ROTHAMSTED RESEARCH

The Culture and Manuring of Fodder Crops

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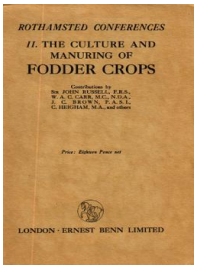

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ROTHAMSTED EXPERIMENTS ON THE MANURING OF FODDER CROPS

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Fodder crops stand out in marked contrast to cereals like wheat and barley grown for direct human consumption. In the first place they are of greater value and importance to the farmer; his whole live stock—the most valuable part of his possessions—depends upon them, and he is bound to have sufficient to see the year through. Secondly, some fodder crops, especially swedes, are more dependent on climatic conditions than cereals, and they are therefore subject to greater fluctuations in yield. Thus the yields of some of our fully manured crops at Rothamsted have been:

Year	*Character of Summer*	*Yield per Acre*				
		Swedes Farm	*Mangolds* [1] *Barnfield*	*Wheat Farm*	*Barley Farm*	*Oats Farm*
		Tons	*Tons*	*Bush.*	*Bush.*	*Bush.*
1921	Dry, hot . .	Failed	31	27	34	42
1922	Wet and sunless . .	27½	12½	21	33	48
1923	Dry . .	14	37	31	36	45
1924	Late, dull, wet.	25	25	24	27	...
1925	Drought early, wet later .	Failed	27	40 [2]	48 [2]	68 [2]

Not only do the yields vary but also the response to manure. A scheme of treatment suitable for the Southern counties would be inappropriate in the cooler North or the wetter West. A third important difference from cereals is that fodder crops do not tolerate starvation conditions as for instance will wheat. Swedes grown on unmanured land at Rothamsted are hardly recognisable, being little larger than radishes, and yielding a few hundredweights per acre only; while wheat without manure on equally poor land gives a good plant quite normal in appearance and differing from ordinary crops only in its poorer tillering; the yield is only one-third that of England and Wales.

So far as manuring is concerned, fodder crops fall into two

[1] Plot 2N receiving dung and complete artificials, including nitrate soda.

[2] The 1925 yields of cereals are not directly comparable with those of earlier years, as they received rather more nitrogenous fertilisers.

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classes according as they can or cannot be grown profitably without farmyard manure. The first class includes swedes, turnips and fodder mixtures; the second includes mangolds, cabbage and kale.

Group I.—Swedes.—Swedes can be grown with artificials alone or with farmyard manure alone, but throughout England south of the Humber, and indeed probably south of the Tyne, there is no advantage in using both. The farmer must decide which to use, and if he is short of farmyard manure he will probably find it better to use artificials, applying the farmyard manure to something else.

Of artificial fertilisers for swedes, the most important is *Phosphate*, especially where yields are likely to be low. Striking increases in crop have been obtained on some soils by the use of superphosphate and basic slag—for example by Professor Scott Robertson in the north of Ireland, and occasionally by others in England: Mr Carr records a Cheshire instance. But if the land is in good condition, if it has received dung, or if the season be favourable to good growth, phosphates may have but little effect on yield. This is well seen in contrasting the poor year 1920 with the good ones 1922 and 1924. Our yields of swedes in tons per acre were:

	Poor Years		*Good Years*	
	1913	1920	1922	1924
No artificials	3·2	3·3	25·2	17·3
No phosphate, but only sulphate of potash and sulphate of ammonia .	6·4	9·3	28·1	19·1
Phosphate (slag, 1922, or super, 1924, in addition)	8·6	16·3	29·0	20·6

