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ROTHAMSTED RESEARCH

Rothamsted Experimental Station Report for 1985

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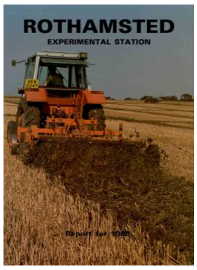

Soil Survey of England and Wales

P. Bullock

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SOIL SURVEY OF ENGLAND AND WALES

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Introduction

Early in the year, under the guidance of the MAFF Work Programme Panel, the main mapping programme was revised following the Ministry's decision that it no longer required detailed strategic mapping at a scale of 1:50 000. As a result, work on six sheets has been stopped completely. Surveying for publication at 1:50 000 scale has continued on five sheets two of which were completed during the year. Two of the 1:25 000 sheets within the Newtown area (Sheet 136) which were near to completion, were selected for publication at 1:25 000 scale. Mapping at 1:10 000 scale for publication at 1:25 000 was completed for an area in Bedfordshire. Overall 2350 km^2 of detailed mapping have been completed. Field work on the National Lowland Peat Inventory was extended to all regions. Approximately 375 km^2 were covered nationally and the field work is nearly complete.

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1:50 000 Scale mapping

Sheet 81 (Alnwick and Rothbury). Over 310 km^2 have been mapped, mainly where the soil pattern is complex or in localities where there has been little previous detailed mapping. Some work has been done on the predominantly till-covered terrain between Longframlington and Alnmouth, where there are extensive stagnogley soils (Dunkeswick, Pinder and Brickfield series), interspersed with brown earths and brown sands over glaciofluvial drift.

In the Cheviot Hills, humic brown podzolic soils, Bowden series, are common on north-facing slopes under *Nardus* grassland. Related soils with dark coloured B horizons have been classified as humic cryptopodzols. Reddish fine loamy stagnogley soils and stagnogleyic brown earths over very stony andesite drift or andesite rock are widespread on footslopes bordering the Cheviot uplands.

The soil pattern is complex around Whittingham, where steeply dipping sandstones, siltstones and shales of the Cementstone Group have a patchy drift cover. On undulating low-lying ground where the till is thickest there are stagnogley soils, but nearby level land carries stoneless reddish clay soils in glaciolacustrine drift. Sandy glaciofluvial and river terrace deposits between Powburn and Wooperton carry Newport and Netherby series. There are some brown podzolic soils, Penrith series, with brightly coloured B horizons and sporadic induration. On low ridges within the Cementstone lowland, typical brown earths over sandstone include Rivington, Neath and Plowden series. Deeper stagnogleyic brown earths and stagnogley soils are found on soft interbedded rocks on ridge tops and flanks. Some of these soils are developed partly in fine loamy drift. Some have argillic horizons.

The Fell Sandstone outcrop has now been completely surveyed. There are extensive sandy humus-ironpan stagnopodzols on upper dipslopes and stagnogley-podzols on middle dipslopes. Lower dipslopes are till-covered and dominated by stagnohumic gley soils of the Wilcocks series. Complex map units, which include several brown podzolic soils, sometimes with incipient ironpans, have been delineated below steep scarp slopes. (Kilgour and Payton)

Sheet 98 (Wensleydale and Wharfedale). A further 65 km^2 were surveyed before work was suspended, mainly in the south-west. Stagnogley soils in medium to fine till predominate on the drumlins of the Wenning and Greta valleys. Similar soil patterns to those mapped last year were found on the Great Scar Limestone and Yoredale Beds in Lonsdale. Rankers, brown earths and stagnopodzols cover the limestone and there are stagnohumic gley soils and raw peat soils on higher ground.

The Silurian inlier at Austwick in Ribblesdale has a distinctive soil pattern. The sequence of flags and intercalated mudstones gives Denbigh soils, with Powys soils on the steep slopes below the Carboniferous limestone. There are Rivington soils over the coarser sandstones and grits and seasonally waterlogged Cegin soils on thick drift.

The summits of Great Whernside and Buckden Pike which rise to 700 m OD are covered by deep raw peat soils of the Winter Hill series which are commonly eroded. In places, shallow peat soils overlie rock and the more-strongly humified Crowdy series occurs locally, possibly where the peat is formed from the remains of purple moor grass. (Carroll)

Sheet 106 (Market Weighton). Mapping, which is now almost complete, was concentrated on the Humber warplands, the footslopes of the Wolds between Hessle and Driffield and those parts of the Vale of York for which there is no earlier detailed mapping. Almost 500 km^2 were surveyed and 400 km^2 of previously published mapping in the Vale of York was revised. Most soils and soil patterns were similar to those described in earlier reports.

On footslopes of the Wolds, the thin cover of till over chalk, representing the western limit of the Holderness till sheet, has been reinterpreted. Previous reconnaissance mapping

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suggested that these slopes were dominated by fine loamy typical argillic brown earths, Hunstanton and Ludford series. Detailed mapping, however, has emphasized the chalky, but non-reddish nature of the drift and many areas have now been re-mapped as Weasenham series. (Furness, King and Bradley)

Sheet 108 (Liverpool). A further 600 km^2 were surveyed. Most of the land between Burtonwood and Coppull is Clifton or Brickfield series with some Salwick and Rivington soils. Near Wigan, there is much land disturbed by extraction for opencast coal. Around Widnes, Clifton soils with pockets of Brickfield series are extensive. Here topsoils are often coarse loamy allowing arable cropping. These soils are marginally suited to spring-sown cereals and most cultivations take place in early autumn. To the north of the Mersey on Hale Head, droughty sandy soils of the Bridgnorth series are found and there are gley-podzols of the Sollom series south of Speke. Near Penketh there are pockets of Arrow and Teme soils.

Earlier mapping on the Formby, Southport and Preston sheets has been re-evaluated using the modern classification. Most of the soil series are directly comparable with their modern equivalents but some small areas have needed re-mapping. Conway soils occur along the Alt alluvium, and the estuarine alluvium to seaward, carries Agney and Blankney series. Study of the peat deposits suggests an average annual wastage of 12 mm. Since the earlier survey in 1954, the peat boundary has retreated considerably. Peat, from former reed beds, on the moss inland of Formby, increases markedly in acidity on exposure to air from the oxidation of naturally occurring sulphides. (Lea and Thompson)

Sheet 119 (Buxton, Matlock and Dovedale). Work was suspended with the completion of Sheet SK15. (Reeve and George)

Sheet 131 (Boston and Spalding). About 350 km^2 were mapped mainly in the south on 1:25 000 Sheets TF21, 31, 51 and 52. North of Crowland, a large area, once peat-covered marine alluvium, now carries mainly Downholland soils. Similar soils containing much jarosite, a mineral often associated with very acid soil conditions, occur locally in discrete patches. Near Crowland, the marine alluvium is thin and overlies the stony loamy and sandy deposits of the Abbey Gravels. Elsewhere, Wallasea and Wisbech series are commonly mapped together but those parts of the low-lying land with creek ridges have patches of calcareous Newchurch and Agney series as their main soils with subsidiary calcareous clayey over coarse silty soils. The disposition of these calcareous soils seems to be associated with small, probably piecemeal, reclamations. Fine silty over clayey Pepperthorpe series and calcareous silty over clayey Stockwith soils usually mark a transition zone between the composite Wallasea-Wisbech map unit and one with mainly Wisbech soils. In the south-east on Agney-Wisbech map unit is more common than elsewhere and the normally widespread complex of Wisbech and Romney soils is confined mainly to old river courses. In the extreme south-east, the boundary between the Fen Clay and the later Romano-British deposits is marked by a peat layer 2–100 cm thick. Where the buried peat is more than 15 cm thick, Dowels series or an equivalent unnamed clayey but calcareous soil occur, otherwise Wallasea or Newchurch series are found. In places where the peat was once exposed at the surface it has been oxidized leaving soils with dark though non-humose topsoil. The Fen Clay is morphologically distinct being much greyer than the more recent alluvium. (Robson, Heaven and George)

Sheet 150 (Worcester and The Malverns). The remaining 450 km^2 on this sheet were completed, the map is being drawn and the text written. The soil parent materials covered this year differ little from those previously described (*Rothamsted Report for 1984,* 201). The southern part of the Malverns has a similar pattern of soils to that described in detail by

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Palmer (1976). To the east of the Malverns, extensive Head deposits cover Triassic mudstones. Soils here are brashy and, where the Head is thick, there are well drained Mayalls soils. Where the drift is thin, seasonally waterlogged Welland soils occur because of the impermeable clayey subsoils formed in the underlying mudstone. Along the Glynch brook to the west of the Malvern Hills, remnants of Wolstonian till cover the lower valley sides. Seasonally waterlogged fine loamy over clayey Oakley and Flint series occur near Hillend but further south, near Bromsberrow Court, variably-stony outwash deposits give well drained, coarse loamy Oglethorpe and Hall soils.

