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Grassland and Fodder Crops

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loam at Doncaster. It was the only fertiliser effective for the early potatoes. Superphosphate acted unusually well, giving four successful responses in five trials and showing up particularly well on the heavy soil at Rothamsted. (The results are given in Table 6.)

Alongside of the field work on the potatoes physiological studies of the growing plant are made by D. J. Watson to find out what the fertilisers do in the plant. Potassic fertilisers decreased the concentration of sucrose in the leaf during the hours of daylight but not during the darkness. They had no recognisable effect on the reducing sugars, however.

Grassland

The manuring of grassland alters not only the yield and composition of each of the individual species of plants but also the balance of competition between one plant and another and therefore changes the entire flora. Two groups of investigations have been made: with phosphatic fertilisers, which broadly speaking tend to give a more pronounced leguminous herbage; and with nitrogenous fertilisers, which tend to make the grasses dominant.

The work on phosphatic fertilisers has been done under the aegis of the Basic Slag Committee of the Ministry of Agriculture; it involves a large amount of analytical work for which R. G. Warren is responsible. The key experiments are made at Rothamsted, and numerous experiments are made at various centres in the country. The outstanding result is the general superiority of superphosphate and of high soluble slag over the low soluble slag and, on non-acid soils, over ground mineral phosphate. On an average the high soluble slag has been about three times as effective in supplying phosphate to the plant as the low soluble slag containing equal amounts of phosphate, while the mineral phosphate has been on certain acid soils about as good as the high soluble slag and on non-acid soils about as poor as low soluble slag. The percentage recovery of phosphoric acid over the three or four years is given in Table 7.

TABLE 7.—Percentage Recovery of Phosphoric Acid in 3 or 4 Years in Grassland Experiments.

Season.	Treatment of grass.	Centre.	Geological origin of soil.	Soil pH reaction.	Low-soluble slag.	Gafsa mineral phosphate.	High-soluble slag.	Super-phosphate.
<i>Neutral or calcareous soils—</i>								
1930-33	Hay	Braintree, Essex ..	Calcareous boulder clay	7.8, alkaline	3	3	17	17
1930-33	Hay	Badminton, Glouc.	Oolite	7.2, neutral	2	4	13	16
1931-33	Repeatedly mown, ungrazed ..	Much Hadham, Herts	Calcareous boulder clay	7.1, neutral	8	8	34	30
1931-33	Grazed, mown once annually ..	Much Hadham, Herts	Calcareous boulder clay	7.1, neutral	6	8	26	30
				Mean	5	6	22	23
<i>Acid soils—</i>								
1930-33	Hay	Chesterfield, Derby	Lower coal measures shales ..	5.1, very acid	6	13	13	16
1930-33	Hay	Lydbury, Salop	Wenlock shales ..	5.2, very acid	10	19	14	18
1930-33	Hay	Cockle Park, North Northallerton, Yorks	Boulder clay ..	4.9, very acid	3	10	7	8
1930-33	Hay	Yorks	Boulder clay on keuper marl ..	5.2, very acid	5	16	18	21
1930-33	Repeatedly mown, ungrazed ..	Dartington Hall, Devon	Devonian shales	5.2, very acid	6	29	31	32
				Mean	6	17	17	19

This superiority of the soluble phosphates shows itself not only in increased yield and larger proportion of good fodder plants, but also in the higher content of phosphorus in the herbage, whereby its feeding value per ton is almost certainly enhanced. A special feature of the work has been the chemical control of the phosphorus uptake by the crop, and this has proved of great help in showing the relative values of the different fertilisers.

So far the experiments have not shown where the line is to be drawn between the high soluble and the low soluble slags. Hitherto this problem has been unimportant, because most samples on the market were either above 75 per cent. or below 30 per cent. solubility. Now, however, there seems the probability that slags of intermediate solubility will be offered for sale and the work is being extended to cover these.

Fodder Mixtures. Further studies were made of the yield and composition of fodder mixtures containing different proportions of oats and vetches, grown with and without nitrogenous manure. The yields of dry matter per acre were highest when the seed mixture contained 3 bushels of oats to 1 bushel of vetches. Nitrogenous manure increased the yield, but not significantly more for one mixture than for another; previous work has shown that the increase is in the starch equivalent per acre and not in the quantity of protein.

