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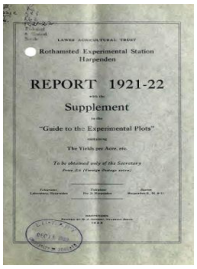
Report 1921-22 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.



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Soil Cultivation

Rothamsted Research

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scientific laboratory, liberal use is made of statistical methods which allow the investigation of cases where several factors vary simultaneously. Thus in the crop investigations a large number of field observations are made; these are then treated statistically to ascertain the varying degrees to which they are related to other factors—such as rainfall, temperature, etc.—and to indicate the probable nature of the relationships. Thus the complex problem becomes reduced to a number of simpler ones susceptible of laboratory investigation.

It has been found desirable to widen the scope of the work by repeating some of the more important experiments elsewhere, and some twenty centres in different parts of the country have been selected for this purpose.

In October, 1921, the Station undertook, so long as its funds should allow, to carry on the continuous wheat and barley experiments at the Woburn Experimental Farm, till then conducted by the Royal Agricultural Society, and Dr. Voelcker gives his services as Honorary Local Director. In December, 1922, E. D. Simon, Esq., generously placed his Leadon Court farm at the disposal of the Station for experimental purposes. This is being used as a large scale test of the soiling system for keeping dairy cows (see p. 26).

REPORT FOR THE YEARS 1921-22

In order to appreciate properly the Rothamsted experiments, it is necessary to understand the purpose for which they are carried out. This purpose is to discover the principles underlying the great facts of agriculture and to put the knowledge thus gained into a form in which it can be used by teachers, experts and farmers for the upraising of country life and the improvement of the standard of farming.

The most fundamental part of agriculture is the production of crops, and to this most of the Rothamsted work is devoted. On the technical side the problems fall into three groups, concerned respectively with the cultivation of the soil, the feeding of the crops, and the maintenance of healthy conditions of plant growth. The subjects will be taken in this order.

THE CULTIVATION OF THE SOIL.

Cultivation has been reduced to a fine art, and a good farmer independent of financial considerations could obtain very satisfactory results without consulting the scientific worker. In practice, however, costs dominate the situation, and efforts are continuously being made to cut them down. Scientific investigation of all cultivation processes therefore becomes necessary. This is done in the Physical Department under Dr. Keen; the effects produced

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by the cultivation processes are investigated, especially those concerned with tilth, water supply and resistance to the passage of implements; and the actual working of typical implements is studied by means of dynamometer tests so as to see what power is required to do a given piece of work and how this is affected by the design of the implement. The first of these enquiries is needed to find out exactly what work has to be done and, if possible, to state the result in engineering terms; the second shows how far our present types of implements are efficient, and if they are not, where the wastage of power occurs.

It is fully recognised that the nature of the soil largely determines the amount of power required to do certain cultivation work. The measurements are showing that the farmer can alter his own soil so as to reduce the power requirement. Thus, on our heavy soil at Rothamsted the drawbar pull on a plough turning three furrows is of the order of 1,500 lb. and the "power factor" (*i.e.*, drawbar pull in lb. multiplied by time in seconds taken to plough 1 ft. length of furrow) is of the order of 550. But when the land is chalked there is a saving of power, which may vary from almost nothing up to 15%, according to the condition of the soil. The following are some of the data:—

Field and Date	Drawbar pull in lb.			Percentage Reduction in power factor due to Chalking
	Unchalked	Chalked	Reduction due to Chalking	
SAWPIT. Stubbles: Autumn; dry . .	473	476	Difference not significant	Nil
Cross ploughing weathered furrows Spring . . .	521	461	60	11.5
GREAT KNOTT. Oct.	924	802	122	14.7
January: very wet	1258	1181	77	4.6

When the land is very dry or very wet, the chalking shows its effects least, but in moist conditions it acts strikingly.

Farmyard manure and coarse ashes also reduce the power requirement in ploughing. On Hoos field the reduction has been, as compared with unmanured soil:—

Due to Farmyard Manure	*Coarse Ashes*
22.6%	12.3%

(values for unmanured soil: drawbar pull = 1,472 lb.; power factor = 614.)

Even artificial manures have some action. This has been studied in the first instance on the Broadbalk wheat field where, however, the effects are much intensified from the circumstance that the same manures are applied year after year. The reduction in power requirement brought about by the use of artificial manures has been:—

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FULL MINERALS, AND, IN ADDITION:—

No Nitrogen Plot 5	Sulph/ammonia 200lb. per acre Plot 6	Sulph/ammonia 400lb. per acre Plot 7	Sulph/ammonia 600lb. per acre Plot 8	Nitrate/soda 275lb. per acre Plot 9
14.2%	12.7%	16.3%	21.5%	8.1%

when compared with the unmanured plot.

The mineral manures have caused some reduction in power requirement, and a still further reduction has been caused by addition of sulphate of ammonia, but nitrate of soda has acted the other way and increased the power requirement.

There are, however, other ways of altering the resistance of soil to the plough, and an interesting electrical method is being studied.

The depth of ploughing influences the power consumption more than might have been expected. An increase of only one inch in depth, *i.e.*, going from 5″ to 6″ deep, increased the power consumption no less than 32%, a portion of which is due to the resistance offered by the "plough-sole" produced below 5″ depth. Against this, maladjustments of the hitch were not particularly wasteful of power, although they caused bad ploughing. Perhaps the most surprising result was that the drawbar pull was practically the same whatever the speed of ploughing within the ordinary limits of the tractor; hence the power consumption per acre depends mainly on the speed and is smallest at the highest speeds. Another way of stating this fact is that the paraffin consumption per hour for the same tractor is approximately the same whether it is taking 1½ hours or 3 hours to plough an acre of ground.

The factors determining the resistance and the power consumption are intimately bound up with the physical properties of the soil which are systematically studied in the Physical Department. These physical properties determine also the water relationships—evaporation of water, percolation, etc.—which are being carefully investigated. This work has important applications in tropical and sub-tropical countries where irrigation is practised, and the Indian Government regularly sends experts to study for a year or two in the Physics Department.

Dr. Keen is also co-operating with Professor Sven Odén, of Stockholm, in elaborating the original Odén apparatus for estimating the amount of fine material of different sizes in soils.

SOIL ACIDITY.

The electrometric method used in the Physics Department by Mr. E. M. Crowther is giving good results and is sharply distinguishing soils of varying degrees of acidity. The values are