In 1920 the superphosphate (2½ cwt. per acre) increased the crop by no less than 7 tons per acre and converted the small crop of 9·3 tons into the very useful one of 16·3 tons, but in neither of the good years did even the complete manure add more than 4 tons per acre to the yield, and of this the phosphate contributed but little; the slag gave an extra ton per acre, and 3½ cwt. superphosphate increased the yield only by 30 cwt. per acre—not a very profitable proposition. But on the other hand the results of 1913 show that superphosphate does not act equally well in all bad seasons: in 1920 the badness had been due to cold, sunless weather; in 1913 it was due to drought, and against drought neither superphosphate nor any other fertiliser avails much. If we could predict the season we should recommend dressings of superphosphate for a cold, poor-growing season and little or no manuring for a good season or a year of drought. But prediction is not possible, and the question arises whether the farmer had better prepare for the worst or hope for the best. One year in four does not seem much

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for a striking result, especially when in the intervening years he gets only one or two tons of swedes for his dressing of superphosphate. But his live stock is at stake; and as he would be hopelessly caught out if he were without keep in a bad season, it is wisest to prepare always for years like 1920 rather than hope for seasons like 1922. A fertiliser that increases the yield in a bad season, when food is most needed, is worth a good deal to the farmer and can be forgiven if it fails to give much increase in a year of good yields, when he has already as many roots as he wants.

But there is another reason for giving phosphates to fodder crops: they bring about an improvement in quality. This is a matter of experience rather than of direct trial; the test is not easy to carry out. But there is good reason to believe that fodder crops well supplied with phosphate gain in nutritive value: the herbage of good fatting grass on Romney Marsh has been shown at Rothamsted to contain more phosphates than herbage of adjoining fields that will not fatten sheep.

Farmers generally recognise the need for giving phosphates to their swedes, but they are not always so sure what particular form of phosphate is best. Until recently there were three possibilities only: superphosphate, bones, and slag. Of these, superphosphate gives the best results at Rothamsted, and probably in most other places also. The yield of swedes in tons per acre was:

Year	*No Phosphate*	*Superphosphate*	*Basic Slag*	*Bone Meal*
1908	14·1	16·9	13·8	16·7
1913 [1]	6·4	8·6	6·6	7·4
1920	9·3	16·3	15·8	8·6

Superphosphate has also the advantage that it generally hastens the development of the young plant so that it is sooner ready for hoeing; in some seasons this is a great advantage. There are, however, instances where basic slag proved best, usually on land subject to finger-and-toe, a disease that does not trouble us at Rothamsted. As a rule the high soluble slag has proved better than the low soluble, and it does not appear that the low soluble slag is improved by finer grinding.

Fear is sometimes expressed that superphosphate may make the soil acid. This possibility has been carefully studied at Rothamsted, both on the Rothamsted and the Woburn soils, but no sign of increasing acidity has been discovered. One would not expect it, but the idea is so persistent that we should like to know how it has

[1] Many of the young plants died through want of rain; more seed was sown but failed to grow.

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arisen; and if a case were found, we should welcome an opportunity of examining it.

Recently two other kinds of phosphatic fertiliser have been offered to farmers: ground mineral phosphates and certain proprietary articles, most of which appear to be ground mineral phosphates also.

Mineral phosphates were first tested in Scotland by two well-known but widely different men: Dr Aitken at Pumpherston and Mr Jamieson in the Aberdeen district. They have remained popular in parts of the north country. Gafsa phosphate from North Africa is used in Northumberland, where the seasons are cool and moist. The essential condition is that these phosphates should be finely ground—passing the sieve with 120 meshes to the linear inch instead of the usual 100 meshes. It is said—but at Rothamsted we have no experimental evidence on the matter—that swedes grown with mineral phosphates or basic slag do not ripen so early as those grown with superphosphate, and may therefore be more useful for feeding to sheep on the land where it would be an advantage to retain the green leaves as long as possible. At Rothamsted Gafsa and Nauru were tested in 1922 and 1924, but neither year was favourable to the action of phosphate and no crop increases were obtained. The Agricultural Education Association tests with Gafsa phosphate gave promising results, and it may be worth while for the County Organiser to arrange a test of slag and mineral phosphate against superphosphate, especially if the mineral phosphate be much cheaper per unit. The test, however, cannot usually be carried out by the farmer himself; it needs proper replication or it may give very misleading results. Assistance in working out the details will always be given at Rothamsted.

