ROTHAMSTED RESEARCH

Report for 1960

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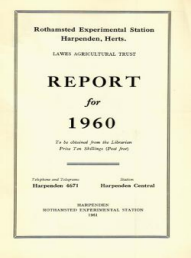

The History and Work of the Soil Survey

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A. Muir and D. A. Osmond (1961) *The History and Work of the Soil Survey ;* Report For 1960, pp 266 - 272 **- DOI: https://doi.org/10.23637/ERADOC-1-93**

THE HISTORY AND WORK OF THE SOIL SURVEY

By

A. Muir & D. A. Osmond

Mankind must have taken an interest in soil from the time when "Adam delved and Eve span", but the first record appears to date from about the year 2210 B.C. when "Da Yu, the first emperor of the Hsia dynasty, took up the study of the soils of nine territories and classified them according to their colour, texture, geographical features and productivity for the purposes of evaluation and assessment of land taxes" (Tang, 1935). However, information about the distribution of the different kinds of soils was not collected systematically in other parts of the world until late in the 18th century. In his Presidential Address to the III International Congress of Soil Science, Sir John Russell said: "One of the striking services that soil science has rendered in recent years has been in surveying soils of the different countries and in the preparation of maps on which any desired part of the information can be represented. This is now recognised as an essential preliminary to all agricultural developments, reclamations and irrigation schemes, and it forms an integral part of any organised development of agriculture such as is now being carried out in many countries of the world. To start on important agricultural development without a preliminary soil survey is to run serious risk of disaster." The importance of the last sentence cannot be overstressed, and it should be borne in mind by all in charge of planning agricultural developments. That the warning has been heeded is apparent from the number of large enterprises in all parts of the world in which one of the first demands is for a soil survey to provide basic background information.

Although in 1665 a committee of the Royal Society circulated a questionnaire to numerous gentlemen asking for information about the kinds of soils in various countries, little was done to collect it and it was not recorded on maps. Later, in 1683, Dr Martin Lister presented to the Society "An Ingenious proposal for a new sort of Maps of Countries, etc.", which was intended to include both rocks and soils; but whether "soils" was used in the more modern sense is not clear—from Lister's description it appears that reference was made only to the top-soil. Not until the end of the 18th century were the first attempts made to prepare soil maps, when the authors of the General Views on Agriculture were requested to do so, and many of the Reports to the Board of Agriculture include maps of the distribution of the various soils in the country. Both top-soil and sub-soil were sometimes described; but land use or superficial geological deposits were often represented rather than soils.

By the 19th century geological maps had been produced and scientists interested in soil naturally turned to them, thinking that, if soil arose from the weathering of rock, then the distribution of soils

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and rocks should be closely related—a belief that is valid only in part. It is not surprising, therefore, that early workers in soil survey, such as Gilchrist (1907), Hall and Russell (1911) and Newman (1912), should have been strongly biased towards using geological maps as the basis for soil maps. It is interesting to notice that these attempts at making soil maps were promoted by scientists working in southern England, where the areas surveyed were only thinly, if at all, covered by glacial drift and where it was feasible in many places to regard the underlying rock as the parent material of the soil. Consequently terms such as " Chalk soil ", " Gault soils ", " Lias soils " and so forth were commonly used and still usefully persist, though their sense may have been refined. However, when one of the best-known workers in British soil science, G. W. Robinson, made a soil survey in Shropshire he began to realise that the intimate relation between solid rock and soil was not so applicable in country that had been glaciated in past eras. This was more forcibly impressed on him when he was appointed Advisory Chemist in North Wales and initiated a soil survey of Wales.

In the course of innumerable visits to farmers, advisory chemists became aware of the many problems of plant growth which could not be entirely solved by applications of fertilisers but which were related to more fundamental and relatively unchangeable soil properties associated with the whole soil profile. They therefore began seriously to canvass the possibility of making maps of the soil as such. Maps were being made in the U.S.A. in which soil drainage and the nature of the subsoil were included in the description of what was called the soil series, but it was not until 1920, after a visit to the U.S.A. by W. G. Ogg, and later G. W. Robinson, that the importance of the soil profile and its morphology was appreciated in Britain and that attention was directed to the achievements of the Russian pedologists.