The Bronsil inlier of Cambrian rocks is bounded on the west by steeply sloping land formed by Llandovery sandstone on which well-drained, coarse loamy Eardiston soils are developed. Drift from this sandstone, incorporated with material from the Cambrian mudstones and shales give seasonally waterlogged, fine loamy Bishampton soils. The Llandovery Beds on Howlers Heath are composed of grey and reddish brown mudstones and clays. The colour changes over short distances so reddish and greyish soils cannot always be separated and Martock series contains reddish inclusions similar to Netchwood series.

Between Malverns and Abberley, much of the parent rock is soft shale and stagnogleyic argillic brown earths of the Yeld series and typical stagnogleys of the Stanway series are common. Barton series occurs over hard shales and Aberford and Elmton series are common on limestone. Because of the steep slopes, much of the land is under woodland or permanent pasture with some top fruit and cereals. West of the Malvern-Abberley ridge, Bromyard soils predominate on Devonian mudstones. These reddish silty clay loam soils are used for cereals, top fruit and hops but on steep slopes permanent grassland is usual. Associated Middleton soils occur in hollows. East of the ridge, Triassic sandstone is extensive giving typical brown earths of the Bromsgrove and Eardiston series most of which is under cultivation with cereals, potatoes and sugar beet.

West of Droitwich, there is a marked boundary between Mercia Mudstone giving heavy textured soils of the Whimple, Worcester and Brockhurst series, and the Triassic sandstones which mainly give coarse loamy brown earths of the Eardiston and Bromsgrove series. Interbedded siltstones and silty shales within the sandstones give Hodnet and Staunton soils. To the north of Ombersley, Lilleshall and Sellack soils occur. Clayey alluvial soils of the Clyst and Compton series are found along the Salwarpe. In the Severn valley west of Ombersley, the silty alluvium is variably brownish and reddish giving Clwyd, Teme and Conway soils, the latter on the lower parts of the floodplain.

Between Eldersfield and Upton-upon-Severn, the Arden Sandstone has a complex pattern of calcareous Clayworth, Agardsley and Hartputy soils with patches of non-calcareous Neath and Hodnet soils. Around Castlemorton and Birtsmorton, Compton soils are found along the narrow floodplains but Fladbury soils dominate wider tracts such as Longdon Marsh. Here there is a commonly thin organic horizon within the alluvium at 45 to 70 cm depth. The alluvium thins around the edges of the marsh, and rests on mudstone and stony drift. Loamy over clayey and loamy paleo-argillic brown earths are found on high river terraces at Bushley Park, Bushley Green and Heath Hill. Lower terraces carry brown earths of the Wick, Oglethorpe and Hall series with fringes of Flint and Bishampton series. (Beard, Palmer, Jones, Cope and Whitfield)

1:25 000 Scale mapping

Sheet TL14 (Biggleswade). The remaining 43 km^2 of the sheet were mapped and the soil map and legend compiled for publication. Work was abandoned on Sheet TL15 (St Neots). (Wright)

Sheet ST41 and 51 (Yeovil). The remaining 10 km^2 were mapped, the map and legend prepared for publication. (Colborne and Staines)

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Sheet SO07 (Abbeycwmhir). Most of the land is above 300 m OD and more than a quarter has brown podzolic soils, mainly Manod series. Shallow soils over siltstone, mainly Powys series cover about a tenth of the land, mainly on convex upper slopes and ridges. Wetter soils, which cover about a third of the district, are usually found on gently sloping concave sites on till. Sportsmans and Brickfield series are widespread in the valleys, but on the wettest sites peaty-topped soils of the Wilcocks and Kielder series dominate. About one fifth of the land is forest, which includes all the main soil types. Unenclosed grassland covers about a third of the district mainly on wet peaty-topped soils or steeply-sloping brown podzolic soils. (Hartnup)

SO19 (Newtown). The land is mainly below 250 m OD, and more than a third is moderately to steeply sloping and carries brown earths dominated by the Denbigh series. Flatter land bordering the Severn and its tributaries has Rheidol soils developed in gravel. Stagnogley soils, belonging mainly to Brickfield and Sportsmans series, occur on till, mainly on gently sloping land. The Severn alluvium gives a variety of mainly deep permeable soils, providing the best land for agriculture, though there is occasional flooding locally. (Hartnup)

National Peat Inventory

Northern England. About 150 km^2 of lowland peat have been sampled at 0·5 km intervals on transects 1 km apart. The peat of Morden and Ricknall Carrs, Durham, is generally 70 cm to 2 m thick. Adventurers' soils predominate, although the upper 25–30 cm of the soil is commonly alluvial clay or clay loam. On Snape Mires and Crakehall Ings, North Yorkshire, the thickness of the peat is very variable, but is usually less than 1 m. There are associated typical humic gley soils and pelo-cambic gley soils.

The soils of Folkton and Flixton Carrs at the eastern end of the Vale of Pickering consist of 2–3 m of peat and usually belong to the Adventurers' series. Altcar series is more common south of Wykeham, where it often occurs in a complex pattern with sandy and humic-sandy gley soils. Near Pickering, Adventurers' series is found, but clayey humic gley soils, Warmingham series, predominate.

The peat deposits associated with the Rivers Torne and Idle in south Yorkshire, Nottinghamshire and Lincolnshire consist of 1–3 m of semi-fibrous and humified grass-sedge peat overlying fibrous reed peat often with abundant wood remains. Both Adventurers' and Altcar series occur, as also do occasional acid Ridley soils. No extremely acid soils have been found, but jarosite occurs in silty clay alluvium south east of Doncaster. In parts of the Torne valley, the peat has a high pH so manganese deficiency occurs. Soils with an upper layer of clayey alluvium, Midelney series, are locally common.

In Lancashire, there are several small linear occurrences of peat soils between Blackpool and Preston. The peat is up to 2·5 m thick and is variably humified. Many soils belong to the Adventurers' series, although they were previously mapped as Altcar series (Crompton 1966, Hall and Folland 1967). The most commonly associated soils are typical humic-alluvial gley soils developed in Downholland Silt. Further north, on Winmarleigh, Cockerham and Pilling Mosses, the peat is semi-fibrous and 1–4 m thick. Turbary Moor soils are mapped where the remains of *Sphagnum* and *Eriophorum* are present and Altcar soils where the peat is composed mainly of grasses and sedges. Peat cutting which was widespread in the past continues in a limited way today. An uncut, unreclaimed portion of Gull and Winmarleigh Mosses, partly designated as a Site of Special Scientific Interest, allows comparisons with adjacent cut and drained peatland.