Nitrogenous Manure.—Many experiments show that sulphate of ammonia applied with the seed increases the crop, 1 cwt. sulphate of ammonia giving about an extra ton of swedes per acre whether the season is good or bad:

	1922 *Good Season*		1923 *Poor Season*	
	Dung	*No Dung*	*Dung*	*No Dung*
Potash and phosphates only .	30·6	26·7	14·3	13·2
2 cwt. sulphate of ammonia in addition . . .	32·6	29·1	16·7	15·7
Gain from 2 cwt. sulphate of ammonia . . .	2·0	2·4	2·4	2·5
Gain per cwt. sulphate of ammonia . . .	1·0	1·2	1·2	1·2

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As usual, the effect of nitrogen is remarkably steady, in sharp contrast with the varying effects of phosphates; 1 cwt. sulphate of ammonia usually gives an additional 20 cwt. of swedes whether the season is good or bad. In 1924 the dressing was varied to test the effect of using larger amounts, but there was no advantage in going beyond 1½ cwt. per acre:

Sulphate of ammonia, cwt. per acre.	...	¾	1½	2¼
Yield of swedes, tons per acre .	25·7	26·1	28·2	27·4
Gain from sulphate of ammonia .	...	0·4	2·5	1·7
Gain per cwt. sulphate of ammonia, tons of swedes	...	0·5	1·7	0·8

It is not yet certain whether the nitrogen is better applied with the seed or later, but some of the experiments suggest that later application is somewhat better. It would be interesting to study the effect of time of application of nitrogenous manure on the incidence of mildew; early sowing seems to increase the liability to mildew in the South—happily Scotland does not suffer so badly—and it would be useful to know if nitrogenous manure applied with the seed had the same effect; if so, the later application would obviously be better.[1]

Potassic Manures.—Potassic fertilisers have no very marked effects on the South, but they are more useful in the North, where the growing season is longer and where, therefore, it is an advantage to keep the crop growing as long as possible.

Summing up this question of the manuring of swedes: either farmyard manure or artificials can be given, but it is not usually necessary to give both. Of the various phosphates, superphosphate is as a rule the best, but basic slag is useful on land subject to finger-and-toe, and there are indications that finely ground mineral phosphates may be useful also. But superphosphate has the great advantage of hastening early growth and so allowing of earlier hoeing, and before getting away from it careful field trials should be made; these are difficult to carry out. Nitrogenous manure gives increases of about 20 cwt. swedes for 1 cwt. sulphate of ammonia, but potassic manures are not strikingly effective. A suitable dressing of artificials is 1 cwt. sulphate of ammonia and not less than 2½ cwt. superphosphate, increasing this where experience shows it to be necessary. In southern conditions the manuring is somewhat of the nature of an insurance against bad seasons, but it will not cover drought; phosphates, however, probably improve the quality and so give better results than the figures indicate.

[1] Mr Carr informs me that in Kincardineshire top-dressings of nitrate of soda are found very useful, especially after a wet June or July.

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Mixture Crops.—Like swedes, mixtures can be grown without farmyard manure, though, like swedes, they respond quite well to it. There have been no critical experiments on the manuring of these crops, and we have only general experience as a guide. On general grounds one would recommend a dressing of basic slag and of kainit—say, 3 cwt. of each, the slag to be of high solubility.

Group II.—Fodder Crops needing Farmyard Manure—Mangolds.—Mangolds, like swedes, are greatly influenced by seasonal factors, especially rainfall and temperature—indeed they are more sensitive to temperature, and so they cannot be grown in parts of the north of England or Scotland. Rainfall affects not only the yield but the manurial scheme and the composition of the roots.

