either with cattle or sheep, and the droppings of the animals produce a more marked and beneficial effect on pasture than from other descriptions of cake.

Many "Cattle Foods" and "Condiments" are prepared and advertised as such, in contradistinction to the Feeding Cakes which are the necessary result of crushing either Linseed or Rape Seed for the production of oil.

"The great value of Oilcake as food for Stock, and the high price for which it sells, has led to many inquiries for a substitute. The possibility of manufacturing 'a Cattle Food,' the selling price of which should be sufficiently low to make it a cheaper food than Oilcake, or our common unmanufactured foods, is worth a little consideration. As every process of manufacture must necessarily add to the cost of the raw material, it is evident that it must be far cheaper to use the raw material as food, without putting it through any process of manufacture, unless this process gives rise to certain things which may be included under one of the two following heads:—

"1st.—That a certain portion of the ingredients contained in the food, possess a value for commercial purposes beyond that which they are worth merely as food; and consequently enable the manufacturer to sell the residue at a lower price as cattle food.

"2nd.—That by a certain process of manufacture, the elements of food can be arranged, so as to produce a feeding value more than equivalent to the cost of manufacture.

"In the manufacture of Oilcakes, we have examples of the cost of manufacture being recovered in the high commercial value of certain ingredients contained in the food. The seed crusher produces oil for commercial purposes. The residue, under the general term 'Cake,' is in much demand amongst agriculturists, either for cattle food, or as manure. If, however, this residue were of

https://doi.org/10.23637/ERADOC-1-142

no value, oil would still be produced. The seed crusher, it is true, is enabled to sell his oil at a lower price, on account of the price which the farmer is willing to give for the cake; but it is the commercial demand for oil, and not the agricultural demand for cake, which gives rise to this branch of trade. Linseed oil is generally worth two or three times as much as the seed containing it, while the cake is, weight for weight, cheaper than the seed; the cost of manufacture is therefore recovered in the price for which the oil will sell as an article of commerce, and hence the manufactured cake is a cheaper food than the seed in its natural state."

These remarks clearly tend to show the great value of Oil-cakes as compared with the cattle foods referred to; as regards the latter, it has not been satisfactorily shown that their feeding properties are enhanced by the mode in which they are prepared, nor in connexion with the manufacture is there any ingredient produced (as in the case of the oil), the commercial value of which, as compared with the food, enables the merchant to put the latter into the farmer's hands on the same terms as he can procure the raw material of equal nutritive power.

ROTHAMSTED FIELD EXPERIMENTS.

Farmers, Seedsmen, and Manure Merchants, or those who desire to receive or impart information as to the proper manures to use in top dressing meadow and pasture, will not fail to be interested and instructed by a careful perusal of the annexed Report on the effect of different manures on the mixed herbage of grass lands. The scientific reader will need no apology for its length and the intricate details of dry facts and figures, while the non-scientific and more general reader, who may be more desirous of a kind of syllabus embodying the principal deductions which he may wish to reduce to practice, will find something equivalent at page 33, commencing with the heading "The unmanured produce," and on to page 51.

Further I have nothing more now to add, unless to express hearty thanks for past favours, to the Landed Proprietors and Tenant Farmers of Ireland; and to repeat the closing sentence of my last year's annual; viz., that "I trust by undivided attention to business, and from the ample resources placed at my disposal, to merit a continuance and extension of the public patronage hitherto so freely accorded."

James Rutherford

https://doi.org/10.23637/ERADOC-1-142

EFFECTS OF DIFFERENT MANURES ON THE MIXED HERBAGE OF GRASS-LAND.

BY

J. B. LAWES, F.R.S., F.C.S.,

AND

J. H. GILBERT, PH. D. F.R.S., F.C.S.

IN Vol. XIX., Part II., and Vol. XX., Parts I. and II. of the Journal of the Royal Agricultural Society, we gave a Report on Experiments with different manures on permanent meadow land, in which we treated of the subject under the following heads:—

Part I. The produce of hay, per acre.
Part II. The produce of constituents, per acre.
Part III. The description of plants developed by different manures.
Part IV. The chemical composition of the hay.

Perhaps the most striking points brought out in the inquiry, were those which illustrated the very great difference in the description and character of the plants developed by the different manures. The general results arrived at under this head, may be very briefly re-stated here.

The unmanured crops, and the light ones grown by manure, were by far the most complex in character; consisting of a comparatively large number of species of plants, or descriptions of herbage, and showing less predominance of a few species than did the more bulky produce obtained by means of more active manures. The smaller crops consisted not only of a greater variety of Graminaceous herbage, or grasses properly so called, but also contained a greater variety, and greater proportion, of miscellaneous or weedy herbage.

As a rule, whatever the description of manure employed, any considerable increase of crop was accompanied by greater simplicity of herbage, greater predominance of grasses proper, and also, generally, a greater predominance of individual species, as well among the Graminaceous or grassy, the Leguminous, and the miscellaneous herbage.

But different descriptions of manure had very different effects.

Mineral manures alone (salts of potass, soda, magnesia, and superphosphate of lime) only moderately increased the amount of crop; rather diminished the proportion of the grasses, and

https://doi.org/10.23637/ERADOC-1-142

considerably that of the weedy herbage; greatly increased the amount per acre, and the proportion in the produce, of the Leguminous herbage, especially the perennial red clover and the meadow vetchling; and also enhanced the ripening tendency, rather than luxuriance of foliage.

Ammonia-salts alone, considerably increased the amount per acre, and the proportion in the crop, of the grasses, but tended very remarkably to the development of leaf rather than of stem and seed; and they also diminished the proportion of both the Leguminous and the weedy herbage, the former being almost excluded.

Mixtures of both the mineral manure and ammonia-salts, gave by far the greatest increase of crop. The produce so obtained was in a much larger proportion Graminaceous, or grassy, than that yielded under any other conditions; clover and other Leguminous plants were almost entirely excluded; and the number of species and amount of weedy herbage were but small, though some few plants grew luxuriantly. Lastly, comparatively few species of grasses contributed to the great bulk of this very luxuriant and highly Graminaceous produce, and the development of stem and seed was very remarkable.

Farm-yard manure alone, with the increase of total produce, also increased the amount and proportion of the Graminaceous herbage; and diminished the variety, and the proportion, of the Leguminous and the miscellaneous herbage.

Farm-yard manure and ammonia-salts gave considerably more increase of crop than farm-yard manure alone; and the produce contained a large proportion of Graminaceous and miscellaneous, but very little Leguminous herbage.

This great variety in the herbage, both as to the description of the plants developed, and the character of their growth, according to the manures employed, and to the consequent amount of crop obtained, is obviously a point of great practical interest and importance in its bearing upon the question of the proper manures to be employed to increase the produce of grass-land.

The results briefly enumerated above are also of great interest in another point of view.

Thus, exclusively mineral manures, when applied to Graminaceous plants grown separately (as wheat, barley, or oats, under ordinary circumstances), produce very similar effects to those upon the allied plants of the mixed herbage; that is to say, they increase the crop comparatively little, but prominently develop the seeding tendency; and again, when these manures are applied to Leguminous crops grown separately, as in the case of the allied plants of the mixed herbage, they considerably increase the luxuriance of their growth.

https://doi.org/10.23637/ERADOC-1-142

Ammonia-salts, on the other hand, which produce such characteristic effects upon the growth of the Graminaceous plants of the mixed herbage, have also a marked influence upon that of the Graminaceous plants grown separately in rotation, and but little on that of the Leguminous ones so grown.

For various reasons, therefore, both practical and scientific, it seemed very desirable that the subject should be further investigated, both here and elsewhere. The experiments at Rothamsted have, accordingly, been continued up to the present time, and they are still in progress.

Our first report, to which we have been referring, gave the results of the first three seasons, (1856, 1857, and 1858), relating to three divisions of the subject, namely—the produce of hay per acre, the produce of constituents per acre, and the chemical composition of the hay—and on these points we have now on hand the accumulated results of four more seasons. The results formerly given on the remaining branch of the subject—*the description of plants developed by the different manures*—related to the produce of the third season only, 1858; and the further details obtained on this head have reference to the produce of the seventh season, 1862. It is to these that it is proposed to confine attention on the present occasion, presenting only such an outline of the voluminous records as will bring to view the points of most interest to the readers of an Agricultural Journal.

Method of Experimenting.

Taking advantage of the experience gained in some attempts to separate and determine the proportion of the different plants, in carefully averaged and weighed samples of the produce in the previous year (1857), the produce of 1858 had been separated into—(1) Graminaceous herbage, stems bearing flower or seed; (2) Graminaceous herbage, detached leaves and indeterminate stems; (3) Leguminous herbage; (4) Miscellaneous herbage, chiefly weeds. The components classified under these heads gave from 14 to 23 different descriptions of herbage; and, no doubt, the results, so far as they went, clearly and truthfully indicated the characteristic and comparative distribution of plants on the different plots. But as there remained, in the separations in question, an amount equal in several cases to a fourth, and in one to more than a half of the whole produce, to be set down as Graminaceous herbage in "detached leaves and indeterminate stems," to the components of which the specific names could not with any confidence be given, it seemed desirable, in again taking up the subject, to follow it out in considerably more of detail. Accordingly, in the separations recently made, of the produce of 1862,

https://doi.org/10.23637/ERADOC-1-142

it was sought to determine the species to which the detached leaves and imperfect stems belonged, and so to include in the amount given for each grass, as far as possible its total yield, whether in culm bearing flower and seed, or in a less definite condition. The classification of the Graminaceous herbage will, therefore, on the present occasion, be somewhat different; and hence the present and the former results will not be strictly comparable.

It will be obvious that to conduct the work on the plan just indicated, not only involved an immense amount of labour, but required very considerable technical knowledge and experience in those superintending the separations. Accordingly, we applied to several botanical friends for a competent botanical assistant; and we have now to express our best thanks to Dr. J. D. Hooker, of Kew, for recommending to us, Mr. W. Sutherland, a young man who, as foreman of the "Hardy Herbaceous ground" in the Kew Gardens, had had, to use Dr. Hooker's words, "the charge of a most extensive named collection of herbaceous plants (some 4-5000), including a good collection of grasses." We have also much satisfaction in bearing testimony to the competency of Mr. Sutherland for the work he undertook, and to the conscientious and assiduous manner in which he has performed his tedious and difficult task.

The mode of taking the samples for the botanical separations was as follows: eight or ten mowers were put upon the half-acre experimental plot, and small quantities of grass were taken immediately after the scythe from each swathe until nearly the whole of the plot was down. The quantities so taken, amounting to very many times more than the required sample, were then carefully mixed on a cloth, so as to shake out as little seed as possible, and from the bulk a sample of 10 lbs. was immediately weighed, before any material change in the condition of the grass could take place by evaporation.

The samples taken as above described were spread out to dry at the ordinary temperature, and afterwards carefully preserved for future operation.

In all, twenty samples have been submitted to botanical analysis; occupying Mr. Sutherland for about four months, and another assistant, and from three to half a dozen boys, for a period of nearly six months.

The plan adopted in the first instance was to work down each sample to the point of something like equal difficulty of further separation. The remaining undetermined residue was then put into a sieve, and the larger stemmy and leafy portions were thus separated from the shedded flowers and seeds, and finely broken leafy matter. The mass of the latter was then separated, by

https://doi.org/10.23637/ERADOC-1-142

means of other sieves of varying fineness, into four or five different lots, in order to facilitate the examination and identification of its components; and notes were made accordingly as to their apparent character. But it was found that there still remained, in some cases, nearly one-fourth of the original sample as undetermined stemmy and leafy residue. Hence, all such residues that amounted to more than 10 per cent. of the original sample were afterwards submitted to a further separation—a most tedious labour—which, however, has in very few cases left as much as 10 per cent. of undetermined matter. Still, after these further separations, the relative proportions of the final stemmy and leafy residues will, to some extent indicate the ease or difficulty attending the separations and identifications, and at the same time, be some indication of the character of development of the herbage. For, it will be readily understood that a very luxuriant and stemmy Graminaceous produce, would be much more easily separated into its components, than a mass consisting almost exclusively of leafy herbage. Indeed, while some of the individual samples required more than a week for the first, and afterwards some days for the second separation, others were worked much more easily.