Lucerne. The inoculation experiments are described later. (p. 36)

For some time past Professor W. Southworth, who is working at Rothamsted after his retirement from Canada, has been experimenting with hybrids of lucerne and black medick, and has obtained at least one promising sort considerably more vigorous in early life than the ordinary Provence variety. The percentage of plants that died during the first year were:

	The new sort.	Provence.
Rothamsted	1.7	23.4
Woburn	0	15

The new sort is at least as productive as the Provence, both of fodder per acre and of seed, and further experiments are being made.

Clover. Cultures of the nodule organism have been prepared which in preliminary experiments made in association with Professor Stapledon greatly improved the "take" of clover on newly sown upland grassland. Should any extensive resowing seem likely to occur, this work ought certainly to be expedited so as to ensure supplies of the cultures in time to meet the farmers' needs.

Marrow stem Kale. This is proving one of the most valuable fodder crops on the farm. In our numerous experiments yields of 25 or more tons per acre are frequently obtained on our poor heavy land. It responds remarkably well to nitrogenous manuring, and is one of the best crops for converting fertiliser nitrogen into valuable animal food.

The residual effect of the farmyard manure applied to the 1932 kale crop at Woburn was studied by following it with barley in 1933, and comparing the yield with that given by sulphate of ammonia. On plots that had dung in 1932 there was an increase of 12.2 cwt. of green matter over the plots receiving no dung; while 0.2 cwt. of nitrogen applied as sulphate of ammonia in 1933 gave an increase of 20.7 cwt. per acre. The residual effect of the dung was therefore

approximately that of 0.118 cwt. nitrogen per acre, or 0.6 cwt. sulphate of ammonia. No residual effect of sulphate of ammonia applied in 1932 could be detected.

Mangolds. In the Statistical Department an examination of the yields of mangolds on Barnfield for the years 1876 to 1930 has been completed by R. J. Kalamkar. The new facts brought out are that the deterioration of yield usually observed where one crop is grown continuously has not been pronounced on the plots receiving farm-yard manure or complete artificials including nitrate of soda, but it becomes more marked when either nitrogen or potash and phosphate are omitted. Slow changes in yield other than deterioration are unimportant except on the dunged plots. The annual variance is increased by nitrogenous manuring but decreased by potassic fertiliser and also by rape cake or dung. Variations in rainfall do not account for the variations in yield due to annual causes though rainfall in excess of the average appears to be somewhat harmful when it comes in Spring (mid-March to end of May) and beneficial when it comes in June and July.

The value of fodder crops. Chemistry is not yet sufficiently advanced to give a complete statement of the feeding value of these fodder crops, and it is still necessary to use the animal as the means of testing. It is proposed to use sheep and pigs, and feeding experiments of a new type have been designed to eliminate the effect of variations in location of the stalls and to reduce the effect of individuality of the animal.

THE SOIL CULTIVATION EXPERIMENTS

In view of the changes brought about by mechanisation in the cultivation of wheat and other cereals, a number of experiments have been made on different methods of seed-bed preparation, including shallow and deep ploughing and rotary cultivation, each in conjunction with spring harrowing, rolling and top dressing with sulphate of ammonia. No significant differences in yield of grain were observed between any of the treatments, and the choice of the different methods would apparently be dictated by their relative cost and convenience. Neither rolling nor harrowing increased the yield.

The conditions were, however, unusual in that sulphate of ammonia had no effect on the yield of grain. On the other hand the yield of straw was increased by the addition of nitrogen. The response to nitrogen varied according to the cultivation. Rolling increased it.

It would be interesting to know whether the grain would show similar responses to cultivation on land where sulphate of ammonia increased its yield.

THE IMPROVEMENT OF FIELD PLOT TECHNIQUE

Some interesting advances have been made during the year in the theory of field plot design, particularly in the methods available for combining several different problems into one experiment. Here the method of "partial confounding" has been developed; this considerably increases the utility of "confounding" for combining different problems into one experiment, since it serves to provide more flexible arrangements. The methods of analysis when the data are incomplete have been extended to cases where several plots are missing, and their validity established. Convenient methods of forming Latin squares for field experiments have been placed on record.