In Great Britain a sub-committee of the Development Commission considered, in 1919, the possibility of making soil maps which would, however, mainly be improved versions of the existing geological maps. From the accounts by Ogg and Robinson of the work in the U.S.A., it became clear that an independent body should undertake soil survey, though officials were reluctant to set up an organised survey. However, the Ministry of Agriculture agreed that certain Advisory Chemists should be allowed assistants to make soil maps. Incidentally, about this time G. W. Robinson introduced into the English language the words " pedology " to describe the scientific study of soils and " pedogenic " to describe the processes of soil formation and metamorphism.

In 1926 the American method of mapping soil series was demonstrated by G. Newlands and W. Dow at the first Soil Survey Conference, held at Harper Adams Agricultural College, when the first soil series map made in England was made of the College farm. After this it was decided to adopt the U.S. system of series and types (texture classes) for use in Great Britain, and at subsequent conferences and field meetings in England and Scotland methods were standardised for surveying and recording the information on maps.

In 1922 the Ministry's Conference of Advisory Chemists recommended that attempts to " correlate fruit culture with soil types

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should be made in East Anglia and in the West Midland counties ", and during the next 20 years the results of several such fruit-soil surveys were published. As much of the work was started before 1926, soils were not described by series, and it was difficult to reconcile some of this older work with the newer ideas prevailing when it came to be published. The report of the fruit-soil survey in East Anglia (Wright & Ward, 1929) was published with maps showing the distribution of soil types (classes), and an attempt was made to relate plant growth to soil type. The second survey, in the West Midlands (Wallace *et al.*, 1931), described what are now recognised as soil series and drew attention to the inherent properties of the soil profile conducive to " good " or " bad " growth of fruit trees as evidenced by measurements of trees of comparable age and variety grown under similar systems of management. In addition, nutritional disorders were investigated and remedial measures suggested. Field trials and laboratory research were initiated on problems arising out of the survey.

These results and many others important to fruit growers and market gardeners were substantiated and extended by later reports on other fruit-growing areas, by Ward (1933) on West Cambridgeshire, Bane & Gethin-Jones (1934) on the Lower Greensand in Kent and Bagenall & Furneaux (1949) on the Hastings Beds, also in Kent. The last report contained the comment that " So local was the distribution of these soil series that it proved difficult to find a single orchard or plantation that was perfectly uniform in soil throughout ", and although series were described so that they could be identified in the field, no soil maps were made. In the fruit-growing district of the Vale of Evesham (Osmond *et al.*, 1949), similar plants were measured to relate the behaviour of fruit trees and horticultural crops with soil properties; the distribution of the series was recorded on maps. Together these surveys covered the largest fruit-growing districts and, besides obtaining information of use in solving some fruit-growing problems, they provided a sound basis for giving advice on planting new sites. The American series system was also used to describe the soils in the Vale of the White Horse (Kay, 1934) and later the strawberry district in South Hampshire (Kay, 1939). In her survey of the Vale of the White Horse Kay showed that Brenchley's rough correlation of weeds with soils could be made more definite and that certain weeds were associated with distinct soil series.

Other surveys, not all for their immediate practical value, were made in various places. G. W. Robinson, who founded a " school " of pedology in Bangor, made, with his staff, extensive oil surveys in North Wales. W. M. Davies and his colleagues began a survey around Harper Adams Agricultural College, following the demonstration of series mapping by Newlands and Dow; the work was eventually published in 1954 as one of the first of the memoirs of the Soil Survey of Great Britain. In the late 1920s W. G. Ogg began a soil survey of East Lothian after completing the mapping of the Edinburgh and East of Scotland College of Agriculture farm, and G. Newlands mapped parts of Aberdeenshire. A survey on the basis of soil texture was made of the district around Ayr by McArthur *et al.* (1932). After the Macaulay Institute was founded in 1930,

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soil survey in Scotland was done mainly from there. The early interest was in classification and soil genesis, but some forest areas and, later, agricultural land were also surveyed (Muir, 1934, 1935; Muir & Fraser, 1940; Glentworth, 1944). During the progress of these various surveys many problems arose in the actual methods of surveying, as well as of classification of soils; these were discussed at the annual Field Meetings held in different parts of Britain, during which parties of surveyors mapped the same area and compared the results.