The numerical results of the inquiry, showing the proportion per cent. in each sample, of each separated portion, are given in the large folding Table, facing p. 48; in which the individual plants, or descriptions of herbage otherwise defined, are classified into—

1.—Graminaceous herbage:
Determined species;
Undetermined stem and leaf;
Shedded flowers and seeds, &c. (chiefly Graminaceous)

2.—Leguminous herbage.
3.—Miscellaneous herbage.

And, as will be seen, the different plants composing the Miscellaneous or weedy herbage, are classified into the Natural Orders to which they respectively belong.

The following is a detailed statement of the manuring of the different plots; a brief description of which is given under the corresponding plot-numbers in the Tables. Unless otherwise stated, the same description and amount of manure has been applied to the respective plots every year since the beginning of the experiments in 1856. The quantities are given *per acre*.

Plot 1.—Unmanured.

https://doi.org/10.23637/ERADOC-1-142

Plot 2.—Unmanured (duplicate plot at the further end of the series).

Plot 3 *a*.—Superphosphate of lime; composed of 200lbs. bone-ash, and 150lbs. sulphuric acid of sp. gr. 1·7. 4th season, commencing in 1859; sawdust alone the three previous seasons.

Plot 3 *b*.—Superphosphate of lime; and 400lbs. ammonia-salts (equal parts sulphate and muriate of commerce, supplying about 82lbs. nitrogen per acre). 4th season, commencing in 1859; the three previous seasons sawdust alone.

Plot 4.—400lbs. ammonia-salts.

Plot 5.—400lbs. ammonia-salts; and 2000lbs. sawdust.

Plot 6.—275lbs. nitrate of soda of commerce (containing about 41lbs. nitrogen). 5th season, commencing 1858.

Plot 7.—550lbs. nitrate of soda (containing about 82lbs. nitrogen). 5th season commencing in 1858.

Plot 8.—Mixed mineral manure, composed of—

300lbs. sulphate of potass.
200lbs. sulphate of soda.
100lbs. sulphate of magnesia.
Superphosphate of lime, as above.

Plot 9.—Mixed mineral manure; and 2000lbs. sawdust. (The mixed mineral manure as Plot 8 to 1861 inclusive, and in 1862 the sulphate of potass excluded, and the amount of sulphate of soda raised to 500lbs).

Plot 10.—Mixed mineral manure, as Plot 8; and 400lbs. ammonia-salts.

Plot 11.—Mixed mineral manure, as Plot 9; and 400lbs. ammonia-salts.

Plot 12 *a*.—Mixed mineral manure, as Plot 8; 400lbs. ammonia-salts; and 2000lbs. cut wheat straw.

Plot 12 *b*.—Duplicate of Plot 12 *a*, but rather sheltered on the west by trees.

Plot 13 *a*.—Mixed mineral manure, as Plot 8; and 800lbs. ammonia-salts, equal about 164lbs. nitrogen (only 400lbs. ammonia-salts, in 1859, 1860, and 1861).

Plot 13 *b*.—Mixed mineral manure as Plot 13 *a*, to 1861 inclusive; the same with 200lbs. silicate of soda and 200lbs. silicate of lime in addition in 1862; and 800lbs. ammonia-salts (only 400lbs. ammonia-salts in 1859, 1860, and 1861).

Plot 14.—Mixed mineral manure, as Plot 8; and 275lbs. nitrate of soda. 5th season, commencing in 1858.

Plot 15.—Mixed mineral manure, as Plot 8; and 550lbs. nitrate of soda. 5th season, commencing in 1858.

https://doi.org/10.23637/ERADOC-1-142

Plot 16.—14 tons farm-yard manure.
Plot 17.—14 tons farm-yard manure; and 200 lbs. ammonia-salts.

With the view of both controlling and adding to the numerical results of the botanical separations, it was decided to have systematic series of notes taken on the ground. To this end, between three and four weeks prior to the date of cutting were devoted to making observations, as under :—

1. On each plot seriatim; remarking the predominance, and character of development, of the different plants.
2. On each of the most important plants seriatim; comparing its predominance, and character of development, on the different plots.
3. On the relative conditions of ripeness of the plots generally, and of individual descriptions of plants, just before cutting.

Then, after the crop was cut, and before its removal from the ground, further notes were taken, with the full view of the produce of the entire plot then at command, the former ones having been made only at either end of the respective plots.

Lastly, notes on the second crop were taken.

In the separations of 1858, the number of species determined in any one sample in no case amounted to twenty; the undetermined Graminaceous herbage was, however, subdivided into four or five different lots, supplying, in addition to the defined species, so many different descriptions of herbage; but in the separations of 1862, forty or more defined species were in some cases identified. It is not supposed that a greater number of plants occurred in the produce of 1862 than in that of 1858. The result is doubtless due to the much greater amount of attention and labour bestowed upon the more recent separations. There is, however, no doubt, that, although the more general characteristics of the herbage on the respective differently-manured plots remain the same as formerly—that is to say, as to the general predominance respectively of Graminaceous, Leguminous, and Miscellaneous herbage, and tendency to stemmy or leafy development—yet that there is a considerably altered predominance of particular plants, as a further consideration of the results will show.

It is not proposed to comment in detail upon the numerical results given in the large folding Table (facing p. 48), nor to quote at any length from the voluminous written observations to which reference has been made, as such a treatment of the subject is more suitable to the pages of a Botanical than of an Agricultural Journal.

The most important practical points for consideration are those which illustrate the character of the herbage *in relation to*

https://doi.org/10.23637/ERADOC-1-142

the manures employed, and to the amounts of crop yielded. In relation to these points, therefore, we shall briefly consider—

1. The general description, and proportion per cent., of the different kinds of herbage (Graminaceous, Leguminous, or Miscellaneous), and the number of species.
2. The description, and proportion per cent., of the predominating species.
3. The tendency to the development of leafy or stemmy produce, and the order of ripeness.

I.— *The general description, and proportion per cent., of the different kinds of herbage (Graminaceous, Leguminous, and Miscellaneous), and the number of species, in relation to the manures employed, and to the amounts of crop yielded.*

In Table II. (pp. 28-29), are given the results relating to this branch of the subject. On the left hand will be found a short description of the manures employed, and a column showing the average annual yield of hay per acre on each plot, reckoned from the commencement of the experiments to 1862 inclusive; the records for the plot giving the largest amount of produce standing at the head of the list, and so on, in order, according to the crop yielded. Side by side with these particulars, on their right, are given, for each plot, the proportion per cent. in the produce, of—

1.—Graminaceous herbage:
  Determined species;
  Undetermined stem and leaf;
  Shedded flowers, seeds, &c., chiefly Graminaceous.
2. —Leguminous herbage.
3.—Miscellaneous or weedy herbage.

Also the number of species, respectively of the Graminaceous, the Leguminous, and the Miscellaneous herbage.

It will be seen that the average annual amount of produce at the head of the list is 6877 lbs., and that there is a pretty gradual diminution down to 2720 lbs., which is the yield without manure of any kind. The heaviest produce was obtained where, in conjunction with the mixed mineral manure, the largest amount of ammonia-salts (containing about 164 lbs. of nitrogen) was applied. Leaving out of consideration for the present the comparatively immaterial influence of cut wheat-straw, or sawdust, the next in order as to amount of crop are the five plots where, with the mixed mineral manure, half the quantity of nitrogen (about 82 lbs.), either in the form of ammonia-salts or nitrate of

https://doi.org/10.23637/ERADOC-1-142

soda was used. Then come two plots, the one with about 41lbs. nitrogen, supplied in the form of ammonia-salts, and the other with the same amount in the form of nitrate of soda; the former with farmyard dung manure in addition, containing, of course, besides a large amount of mineral constituents and carbonaceous organic matter, a considerable quantity of nitrogen; the latter with the mixed mineral manure. Next comes the plot with ammonia-salts (= 82 lbs. nitrogen) and superphosphate of lime instead of the mixed mineral manure, showing a deficiency of produce, due to the exclusion of the alkaline salts, of 1,200 lbs. to 1,400 lbs. per acre per annum. Still, this obviously defective combination gives more produce than an annual dressing of 14 tons of farm-yard manure per acre, with all its mineral and carbonaceous organic matter, and a good deal of nitrogen also. Nitrate of soda alone = 82 lbs. nitrogen, stands next to farmyard manure alone, giving more produce than the mixed mineral manure alone, which, in its turn, gives slightly more than ammonia-salts alone = 82 lbs. nitrogen, or nitrate of soda alone = 41lbs. nitrogen, and considerably more than superphosphate of lime alone. But although the mixed mineral manure alone gave more total produce than the ammonia-salts alone (= 82 lbs. nitrogen), it in point of fact gave very much less of Graminaceous herbage, its increase consisting in very large proportion of Leguminous plants.

The general result is, then, that the largest amounts of gross produce were obtained where the largest amounts of nitrogen were applied in the manure; provided only, that a sufficiency of mineral constituents was at the same time supplied. Further, that much larger crops were obtained by means of artificial manures supplying nitrogen and mineral constituents, than by a heavy dressing of farmyard manure, with all its carbonaceous organic matter, in addition to its large amount of nitrogen and mineral constituents. And again, a complex mineral manure alone gave about as much total produce as ammonia-salts alone or nitrate of soda alone; but the description of herbage developed was very different in the two cases.

Let us now consider the varying character of the herbage coincident with the use of such very different descriptions of manure, and the production of such very varying amounts of crop.

A glance at the Table (II.) shows that with the highest amount of produce there was the highest proportion in it of Graminaceous herbage, = about 95 per cent., no Leguminous herbage whatever, and the lowest proportion of Miscellaneous herbage = not quite 5 per cent. There was also, with the lowest amount of produce, only about 74 per cent. of Graminaceous herbage (which is

https://doi.org/10.23637/ERADOC-1-142

almost the lowest proportion), about 7 per cent. of Leguminous herbage, and nearly the highest proportion of Miscellaneous or weedy herbage.

Again, whilst the smallest number, or only 21 species of plants, was discovered in the sample of the heaviest produce, the largest number, or 43 species, was found in that of the smallest produce.

These extreme results prominently bring to view the fact that with large produce there was an almost exclusively Graminaceous, and a comparatively simple herbage; and that with small produce the herbage was at once much less Graminaceous, and much more complex. There is, moreover, with some instructive exceptions, to which attention will be directed, something like a gradual decrease in the proportion of Graminaceous, and increase in that of the Miscellaneous herbage, and especially in the number of species, as we proceed from the larger to the smaller crops.

Taking the results given in the Table a little more in detail, it will be well to bear in mind the general character of the herbage on the unmanured land, as the standard by which to compare that on the variously manured plots.

The unmanured produce, taking the mean result of the two plots, consisted, in round numbers, of about 74 per cent. Graminaceous, 6 to 7 per cent. Leguminous, and about 19 per cent. Miscellaneous herbage; and it comprised about 40 species of plants.

In contrast with the above composition, that of the six or seven heaviest crops at the head of the list in the Table (II.) may be taken, in round numbers, at from about 90 to 95 per cent. Graminaceous, from 0 to 0·86 per cent. Leguminous, and from 5 to something over 10 per cent. Miscellaneous herbage; the number of species varying from 21 to 30.

