



GHANA

REPORT
ON THE
DEPARTMENT OF
SOIL AND LAND-USE SURVEY
FOR THE PERIOD
1st JANUARY TO 31st JULY, 1957

GHANA

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**REPORT ON THE DEPARTMENT OF SOIL AND LAND-USE SURVEY
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INTRODUCTION

Towards the end of June, 1957, it was decided that the Department of Soil and Land-Use Survey should be amalgamated with the Department of Agriculture with effect from 1st August, 1957. This report is submitted to cover the last seven months of the Department's existence as an independent organisation.

This period saw a marked reduction in the scale of field operations resulting from the continuing deterioration in the senior staff situation. Efforts were mainly concentrated on sorting out and putting on record information collected by the Department during previous years whilst some of the officers responsible for the original fieldwork remained available.

ADMINISTRATION

Staff

The senior staff situation continued to deteriorate during the period under review. Two Soil Survey Officers, Miss H. T. Brash and Mr. M. F. Purnell, departed on leave in March prior to the expiry of their contract appointments, and two more Soil Survey Officers announced their intention not to seek renewal of their contracts at the end of their current tours expiring during the latter half of 1957.

There was no response to recruiting advertisements during the period. The post of Director remained unfilled and lapses on the amalgamation of the Department with the Department of Agriculture. Because of the apparent impossibility of attracting a suitable recruit to the long-standing vacancy, it was decided by Government that the post of Senior Geographer should lapse at the end of the 1956-57 financial year on 30th June.

The senior staff position as at 31st July is given in the table below. Figures for 31st December, 1956, are given for comparison.

Post	31st Dec., 1956		31st July, 1957		Remarks
	Occupied	Vacant	Occupied	Vacant	
Director	—	1	—	1*	*To lapse 31st July, 1957.
Senior Soil Scientist	1	—	1	—	
Senior Geographer	—	1	—	—*	*Lapsed 30th June, 1957.
Soil Analyst	3	1	3	1	
Soil Survey Officer	7	3	7*	3	*Includes 2 officers on final leave.
Grassland Ecologist	1	—	—	1	
Crop Ecologist	—	1	—	1	
Compilation Officer	1	—	1	—	
Assistant Accountant	—	1	—	1	
Totals	13	8	12	8	

Mr. H. Brammer acted in the post of Director until his departure on leave on 3rd July. Thereafter, Mr. C. W. Montgomery, Soil Analyst, acted as Director.

Whilst the senior staff situation continued to deteriorate, there was a continuing improvement in the position regarding junior technical officers. There was little doubt, in fact, but that it would become possible within a further year or two to fill most of the vacancies in the various technical grades. On the satisfactory completion of their three-year training course, three learners were appointed junior technical officers on 1st June: two of these become Assistant Soil Survey Officers, Grade II; the other becomes an Assistant Soil Analyst. Consequent upon the abolition of the post of Senior Geographer a number of posts of Assistant Surveyor, Assistant Soil Survey Officer and Field Superintendent were allowed to lapse at the end of the 1956-57 financial year. The situation in the junior technical grades as at 31st July is shown in the following table. Figures for 31st December, 1956, are given for comparison.

Post	31st Dec., 1956			31st July, 1957			Remarks
	Occupied	Vacant	Trainees	Occupied	Vacant	Trainees	
Assistant Soil Survey Officer, Grade I	3*	1	—	3*	1	—	*(One on Scholarship in U.K.)
Assistant Soil Survey Officer, Grade II	5	13	7	7	9*	—	*2 posts lapsed on 30-6-57
Soil Survey Assistant	2	—	—	2	—	—	*Post abolished 30-6-57.
Assistant Surveyor, Grade I	—	1	—	—	*	—	do.
Assistant Surveyor, Grade II	—	4	—	—	*	—	
Senior Assistant Soil Analyst	1	—	—	1	—	—	
Assistant Soil Analyst	3	5	2	4	2*	1	*2 posts lapsed on 30-6-57.
Laboratory Technician	—	1	—	—	*	—	*Post abolished 30-6-57.
Station Superintendent	1	—	—	1	—	—	
Field Superintendent	3	3	—	3	1*	—	*2 posts lapsed on 30-6-57
Senior Assistant Compilation Officer	1	—	—	1	—	—	
Assistant Compilation Officer	—	2	1	—	2	1	
Draughtsman, Grade I	—	1	—	—	1	—	
Draughtsman, Grade II	4*	—	—	4*	—	—	*1 held against Grade I vacancy.
Totals	23	31	10	26	16	2	

The reduction in the scale of field operations also made necessary a substantial reduction in the numbers of daily-rated field staff that could be employed and considerable numbers were declared redundant in January and in June-July. Comparative figures for 31st December, 1956, and 31st July, 1957, in the main field grades affected are given below and indicate the scale of this retrenchment.