With surveys extending, there was evident danger that the same soil might be differently named by surveyors in different parts of the country; the identification of the parent material (when a drift deposit and not a solid rock) was a source of possible trouble, and there was obvious need for a standard system of classification. A Soils Correlation Committee was therefore set up to consider these matters, and members made tours in England and Wales in 1930 and 1935 and in Scotland in 1932 to examine soil series being mapped.

The Soils Correlation Committee was replaced in 1936 by the Soil Executive Committee with similar functions, and in 1939 it was decided to set up the Soil Survey of England and Wales with Prof. G. W. Robinson as Director; a close connexion was maintained with the soil survey in Scotland conducted from the Macaulay Institute. A small committee, formed in 1938 to discuss colouring soil maps, prepared a working classification of soils as then known. This, together with a classification of parent materials prepared by the Correlation Committee, was included in a *Soil Survey Field Handbook* by G. R. Clarke which provided standardised methods for describing soil profiles, classifying soils and colouring maps that remained in use for many years. However, recent advances, both at home and abroad, in the technique of describing and mapping soils showed deficiencies in the *Handbook* which has now been revised and a new edition published (1960).

During the War soil survey almost ceased, but the knowledge acquired was of great use in the recommendations made by committees for ploughing up old grassland and allocating the limited amounts of fertilisers. The survey officers in effect became advisory officers, and when the National Agricultural Advisory Service was formed after the War, some joined the new organisation. The headquarters of the Soil Survey of England and Wales was transferred to Rothamsted Experimental Station, and A. Muir was appointed Head of the Survey in 1946. In Scotland the Macaulay Institute continued to be the headquarters of the Scottish Soil Survey. To guide the Surveys, a Soil Survey Research Board was set up by the Agricultural Research Council.

Until recently, mapping in England and Wales was done at 1 : 63360, and four memoirs (Crompton & Osmond, 1954; Avery, 1955; Roberts, 1958; Ball, 1960) with soil series maps have so far been published and a map of the soils of the Pwllheli district without a memoir (1958); several more maps and memoirs are nearly completed. Most of the surveys are done to obtain knowledge of the distribution of soils, but the Glastonbury district was surveyed because of the teart disorder of cattle in Somerset. Although the

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survey did not solve the problem, it directed attention to the prevalence of the trouble on particular soils associated with the Lower Lias formation, which were later shown to promote unusually high contents of molybdenum in the pasture plants. Since then excess or deficiency of this element has been shown to be important in animal and crop husbandry in many parts of the world. Deficiencies of other minor elements have come to light and their correlation with soil series shown in other parts of Great Britain. As might be expected, some of these minor-element troubles in this country depend on the kind of rock from which the soils are derived. Thus, cobalt deficiency is linked with certain areas of granite in Devon and Cornwall and with some areas of Old Red Sandstone in the north of Scotland. Nevertheless, considerable changes in minor-element content can be produced in soils by differences in drainage.

In Scotland the survey is made mainly at 1 : 25,000 and four memoirs (Glentworth, 1954; Muir, 1956; Mitchell & Jarvis, 1956; Ragg, 1960) with maps have been published; others are being prepared. Mainly at the instigation of the National Agricultural Advisory Service, reconnaissance mapping at 1 : 25,000 has been adopted in England and Wales since 1959, and a considerable area has been mapped on this basis; the surveyors are stationed at the regional headquarters of the National Agricultural Advisory Service, with mutual benefit to both.

Many official bodies are now taking heed of Sir John Russell's words quoted above, and requests for surveys of particular areas are numerous. All the Experimental Husbandry Farms, sites of many field experiments of the National Agricultural Advisory Service and several county farm institutes have been surveyed, and it is hoped that the relation between crop, management and soil will become better established than now and so allow better advice to be given and yields better predicted. Similar surveys have been made for the Forestry Commission, and a map is being made of the soils in Thetford Forest—the largest in England.