Comparing these heavier crops with one another, it is interesting to observe that Plot 13 *b*, manured with ammonia-salts and a mineral manure including silicates, gave a higher per-centage of Graminaceous, and a lower per-centage of Miscellaneous herbage, than Plot 13 *a*, with otherwise the same manure, but excluding silicates. Again, Plot 10, with ammonia-salts, and mineral manure, including potass, gave rather more produce, and a rather higher proportion of Graminaceous herbage, than Plot 11, with the same amount of ammonia-salts, and otherwise the same mineral manure (and sawdust in addition), but excluding potass. Plot 10 also gave rather more produce than either Plot 12 *a* or Plot 12 *b*, which had the same amount of ammonia-salts and mineral manure, with 2,000 lbs. of cut wheat straw per acre per annum in addition, though these plots, with the cut wheat-straw, gave a slightly higher proportion of Graminaceous herbage.

Plot 15, with the same mineral manure as Plot 10, and with about

https://doi.org/10.23637/ERADOC-1-142

TABLE II.—Showing the General Description, and Proportion per Cent., of the employed, and to the amounts of Crop

ORDER OF MOST PRODUCE, PER ACRE.			GENERAL DESCRIPTION	
			Per Cent.	
			Graminaceous.	
Plot Nos.	General Description of Manures.	Hay, per Acre per Annum; average of 7 Years, 1855-62.	Determined Species.	Undetermined Stem and Leaf.
		lbs.		
13*b*	Ammonia-salts=164 lbs. nitrogen, and mixed mineral manure, including silicates	6877	81·95	8·88
13*a*	Ammonia-salts=164 lbs. nitrogen, and mixed mineral manure (without silicates)	6876	80·91	5·69
10	Ammonia-salts=82 lbs. nitrogen, and mixed mineral manure	6357	77·57	6·31
11	Ammonia-salts=82 lbs. nitrogen, and mixed mineral manure (excluding potass in 1862), and sawdust	6216	72·97	8·91
12*a*	Ammonia-salts=82 lbs. nitrogen, mixed mineral manure, and 2000 lbs. cut wheat-straw	6159	80·61	6·52
12*b*	Duplicate of plot 12*a* (half of the plot rather sheltered by trees)	6141	74·39	12·09
15	Nitrate of soda=82 lbs. nitrogen, and mixed mineral manure	5783*	67·39	12·65
17	Ammonia-salts=41 lbs. nitrogen, and farmyard manure	5468	73·48	5·82
14	Nitrate of soda=41 lbs. nitrogen, and mixed mineral manure	4939*	65·78	8·27
3*b*	Ammonia-salts=82 lbs. nitrogen, and superphosphate of lime	4877†	69·45	6·40
16	Farmyard manure, alone	4775	60·33	7·88
7	Nitrate of soda, alone=82 lbs. nitrogen	4126*	52·34	17·65
9	Mixed mineral manure (excluding potass in 1862), and sawdust	4100	65·21	4·40
8	Mixed mineral manure, alone	3919	56·47	5·83
5	Ammonia-salts=82 lbs. nitrogen, and sawdust	3839	77·43	1·59
6	Nitrate of soda, alone=41 lbs. nitrogen	3805*	57·27	14·61
4	Ammonia-salts, alone=82 lbs. nitrogen	3719	78·68	5·07
3*a*	Superphosphate of lime, alone	3164†	62·36	8·90
2	Unmanured	2927	58·13	11·61
1	Unmanured	2720	58·82	7·43

* Average of 5 years only, 1858-62 inclusive.
† Average of 4 years only, 1859-62 inclusive.

https://doi.org/10.23637/ERADOC-1-142

different kinds of Herbage, and the Number of Species, in relation to the Manures yielded. SEVENTH SEASON, 1862.

OF HERBAGE.

Per Cent.				Number of Species.			
Graminaceous.							
Shedded Flowers and Seeds, &c., chiefly Graminaceous.	Total.	Leguminous.	Miscellaneous.	Graminaceous.	Leguminous.	Miscellaneous.	Total.
4·19	95·02	0·00	4·98	14	0	7	21
3·81	90·41	0·00	9·59	15	0	9	24
5·78	89·66	0·12	10·22	14	2	12	28
4·96	86·84	0·13	13·03	15	2	13	30
3·25	90·38	0·46	9·16	14	2	13	29
5·06	92·14	0·02	7·84	14	2	10	26
9·71	89·75	0·86	9·39	13	2	10	25
10·28	89·58	0·21	10·21	16	4	8	28
5·64	79·69	1·92	18·39	15	3	13	31
7·63	83·48	0·11	16·41	13	3	16	32
10·86	79·07	1·72	19·21	13	3	11	27
10·32	80·31	0·17	19·52	16	2	10	28
8·07	73·58	18·28	8·14	16	4	16	36
4·10	66·40	24·09	9·51	17	4	19	40
3·25	82·27	0·24	17·49	16	4	15	35
12·34	84·22	0·32	15·46	15	3	13	31
4·59	88·34	0·15	11·51	16	3	14	33
7·46	78·72	2·60	18·68	16	4	19	39
4·25	73·99	6·16	19·85	15	3	20	38
7·95	74·20	7·61	18·19	16	4	23	43

https://doi.org/10.23637/ERADOC-1-142

about the same amount of nitrogen, but in the form of nitrate of soda instead of ammonia salts, gave considerably less produce but almost exactly the same proportion of Graminaceous herbage, and more Leguminous herbage (0·86 per cent.), than any of the plots manured with ammonia-salt.

The better adaptation of nitrate of soda than ammonia-salts as a manure for Leguminous plants, a fact which we have in other cases observed, is again seen in the results of Plot 14. In that case, with a smaller amount of nitrate of soda and the mixed mineral manure, the Leguminous herbage amounted to nearly 2 per cent. of the produce. There was, at the same time, a larger proportion of Miscellaneous or weedy herbage (18·39 per cent.), and consequently a smaller proportion of the Graminaceous, than in any other case with an equally bulky crop. Ammonia-salts, even in conjunction with farm-yard manure, increased the proportion of Graminaceous plants at the expense of the Leguminous and Miscellaneous herbage.

Farm-yard manure alone, increased the proportion of the Graminaceous at the expense of the Leguminous herbage, the proportion of Miscellaneous herbage remaining about the same, though its character was very different, there being much fewer species and much greater predominance of individual weeds. In fact, under the influence of farm-yard manure there were fewer species developed within each division—Graminaceous, Leguminous, and Miscellaneous—the manured crop affording only 27 species, against 38 in one case, and 43 in another, without manure.

Perhaps the most striking of the results recorded in the Table is that obtained on Plot 8, by means of the mixed mineral manure alone. Whereas, without manure we have 74 per cent. Graminaceous, 6 to 7 per cent. Leguminous, and nearly 20 per cent. Miscellaneous herbage; and with the mixed mineral manure, *and ammonia-salts in addition*, 90 to 95 per cent. of the produce Graminaceous, either no Leguminous herbage at all, or but a fraction of 1 per cent. of it, and 5 to 10 per cent. of Miscellaneous herbage; we have, with mixed mineral manure *alone*, only about 66½ per cent. of Graminaceous herbage, as much as 24 per cent. Leguminous herbage, and only about 9½ per cent. Miscellaneous. Thus, two-thirds only of the produce by the mixed mineral manure alone consisted of grasses, whilst nearly one-fourth of it consisted of clovers, meadow vetchling, and trefoil. The total number of species was, however, about as high as without manure, and very much higher than with the same mineral manure and ammonia-salts in addition.

As already alluded to, when such mineral manures are applied to crops grown separately, as in rotation, instead of together in a

https://doi.org/10.23637/ERADOC-1-142

mixed herbage, they generally increase the produce of Graminaceous ones but little, and that of Leguminous ones very characteristically. It has been found, too, that even in a clayey soil, the constituent of mineral manures which seems to have the most influence upon the growth of the Leguminous plants of rotation, beans and clover for example, was potass; and we have in the results under consideration a striking instance of the effects produced on the growth of the allied plants of the mixed herbage by a liberal supply to the soil of that constituent. Thus, Plot 9 had in every previous year of the experiments received the same description and amount of mineral manure as Plot 8, but in 1862 the potass was excluded (from Plot 9), and a larger amount of soda-salt substituted. The result was that the produce of Plot 9, without the potass, gave only 18 instead of 24 per cent. of Leguminous herbage, or only three-fourths as high a proportion as that of the plot manured otherwise similarly, but with the potass in addition.

Superphosphate of lime alone, used for a series of years, has somewhat increased the amount and proportion of the grasses, at the expense of the Leguminous plants; the proportion of the Miscellaneous herbage remaining about the same. Still, the proportion of the Leguminous herbage under the influence of this manure, though considerably less than without manure, and little more than one-tenth as great as with the mixed mineral manure (containing salts of potass, soda, and magnesia, as well as superphosphate of lime), was considerably greater than in any case where either ammonia-salts or nitrates were used, whether they were employed alone, in combination with mixed mineral, or with farm-yard manure.

Lastly, ammonia-salts alone (or with only sawdust in addition), or nitrate of soda alone, considerably increased the proportion of the grasses, almost excluded the Leguminous herbage, reduced the proportion of Miscellaneous plants, and also the total number of species.

It will perhaps, be remembered that some years ago Baron Liebig stated he had obtained marked effects by the use of sawdust as a manure; a result which he considered due to the evolution of carbonic acid from the decomposing sawdust, by means of which the supply of mineral constituents within the soil was rendered more rapidly available.

We have, therefore, for some years past, applied 2000 lbs. of sawdust per acre, per annum, to a few of the experimental plots. Where, in previous years, the sawdust was used, either alone, with mineral manure without ammonia-salts, or with ammonia-salts without mineral manure, some, but generally a very small increase of produce, has been the result. But where the sawdust has been

https://doi.org/10.23637/ERADOC-1-142

employed with both mineral manure and ammonia-salts, that is to say, with a combination itself yielding a pretty full increase of produce, no further increase has been obtained by its means; nor has the use annually of 2,000 lbs. of finely-cut wheat-straw, in addition to the mixture of mineral manure and ammonia-salts, had as yet any beneficial effect upon the amount of gross produce per acre, notwithstanding the large amount of mineral matter peculiarly adapted for the growth of Graminaceous plants, which in addition to its decomposing carbonaceous substance, it would in the course of time supply.

Sawdust has, for similar reasons, also been tried on some of the crops grown on land under tillage, and with equal failure of beneficial result.

So far as observation goes, the effects of sawdust have been as immaterial on the character of the mixed herbage as on its amount; but as in the past season, 1862, in two out of the three cases where sawdust was employed potass was excluded from the mixed mineral manure used with it, the results are not in the season in question, strictly comparable with those of the plots with which they had previously been compared, but which now differ, not only in not having sawdust, but in having potass. The only strictly comparable experiments in 1862 are that of Plot 4 with ammonia-salts alone, and that of Plot 5 with the same amount of ammonia-salts, and sawdust in addition; and so far as the figures go, it would appear that the sawdust somewhat reduced the proportion of the grasses, and increased that of the Miscellaneous or weedy herbage.

We now turn to a consideration of the next branch of the subject.

II.—*The description and proportion per cent. of the predominating species, in relation to the manures employed, and to the amounts of crop yielded.*

Table III. (pp. 34, 35) illustrates this branch of the subject. As in table II., the Plots are arranged in order according to the amount of produce, the one yielding the most being at the head of the list, and so on. The particulars given relating to the predominating plants are—

1. The names, and proportion per cent., of the 5 predominating Graminaceous plants, or genera.
2. The names, and proportion per cent., of the 2 predominating Leguminous plants, or genera.
3. The same particulars for the 3 predominating Miscellaneous or weedy plants.

Although it is believed that the figures in the various Tables

https://doi.org/10.23637/ERADOC-1-142

may be fully relied upon as showing the general relation to one another of the individual species, or different orders of plants, it is by no means supposed that small numerical differences, or even in all cases, greater ones, are to be taken unconditionally as representing corresponding differences in the character of the herbage. It will be readily understood that in any case, and especially in that of a very heavy and luxuriant crop, there must be great difficulty in collecting a sample of no more than some ten pounds weight which will absolutely represent the bulk of the mixed herbage. Then again, the difficulty of separation and identification, in the case of a mass of ill-defined and mutilated leafy produce, is extremely great. It was with a full appreciation of these difficulties that we felt it necessary, if for no other reason than as a means of control over the numerical results, that the several series of notes to which reference has been made should be taken.