Grade	Numbers employed	
	31st Dec., 1956	31st July, 1957
Leading Field Assistant	18	18
Field Assistant	23	2
Soil Grinder	35	20
Drawing Office Assistant	12	12
Driver	14	9
Totals	102	61

Accommodation

The installation of water, gas and electricity services in the newly-erected Kjeldahl house adjoining the main laboratory block was completed during the period. A room adjoining the physico-chemical laboratory, formerly used as a stationery store, was converted into a dark-room so as to facilitate the development of X-ray photographs obtained on the apparatus installed in the neighbouring room.

A site adjoining the main stores was levelled in preparation for the erection of a 12-bay Arcon structure to provide fitters', carpenters' and black-smiths' shops.

Wooden louvred shutters in the junior staff quarters which had provided inadequate protection against rain squalls were replaced by glass windows.

POLICY

The Department's policy remained unchanged during the period.

In summary, this policy is:—

- (i) to carry out a systematic Detailed Preliminary survey of the country's soil, vegetation and present land-use;
- (ii) to carry out Detailed surveys of Sample Strips within each of the major soil associations delineated during the Detailed Preliminary surveys;
- (iii) to carry out surveys in such detail as may be necessary of areas considered suitable for agricultural development;
- (iv) to obtain analytical data characterizing all soils of importance collected during the above surveys;
- (v) to provide Government with the basic information necessary for planning successful land-use;
- (vi) to provide other departments and organizations engaged on development work with such scientific data on soils and their associated topography and vegetative cover as may be needed.

The progress made during the period in implementing this policy is detailed in subsequent sections of this report.

As in 1956, the major obstacle to progress arose from the diminution in the number of professional officers at post. Early in the period, the scale of field operations had to be drastically reduced and, in effect, throughout most of the period it was only possible to maintain one special surveys party in the field in place of the scheduled three regional survey and one special surveys parties, together with topographical survey, Crop Ecology and Grassland Ecology parties.

WORK OF THE FIELD SECTIONS

COCOA SOILS

The Department's knowledge concerning cocoa soils has been summarized in a paper by Mr. A. J. Crosbie, Soil Survey Officer, for presentation at the 1957 Conference of the Cocoa, Chocolate and Confectionery Alliance, Ltd. This paper is based on experience gained during previous years during surveys over more than 16,000 square miles of the forest zone, an area representing more than half the area climatically suited to the growth of the tree and including soils formed over all the country's major geological formations under all climatic, topographic and vegetation conditions known to occur in the forest zone. This experience is now sufficient to make possible an assessment of the suitability for cocoa production of the soils of the whole forest zone. The paper includes a map showing the distribution of the various categories recognized (reproduced in this report as Map 2), as well as analytical data for the two most widespread cocoa soils.

The major criteria used in this assessment, soil moisture relationships and inherent soil fertility, are similar to those employed by the late C. F. Charter in his "Cocoa soils: good and bad" which appeared in 1948. Particular importance is attached to moisture relationships. In the first place, the amount and seasonal distribution of annual rainfall are primarily responsible for the differences between the two major soil groups of the forest zone, the Forest Ochrosols and the Oxysols. Forest Ochrosols occur under mean annual rainfalls of approximately 45 to 65 inches where there is a marked accumulation of nutrients in the topsoil and this group provides the country's major cocoa-producing soils. Oxysols, developed where annual rainfall exceeds approximately 70 inches and the dry season is very short, are highly leached throughout and are unsuitable for cocoa production. The intergrade zone between these two major groups generally provides only poor conditions for cocoa.