It would be tedious to detail all the *ad hoc* surveys (see *Annual Reports*) undertaken, but some of the more interesting deserve mention. In 1950 a preliminary survey, which was later extended, was made of the Wentlloog and Caldicot Levels (Glamorgan) where 26,000 acres were mapped to determine the extent of poorly drained soils on which productivity is limited although their inherent fertility is high. In the same year a survey was initiated of some of the "moss" lands in Lancashire; the information provided on the differing kinds of peat soils, their thickness, the nature of the underlying mineral soil and their agricultural potential aroused so much interest that the survey was extended; by 1957 35,000 acres were mapped, and the report was incorporated in the recommendations made about their use and drainage. One of the problems of opencast iron- and coal-mining is to restore the sites to agricultural use afterwards, and several surveys have been made at different times in this connexion; the rate at which large agriculturally intractable blocks of limestone weather and the rate of soil formation on these highly disturbed, heterogeneous materials has also been studied. Deposits of Shirdley Hill Sand in Lancashire subjected to certain pedological processes yield a quartz sand highly suitable for

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glass-making. In waterlogged soils, particularly under a peaty organic covering, iron oxides are strongly reduced, and the reduced iron readily diffuses out of the upper layers, leaving a strongly bleached residue. When this occurs in the Shirdley Hill Sands, it leaves an excellent glass sand. Thus the soils when classified genetically fall into groups that fairly closely represent glass-sand quality. As much of the deposit was in an area proposed for a new town, a survey was made in 1958–59 to determine the extent of the glass-sand; its distribution and quality were mapped, and as a result a sequence of building was arranged so that this valuable resource should not become unusable as happened in a district built over earlier.

Much horticultural land is level and well-drained, so it is often coveted for building sites, and surveys have been made to delimit its extent, notably in Sussex and Guernsey. The whole of Guernsey was surveyed, and in Sussex the survey is being extended to cover the whole coastal district. In connexion with the proposed routes of new roads, by-passes, etc., in various parts of England, soil profiles were described at frequent intervals and samples supplied to the Road Research Laboratories for investigation. Surveys have been made of several large areas, proposed as the sites of new towns, where there is a possibility of the loss of much high-class agricultural land. This use of survey information dates from the close of the Second World War when land classification maps were made of Herefordshire, Worcestershire, Shropshire, Warwickshire and the environs of Birmingham for the West Midland Group on Post-War Reconstruction and Planning (West Midland Group, 1946, 1947, 1948). Specifications of site and soil were drawn up by a committee, on which the Soil Survey was represented, to enable three " qualities " to be differentiated, and maps and reports were presented on this basis. A similar survey was made later in Somerset, Gloucestershire and Wiltshire for the Reconstruction Research Group (1947) of Bristol University, and the method is now being used by the Ministry of Agriculture, Fisheries and Food in surveys of potential horticultural land. Maps and reports have also been made more recently by the Soil Survey on similar projects for new towns in the north of England and in connexion with post-war planning in the Midland Valley of Scotland.

Although these *ad hoc* surveys mean there is less time for " routine " surveys, the two do not always conflict. Sometimes the information needed exists in the routine survey and needs only to be put in an appropriate form for immediate use; at others the request leads to an extension of the survey, or, information from an *ad hoc* survey becomes of use when it is later decided to make a routine survey of that particular district.

In addition to preparing maps and memoirs and reports on specific areas, the Survey publishes an *Annual Report* (1950–59) describing the year's work, with brief descriptions of new soil series and *ad hoc* surveys.

A soil map of Great Britain (1 : 2,500,000), made from a reconnaissance survey by the staff at 1 : 625,000, is incorporated in the soil map of Europe prepared by the Food and Agriculture Organisation of the United Nations, and officers of the Survey take part in

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international discussions concerned with soil classification and the preparation of a soil map of the world.

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