And although the botanical separations have been conducted at the cost of an immense amount of care and labour, we shall, in the few remarks we have to make on the results on the present occasion, be guided by a careful consideration of the recorded observations, as well as of the figures given in the Tables.

Taking the distribution of plants in the produce of the unmanured land as the standard by which to compare that of the other plots, attention will be directed in some detail to its components.

The Unmanured Produce.

Sixteen Graminaceous species were identified in the unmanured produce, constituting together about 74 per cent. of its weight; and although their distribution was more even than in most of the cases of the manured land, the species of the five predominating genera amounted in one case to 43, and in another to 47 per cent. of the total produce. In the produce of the heaviest crops, however, generally over 60, and sometimes as much as 68 or 69 per cent. were referable to the five predominating species, or at any rate to the species included within the five predominating genera.

In the unmanured produce, Festuca duriuscula, or F. pratensis, which are hardy and good grasses, Avena pubescens and A. flavescens, sweet and good grasses, adapted to dry and chalky land, and much liked in hay, were the most prominent; but they were by no means in such large proportion as the predominating grasses on most of the manured plots. Next to these were Lolium perenne, a very good and free-growing grass; Agrostis vulgaris, a creeping-rooted plant, said to be not liked by cattle; and Holcus lanatus, also a bad food-grass, being too soft and woolly. After these came Arrhenatherum avenaceum, a rather favourite

https://doi.org/10.23637/ERADOC-1-142 pp 34

TABLE III.—Showing the Description, and Proportion per Cent, of the predominating

SEVENTH

Order of Most Produce, per Acre.			Description, and per Cent.,			
Plot Nos.	General Description of Manures.	Hay, per Acre per Annum; average of 7 Years 1856-62.	The Five predominating			
			1	2	3	4
		lbs.				
13b	Ammonia-salts = 164 lbs. nitrogen, and mixed mineral manure (including silicates)	6877	Dactylis gl. 21·9	Agrostis vul. 19·3	Poa tr. & pr. 14·3	Holcus lan. 7·0
13a	Ammonia-salts = 164 lbs. nitrogen, and mixed mineral manure (without silicates)	6876	Dactylis gl. 23·6	Poa tr. & pr. 16·6	Agrostis vul. 9·2	Holcus lan. 8·8
10	Ammonia-salts = 82 lbs. nitrogen, and mixed mineral manure	6357	Avena p. & f. 18·1	Poa tr. & pr. 12·7	Lolium per. 11·9	Agrostis vul. 11·6
11	Ammonia-salts = 82 lbs. nitrogen, and mixed mineral manure (excluding potass in 1862), and sawdust	6216	Avena p. & f. 19·2	Dactylis gl. 11·9	Poa tr. & pr. 9·1	Holcus lan. 8·6
12a	Ammonia-salts = 82 lbs. nitrogen, mixed mineral manure and 2000 lbs. cut wheat-straw	6159	Dactylis gl. 23·6	Avena p. & f. 12·6	Agrostis vul. 12·0	Poa tr. & pr. 9·0
12b	Duplicate of Plot 12a (half of the plot rather sheltered by trees	6141	Dactylis gl. 31·0	Poa tr. & pr. 12·0	Holcus lan. 6·3	Festuca p. & d. 6·3
15	Nitrate of soda = 82 lbs. nitrogen, and mixed mineral manure	5783*	Poa triv. 7·11	Dactylis gl. 11·6	Lolium per. 10·0	Bromus mol. 9·4
17	Ammonia salts = 41 lbs. nitrogen, and farmyard manure	5468	Poa tr. & pr. 29·5	Dactylis gl. 16·9	Bromus mol. 12·5	Holcus lan. 6·0
14	Nitrate of soda = 41 lbs. nitrogen, and mixed mineral manure	4939*	Avena f. & p. 17·8	Festuca d. & p. 11·1	Agrostis vul. 10·3	Holcus lan. 9·6
3b	Ammonia-salts = 82 lbs. nitrogen, and superphosphate of lime	4877†	Agrostis vul. 18·6	Holcus lan. 15·3	Avena p. & f. 8·4	Poa triv. 7·3
16	Farmyard manure, alone	4775	Poa triv. 27·4	Bromus mol. 9·6	Avena p. & f. 7·3	Dactylis gl. 4·9
7	Nitrate of soda alone = 82 lbs. nitrogen	4126*	Festuca d. & p. 16·0	Alopecurus pr. 6·9	Agrostis vul. 6·2	Avena p. & f. 6·0
9	Mixed mineral manure (excluding potass in 1862), and sawdust	4100	Avena p. & f. 17·7	Festuca d. & p. 9·9	Agrostis vul. 7·6	Lolium per. 7·0
8	Mixed mineral manure, alone	3919	Avena p. & f. 16·7	Festuca d. & p. 12·8	Poa tr. & pr. 6·7	Arrhenath. av. 5·3
5	Ammonia-salts = 82 lbs. nitrogen, and sawdust	3839	Agrostis vul. 20·5	Avena p. & f. 16·6	Festuca d. & p. 14·4	Holcus lan. 8·1
6	Nitrate of Soda, alone=41 lbs. nitrogen	3805*	Alopecurus pr. 19·7	Festuca d. & p. 8·0	Agrostis vul. 6·8	Holcus lan. 6·7
4	Ammonia-salts, alone = 82lbs. nitrogen	3719	Festuca d. & p. 23·3	Agrostis vul. 21·3	Holcus lan. 9·7	Avena p. & f. 8·5
3a	Superphosphate of lime, alone	3164†	Avena p. & f. 12·5	Festuca d. & p. 12·2	Holcus lan. 11·9	Lolium per. 9·5
2	Unmanured	2927	Festuca p. & d. 16·2	Avena p. & f. 11·3	Agrostis vul. 5·5	Dactylis gl. 5·2
1	Unmanured	2720	Festuca p. & d. 13·9	Avena p. & f. 11·0	Lolium per. 8·7	Agrostis vul. 8·6

* Average of 5 years only, 1858-62 inclusive.
† Average of 4 years only, 1859-62 inclusive.

https://doi.org/10.23637/ERADOC-1-142

Species, in relation to the Manures employed, and to the Amounts of Crop yielded.

SEASON, 1862.

OF PREDOMINATING SPECIES.

Graminaceous Plants.		The Two predominating Leguminous Plants.			The Three predominating Miscellaneous Plants.			
5	Total per Cent.	1	2	Total per Cent.	1	2	3	Total per Cent.
Arrhenath. av. 5·7	68.2	0·00	0·00	0·00	Rumex acet. 3·72	Carum Car. 0·82	Achillæa mil. 0·39	4·93
Lolium per. 8·6	66·8	0·00	0·00	0·00	Rumex acet. 6·40	Achillæa mil. 1·53	Carum Car. 1·35	9·28
Holcus lan. 11·1	65·4	Lathyrus pr. 0·11	Trifolium rep. 0·01	0·12	Rumex acet. 4·93	Carum Car. 2·34	Achillæa mil. 1·96	9 23
Agrostis vul. 8·0	56·8	Lathyrus pr. 0·12	Trifolium rep. 0·01	0·13	Rumex acet. 9·26	Carum Car. 1·47	Achillæa mil. 0·90	11·63
Lolium per. 7·5	64·7	Lathyrus pr. 0·41	Trifolium pr. 0·05	0·46	Rumex acet. 4·88	Achillæa mil. 2·08	Carum Car. 1·74	8·70
Avena p. & f. 6·0	61·6	Lathyrus pr. 0·01	Trifolium rep. 0·01	0·02	Rumex acet. 5·56	Carum Car. 1·33	Achillæa mil. 0·75	7·64
Holcus lan. 6·7	54·8	Lathyrus pr. 0·84	Trifolium pr. 0·02	0·86	Rumex acet. 7·09	Carum Car. 1·09	Ranun. a. & b. 0·52	8·70
Avena f. & p. 3·8	68·7	Lathyrus pr. 0·14	Trifolium pr. 0·05	0·19	Rumex acet. 5 76	Achillæa mil. 1·39	Ranun. a. & b. 1·39	8·54
Poa triv. 7·3	56·1	Trifol. p. & r. 1·87	Lathyrus pr. 0·05	1·92	Rumex acet. 5·33	Ranun. a. & b. 5 18	Carum Car. 3·75	14·26
Festuca d. & p. 6·9	56·5	Lathyrus pr. 0·07	Trifol. p. & r. 0·04	0·11	Rumex acet. 11·05	Ranun. a. & b. 1 73	Achillæa mil. 1·70	14·48
Arrhenath. av. 2·7	51·9	Lathyrus pr. 0·90	Trifol. p. & r. 0·82	1·72	Rumex acet. 10·33	Ranun a. & b. 2·34	Achillæa mil. 2·34	15·01
Lolium per. 4·6	39·7	Trifolium pr. 0·16	Lotus cornic. 0·01	0·17	Plantago lanc. 6 99	Rumex acet. 5·72	Achillæa mil. 2·55	15·26
Arrhenath. av. 5·1	47·3	Trifol. p. & r. 10·01	Lathyrus pr. 8·10	18·11	Rumex acet. 1·70	Carum Car. 1·39	Achillæa mil. 0·95	4·04
Holcus lan. 4·9	46·4	Lathyrus pr. 13·24	Trifolium pr. 7·51	20·75	Rumex acet. 1·86	Carum Car. 1·79	Achillæa mil. 1·69	5·34
Lolium per. 5 8	65·4	Lathyrus pr. 0·22	Trifolium pr. 0·01	0 23	Rumex acet. 10·64	Achillæa mil. 3 37	Galium ver. 0·95	14 96
Poa tr. 5·7	46·9	Trifolium pr. 0·28	Lotus cornic. 0·03	0·31	Centaurea nig. 3 93	Plantago lanc. 3·06	Rumex acet. 2·84	9·83
Arrhenath. av. 5·8	68·6	Lotus cornic. 0·07	Trifolium pr. 0·07	0·14	Rumex acet. 7·88	Achillæa mil. 1·33	Carum Car. 0·86	10·07
Poa tr. & pr. 5·7	51·8	Trifol. p. & r. 1·93	Lotus cornic. 0·39	2·32	Plantago lanc. 5·35	Ranun. a. & b. 4·27	Rumex acet. 3·17	12·79
Holcus lan. 4·8	43·0	Trifolium pr. 2·66	Lathyrus pr. 1·88	4·54	Plantago lanc. 7·72	Rumex acet. 2·68	Carum Car. 2·52	12·92
Holcus lan. 5·0	47·2	Trifol. p. & r. 4·73	Lotus cornic. 1·69	6·42	Plantago lanc. 6·87	Ranun. a. & b. 3·61	Luzula camp. 1·54	12·02

https://doi.org/10.23637/ERADOC-1-142

grass as early feed, and for its second cut; Poa trivialis, also a good grass for early feed and second crop, but from its tufty growth and strong creeping roots said to be apt to banish other grasses; Anthoxanthum odoratum, a fragrant grass, but not relished in large quantity; and Alopecurus pratensis, better as green food than as hay. All the above were more evenly distributed in the small unmatured produce than in any other; and it contained besides, insignificant quantities of Dactylis glomerata, a bulky and free-growing grass under favourable conditions, and much liked by stock when not too old; Briza media, a plant of limited growth, and not much relished as food; Cynosurus cristatus, varying in character considerably, according to circumstances of growth, better for pasture than for hay, but upon the whole of little utility; and lastly Bromus mollis, a soft and very bad food-grass.

It is true that on one of the unmanured plots (No. 2) Dactylis glomerata occurred in notable quantity; but as that plot was situated between plots 12 *a* and 13 *b*, on both of which Dactylis was very luxuriant, it is more probable that it has, from time to time, been seeded from them, than that such a grossly-feeding grass flourished naturally on the unmanured land. Observation, indeed, led to the conclusion that in some other cases unexpected differences in the indications of the figures are attributable to adventitious circumstances of an allied kind.