On Chat, Barton, Worsley and Carrington Mosses, west of Manchester, there are man-made topsoils from the former addition of night soil from the city. The underlying *Sphagnum* peat is of varying thickness; much was removed by cutting before the application of night

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soil. The underlying matted *Eriophorum* peat is 5 m or more thick. Some sites under scrub and woodland are relatively undisturbed. (Bradley and Carroll)

Eastern England. A further 105 km² of peat fenland have been surveyed with over 785 deep auger borings bringing the fieldwork near to completion. Work was undertaken in Hilgay and Fordham Fens, the Yare, Bure Thurne and Nar Valleys and Methwold Common in Norfolk; in Lakenheath, Hockwold and Mildenhall Fens in Suffolk; Bourne Fen in Lincolnshire; and in Borough Fen, the Nene washland, the Cam valley and Haddenham, Wimblington and Mepal Fens in Cambridgeshire.

The complex soil patterns with their common occurrence of subsoil acidity in both organic soils and humic alluvial gley soils, especially those with contrasting thin intercalations are similar to those in other parts of the Fenland previously reported in 1983 and 1984. Acid sulphate soils, which cover large parts of the Fenland, restrict rooting and reduce yields of most crops especially in dry years. Observations made on sugar beet show that rooting is checked by a subsoil horizon with pH 4·0 or less, which frequently occurs between 35 and 60 cm depth in acid sulphate soils. (Burton and Corbett)

South West England. Fieldwork has been mainly in Somerset, Avon and Dorset. Many of the peats sampled in Bridgwater area are humified in the upper layers giving earthy eutro-amorphous peat soils of the Adventurers' series which often contain considerably woody remains.

In Dorset most peats occur as acid sphagnum-rich valley bogs, but, in the larger valleys draining to Poole Harbour, there are thicker more humified and less acid peats. (Hogan and Colborne)

Midland and Western England. In Shropshire, Staffordshire and Cheshire more than 150 peat profiles were sampled in the valley mires and mosses. The valley mires from a series of narrow interconnecting depressions commonly filled with 0·5 to 2 m of detrital peat. Adventurers' soils are dominant, mostly in detrital woody peat with thin layers of reed peat in deeper hollows. Around Newport, some very deep hollows contain 3 to 7 m of detrital peat. Occasional Altcar soils occur in semi-fibrous reed peat along the edges of the larger hollows. In most moors, however, there is less peat than indicated in previous surveys. The deposits below the peat are very varied. Under most of the Weald Moors the peat rests on glaciofluvial sands and loams or calcareous till. South of Ellesmere, in Baggy Moor, Burlton Moor, Lyneal Moor and Tetchill Moor the peat often overlies extremely calcareous shelly sandy silt loam or silt loam (*Chara* marl). This gives rise to marked variations in pH, especially on shallow peat soils where the ditch dredgings have been spread. In Baggy Moor, for example, the pH varies from 5·0 to 7·3 at the surface, and from 3·1 to 7·1 at 50 cm depth, the high pH causing manganese and copper deficiencies in crops. Very acid peat also occurs locally in the Weald Moors.

The mosses and acid grasslands surrounding the Shropshire mires mostly contain oligotrophic peat between 1–4 m thick. Reed fen peat usually passes upwards into *Eriophorum-Sphagum* peat and then into woody peat where wooded. If drained, the woody peat humifies rapidly giving Blackland soils with upper layers of loose humified peat surrounding living roots. Raw peat soils are confined to permanently-wet peat in deep quaking bogs (swingemoors) such as Chartley Moss and Lin Can Moss which have Longmoss soils in the central floating sphagnum peat and Floriston soils in surrounding *Eriophorum* peat. (Cope)

Wales. About 40 km² of lowland peats occurring mainly as small patches from the Lleyn peninsula to Rhosgoch in south Powys were mapped and sampled. (Rudeforth and Hartnup)

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Consultancy work

Following the announcement early in the year, that MAFF would be reducing its funding from April 1986, the Soil Survey has made strenuous efforts to make more widely known the kinds of data it holds and the expertise and services it has to offer. A preliminary market survey was undertaken by Minster Agriculture Ltd as part of their management study of the Soil Survey for the AFRC and this survey has provided a preliminary guide to potential development. In addition, some previously-established links have been further exploited. The following paragraphs identify some of the markets in which the Soil Survey has already been sucessful.

Agricultural land management. Many of those involved in managing land for agriculture still lack adequate information about their soils. The Soil Survey has been providing a service for individual farmers, groups of farmers and for management advisers and estate agents. The service includes a soil survey of the land, a detailed soil map either in colour or black and white and a written report describing the agronomic properties of the soils their condition and behaviour and the cropping potential of the land. This service is proving particularly valuable in situations where new land is acquired, personnel change or new cropping systems are introduced. The cost of such a survey can often be quickly recovered by rationalizing land management; for example, by ordering cultivation priorities to avoid soil structure damage or by reducing the number of tillage operations or the frequency of subsoiling.

Agricultural rent reviews. The quality of land for agriculture is an essential input to assessing a fair rent. The Soil Survey has provided data about land under review for example in the Fens where the uses of some peat land is limited by acid sulphate conditions or peat shrinkage and loss.

Sales of agricultural land. The amount of information available to prospective purchasers about land for sale is often limited and general. The Soil Survey has begun to provide suitable data for estate agents to include in sale particulars.

Agricultural potential of conserved land. When a farmer wishes to improve land designated as a Site of Special Scientific Interest (SSSI) he can negotiate compensation payments for loss of earnings from the profitable use of the land for agriculture. The Soil Survey has been asked to evaluate several such sites in terms of their cropping potential as an objective input to the compensation discussions.

Irrigation. The design of irrigation systems and the scheduling of water application require a knowledge of the water-holding capacity of the soil. The Soil Survey is cooperating with an irrigation equipment manufacturer and with an organization monitoring field moisture to aid design and scheduling by providing data and expertise.

Less Favoured Areas. Large areas of England and Wales have been given this status under an EEC directive and recently there has been the opportunity for farmers outside the designated areas to apply for inclusion. The Soil Survey has advised a number of farmers about their land and its quality relative to other land already within Less Favoured Areas.

Crop suitability. The Soil Survey has been asked to identify suitable land for growing nursery stock and witch hazel. The latter involved researching the conditions under which the shrub grows in its native North America. Data from a farm survey have also been re-evaluated to predict the suitability of land for alternative crops including sunflowers and linseed.

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Agricultural experiment sites. Many organizations, both official and industrial, test their products and techniques on experimental sites. In order to extrapolate their results there is a need to characterize the soil, understand how it behaves and how it relates to other land elsewhere. The Soil Survey has been asked to provide this kind of information by a number of organizations.

River catchment studies. The movement of water over and through soils affects river levels and run-off. The Soil Survey has participated in assessing the benefits to land where channel improvements have been made. Groundwater abstraction schemes frequently lead to fears of an increased drought risk to crops, and soil studies have been undertaken to identify land that might be affected.

Pipeline routes. The costs of pipeline installation are dependent in part on the soils in which the pipes are laid and the Soil Survey has drawn on its database to alert organizations planning pipelines routes about potentially difficult ground.

Landscape planning. Where longer developments are planned, there is often the need to remove, store and sometimes import soil to cover poor substrates. Landscape architects have asked for information about the quality of soil, why planted shrubs and trees are in poor health and the effects on vegetation of raising or lowering local water tables.

Environmental studies. The acid rain debate hinges in part on the degree to which soils can buffer incoming rain and the effects of increasing acidification on aluminium solubility. The National Soil Inventory database is a source of spatial information about soil acidity and trace elements that is of interest to organizations assessing the impact of wet and dry deposition.

The Soil Survey has provided data about the soils of conserved land as a basis for management strategies and as an insight into one aspect of their ecology.

Mineral extraction and land restoration. Large areas of land are exploited annually for the sand and gravel or coal beneath them. The Town and Country Planning Acts 1971 and 1981 require that an assessment be made of the land before extraction commences and that the restored land be monitored during a period of aftercare. Soil Survey staff have recorded land quality in support of applications to extract sand and gravel and have investigated changes in soil water content and strength during stripping operations.

