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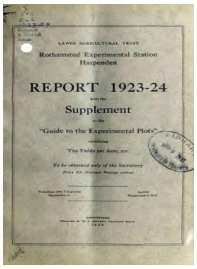
Report for 1923-1924 With the Supplement to the Guide to the Experimental Plots Containing the Yields per Acre Etc.



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Rothamsted Research

Rothamsted Research (1925) *Soil Tilth and Cultivation ;* Report For 1923-1924 With The Supplement To The Guide To The Experimental Plots Containing The Yields Per Acre Etc., pp 28 - 30 **- DOI: https://doi.org/10.23637/ERADOC-1-116**

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SOIL TILTH AND CULTIVATION.

In the Physical Department the studies of tilth under Dr. Keen are being continued. The work includes exact laboratory studies of the physical factors involved in tilth and also measurements of the drawbar pull when land is ploughed under varying conditions. An investigation of this kind is prolonged but already interesting results are emerging. The purpose of the laboratory work is to develop the science of soil physics on which ultimately a scientific soil cultivation can be based, just as scientific manuring is based on chemistry and plant physiology. Mr. Haines has completed some important pioneering work on the physical properties directly concerned in ploughing: cohesion and plasticity of soil, and surface friction between soil and metal. But in order to get very far with the investigation it is necessary to study the underlying causes, and so researches are carried out which, while less obvious in their bearing, are no less, but possibly even more, essential than those just mentioned. Good tilth in soil is traditionally associated with the formation of compound particles or soil aggregates. These in turn are determined by the colloidal properties of the soil: and so it comes about —as often in agriculture—that progress in a practical problem cannot be made until some abstruse and apparently wholly irrelevant scientific problem is solved. The friction between the plough and the soil is a practical problem of the first importance: but it cannot be adequately studied without a proper understanding of the colloidal properties and the ultimate constitution of the soil. The three methods of investigating these in the Physics laboratory are:—

(*a*) A study of the relative intensity of the forces holding soil particles together when the soil has been subjected to a variety of treatments that simulate field conditions. The method adopted is the measurement of the amount of soil in suspension after shaking with water under definite conditions;

(*b*) Direct measurements of the vapour pressure at different moisture contents of soils treated in various ways;

(*c*) Indirect measurements of the vapour pressure using a method that depends on the lowering of the freezing point depression of benzene in contact with the moist material that has an affinity for water.

The results show that many of the observed properties of soils can be interpreted on the assumption that the colloidal material is permeated with minute capillaries, analogous to those investigated by Zsigmondy and Anderson in silica gel. They also indicate that compound particles are formed in soil at comparatively high moisture contents, and that once formed they are not easily disintegrated. This last conclusion has led to a somewhat disconcerting discovery. It is found that complete dispersion of soil is frequently not attained in the standard method of mechanical analysis: hence many of the recorded