Of Leguminous herbage, the unmanured produce contained from 6 to 7 per cent., the larger portion of which consisted of perennial red clover, with a little white clover. Lathyrus pratensis (meadow vetchling), and Lotus corniculatus (bird's-foot trefoil) occurred in less quantity, but the two about equally, and more largely than in any other case excepting where the mixed mineral manures were employed.

The Miscellaneous or weedy herbage, of which nearly 20 per cent. of the unmanured produce was composed, also consisted, like the Graminaceous herbage, of a great variety of species, of which few specially predominated, excepting the Plantago lanceolata (ribwort plantain). The next in prominence were the Ranunculus acris and R. bulbosus (crow-foots), Rumex acetosa (sorrell dock), Carum Carui (common caraway), Achillæa millefolium (milfoil), and Luzula campestris (field wood-rush). In smaller quantity occurred—of the Order *Compositæ*—Centaurea nigra (black knapweed), Leontodon hispidus (rough hawkbit), Tragopogon pratense (yellow goat's beard), Taraxacum Dens-leonis (dandelion), Hypochœris radicata (cat's-ear), and Bellis perennis (daisy); of the Order *Umbelliferæ*, Pimpinella saxifraga (burnet saxifrage), and Heracleum sphondylium (hogweed); and of plants of various other natural Orders, occurring still less pre-

https://doi.org/10.23637/ERADOC-1-142

valently, where the Veronica chamædrys (germander speedwell), Cerastium vulgatum (mouse-ear chickweed), Stellaria graminea (lesser starwort), Scabiosa arvensis (field scabious), Hypnum squarrosum (squarrose moss), Primula veris (cowslip), Sanguisorba officinalis (great burnet), Geum urbanum (common avens), Galium verum (yellow bed-straw), Ajuga reptans (bugle) and Ophioglossum vulgatum (adder's tongue). And there were probably others of too unpretending and restricted growth to be observed on the ground, or to come within reach of the scythe.

Upon the whole the unmanured produce—Graminaceous, Leguminous, and Miscellaneous—was more complex, and less characterised by the prevalence of individual species, than that of any of the manured plots. The most predominating plants were, of the grasses Festuca duriuscula and F. pratensis, Avena pubescens and A. flavescens; and of the Miscellaneous or weedy plants, Plantago lanceolata.

It is only necessary to add that the meadow yielding the mixed herbage composed as above described, though giving hay of fair average quality, and useful after-feed for store stock, or sheep, by no means partakes of the character of a fattening pasture.

Effects of Mineral Manures alone.

The plots on which the Graminaceous herbage more nearly approached to that of the unmanured land, both in complexity and in general prevalence of the same species, were plot 3 *a* manured with superphosphate of lime alone, and plots 8 and 9 with the mixed mineral manure. The chief distinctions apparent are, that by superphospate of lime alone the inferior grass Holcus lanatus was brought into somewhat greater prominence, and that by it, as well as by the mixed mineral manure alone, the useful grass Poa trivialis was somewhat increased in relative amount. By the mixed mineral manure, Arrhenatherum avenaceum also appears to be somewhat encouraged. The free growing and bulky Dactylis glomerata was in very small quantity on either of the plots manured with mineral manure alone; nor are either of the other grasses which occur in predominating amount on one or other of the plots yielding the heavier crops, found at all prominently in the comparatively small produce grown under the influence of mineral manures alone.

It was on the amount and character of the Leguminous herbage that the mineral manures alone produce the most striking effects. Superphosphate of lime alone, considerably reduced the proportion of such herbage; but when with it salts of potass, soda, and magnesia were used, Trifolium pratense perenne, and Lathyrus pratensis, were developed in an extraordinary degree. When the

https://doi.org/10.23637/ERADOC-1-142

mixed mineral manure contained potass, as well as soda and magnesia (Plot 8), the Lathyrus somewhat predominated; and where the potass was excluded (Plot 9) it was in a smaller proportion. Lotus, again, was more abundant on Plot 8, where the potass was employed. As already alluded to, however, the total amount of Leguminous herbage was very much the less on Plot 9, where the potass was excluded; and as at present it has only been for one season excluded, it is not improbable that the proportion of such herbage will in future be greatly reduced. It is worthy of remark, too, that on Plot 8, where the application of potass is continued, the proportion of Leguminous herbage was almost exactly the same in the produce of the seventh year of the experiments, 1862, as it had been found to be in that of the third season, 1858.

Superphosphate of lime alone, which tended to decrease the proportion of Leguminous plants, seemed to be generally favourable to the development of the Miscellaneous ones, both the variety and amount of such herbage being considerable. The proportion of Plantago lanceolata was nearly as great as on the unmanured plot, and that of Ranunculus (acris and bulbosus), Rumex, Achillæa, and Carum Carui, was also comparatively large. On the other hand, the mixed mineral manures, which so much increased the proportion of the Leguminous plants, considerably diminished that of the Miscellaneous ones. The variety of such herbage was, however, considerable; the reduction in amount being due to the diminished luxuriance of several species, and especially the Plantago, which was in very small amount.

Effects of Ammonia-Salts alone.

Compared with the unmanured produce, ammonia-salts alone, or with sawdust only in addition, considerably increased the proportion of total Graminaceous herbage, and also the amount referable to the species of the five predominating genera, the latter reaching from 65 to 68 per cent. of the total produce. To a great extent, however, the same grasses prevailed as in the small crops without manure, or with mineral manures alone. The most prominent effect of this relatively excessive nitrogenous condition, was the encouragement of the Festuca duriuscula and Avena pubescens, two good elements predominating in the produce without manure; to a greater extent still that of the objectionable creeping-rooted Agrostis; and in some degree also that of the inferior Holcus lanatus. Compared with the effects on the distribution of the Graminaceous herbage of mineral manure alone, the most marked result of the ammonia-salts alone was the great increase of the Agrostis and the Holcus, at the

https://doi.org/10.23637/ERADOC-1-142

expense, to some extent, of the superior Poa trivialis, but in a greater degree of the Leguminous herbage. The free growing and bulky Dactylis, as by mineral manures alone, so also by ammonia-salts alone (which characteristically favour the growth of Graminaceous herbage generally), appears to be kept in the background. In fact, although the increase by ammonia-salts alone was exclusively Graminaceous (other plants being actually reduced in amount), it was also almost exclusively composed of the leafy herbage of the less grossly growing grasses.

Under the influence of ammonia-salts alone the produce did not contain a quarter of 1 per cent. of Leguminous herbage.

The proportion of total Miscellaneous plants and the number of species, were reduced by the use of ammonia-salts alone; but some few plants were very strikingly encouraged, especially the Rumex acetosa, which was both abundant and luxuriant. Carum Carui was also very prevalent, more so than the figures would indicate; the small weight being probably due to its being ripe, and having shedded much seed before being cut. Achillæa millefolium was also a very prominent plant; and Luzula campestris was more so than on most of the manured plots.

Effects of Nitrate of Soda alone.

The effects of nitrate of soda alone, though in many respects similar to those of ammonia-salts alone, show some peculiarities. The proportion of the total herbage referable to the five predominating Graminaceous genera is unusually small; whilst a plant occurring in the produce without manure in very small quantity, and in less amount still in that by mineral manure alone, or ammonia-salts alone, comes here into very great prominence. This grass, Alopecurus pratensis (fox-tail grass), a good pasture plant, but not a good element in hay, contributed 19·7 per cent. to the produce where the smaller amount of nitrate of soda was used alone, and nearly 7 per cent. where the larger amount was employed; though, in only one other case, excepting in the produce without manure did it exceed 2 per cent. This grass was, in fact, quite characteristic of the nitrated plots. Otherwise, there was a pretty equal distribution of the grasses prevailing on the plots hitherto considered; though, as with ammonia-salts without mineral manure, there was here a great tendency to development of foliage from the base, rather than to the growth of stem and stem-leaves.

Nitrate of soda alone, like ammonia-salts alone, very much discouraged the Leguminous herbage. Lathyrus and Lotus were almost totally excluded; and Trifolium only contributed about a quarter of 1 per cent. of the produce.

https://doi.org/10.23637/ERADOC-1-142

Unlike ammonia-salts alone, the nitrate of soda seemed to encourage the Plantago lanceolata; and under its influence Centaurea nigra and Taraxacum Dens-leonis, though in small amount, were somewhat more prominent than usual. But next to Plantago lanceolata, Rumex acetosa, Achillæa millefolium, Ranunculus (acris and bulbosus), and Carum Carui were the most abundant of the Miscellaneous plants, though none of them were very luxuriant. The total amount of Miscellaneous herbage was comparatively large, but resulted from the great frequency of some few species, rather than from either great variety, or great luxuriance of any particular plants.

Effects of Farm-Yard Manure alone.

Farm-yard dung alone, the manure upon which dependence must to a great extent be placed for grass-land devoted to the production of hay, gave a produce containing 79 per cent. of total Graminaceous herbage, but a comparatively small proportion (51·9 per cent.) referable to the five predominating genera; and this was the case notwithstanding that one grass, Poa trivialis, which was not at all prominent on any of the plots already considered, contributed 27½ per cent. of the total herbage as sampled. The notes taken on the ground agree with the figures in showing this plant to have been very prominent; and, as will presently be seen, it also occurred in very predominating amount on the plot manured with farmyard-manure and ammonia-salts. So far farmyard-manure improves the character as well as increases the amount of the Graminaceous herbage; but it also brings into greater prominence than any of the other manures Bromus mollis, which is reputed to be a very bad food-grass. It, at the same time, encourages the free-growing, productive, and, upon the whole, good but somewhat coarse grass Dactylis glomerata more than any of the manures yielding the smaller crops. The three grasses Poa trivialis, Bromus mollis, and Dactylis glomerata, which are thus seen to be increased in their development by farmyard-manure, are so at the cost chiefly of Festuca duriuscula and F. pratensis, but partly of Avena pubescens and Agrostis vulgaris, and in a less degree of some other grasses.

The produce by farmyard-manure contained a much less amount and proportion of Leguminous herbage than that without manure; both Trifolium and Lathyrus being much reduced, and Lotus excluded, at any rate from the mown sample. This result is probably due more to the increased luxuriance of the grasses and certain Miscellaneous plants, by which the Leguminous ones are displaced, than to any directly injurious effect of the farmyard-manure; for the notes taken on the ground show

https://doi.org/10.23637/ERADOC-1-142

that although Trifolium and Lathyrus were less frequent on the farmyard-manure than on the unmanured plot, they were on the other hand more luxuriant.

The Miscellaneous or weedy plant most prominently developed by farmyard-manure was the Rumex acetosa, or sorrel dock, which amounted to rather more than 10 per cent. of the sample examined; though, from the notes taken on the ground, it is concluded that the sample perhaps included a somewhat undue proportion. According to the notes, Carum Carui was by far the most frequently occurring weed. Ranunculus (acris and bulbosus), and Achillæa millefolium were also each very frequent; and Plantago lanceolata was more so than in most of the crops of equal bulk. Besides those mentioned, scarcely any other weedy plants occurred; there being a large total per-centage of Miscellaneous herbage, but referable to comparatively few species, and it was the frequency rather than the luxuriance of these that contributed to the large amount.

Effects of Farmyard-manure and Ammonia-salts.

As already alluded to, the combination of farmyard-manure and ammonia-salts, like farmyard-manure alone, very strikingly developed the Poa trivialis, and to a considerable extent the Bromus mollis also. The chief distinction is, that the ammonia-salts used in conjunction with a manure supplying a large amount of mineral matter, strikingly increases the growth of the Dactylis glomerata, apparently at the expense of the Miscellaneous herbage, of which there were but very few species, and but a small amount, whilst the proportion of total Graminaceous herbage was considerably increased. In other respects, the produce was very similar in its Graminaceous componênts to that by farmyard-manure alone; there being, in the two cases, besides the grasses which have been specially noticed, pretty equal proportions of most of those occurring on the unmanured plot. Holcus lanatus was, however, rather more plentiful and luxuriant where the ammonia-salts were used.