Archaeological investigations. The interpretation of buried soils and other soil material in archaeological excavations is often significant for reconstructing human activity. Soil Survey staff have given advice to a number of archaeologists for this purpose. (Jarvis, Thompson, Wright and other staff)

Special projects for MAFF. Nine crop trial sites in Yorkshire, Northumberland, Durham and Cumbria were surveyed. (Bradley, Carroll and Kilgour)

Detailed results of an earlier survey of an opencast coal site were supplied to Land and Water Services (LAWS), MAFF. (Bradley)

Advice was given to LAWS staff on suitable sites for drainage demonstrations. (Carroll)

Pits were described and sampled on joint ADAS/Animal and Grassland Research Institute nitrogen response trial sites. (Kilgour and Harrod)

A soil survey of Kinley Farm (120 ha) near Telford was undertaken to prove a basis for soil advice within the farm development plan offered by ADAS. (Jones)

A survey was made of an opencast coal site (50 ha) at Benthall, Shropshire to support soil advice given by ADAS soil scientists on soil handling and restoration. (Jones)

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Detailed soil surveys were made of five sites in Staffordshire selected for the Silsoe College—ADAS moling project which commenced this year. Representative profiles will be excavated in 1986 to provide data in support of this project. (Palmer)

Soil variability was assessed on LAWS drainage sites in Shropshire and Cheshire. (Palmer)

A survey of a *Farmers' Weekly* demonstration farm at Marston Trussell was made for ADAS. (Hodge)

Soils were described and sampled at experimental sites for ADAS. (Rudeforth)

The national 1:250 000 soil map was interpreted to identify areas within Midland and Western England with a drainage need. (Palmer)

Courses were run at Hereford and Worcester to acquaint Agricultural Advisory Officers with the agreed Soil Survey—ADAS texture scheme. (Palmer)

Other work. A detailed survey of 437 ha about the River Tame near Stokesley, North Yorkshire, was made for Northumbria Water in connection with proposed flood prevention measures. (Carroll)

A survey was made of Gardenstone Farm, Hutton Rudley, North Yorkshire (150 ha). (Bradley and Carroll)

Existing soil mapping adjacent to the Bridgewater Canal, Leigh was interpreted for Soil Mechanics Ltd. (Bradley)

A survey was made of Throstle Nest Farm, Pocklington, Humberside (140 ha). (Furness and King)

Four short reports on soils and land classification in the Driffield district of Humberside were prepared for a Driffield land agent. (King)

Assessment was made of soil types at archaeological sites near Driffield on behalf of the British Museum (King) and near Ravenglass, Cumbria for Edinburgh University. (Payton)

The Survey supplied data for the ICI Agricultural Division for use in their Agviser computerized farmers advisory service. (Furness)

Soil and climate datasets within the Soil Information System (SIS) have been used for assessing suitability of sites for witch hazel at the request of Optrex UK Ltd. (Jones)

Details of workability, droughtiness and crop suitability modelling within SIS have been supplied to Plymouth Polytechnic who will use the information as part of student curricula. (Jones)

A survey of soil structure on Alrewas Hayes, Barr Hall, Easthill and Catton Farms (600 ha) near Burton upon Trent, Staffordshire, was made prior to autumn cultivation. Soil samples were also collected for nutrient analyses by MAFF. (Jones)

A soil survey at 1:10 000 scale was made of 250 ha of Whiston Hall Farm, Albrighton, Staffordshire to aid farm management and assess drainage need for suitability for irrigation. (Palmer)

Five sites were located on the Worcestershire College of Agriculture Farm where permanent profile pits could be excavated for use as teaching aids. (Palmer)

A soil survey at 1:10 000 scale was made of 356 ha of the Chillington Estate, Codsall Wood, Staffordshire. A report was prepared which included soil suitability for the main arable crops, need for drainage and the workability and droughtiness of soil series. (Palmer)

Three provisional sites, on Whimple, Dale and Cuckney soil series, were selected for an EEC project on land evaluation. (Reeve)

A farm survey was made at Bearley, near Stratford upon Avon, Warwickshire, where 250 ha of land was classified according to the MAFF agricultural land classification following the removal of radio masts from ground that had previously been placed in grade 4. (Whitfield)

At Quarrendon near Aylesbury, Buckinghamshire, 140 ha were surveyed with specific

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reference to soil structural conditions. Information on workability and crop suitability together with an assessment of the land classification was included in the report. (Whitfield)

At Bricklehampton near Evesham, Worcestershire, a soil survey of about 400 ha was completed on an extensive area of Head below Bredon Hill. Crop suitability, soil workability and droughtiness assessments were made on all soils. (Whitfield)

An assessment of the land class on a farm at Alvechurch was made to separate areas of better grade land prior to sale. (Whitfield)

Two farms in south-central Lincolnshire owned by Crown Estates were mapped and reports prepared about the soils, their workability, droughtiness and crop suitability. (Heaven and Robson)

The soils of Hemingstone Fruit Farm were surveyed and assessments made of the management implications of the soil conditions with regard to drainage and irrigation of orchards. (Wright)

The soils of Clifton Bury Farm, Bedford were mapped and the soils assessed from the point of view of irrigation. (Wright)

A survey was made of Pitt Dene Farm, Elsworth to identify the soil series present and their properties. (Wright)

A soil survey and land evaluation was made of a farm near Ely and the extent and acidity of acid sulphate soils identified. (Burton)

A survey was made of Coombe Grove Farm, Arlington. The land was classified and a report made on problems of soil structure. (Wright)

An assessment was made of soil structure conditions and the suitability of soils for the cultivation of peas at Stonebury Farm, Hertfordshire. (Hodge)

The relationship between poor growth in sugar beet in relation to soils was investigated at a farm near Mildenhall, Suffolk. (Burton)

The effect of lowering of the water-table by pumping on the surrounding soils was investigated at a farm at East Harling, Suffolk, (Wright)

The depth and nature of peat was determined at Buckenden Marsh, Norfolk. (Corbett)

A survey of approximately 10 ha of land was made at Rectory Farm, Littlebury, Saffron Walden, to assess the extent of a former borrow-pit. The soils within and around the pit were described, their management problems were assessed and recommendations made for ameliorative courses of action. (Hollis)

A report was made for Halcrow Water on the feasibility of disposing of reservoir sediment on to fields adjacent to Chew Magna reservoir, Avon. (Cope)

A pipeline section was described and soil acidity investigated on Culleys Farm, Marlborough, Wiltshire. (Cope)

An assessment of acid soil problems was made on Draycott Farm, Chisledon, Wiltshire, and a report written. (Cope)

A soil survey was made of the soils and potential land use of 15 ha of Broomsgrove Farm, Pewsey, Wiltshire. (Cope)

A soil survey of 200 ha and two small soil investigation studies were undertaken for Woodsford Farms Limited, Dorset. (Colborne)

The soils and potential uses of about 8 ha on the outskirts of Southampton were appraised for Janie Thomas Associates of Bristol. (Colborne)

A case for inclusion of their land within the EEC Less Favoured Area was made for a group of farmers in North Cornwall. (Harrod)

Updating of the County Agricultural College farm maps and reports was carried out for Cannington (Somerset) and Bicton (Devon). (Findlay and Hogan)

A survey was made of 1 km^2 at Huish Barton, Williton, Watchett and a report written. (Staines)

A soil survey and land evaluation of 3 km^2 at Lulworth, Dorset and 2 km^2 at Culmstock

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Beacon, Devon was undertaken for the Nature Conservancy Council to aid management agreements. (Staines)

Soil information was provided for Nicholas Pearson Associates at Ringwood to aid an environmental impact assessment of a proposed reservoir development, upon an SSSI (2 km^2). (Staines)

Examination and sampling of soils was carried out on Milton Trading Estate, Didcot, for Hugh Watson Associates, Winchester, in relation to poor shrub and tree growth and proposed amenity planting schemes. (Staines)

A survey was made of a farm at Finningham, Suffolk. The report included assessments of soil structure, drainage techniques and the suitability of soils for specific crops. (Staines)