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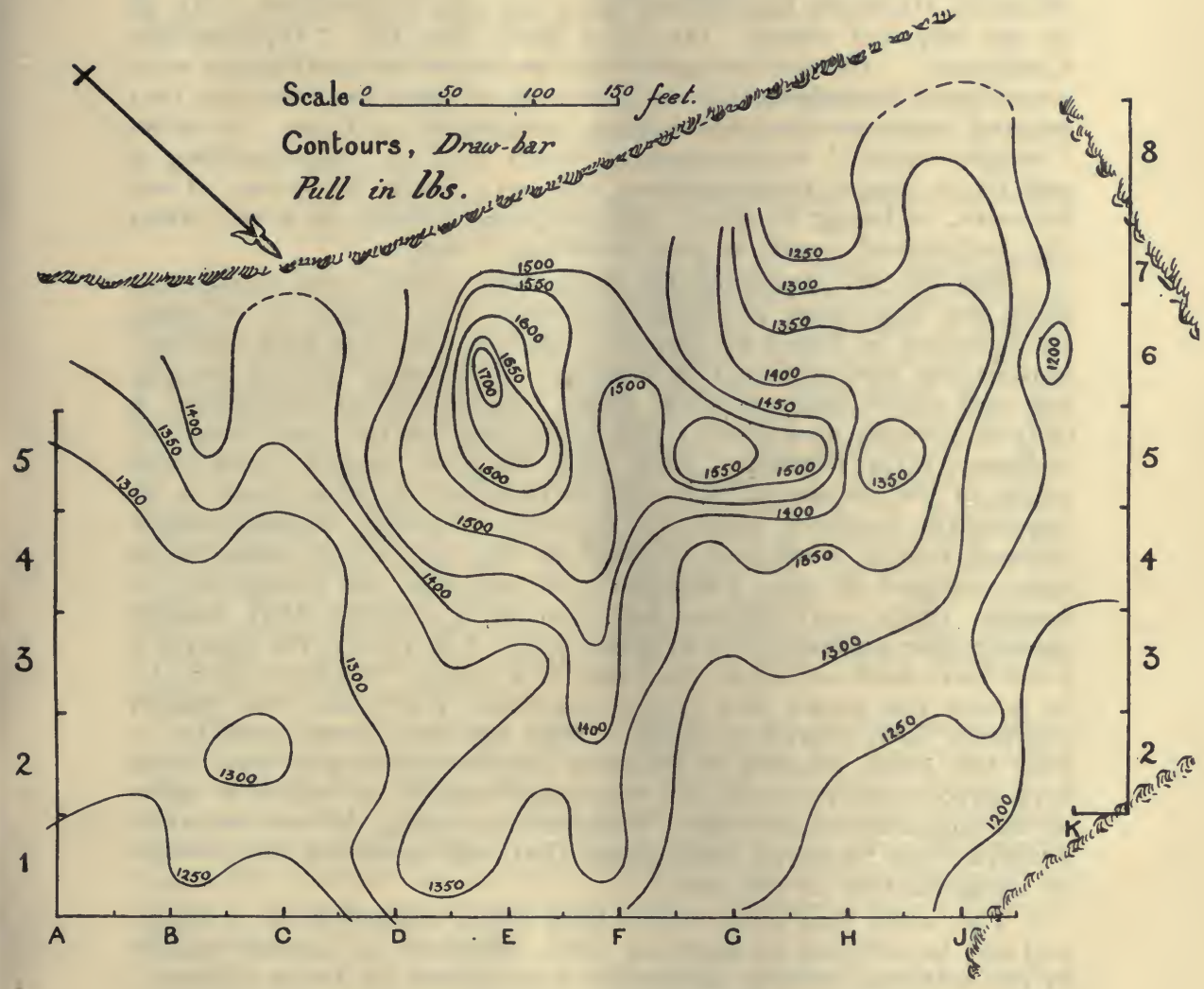

FIG. I.—Diagram showing the variation in drawbar pull over an area that to visual inspection appeared uniform.

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data are erroneous. Nor is dispersion complete in the standard dilution method for counting soil organisms, and the results of any given plating are liable to the error of counting as a single organism a group or colony on an undispersed soil aggregate.

A further consequence of great interest to the expert has also emerged: certain of the so-called " constants " of the text books, such as the Hygroscopic Coefficient, the Wilting Coefficient, Moisture Equivalent, etc., are not " constants " at all in the physical sense. Dr. Puri finds that the " Hygroscopic Coefficient " (the percentage of soil moisture in equilibrium with a saturated atmosphere) is so inherently difficult to determine that marked discrepancies are almost inevitable. These so-called " single value " measurements which aim at characterising a soil by a single determination are very liable to error. One, however, is being studied: the moisture content of a soil when the well-mixed mass is just becoming sticky.

But all this fundamental work takes time, and meanwhile there are important practical problems for which a working solution can be found by empirical means. On the field side Mr. Haines has obtained further readings of drawbar pull in ploughing and cultivating, as done under ordinary farm conditions, a criterion which necessitates the dovetailing of the work into the ordinary farm routine. This year detailed studies have been made of the causes of the irregularities of drawbar pull in an apparently uniform piece of ground. Careful measurements showed that a level field uniform to the eye which would have been selected by any Committee as suitable for ploughing or tractor trials nevertheless had soil irregularities that caused considerable differences in drawbar pull. The results for Sawyer's Field have been set up in the form of a contour diagram (Fig. 1), in which the peaks and ridges represent high, and the valleys represent low, drawbar pulls. Had the field been used for a test, the areas allotted to different implements might have been very favourable to some and very unfavourable to others in spite of the apparent uniformity. Methods are being devised whereby a survey can be made beforehand that will show the distribution of irregularities in the soil.

The work has also shown how much reduction in drawbar pull can be effected by applying lime, limestone or organic matter to the soil, and how to obtain the best effects by these methods. Further, it has been found that the friction of ploughing can be reduced by an electric device simple in principle and only awaiting exploitation to become important in practice.

Much work is done in the Physics Department in studying the moisture relationships of the soil. Measurements conducted in large cylinders filled with Rothamsted soil show that little water rises to the surface from the subsoil when the ground water falls to 4 or more feet below the surface. A definite relation was found between the potential evaporating power at the surface and the change in ground water level. This work will be greatly facilitated when the continuous recording devices now being devised are installed.

https://doi.org/10.23637/ERADOC-1-116