Under the influence of ammonia-salts in conjunction with farmyard-manure all the elements of Leguminous herbage were almost as completely excluded as when ammonia-salts were used alone.

The number of species of Miscellaneous plants was unusually small under the conditions of manuring now in question; and the proportion in the produce of such herbage was also small. As in the case of farmyard-manure alone, Rumex acetosa was the most prominent weed. Judging from the notes and figures together, Carum was probably next in order of prevalence; and after it

https://doi.org/10.23637/ERADOC-1-142

came Ranunculus (acris and bulbosus), and Achillæa millefolium. But none of the Miscellaneous plants enumerated were so abundant here as under the influence of the farmyard-manure alone; still, the amounts recorded in the Tables are attributable rather to their frequency than to great luxuriance.

Effects of Ammonia-Salts and Superphosphate of Lime.

Ammonia-salts in conjunction with superphosphate of lime, gave considerably more produce, a larger proportion of Graminaceous herbage, and a larger proportion referable to the five predominating Graminaceous genera than superphosphate of lime alone: the proportion of the latter being increased from 51 to 56½ per cent. of the total produce. The proportions of Poa trivialis and Lolium perenne are not much affected by the addition of the ammonia-salts; but those of Festuca duriuscula, Avena pubescens, and A. flavescens are considerably reduced; whilst the inferior grasses, Agrostis vulgaris and Holcus lanatus (especially the former), are brought into very considerable prominence. Although, therefore, the amount of produce was much increased by the addition of the ammonia-salts, the character of the Graminaceous plants developed was somewhat inferior. Dactylis glomerata was not encouraged by the combination in question.

As in other cases where nitrogenous manures were freely employed, Leguminous herbage of all kinds was almost excluded.

Of Miscellaneous herbage—as under somewhat similar conditions in other cases—Rumex acetosa was by far the most prominent element, being both very abundant and very luxuriant. Carum Carui was likewise both abundant and luxuriant, but had shedded a good deal of its seed; Ranunculus acris and R. bulbosus were frequent rather than luxuriant; Achillæa millefolium occurred in notable quantity; other Miscellaneous species were somewhat few in number and insignificant in amount.

Effects of Nitrate of Soda and Mixed Mineral Manure.

By nitrate of soda and mixed mineral manure together, both the amount of produce and the proportion of it referable to the few predominating Graminaceous species were greater than by either nitrate of soda alone or mixed mineral manure alone. Where the smaller amount of nitrate of soda was used with the mixed mineral manure, Avena flavescens, Holcus lanatus, and Poa trivialis were the predominating grasses; and, according to the figures, Festuca duriuscula and Agrostis vulgaris were also in large amount, though the notes taken on the ground did not lead

https://doi.org/10.23637/ERADOC-1-142

to the conclusion that they were predominating. All these grasses occurred in larger amount than where the nitrate of soda was used alone. But the most remarkable effect of the addition of the mixed mineral manure was the almost entire exclusion of the Alopecurus pratensis, which had flourished in such an extraordinary degree under the influence of the nitrate of soda alone, and the great development in its stead of the Avena flavescens, which under the latter condition had occurred in very insignificant amount. With twice the amount of nitrate of soda and the same mixed mineral manure, the distribution of Graminaceous species was again very strikingly but very differently affected. Poa trivialis was now the predominating species; and Dactylis glomerata, Lolium perenne, and bromus mollis were also in considerable quantity; Holcus lanatus coming next in order. Here again Alopecurus pratensis—the characteristic plant with nitrate of soda alone—was almost excluded; whilst Festuca duriuscula was reduced to a very insignificant amount, and Avena flavescens —so luxuriant with the smaller amount of nitrate and mineral manure—was here by no means prevalent. With regard to the great prominence of Poa trivialis and Bromus mollis on the plot now under consideration, it is, however, worthy of remark that it adjoined Plot 17, manured with farmyard-manure and ammonia-salts, where these two grasses were the characteristic plants. It would seem probable, therefore, that the result was, at any rate partly, due to seeding from the farmyard manure plots, and hence so far accidental.

Of Leguminous plants, there was a somewhat larger proportion than by nitrate of soda alone, or by ammonia-salts either alone or in combination with the mixed mineral manure, though much less, especially of Trifolium, where the larger than where the smaller amount of nitrate of soda (with the mineral manure) was used, and in both cases very much less than without manure. The Lathyrus was more frequent than the Lotus: the latter, indeed, was all but wanting.

The amount and character of development of the Miscellaneous herbage differed very greatly on the two plots with nitrate of soda and mineral manure, both the proportion and the luxuriance being generally much greater with the smaller amount of nitrate. With the smaller amount of nitrate, Rumex acetosa, Ranunculus (acris and bulbosus), Carum Carui, and Achillæa millefolium were all both frequent and luxuriant, and Plantago lanceolata was somewhat so. With the larger amount of nitrate, Rumex acetosa was by far the most frequent and abundant weed; neither Achillæa millefolium nor Plantago lanceolato was at all prevalent; whilst Carum Carui and Ranunculus (acris and bulbosus), though somewhat frequent, were not luxuriant; and other weeds

https://doi.org/10.23637/ERADOC-1-142

were small, both in number and amount. The general result is, that with the larger amount of nitrate and the mixed mineral manure, as with the corresponding amount of ammonia-salts and mixed mineral manure—both the number of species and the total amount of Miscellaneous plants were comparatively small.

Effects of Ammonia-salts and mixed Mineral Manure.

There remain to be noticed the distribution and predominance of species on Plots 10, 11, 12*a*, 12*b*, 13*a*, and 13*b*, on which both ammonia-salts and mixed mineral manure were employed, and on which by far the largest crops were obtained.

Excepting in the case of Plot 11, where in 1862 potass was excluded from the mineral manure, the produce contained from 89½ to 95 per cent. of Graminaceous herbage; and the five predominating grasses ranged from about 61½ to about 68¼ per cent. of the total produce. In four out of the six cases the free-growing and bulky Dactylis glomerata was the predominating grass, contributing in one case 31 per cent., and in the case of the smallest amount of it, nearly 22 per cent. of the total produce. In the other two cases, the Avena pubescens and A. flavescens, in about equal proportions, predominated, amounting together to from 18 to 19 per cent. In two out of the four cases where Dactylis predominated (Plots 13*a* and 13*b*) a very excessive amount of ammonia-salts was employed; and in the one case the mineral manure contained silicates, when a considerably larger amount of Agrostis was found in the produce; but whether the result were really due to the supply of the silicates may be a question. In fact, it was in dealing with the very heavy and luxuriant crops that the difficulty of fairly sampling was the greatest; and we would therefore, especially in such cases, rest our conclusions much more upon the general than upon the exact indications of the figures. Although Agrostis and Holcus, two bad elements, occurred in considerable quantity in the bulky produce of all the highly-manured plots, it is satisfactory to observe that the free-growing and useful Dactylis, the sweet and much-relished Avena pubescens and A. flavescens, the useful Poa trivialis, and the free-growing and nutritive Lolium, were all prominent components in these luxuriant crops. Of other grasses, Festuca duriuscula or F. pratensis, came next in order of prevalence, the rest occurring, for the most part, in very insignificant proportions.

Of Leguminous plants these heavy crops in some cases contained scarcely a trace, and in others only very insignificant amounts.

Of Miscellaneous herbage, Rumex acetosa, as usual with full

https://doi.org/10.23637/ERADOC-1-142

manuring of any kind, is by far the most predominating plant; Carum Carui and Achillæa millefolium coming next in order. All others, Ranunculus and Plantago included, occurred in very small amounts; and the total quantity of Miscellaneous herbage, which was small, was attributable chiefly to the luxuriance of the Rumex and the Carum, and the frequency of the Achillæa millefolium.

III. *The tendency to the development of leafy or stemmy produce, and the order of ripeness.*

As already explained in the separations of 1858, the results of which were recorded in our former Report, the Graminaceous herbage was classified into "Stems bearing flower or seed," which could be referred to particular species, and into "Detached leaf and indeterminate stems;" and hence the figures pretty directly indicated the relative tendency to the production of stem and seed, or of leaf. But since in the recent separations all the detached leafy matter that could be identified is included, with the stemmy portion, under the head of "Determined species" —the remainder only being put down as "Undetermined stem and leaf," or "Shedded flowers and seeds, &c."—the numerical results of the present inquiry do not serve to illustrate the subject of the tendency to the development of leafy or stemmy produce. The figures in the column in Table II., showing the amounts remaining as "Undetermined stem and leaf," do indeed indicate, where the amount is large, that the separation and identification were unusually difficult, and so far, generally, that the produce was leafy and ill-defined rather than stemmy and matured; but in the few remarks we have to make on the point in question, as well as on that of the relative ripeness, we shall rely on careful observations made on the ground, just before and at the time of cutting, in which ten conditions or orders of ripeness of the produce (of the 20 plots) were noted.

The unmanured plots presented a very thin crop of stem, with a full and uniform development of leaves, which were, however, very short, affording, upon the whole, a pretty even and close, but meagre bottom herbage, which was green and late at the time of cutting, its order of ripeness being No. 8. Leguminous and Miscellaneous plants were numerous, but mostly of stunted growth.

Superphosphate of Lime alone gave a crop very much like the unmanured one as to general relation of leaf and stem, &c., but it was rather more luxuriant, and showed more tendency to the production of fine leaf, chiefly belonging to the smaller and later

https://doi.org/10.23637/ERADOC-1-142

grasses; it contained much less Leguminous herbage, nearly the same proportion of Miscellaneous plants, and was somewhat more matured at the time of cutting, its order of ripeness being No. 6.

Mixed mineral manures alone gave a very equally maturing and generally ripe crop, but with only a small proportion of the more grossly growing grasses; the finer ones, however, mostly flowering or seeding. Leguminous plants were very numerous and luxuriant, but few of the Miscellaneous ones were so. Order of ripeness No. 2.

Ammonia-salts alone gave a very green and unripe crop, the order of ripeness being No. 10. There was a dense bottom herbage, with the foliage coming chiefly from the root, and very little flowering tendency. Upon the whole the grasses, which were for the most part of the smaller kinds, seemed but partially developed, apparently exhausted, and not likely to mature. Lolium perenne showed the most tendency to form stem and seed, but was frequently monstrous or dying.

Nitrate of soda alone gave a crop which at the time of cutting was very late, dark green, and still growing, without the look of exhaustion exhibited by the herbage grown by ammonia-salts alone; it was much more leafy than stemmy, forming a dense mass of grassy produce, for the most part referable to the smaller-leafed species; and, as the amount of undetermined stem and leaf will show, the separation and identification of its components were unusually difficult. The order of ripeness was No. 9.

Farm-yard manure alone yielded a produce which was, upon the whole, comparatively ripe, standing 4th in this respect, but it was very unequally so. All the grasses gave a fair proportion of stem, and they were also generally plentiful in both base and stem-leaves. Poa trivialis and Bromus mollis were the predominating grasses, but there was a fair proportion of most of the others found on the unmanured land, the grosser species being, however, somewhat restricted in development.

Farmyard manure and ammonia-salts, like farmyard-manure alone, gave a very unequally ripe crop, which also in order of ripeness was No. 4. Its characteristics were great luxuriance, a fair proportion of both stem and leaf, and a considerable variety of herbage; but with Poa trivialis, Dactylis glomerata, and Bromus mollis, by far the most prominent species among the grasses, giving upon the whole a strong and thick-bottomed, but rather rough crop.