An examination of a 5 ha smallholding at Shepton Mallet was made to assess its possible use for market gardening and viticulture. (Staines)

An area of 6 km^2 was mapped around Maiden Castle, Dorchester for English Heritage in connection with the excavation of the castle. (Staines)

Advice was given to AERE Harwell on siting of radio-nuclide monitoring sites in Dorset. (Staines)

Advice was given to archaeologists from Wessex Trust for Archaeology on two sites in Dorchester. (Staines)

A soil map was compiled of Bodmin Moor SSSI (54 km^2) and a report written for the Nature Conservancy Council (NCC). Information was drawn from recent fieldwork on 1:50 000 Sheet 201 (Plymouth and Launceston) in addition to the published 1:250 000 National Map and 1:25 000 Sheet SX18 (Camelford). (Hogan)

A soil map was made of Llwynrheol Farm (75 ha) at Mydroilyn, Dyfed to help the local Farming and Wildlife Advisory Group prepare a conservation management plan. (Hartnup)

The soils of Hoggshead Wood (23 ha) were surveyed for Alfred McAlpine Minerals Ltd. (Thompson)

A survey was made of Taylors Farm, Banks Estate, near Southport for the Lancashire County Council. (Lea)

A map and report was provided for the NCC to help with research and management of an SSSI (27 ha) at Plwmp, Dyfed. A soil report was also submitted to NCC for 10 other SSSIs in south-west Dyfed supported by 30 soil profile descriptions. (Hartnup and Rudeforth)

Soil information along a 20 km gas-pipeline route north of Cardiff was compiled for Richards, Moorehead and Laing Ltd. (Rudeforth)

Basic, methodological and applied research

Introduction. Research and development effort is mainly directed towards the Soil Information System, the physical properties of soils, including soil/water/air relations, and land evaluation methodology.

The information system is now at a stage where it can be used. During 1985 a significant number of data sets and procedures have been included, all of which are available using Datatrieve command language. Progress has also been made towards producing a user friendly interface, so a knowledge of Datatrieve will not be necessary.

The development of models to predict water movement and water state in soil profiles and eventually for fields and catchments has high priority. Data acquired by neutron probe, measurements of water retention, suction, field hydraulic conductivity and macro-porosity are being accumulated. The award of an EEC contract in 1986 on the 'Use of modern physical field methods and computer simulation for land evaluation', will encourage progress in model development. This topic is also relevant to prediction of nitrate status and losses.

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Work is in progress to examine the relations between soil moisture regime, strength, plasticity, shrinkage and density. A large volume of laboratory and field measurements from well classified and monitored sites are needed to predict soil behaviour under tillage or for earth-moving purposes.

The models published in the Soil Survey Regional Bulletins (1984) enabling soil maps to be interpreted for crop suitability and management techniques are under continuous review. Specimen crop suitability maps at 1:250 000 and 1:25 000 have been prepared. Interpretive maps for straw incorporation, irrigation, erosion risk and slurry disposal have also been drafted.

A project on susceptibility of soils to erosion is now in its fourth year and has yielded much useful data. Future work should aim to improve quantification of the amount of erosion in relation to soil, land use and weather and derive better estimates of erosion risk.

Much information in our existing datasets on chemical and physical properties is relevant to the evaluation of soil and land for waste disposal and pollution risk. Systematic procedures are being developed and will be tested against real field situations in cooperation with other interested parties. (Ragg and Thomasson)

Soil Information System (SIS): Data sets for field and laboratory records, the soil map of England and Wales, agro-climatic information and soil-series-related data have been produced during the year. Those available are:

(a) Field and laboratory records:
National Soil Inventory (at 5 km intervals)
— field records (complete)
— pH, extractable P, K, Mg (partially complete)
— trace elements (partially complete)
Purposive auger bores
— partially complete
Detailed profile descriptions (continually updated)
— field records (partially complete)
— laboratory analyses
(b) Soil map of England and Wales (1:25 000):
— soil map units as 100×100 m pixels
— legend (soil association, ancilliary sub-groups and soil series)
(c) Agro-climate (at 5 km intervals):
— altitude
— rainfall
— accumulated temperatures (above 0°, 5·6° and 10·0°)
— field capacity days
— growing season
— moisture deficit (potential and crop adjusted)
(d) Soil-series-related data:
— profile available water
— wetness class
— workability assessment

Many requirements of the system depend on location and soil class. Standard procedures developed and operational include:

(a) Location:
— direct from a given grid reference
— obtained from field records

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— obtained at fixed intervals for given minimum and maximum eastings and northings and an interval
— obtained locations of the transept and the interval.

(b) Soil class:

— direct from a given soil series
— obtained from field records
— obtained from the national map

Other procedures developed and operational include:

— finding all field records with a given distance of a given point
— droughtiness, machinery work days and crop suitability
— calculations using models described in the Regional Bulletins.

Data extracted from the system has been successfully interfaced with SURFACE II for contouring and with PLOT for graphical output. (Proctor, Jones and Ragg)

The current models for droughtiness, workability (machinery workdays) and crop suitability (cereals and root crops) have been built into the system as Datatrieve procedures. The current national lists of profile available water, workability assessment and wetness class for most of the nationally extensive soil series are also accessible within SIS. It is now possible, therefore, to calculate workability, droughtiness and crop suitability for a locality given its grid reference and either a soil series or soil association identified from the national map. The procedures used will be refined and expanded during the early part of 1986. (Proctor and Jones)

Several files of soil properties at 5 km resolution have been generated from the Soil Information System for incorporation in the BBC Doomsday Project. (Proctor)

DEC Rainbow microcomputers were set up at the Alice Holt and Wolverhampton centres. These machines can be operated in terminal mode and file-transfer facilities exist to the VAX computers at Rothamsted. Much of the software developed on the Midas system at Shardlow, including available water calculation, retrieval of moisture release characteristics and the management of contract work, has been mounted on the Rainbow microcomputers and can be operated in stand-alone mode. (Ragg)

Agriculture land classification (ALC). Four meetings of the MAFF ALC climate sub-committee set up to finalize the climatic input to a new agricultural land classification were held during the year. Datasets (on a 5 km grid) of annual average rainfall (AAR), average summer (April to September) rainfall (ASR), accumulated temperature above 0°C (January to June) (ATO), and accumulated summer (April to September) temperatures above 0°C (ATS) were prepared by Meteorological Office staff and processed on the VAX computers at Rothamsted to provide base data for calibration of the new system. Copies of the national datasets of annual average rainfall and accumulated temperature above 0°C (January to June) were prepared specially for image processing using the GIMMS system at the Royal Aircraft and Space Establishment, Farnborough, the results of which have now been received by MAFF. All these datasets will soon be set up for access within the Soil Information System at Rothamsted. (Jones and Proctor)

Laboratory Automation. A Laboratory Information Management System (LIMS) has been written, and mounted on an IMP microcomputer running under IDRIS and fitted with a 10 Mb hard disk store. The system deals with sample information and analytical data from laboratory instruments, performs some instrument control, and produces reports. It also allows interaction with and transfer of validated data to the main Soil Information System held on the VAX machine. (Loveland, with Summerfield, Computing Unit).

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A microprocessor-controlled version of the automatic particle-fraction collector (*Rothamsted Report for 1984*) has been built and is undergoing trials. (Loveland, with Edwards, Instrument Workshops)

Soil erosion. Water erosion continued to be monitored at 17 localities in England and Wales in conjunction with MAFF. Air photos were taken this year of 16 of the 17 sites. Only that on chalk downland was not photographed, as field checking indicated that erosion here was only slight. Elsewhere, there was much erosion, the number of eroded fields identified being significantly higher than in 1982 or 1984. In localities with frequent erosion, the soils tend to be sands or light loams. Most erosion was recorded under winter cereals in Somerset, Staffordshire and Shropshire whereas in Nottinghamshire and Norfolk most erosion was in fields under spring-sown crops, particularly sugar beet.