In moderately dry regions, as in the east and centre of England, the mangold requires three manures: (1) farmyard manure, (2) nitrogenous, and (3) potassic fertilisers.

(1) *Farmyard Manure.*—Dairy farmers who want large crops of mangolds and have plenty of farmyard manure sometimes give very large dressings. Surrey dairy farmers in pre-war days have been known to apply some 40 or 50 tons per acre and to get crops of 80 tons of mangolds. These heavy dressings are justified only when the farmer has so much manure he does not know what to do with it. Equally good results could be expected from, say, 20 tons farmyard to the acre and a proper dressing of artificials.

On many farms the difficulty is to find enough farmyard manure. We have experimented with two substitutes: town refuse and composts; but our tests are not yet sufficiently advanced to justify definite conclusions. The town refuse from two of the London boroughs was tested in 1923 with promising results, but many more tests are needed before useful comparisons could be made. Composts of waste straw and other like materials are being used now on our farm by Mr Heigham; from what we know of their decomposition in the soil we should expect sulphate of ammonia or nitrate of soda would need to be applied to the crop before the full benefit of the compost could be obtained.

There has been some discussion as to the best time of applying farmyard manure. This depends on the amount of winter rainfall; and if we leave out of account the question of convenience, the best results have been obtained by ploughing in the manure in autumn where the winter rainfall is fairly low, and in spring where it is high. But farmyard manure involves so much handling that the question of convenience cannot be left out of account, and probably most farmers would prefer to apply it as soon as it is available in the autumn or winter, so as to get the job done.

(2) *Artificial Manures for Mangolds.*—Of the nitrogenous manures the Barnfield results show that nitrate of soda is the best, especially

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for top-dressing, while sulphate of ammonia is most usefully applied with the seed. Nitrate of lime has, however, given good results as a top-dressing. There is little good experimental work as to the time of application, but some indication that the time of singling is perhaps the best.

(3) Of the potassic manures either 30 per cent. potash salts, kainit or muriate is suitable, but it is not certain which is the best. Both French and German kainit and the "30 per cent. salts" contain salt, and German kainit contains in addition magnesium sulphate: there is some evidence that both of these are beneficial to mangolds, and if so, kainit or 30 per cent. potash salts would be the better fertiliser. But the case is not proved, and the muriate being more concentrated involves less handling and cartage and may therefore be the more economical.

Whichever potassic fertiliser is used, it should be in some proportion to the amount of nitrogenous manure. For each hundredweight of sulphate of ammonia and nitrate of soda given to the mangolds there should be 1 cwt. muriate of potash or 2 cwt. kainit. If the nitrogen is in excess, the plant may become unhealthy and lose some of its feeding value: striking examples occur on the Barnfield plots.

The need for phosphate is less clear; it has not often been tested by experimenters, but neither at Rothamsted nor in the Agricultural Education Association tests did it produce any useful effect.

In wet districts the manurial scheme needs some modification. At Bangor, where the rainfall is very high, nitrogenous manures seem to have but little action, and in some seasons none at all. The composition of the roots also is affected: mangolds from the wet parts of North Wales contain only some 10 per cent. of dry matter; those at Aberystwyth under less rainfall contain 11 to 12 per cent. and sometimes more, while at Rothamsted and in the Eastern parts of England values up to 12 and 13 per cent. are common. Varieties differ in their composition, however, and some contain more dry matter than others; obviously, in view of the cost of handling bulky crops like mangolds, it is an advantage to grow only those rich in dry matter.

Kale and Cabbage.—Few field trials have been made with these crops, but experience shows that they respond to good dressings of dung followed by dressings of artificials, mainly nitrogenous: a mixture of, say, 1½ to 2 cwt. nitrate of soda or sulphate of ammonia, 2½ cwt. superphosphate, and 3 cwt. kainit per acre might be expected to give good results. Farmers making their own tests of manures should weigh the produce; judgment of fodder crops by eye is particularly liable to mislead.

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