With superphosphate of lime and ammonia-salts the crop was much more backward than with superphosphate of lime alone, coming 10th instead of 6th in order of ripeness. There was,

https://doi.org/10.23637/ERADOC-1-142

relatively, much less development of stem and much more of leaf, forming a strong and luxuriant bottom-grass, of a dark-green colour.

The mixed mineral manure and nitrate of soda gave crops which were very much riper, especially where the double amount of nitrate was used, than those by nitrate of soda alone; the order of ripeness was with the smaller amount of nitrate (and minerals), No. 5, and with the larger amount, No. 1; the crops with nitrate alone standing 9th, and those with the mixed mineral manure alone 2nd. There was, however, a great tendency to the production of leaf, the stems being somewhat thinly distributed.

The mixed mineral manure in conjunction with ammonia-salts, as with nitrates, greatly enhanced the production of stem and the ripening tendency. The crops grown by this combination —which were the heaviest in the series—were very luxuriant, and still vigorously growing at the time of cutting, the grosser species of grass predominating. There was a very full development of both stem and leaf; the foliage, however, coming in larger proportion than usual from the stem. With the smaller amount of ammonia-salts the crops were 4th in order of ripeness; but with the larger amount they were only 7th, being later, greener, and more vigorously growing, and showing a greater abundance and luxuriance of Dactylis glomerata.

In connexion with the results brought out in this inquiry into the action of special manures on the mixed herbage of grass-land, it will be interesting, at the present time, when the subject of the utilisation of *town sewage* is so much discussed, to call attention to the prominent characters of the herbage developed when it is applied to permanent meadow land.

In some experiments conducted during the last two years by the Royal Sewage Commission, and still in progress on the application of the town sewage to grass land at Rugby, it is found that effects have resulted very similar to those recorded in this paper. The prevailing grasses on the unsewaged land were Dactylis, Holcus, Lolium, Festuca, Agrostis, Poa, and Avena; a number of others occurring in smaller proportion. Of the sewaged produce, by far the largest proportion consists of Dactylis, Holcus, and Lolium; whilst Festuca, Agrostis, Avena, Poa, and other grasses, are far less prominent than in the unmanured produce. Under the influence of sewage too, the Leguminous herbage is found to be almost excluded; and the Miscellaneous weedy plants are very much reduced in variety, though some few are very much increased in luxuriance, among which Rumex, Ranunculus repens, and sometimes Taraxacum, are the most prominent.

https://doi.org/10.23637/ERADOC-1-142

In the well-known Edinburgh sewaged meadows again, the herbage is for the most part of a very simple character. Of the grasses the most prominent, and the most valued for its yield of green food, is the Poa trivialis; next in prevalence, and perhaps in general estimation also, is the Triticum repens, or couch grass; and after these, frequently occur Lolium perenne and Dactylis glomerata. Of weedy plants, the Ranunculus seems to be the most prevalent and luxuriant, especially where the drainage is imperfect. It should be observed, however, that many of the Edinburgh meadows have been laid down specially with a view to sewage irrigation; though, where old permanent meadows have been brought under treatment, or a considerable mixture of grasses has been sown in laying down for irrigation, it is still found, after a few years, that the great bulk of the herbage is composed of but a few of the freer growing grasses.

It will be readily understood, however, that the value of the produce of ordinary permanent meadow land, and of a sewage-irrigated meadow, depends upon very different qualities, and that a character of growth which may be a disadvantage in the one case, may be advantageous in the other.

The produce of the ordinary meadow, if designed for hay, is allowed to approach nearly to maturity before being cut, and over luxuriance of growth, tending to the great predominance of a few very free growing grasses, is likely to be accompanied by an undue development of woody stem, giving a hard, coarse, and comparatively indigestible and innutritious food. There is, in fact, an obvious limit beyond which it is not advantageous to go in forcing the hay crop by means of artificial manures; for, beyond a certain point, which the intelligent practical farmer will not be slow in discerning, not only is less increase of produce obtained for a given amount of manure employed, but the increased quantity is gained at too great a sacrifice of quality.

It is quite otherwise with the sewage-irrigated meadow, the produce of which is to be cut green. Although it may happen that only the very free growing (and under some circumstances objectionable) grasses may be encouraged, yet they are mown in a young and succulent condition, before their objectionable qualities have been developed, and the faster they grow the oftener they are cut. Hence, whilst their great luxuriance is only an advantage, their tendency to yield a hard later growth is not against them.

The most prominent results of the whole inquiry may be briefly enumerated as follows:—

1. So far as the general distribution of Graminaceous, Leguminous

https://doi.org/10.23637/ERADOC-1-142

BAGE OF GRASS-LAND.

S OF HERBAGE. SEVENTH SEASON, 1

ARTIFICIAL MANURES.				COMMON NAMES.
Mixed Alkalies and Superphos				
With Ammonia Salts— (= 82 lbs. Nitrogen.)	With Ammonia Salts— (= 82 lbs. Nitrogen; & Sawdust.	With Ammonia Salt (= 82 lbs. Nitrogen and Cut Wheat Stra		
10	11	12 a	12 b	
14	15	14	14	
2·98	3·42	2·03	0·95	Hard Fescue.
1·35	1·90	1·57	5·36	Meadow Fescue.
9·35	10·43	8·93	1·79	Downy Oat-grass.
8·75	8·79	3·68	4·20	Yellow Oat-grass.
11·55	7·96	11·97	5·25	Common Bent-grass
11·89	6·08	7·46	4·41	Rye-grass.
11·06	8·63	4·00	6·25	Woolly Soft-grass.
5·04	11·91	23·55	30·97	Rough Cock's-foot.
12·00	8·97	8·63	11·69	Rough Meadow-grass.
0·72	0·13	0·40	0·34	Smooth Meadow-grass.
0·14	0·30	1·22	0·77	False Oat.
0·49	1·42	1·23	0·54	Sweet Vernal-grass.
0·04	1·55	5·65	1·55	Fox-tail.
...	...	...	...	Quaking-grass.
...	0·11	...	...	Crested Dog's-tail.
2·21	1·37	0·29	0·32	Soft Brome-grass.
...	...	...	...	Cat's-tail.
...	...	...	...	Tufted Hair-grass.
77·57	72·97	80·61	74·39	
6·31	8·91	6·52	12·69	
5·78	4·96	3·25	5·06	
89·66	86·84	90·38	92·14	

https://doi.org/10.23637/ERADOC-1-142

5. *Nitrate of soda alone*, like ammonia-salts alone, considerably increased the produce of Graminaceous herbage, and tended chiefly to the production of root-foliage. The nitrate, however, strikingly brought into prominence the Alopecurus pratensis, at the expense, compared with the produce by ammonia-salts, chiefly of Agrostis vulgaris, and partly of Festuca duriuscula. Otherwise, the distribution of species was not very materially altered, the more luxuriantly-growing grasses not being much developed. The crop was much more leafy than stemmy, very dark green, and late; contained very little Leguminous herbage, though rather more than the produce by ammonia-salts alone; and the weedy plants were luxuriant rather than numerous—Plantago lanceolata, Centaurea nigra, Rumex acetosa, Achillæa millefolium, Ranunculus, and Taraxacum, all being more or less encouraged.

6. *The combinations of nitrogenous manure* (ammonia-salts or nitrates) *and mixed mineral manures*, gave by far the largest crops, the largest proportion of Graminaceous herbage, the largest proportion referable to a few species, scarcely a trace of Leguminous plants, and a small proportion both in number and amount of Miscellaneous or weedy ones. The produce was very luxuriant, with a great development of stem and stem leaves, and a much greater tendency to ripen than when the ammonia-salts or nitrates were used without the mineral manure. The predominating grasses were the most bulky and free-growing ones; Dactylis glomerata, and Poa trivialis, being very prominent; and Avena pubescens or A. flavescens, Agrostis vulgaris, Lolium perenne, and Holcus lanatus, somewhat so. Festuca duriuscula, F. pratensis, Arrhenatherum avenaceum, Alopecurus pratensis, Bromus mollis, and others, were almost excluded.

7. *Farmyard-manure* considerably increased the growth of the grasses, and of some few weeds, particularly Rumex, Ranunculus, Carum, and Achillæa, and reduced that of clover and allied plants, more especially when used in combination with ammonia-salts. It greatly encouraged the growth of the good grass Poa trivialis, and of the bad one Bromus mollis; and when in conjunction with ammonia-salts the Dactylis glomerata. Under both conditions Festuca duriuscula and F. pratensis were nearly excluded, and Avena flavescens, A. pubescens, Agrostis vulgaris, Lolium perenne, and Arrhenatherum avenaceum, were very much reduced. The crops were upon the whole bulky, comparatively simple as to description of herbage, fairly luxuriant both in stem and leaf, somewhat rough and coarse, and showing a tendency to unequal ripeness.

8. *Leguminous herbage* was almost entirely excluded whenever nitrogenous manures were used in any quantity, whether in

https://doi.org/10.23637/ERADOC-1-142

the form of ammonia-salts or nitrates, alone or in combination with mineral manures; but it was somewhat less so with the nitrate than with the ammonia-salts. Mineral manure alone, containing both potass and phosphoric acid, greatly increased the growth of the Leguminous plants, perennial red clover and meadow vetchling. Farmyard-manure like artificial nitrogenous manures, also, but in a less degree, much diminished the proportion of the Leguminous herbage.

9. Every description of manure diminished the number of species, and the frequency of occurrence, of the *Miscellaneous* or *weedy herbage;* mineral manures alone less so than any other; nitrogenous ones, especially in combination with mineral constituents, did so very strikingly, but they at the same time greatly increased the luxuriance of a few species, especially Rumex acetosa, and frequently Carum Carui and Achillæa millefolium. Plantago and Ranunculus were generally discouraged by active manures, excepting farmyard-manure and nitrate of soda. The nitrate also favoured Centaurea nigra and taraxacum dens-leonis.

10. Considerable increase of produce was only obtained by means of farmyard-manure, or artificial manures containing both mineral constituents and ammonia-salts or nitrates. The crops so obtained were much more Graminaceous, and consisted in much greater proportion of but a few species of plants. The grasses developed were chiefly of the more bulky and freer growing kinds, and the produce was generally very stemmy—being the more so, and the coarser, the more excessive the manuring.

11. Meadow-land mown for hay should not be manured exclusively with artificial manures, but should receive a dressing of well-rotted farmyard-dung every four or five years.

12. Sewage irrigation, like active manures applied to meadow-land in the ordinary way, has also a tendency to develop chiefly the Graminaceous herbage, excluding the Leguminous, and to a great extent the Miscellaneous or weedy plants. It also, at the expense of the rest, encourages a few free-growing grasses, among which, according to locality and other circumstances, Poa trivialis, Triticum repens, Dactylis glomerata, Holcus lanatus, and Lolium perenne have been observed to be very prominent. The result is an almost exclusively Graminaceous and very simple herbage. But, as the produce of sewage-irrigated meadows is generally cut in a very young and succulent condition, the tendency which the great luxuriance of a few very free-growing grasses has to give a coarse and stemmy later growth is less objectionable than in the case of meadows left for hay.

https://doi.org/10.23637/ERADOC-1-142

THE INFLUENCE OF SEASON ON THE PRODUCE OF WHEAT.

By J. B. LAWES.

It is proverbial that the weather exerts a very powerful influence on the produce of our fields. The accounts of the condition of the crops about the time of harvest, which are collected with much care by some of the agricultural papers, give, under the terms average, above average, below average, good, bad, &c., the opinions of individuals as to the probable yield of the most important crops in many different localities. In other words, they sum up, in general terms, the probable effects of the weather of the particular season on the quantity and quality of its produce. But they at the same time necessarily take into account a great many influences besides those of the weather alone. Indeed, even were it possible to reduce these general terms to figures, and it were attempted to state numerically the proportion which the produce of one season bears to that of another, or to the average of any number of seasons, the figures would not show the comparative effects of the seasons alone, unless the crops reported on were grown under otherwise the same conditions year after year in the same locality. It would be necessary to this end that the character of the land should be the same; and that the tillage operations, the previous course of cropping, and the manuring, should also have been very nearly the same each year. But we know that these conditions do not remain the same.