The evidence from the monitoring indicates that fields under sugar beet are very susceptible to rilling and, where the soils are sandy or light loamy and slopes are steeper than 3°, fields sown to beet will erode in most years. It is likely that rates of erosion are higher under beet than under cereals because rills occur more frequently under the former.

Marked erosion occurred in Cumbria in September. Rainfalls of 24, 26 and 14 mm recorded at nearby Carlisle caused severe erosion in a recently sown field of oilseed rape, and recently ploughed fields were rilled.

Two localities in Suffolk were photographed this year for the Survey by the MAFF Aerial Photography Unit, one near Hacheston to record severe erosion in winter barley, the other near Huntingfield. Photography of the latter site showed many eroded spring-sown fields but in spring 1985 only winter cereals had eroded, and these only slightly. Since 1981, a number of fields flanking a stream have been converted from grassland to arable and the field boundaries removed. This has resulted in high rates of run-off and the stream channel is now eroding rapidly.

The monitoring programme has one further year to run. In view of the increasing evidence of erosion in England and Wales, it is hoped that a more comprehensive, statistically-based monitoring programme can be undertaken to give a sounder national picture of the extent of soil erosion. (Evans)

Work on soil erosion on clayey and silty soils in Dorset and Somerset continued. Twenty fields on Haselor, Bridport and Yeld series were monitored over the winter of 1984/85 and the amount of erosion recorded. On the silty soils slightly more erosion occurred as trace erosion rather than rill erosion. Most erosion was concentrated in wheelings. Nowhere on the silty soils did off-field sources of water cause erosion and ten fields lost an average of 1 t ha^{-1}. In contrast the clay soils in Dorset lost 3 t ha^{-1}. Here water running off adjacent fields and lanes caused two-thirds of the erosion usually in large rills and small gullies. Small rills, usually aligned down tramlines and wheelings, accounted for most of the remaining soil loss. It is clear that, on clayey soils such as those in Dorset, attention to ditches can lead to significant reduction of erosion by curtailing overland flow from adjacent fields and lanes. (Colborne and Staines)

Dating of colluvial soils. Samples for radiocarbon dating were obtained from colluvial soils in the Yeovil district. There are extensive deep accumulations of silty colluvium in most valleys on the outcrop of the Yeovil Sands. To date, peat and organic layers buried below colluvial deposits have yielded dates of 1460 and 290 years before present, whilst other colluvial deposits yet to be dated contained Bronze Age pottery, carbonized cereal grains and fragments of charcoal. The charcoal was mainly hawthorn with some oak, hazel, ash and vetch. This combined with the presence of large numbers of emmer, smelt wheat and oat carbonized grains, glume bases and spikelet forks suggest that these deposits are the result of early arable cultivation. The large amount of hawthorn suggests that the arable episode

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recorded here resulted from the clearance of secondary rather than primary woodland. The available dates provide evidence that erosion in this district is a more-or-less continuous process over at least the past 1500 years and probably the last 4000 years. (Staines and Colborne)

Soil water regimes. The investigation concerning crop exploitation of available water on sites in Leicestershire and Hampshire has continued. Soil moisture was monitored using neutron probes and tensiometers. Monitoring at the grassland sites of the Dale, Staunton and Worcester series in Leicestershire has been completed and data is currently being analysed to provide a comprehensive account of the water regimes of these soils. (Carter and Bembridge)

Ground water levels on sandy soils in the Selby Coalfield district were monitored for a further year. (Furness)

Two concurrent projects have been started in cooperation with INRA, Science du Sol, Rennes, France. The projects are to investigate the relationship between gley morphology and current soil water regime in soils showing evidence of periodic waterlogging and to provide better methods for characterizing and identifying slowly permeable subsoil horizons in the field and the laboratory. It is hoped that both projects will lead to the refinement of field methods for assessing soil wetness class.

Eight sites have been selected for the first project and four of these will also be used for the second project. Each site has comprehensive data on its present soil water regime from dipwell measurements taken regularly over a number of years and, in most cases, also from tensiometer, piezometer or neutron probe records. To date, soils at seven of the eight sites have been described and sampled, with bulk samples, triplicate water release samples and duplicate large micromorphological samples being taken from each soil horizon. Seasonal measurements will be made of hydraulic conductivity at 40 and 70 cm depth at each site. Micromorphological studies will be used in conjunction with field descriptions to characterize gley morphology and micromorphometric studies of porosity and structure will be used with the water release data and hydraulic conductivity measurements to quantify permeability. (Hollis with P. Curmi)

Following assessment of the results from a project to monitor the water regimes of drained and undrained soils in England and Wales, a revision of the definitions for wetness classes has been proposed:

Proposed definitions of wetness classes

1. The profile is not wet within 70 cm depth for more than 30* days in most† years.
2. The profile is wet within 70 cm depth for 30 to 90 days in most years.
3. The profile is wet within 70 cm depth for 90 to 180‡ days in most years.
4. The profile is wet within 70 cm depth for more than 180 days, but not wet within 40 cm depth for more than 210 days§ in most years.
5. The profile is wet within 40 cm depth for 210 to 335 days in most years.
6. The profile is wet within 40 cm depth for more than 335 days in most years.

* The number of days is not necessarily a continuous period.
† 'In most years' is defined as more than 10 out of 20 years.
‡ Or if the profile has no slowly permeable horizon within 80 cm depth, it is wet within 70 cm depth for 90 to 365 days but not wet within 40 cm for more than 60 days, in most years.
§ Or if the profile has no slowly permeable horizon within 80 cm depth, it is wet within 70 cm depth for more than 180 days and wet within 40 cm depth for 60 to 210 days in most years.

The proposed new definitions give a better separation of undrained stagnohumic gley soils and stagnogley soils and also give a better separation of wetness classes 3, 4 and 5 in soils which are waterlogged at 40 and 70 cm depth for similar periods.

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The results of the soil water regime project have also been used to propose revised guidelines for the field estimation of wetness class. The guidelines are based on the depth to a slowly permeable layer within the profile, the depth to a gleyed subsurface horizon within the profile, the site drainage history and the local field capacity period. (Hollis)

Work began in September on the project on moisture regime and profile variation in upland soil (NERC/CASE studentship with Exeter University). Iron-pan stagnopodzols, ferric stagnopodzols and stagnohumic gley soils in reclaimed fields and on unreclaimed moorland have been instrumented at two groups of sites on Exmoor. Tensiometers and piezometers installed in Oh, A, Eag, Bs, Bg and BC horizons will be monitored regularly. (Maureen McHugh, Exeter University and Harrod)

Nitrate pollution. The Soil Survey of England and Wales has developed a simple scheme for categorizing soils according to the risk of pollution to groundwater supplies. The scheme is applicable to soils over permeable bedrock such as chalk, limestone and sandstone. The soil physics database contains a large store of data of relevance to the mechanisms of nitrate pollution which is being used as a basis for risk classification. A preliminary leaching risk map of the Sleaford area (TFO4) at 1:25 000 scale and a text have been produced to aid practical agricultural recommendations to minimize nitrate leaching. (Carter and Robson)

Slurry and sewage sludge acceptance of soils. A map showing the suitability of soils for the acceptance of slurry or sewage sludge was published at 1:25 000 scale (Sheet SJ35, Wrexham North). Four acceptance classes show the degree of pollution risk. (Lea)

Changes during soil stripping operations. A National Coal Board-funded project was started to evaluate changes in soil strength and soil water content during soil stripping operations. Adjacent sites on Dale series, one stripped of topsoil and unvegetated, the other undisturbed and vegetated, were monitored at weekly intervals throughout the wetter-than-average summer. Measurements of soil moisture were made gravimetrically and by tensiometer and neutron probe; measurements of soil strength were by penetrometer and shear vane.

The exposed stripped ground became harder, drier and stronger than the equivalent unexposed subsoil, implying that further stripping could have been undertaken with less risk of damage to soil structure. However, this ameliorative effect was limited to the upper 20 cm of stripped ground. Below that level the subsoil moisture content and strength changed little but the equivalent layer of the undisturbed plot continued drying due to moisture extraction by vegetation.

The investigation has been extended to sites on Eardiston and Brickfield series and the final results will provide valuable data for planning soil stripping during opencast coal operations. (Reeve, Carter, Bembridge, Burridge and Leverton)

Woodland soils. The relationships between soils and the vegetation of ancient semi-natural woodlands have been investigated. Data from woods in Essex and Hampshire have been examined and some broad correlations were apparent. Stands containing field maple were usually on soils with calcareous layers although topsoil reaction varied from alkaline to moderately acid. Birch-oak woodland was restricted to the deep non-calcareous and most acid soils. (Allen)

Bracken in relation to soil type and slope. Bracken, one of the world's more successful opportunist species, is currently becoming more widespread in Britain and there is concern about the agricultural and wildlife implications of this.

Data collected during the National Soil Inventory for Wales included the dominance,

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presence of absence of bracken. Analysis of site and soil properties on sites with bracken have provided valuable insight into its ecological range. Bracken was found on a limited number of soil sub-groups of which typical brown podzolic soils and typical brown earths accounted for the majority of sites. Brown podzolic soil-led associations on the National Soil Map contain the most bracken land, and the Manod association, partly because of its large extent, is the single most important association. Ninety per cent of bracken occurs on slopes steeper than 7°.

In Wales, bracken is seldom found on the peaty soils of the high plateaux except where slopes are above average. In the North York Moors however, drying of similar soils by burning, drainage and other processes has rendered such land accessible to the plant, and bracken is threatening open heather moorland. Moorland reclamation in Wales may trigger a similar expansion of the fern's ecological range, but more detailed work is needed. (Thompson)

Soil acidity. pH values of topsoils (0–15 cm), measured during both the normal mapping and National Soil Inventory programmes, were used to prepare a soil acidity map of Wales. The data were grouped into three classes:

pH >5·6—soil buffered by exchangeable cations
pH 4·6–5·5—soil buffered by exchangeable cations and aluminium
pH<4·5—soil buffered by aluminium

Additionally, pH values were plotted against vegetation class (agricultural land, rough grazing, heather moorland, broadleaf woodland, coniferous woodland), soil type and moisture regime class (Bendelow and Hartnup, 1980). Mean topsoil pH is lowest, *given the same soil type,* under heather moorland and coniferous woodland (Table 1), whereas moisture

TABLE 1

pH of common soils in Wales by land use categories

Soil	Soil subgroup	pH under: Agricultural land	Rough grazing*	Broadleaf woodland	Coniferous woodland
Powys	Brown rankers	5·7† (±0·8) 17‡	4·6 2	4·7 1	
Denbigh and Barton	Typical brown earths	5·6 (±0·6) 47	4·0 1	3·9 1	4·1 1
Milford	Typical brown earths	5·9 (±0·9) 15			
Manod	Typical brown podzolic soils	5·4 (±0·8) 35	4·8 (±0·6) 9	4·4 (±0·4) 8	4·0 (±0·3) 8
Withnell and Whitcott	Typical brown podzolic soils	5·2 (±0·8) 11	4·1 (±0·5) 3	4·1 (±0·1) 2	4·1 1
Cegin	Cambic stagnogleys	5·7 (±0·4) 24	4·5 (±0·3) 3	5·1 (±0·9) 3	4·0 1
Brickfield	Cambic stagnogleys	5·6 (±0·5) 24	4·6 (±0·5) 7	4·5 (±0·1) 2	3·9 1
Hafren and Hiraethog	Ferric and ironpan stagnopodzols	5·6 (±0·7) 6	4·1 (±0·4) 16		3·8 (±0·3) 2
Wilcocks	Cambic stagnohumic gley soils	5·7 (±0·5) 5	4·4 (±0·5) 24	4·2 1	3·8 (±0·1) 3
Wenallt and Beacon	Cambic stagnohumic gley soils	5·3 1	4·3 (±0·5) 21		
Crowdy	Raw oligo-amorphous peat soils		4·1 (±0·4) 13		

* Rough grazing includes upland grassland (unenclosed), heather moor and bog, in this table.
† First figure is the mean pH in water.
‡ Second figure is number of sites.

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regime showed surprisingly little effect (Thompson and Loveland, 1985). The work is being extended to England, as the findings will be useful to the debate surrounding acid rain and its effects on soils. (Thompson and Loveland)

Soil salinity. The field work in the North Kent marshes was completed, a soil map drawn, and derivative maps prepared showing electrical conductivity and dispersion ratio (MAFF, 1982) at 0–15, 35–50 and 70–85 cm depths. Using these maps land can be graded in terms of the risk of soil structure collapse and drain failure upon a change of the use from grass to arable.

Mathematical analysis of the experimental data (*Rothamsted Report for 1984*) showed that soil structural stability is best assessed by laboratory measurement of dispersion ratio (DR), exchangeable sodium percentage (ESP), organic carbon content (OC) and calcium carbonate equivalent. From these data the following stability scale has been derived:

Criteria for assessment of soil stability

Class	DR %	ESP %	OC %	$CaCO_3$ %
Slightly unstable	<15	<10	>7·5	>2
Moderately unstable	15–30	10–30	2·5–7·5	<2
Very unstable	30–50	>30	<2·5	<2
Extremely unstable	>50	>30	<2·5	<2

Further work has shown that the salt-affected soils of North Kent have flocculation values (van Olphen, 1977) of about 40 mEq $Na^+ l^{-1}$, which corresponds to an electrical conductivity of about 3·5 mS cm^{-1} at 25°C. This suggests that the soil solution salt concentration (as NaCl) should be maintained above 2 g l^{-3} if structural instability is to be minimized. Unfortunately, almost all of the 0–15 cm samples examined during the survey have salt concentrations below this value, and many of those from lower depths are close to or below this threshold.

Similarly, the dispersion ratio measured for these soils can double if they are mechanically disturbed when wet. Further work is in progress to quantify this effect. (Loveland, Hazelden and Sturdy)

Humber warplands. Supervision of work on the warplands and adjoining areas by NERC/CASE student J. Atherton continued. Further sampling for study of the mineralogical, chemical, micromorphological and water holding properties of the soils was carried out in the autumn, mostly on Sunk Island and on the floodplains of the Trent and Ouse. Preliminary results from earlier sampling show distinct chemical and mineralogical changes in the sediments along the estuary and its tributaries. The Ouse sediments in particular reflect their Pennine origins as the mineral suite has affinities with that of the North Pennine orefield. (Mr J. Atherton, Hull University with Furness)

Thin ironpan formation. Humus-ironpan stagnopodzols are widespread on the Fell Sandstone in Northumberland, where field evidence suggests that they develop from humo-ferric podzols. The chemical, physical and micromorphological properties of both soil types have been compared and a detailed study made of their composition using the scanning electron microscope and energy dispersive X-ray analysis of polished thin sections. It was concluded that humus-ironpan stagnopodzols develop from humo-ferric podzols, which themselves were formerly argillic brown earths. An ironpan develops between the Bh and Bs horizons in response to increased wetness in the Bh horizon and the principal process in its formation involves the reduction of previously translocated iron in the Bh and the surface of the Bs horizon. Iron is precipitated in response to the more oxidizing environment in the

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Bs horizon, where the initial sites of deposition are possibly controlled by pre-existing illuvial clay. No marked accumulation of aluminium was found in ironpans, compared with amounts in Bs horizons. (Payton)

Joint Soil Survey Handbook. Work has continued on the development of an agreed format and terminology for a joint Soil Survey of England and Wales and Soil Survey of Scotland Handbook for the description of soils in the field. A first draft is now complete and will be circulated to staff for comments. It comprises five main sections: General; Site Description; Profile Description; Horizon Nomenclature; and General Site and Profile Characteristics. In addition there are Appendices describing Sampling Procedures; Methods for the Field Estimation of Bulk Density and Packing Density; Stoniness and some simple Chemical Tests. The draft is based on Soil Survey Technical Monograph No. 5 (Hodgson 1976), with some minor alterations to ensure internal consistence of terminology and general agreement with other national systems of soil description such as the USDA National Soils Handbook (Soil Survey Staff 1983). The proposed changes to Technical Monograph No. 5 include:

(i) A revision of Table 4 (Hodgson 1976, p. 39) relating to packing density. This follows a re-evaluation of the criteria used to assess packing density and a study of the feasibility of incorporating the Peerlkamp system of structural assessment into the section on Description of Cultivated Horizons.