In a field at Rothamsted in which Wheat has been grown on some plots without manure, and on others with different descriptions of manure for twenty successive years, the tillage operations having been, as far as the seasons would allow, the same year after year, the essential conditions for comparing the productive characters of one season with that of another are perhaps better fulfilled than in the case of most records of ordinary farm practice. Unfortunately, none of the plots have been dressed with exactly the same description and quantity of manure every year since the commencement, excepting the one with farmyard dung; and owing to the great accumulation of almost every important constituent that must take place within the soil when a large quantity of this manure is annually employed, it is obvious that the difference in the amount of produce yielded by it year after year, cannot be taken as simply due to the comparative effects of the different seasons. Many of the plots have, however, been supplied with artificial mineral manures alone, or with mineral

https://doi.org/10.23637/ERADOC-1-142

manures and ammonia salts together, without any material change either in the description or the amount employed, for the last twelve or fifteen years; and as there is sufficient evidence that the influence of these manures upon the crop of the succeeding year is comparatively limited, I propose to compare the produce and increase obtained by the application of some of these artificial mixtures in the remarkable season of 1863, with the average result yielded by the same manures over the last twelve years.

Many years ago, in a paper published in the journal of the Royal Agricultural Society of England, it was stated, as the result of the experiments now under consideration so far as they had then proceeded, that the farmer might assume, for practical purposes, that he would on the average of seasons, get one bushel of increased produce of wheat, with its proportion of straw, for every 5 lbs. of ammonia applied as manure for the crop, provided the soil were not deficient in the necessary mineral constituents. This statement met with much ridicule from Baron Liebig, who said it was "a mere stroke of fancy." Whether the statement in question, or this condemnation of it, partakes most of "a mere stroke of fancy," may be judged by the following record of facts relating to it.

On one of the experimental plots a complex mineral manure has been applied every year for the last twelve years, and on another the same mineral manure, with an amount of ammonia, salts containing 50 lbs. of ammonia, has been annually applied. The average annual produce of wheat over the last twelve years has been—

	Bushels.
With mineral manure and 50 lbs. of ammonia	28½
With mineral manure alone	18½
Increase by the use of 50 lbs. of ammonia	10

Taking the average of twelve years, therefore, we have in this experiment an increase of exactly 1 bushel of wheat, with its proportion of straw, for every 5 lbs. of ammonia. I propose, then, to consider this as the yield in a season of average productiveness; and, adopting this standard, to consider a season good or bad in proportion as it gave more or less increase than 1 bushel of wheat and its proportion of straw for every 5 lbs. of ammonia used as manure.

In 1863 the same mixture of mineral manure and ammonia-salts gave a produce of 39½ bushels, or an increase of 21 bushels over the average produce with the mineral manure alone. In this experiment, therefore, 5lbs. of ammonia has given, in the sea-

https://doi.org/10.23637/ERADOC-1-142

son of 1863, an increase of more than 2 bushels of Wheat and its equivalent of straw, or more than 100 per cent. above the average effect.

On another plot, with the same mineral manure, but with the large amount of 100lbs. of ammonia annually applied, the average result over twelve years was as follows:—

	Bushels.
With mineral manure and 100lbs. of ammonia, ...	36½
With mineral manure alone, ...	18½
Increase by the use of 100lbs. of ammonia, ...	18

There is, then, even with this comparatively heavy dressing an average of nine-tenths of a bushel of increase of Wheat, and its proportion of straw, for every 5lbs. of ammonia employed in the manure. In 1863 this plot gave 53½ bushels, or an increase of 35 bushels over the average produce with the mineral manure alone; that is, again very nearly 100 per cent. over the average result.

On another plot where, in addition to the mineral manure, a still larger amount of ammonia was annually employed, the produce amounted in 1863 to nearly 1 ton 13 cwt. of grain, and more than 3 tons of straw per acre. Large as this produce is, it would doubtless have been larger, had not the heavy storms of June laid the crop completely flat, in which condition it remained up to the time of harvest.

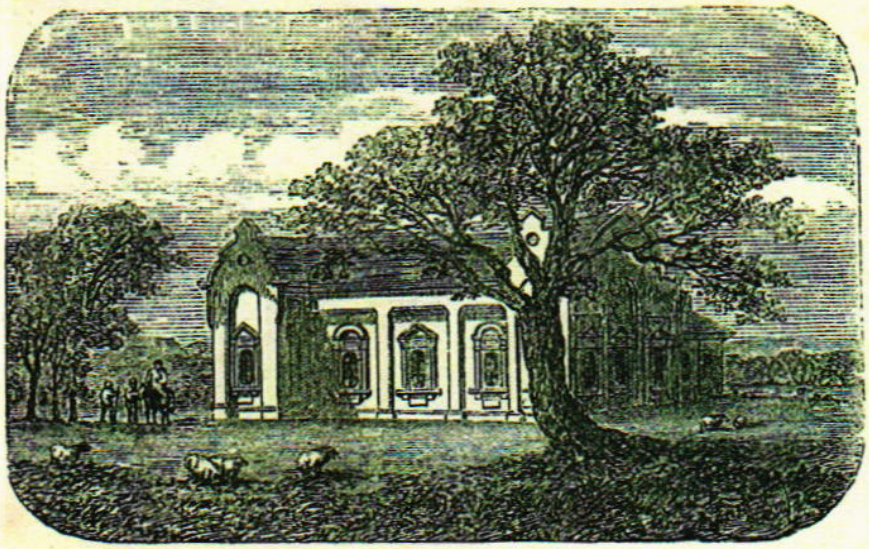
Throughout the twenty years of the experiments no season has yielded a crop at all equal to that of 1863. In 1847, 1857, and especially in 1854, the produce was very large, and in both 1854 and 1857 that obtained by the mineral manure alone even exceeded that by the same manure in 1863. But owing to some peculiar meteorological influences in 1863 (which deserve a careful study), the increase of crop was, in every instance where ammonia, salt or nitrate of soda was employed, very much greater in that year than under like conditions in any preceding season. It was about 100 per cent. over the average of the last twelve years, and in many cases about 400 per cent. over that of the worst of those twelve seasons. In fact, the results of the whole set of experiments are perfectly consistent with those of the individual cases that have been quoted, in showing the extraordinary productiveness of 1863, compared with that of any of the other years under consideration, whenever ammonia, or nitrogen in some other available form, was liberally supplied in the manure.

https://doi.org/10.23637/ERADOC-1-142

There is no doubt that the wheat crop of 1863 has been pretty generally a large one. But it would be fallacious to conclude from the results above referred to, that it has been over any very extensive area so much above the average as in the case of the experiments quoted. The season might possibly be too dry for wheat growing on many of the lighter descriptions of soil. And as the experimental plots manured with the mineral manure without ammonia, gave a less crop in 1863 than in either 1854 or 1857, it may perhaps be judged that the past season would not be unusually favourable for the crop on lands deficiently supplied with nitrogenous manure.

At any rate the effect of ammonia on the crop was, at Rothamsted, much greater in 1363 than in any preceding year of the experiments. And the fact that by its use, the crop was increased from 18½ bushels (the average produce by the mineral manure alone) to 56½ bushels, in the twentieth year of the growth of wheat on the same land, is surely a very significant one, and well worthy the careful consideration of those who maintain that the atmosphere is a sufficient source of ammonia (or nitrogen in some other available form) for cultivated crops, and that it is of little value or importance as a constituent of manures.

Rothamsted. J. B. LAWES.

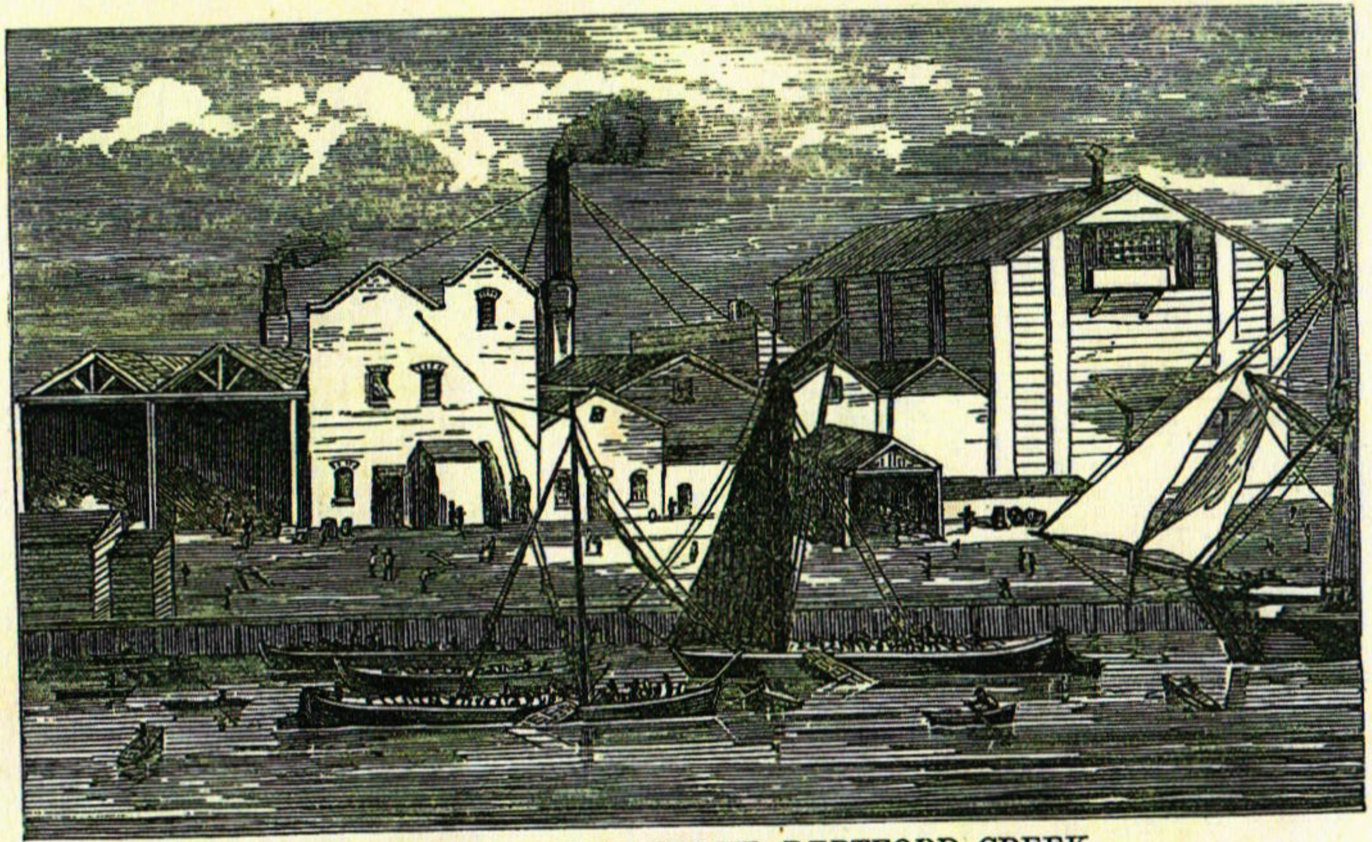


J. B. Lawes' Laboratory.

Browne & Nolan, Printers, Nassau-street, Dublin.

https://doi.org/10.23637/ERADOC-1-142

☞ THESE WORKS, INCLUDING THE BARKING CREEK FACTORY, (SEE OUTSIDE OF COVER) ARE CONSTRUCTED TO COMPLETE THE MANUFACTURE OF FULLY ONE HUNDRED TONS MANURE DAILY, AND WHEN THE DEMAND REQUIRES WORKING EXTRA TIME. THE QUANTITY PREPARED WEEKLY, EXCEEDS EIGHT HUNDRED TONS.



LAWES' MANURE FACTORY, DEPTFORD CREEK.