(ii) The inclusion of a subsection on Induration within the Profile Description section.

(iii) A new section on General Profile and Site Characteristics. This is for the recording of general profile features or site factors which are closely related to soil properties and soil formation, but cannot be directly measured or estimated. The section includes:

- (a) Depth to a watertable.
- (b) Wetness class of the profile.
- (c) Soil parent material, which incorporates a correlation of the soil parent materials recognized in Scotland, with the parent material types recognized in England and Wales.
- (d) Climate—either the Bioclimatic Region (Birse 1971) or specific data from the Soil Survey of England and Wales Agroclimatic Dataset (Jones and Thomasson 1985).
- (e) Plant community (Robertson 1984).
- (f) Interpretations.

(Hollis, with C. J. Bown, Soil Survey of Scotland)

Supporting work

Soil water retention. The Shardlow laboratory measured the soil water retention properties over 1700 samples from 118 profiles. These included profiles dug to characterize soil series for which few data are available, research projects and samples taken for the North of England Soils Discussion Group, Severn Trent Water Authority and the Animal and Grassland Research Institute. Approximately 300 samples were analysed for the Midland Research project, which has been investigating soil physical factors affecting reclamation after opencast coal extraction. The Shardlow database has continued to be an invaluable asset in answering enquiries about soil physical properties from ADAS, environmental consultants and other research institutes. (Bembridge, Burridge and Carter)

Soil micromorphology. Over 300 samples were impregnated with resin and either made into thin sections or used in image analysis of soil structure.

A handbook on 'Thin section preparation of soils and sediments' has been prepared under

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auspices of the International Society of Soil Science and will be published in early 1986. This book aims to outline the most suitable techniques and materials for sampling, water removal, resin impregnation and thin section preparation of soils and sediments around the world. (Murphy)

Publications programme

Since February, the texts of 25 Records have been edited in a simplified, cheaper format which will enable the backlog of those publications, suspended because of financial restrictions during the National Map programme, to be cleared. Of these one was published during the year and five are at the printers. The rest are either at the printers for estimating or are being word processed.

Other publications edited include the text of the special survey of the North Kent Marshes, a reprint of the Field Handbook and three new Technical Monographs, numbers 16, 17 and 18, of which numbers 16 and 17 have been published.

As an economy measure, maps to accompany most of the Records are being published in black and white but the first of the 1:50 000 scale maps (Worcester and the Malverns) is being digitized and printed in colour. (Hodgson, Reeve, Palmer and others)

Special surveys

Epping Forest. The soils of Epping Forest are currently being surveyed at a scale of 1:15 000 as part of a community programme funded by the Manpower Services Commission. The survey is being carried out by Mr Kamal Bharj of the Forest Projects Community Programme Agency, with a watching brief from the Soil Survey of England and Wales. To date about half the Forest has been surveyed and a preliminary report on the geology, soils, landscape and vegetation is in preparation.

The area is underlain by Tertiary deposits (London Clay, Claygate Beds and Bagshot Beds) with middle-Pleistocene gravels capping the highest plateaux, along with remnants of chalky till. The gravels are deeply weathered, but have been extensively reworked by solifluction so that Head deposits of variable thickness mantle upper and middle slopes throughout the Forest. Soils of the Wickham series are extensive, covering most of the sloping ground where thin Head overlies Tertiary clays. Windsor soils are found mainly on lower slopes and valley bottoms, or in the lowest parts of the Forest where there is little drift contamination. Bursledon and Dundale soils occur unpredictably on middle and upper slopes, mainly in the higher parts of the Forest where loamy intercalations occur within the Tertiary formations. These soils are sometimes associated with small areas of stagnogley-podzols or humo-ferric podzols (Holidays Hill or Shirrell Heath series) formed in thin sandy superficial drift. Paleo-argillic stagnogley soils of the Essendon series cover most of the higher plateau and are associated with areas of disturbed soils formed in old gravel diggings. A small inclusion of Beccles soils has also been mapped on a remnant of chalky till.

Soil monoliths of Essendon, Wickham, Windsor, Bursledon, Dundale, Holidays Hill profiles have been taken and are on display at the Epping Forest Conservation Centre along with relief models showing the soil distribution in parts of the Forest. Topsoil pH has been measured on some random samples and it is hoped to carry out a comprehensive sampling programme to study the variation of pH within one Forest sector. (Hollis, with Mr K. Bharj)

Martin Down National Nature Reserve. The soils of this reserve were surveyed for the Nature Conservancy Council using information from 113 shallow pits and auger borings on a 250 m grid. Most of the land has silty Andover soils with chalk at shallow depth. Some deeper silty over clayey Carstens and Porton series also occur. A complex striped pattern of

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soils occurs on a prominent ridge in the south of the area. Here deep sandy Ebstree soils occur in close proximity to shallow sandy and coarse loamy soils over chalk at shallow depth. Ninety four samples were taken for pH measurement. The vegetation was described at each grid observation point and the relationship between soil properties and vegetation investigated. (Allen)

Staff

D. Mackney retired as Head of the Survey in March after 35 years in the organization, seven of them as Head. He was a stimulating and vigorous leader. During his period of office he initiated and supervised the production of the National Soil Map at 1:250 000 scale. His services to agriculture were justly rewarded with the award of an OBE in the New Year Honours list.

Two other long serving members of staff retired, D. C. Findlay, Regional Officer for the South West, after 34 years and R. D. Green, Publications Editor, after 32 years. S. J. Fordham resigned to join a firm of consultants and A. J. Moffat joined the Forestry Commission. Other resignations through the year have come from Elaine L. Avis, G. P. Bailey, Amanda J. Frith, W. G. Marshall and Debra J. Writer.

P. L. Thorne was appointed to work on the Soil Information System section.

A NERC/CASE award was secured in partnership with the Department of Geography, University of Exeter to work on a hydrological model for upland soils. Maureen McHugh was appointed to this studentship.

D. M. Carroll and R. Evans attended the International Society of Soil Science Working Group Meeting on 'Remote Sensing for Soil Surveys' in the Netherlands and presented a paper. R. G. O. Burton studied peat inventory methods in the field and laboratory while on a visit to Kuopio, Finland as a guest of the Geological Survey of Finland. Andrée D. Carter attended the first TNO Conference on Contaminated Soil in Utrecht, The Netherlands. She also spent five days with the Dutch Soil Survey studying soil physical techniques used in land evaluation. C. C. Rudeforth attended an EEC Joint Research Centre Collaborative Programme meeting on Remote Sensing in Wageningen, The Netherlands. P. Bullock and C. P. Murphy attended the 2nd ISSS Sub-Commission Meeting on Soil Micromorphology in Paris at which they chaired sessions and presented papers. A. J. Thomasson attended the 10th Conference of the International Soil Tillage Research Organization in Guelph, Canada and presented a paper. P. J. Loveland gave lectures and seminars at a NATO-Advanced Study Institute on 'Iron in Soils and Clay Minerals' at Bad Windsheim, Germany. He also visited the Research Institute for Agrochemistry and Soil Science of the Hungarian Academy of Sciences under the auspices of the British Council. The visit concentrated on the chemistry, mapping and amelioration of salt-affected soils.

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