Then, within the Ochrosol belt, the soil must be able to retain sufficient moisture to support the cocoa tree during the main dry season. This depends partly on the texture of the soil and partly on the length of the dry season or exposure of the locality or site to harmattan winds. Further, in the deeply-weathered soils which occupy most of the belt, speed of drainage of the soil, determined by the texture of the whole profile and the topographic site, determines the rate at which nutrients accumulated in the topsoil under the natural forest vegetation are lost by downward leaching through the profile when the forest cover is cleared to make way for cultivation.

This assessment is based on the soils as they exist under their natural forest vegetation. No account is taken of the possibilities of manuring the crop since none of the crop is yet produced with this aid. Nor does it take into account changes which have already taken place in areas where the forest has been cleared for cultivation or of areas affected by the major cocoa diseases; in fact, wide areas of Second and Third class soils have already gone out of cocoa cultivation. Further, in referring to the map it has to be pointed out that soil patterns in the forest zone are typically complex so that only the suitability of the major upland soils, covering perhaps 40 to 80 per cent of any particular area, can be indicated.

The four categories mapped are briefly described below and the area covered by each unit is tabulated.

First class soils occur only over incompletely-weathered, basic or near-basic rocks. They are well supplied with nutrients, contain little coarse material and possess a clay texture having a high nutrient and moisture-retaining capacity. With adequate shade preserved, they can support high-yielding cocoa almost indefinitely; it might be expected that production could be increased still further by the addition of certain fertilizers. Such soils altogether cover only about 300 square miles, generally in small pockets of 10 to 100 acres on Upper Birrimian hill ranges, but larger expanses occur around Tafo, Eastern Region, and Goaso, western Ashanti.

Second class soils are clay earths containing little coarse material developed mainly over biotite granite or schist. They have good moisture relationships and moderate nutrient reserves. With adequate shade maintained, they support good cocoa for approximately 30 to 40 years before yields seriously decline. Economic responses to the application of fertilizers are to be expected on soils of this category, and they could then be kept permanently in production. It was on these soils in the old Eastern Province and in Ashanti that the cocoa industry first developed, but they passed their production peak in the 1930's. It is to be expected that with the use of fertilizers and other improved methods of husbandry many soils in the latter areas could once again be made to produce good cocoa. Altogether, Second class soils cover some 2,400 square miles, or almost 8 per cent of the forest zone.

Third class soils generally have large proportions of silt, sand and/or gravel giving them poor nutrient- and moisture-retaining capacity or occur on unsuitable topographic sites such as steep slopes or river flood-plains. Parent materials include phyllites, tuffs, sandstones and some poorly-drained colluvial and alluvial deposits. This category also includes soils occurring in the marginal climatic conditions near the northern edge of the forest zone, especially in Togoland. Cocoa does well for up to 20 to 25 years on such soils, but yields decline thereafter. It would doubtfully be economic to manure most soils of this category. These are the most extensive and most widely distributed soils of the forest zone, covering altogether some 14,800 square miles, or almost half the whole area of the zone.

Unsuitable soils for cocoa production comprise those which are highly acid, droughty, shallow or ill-drained. They include all the soils of the Oxysol belt with the exception of certain yellow alluvial earths bordering some of the rivers, and almost all the soils of the Forest Ochrosol-Oxysol intergrades belt. Within the Ochrosol belt, they comprise soils developed over coarse-grained granites and pegmatites which occur extensively throughout the zone, particularly in the south of the old Eastern and Central Provinces; soils developed over deep peneplain drifts occurring extensively to the north of Kumasi and in western Ashanti; soils over quartzite and shallow soils over other rocks or sheet ironpan; and soils over most colluvial and alluvial sediments. Cocoa either fails to become established or yields at only a low level on such soils, and it would doubtfully be economic to add manures. Altogether, soils of this category cover some 13,500 square miles, or over 40 per cent of the forest zone.

The respective areas covered by these categories are shown in tabular form below.

Category	Area in square miles	Per cent of forest zone
Ochrosols:		
First class	300*	1.0
Second class	2,400*	7.8
Third class	14,800*	47.7
Unsuitable	3,100	10.0
Intergrades	7,100	22.9
Oxysols	3,300	10.6
	} 13,500	} 43.5
Total area climatically suited to cocoa cultivation	31,000	100.0

The main implications of this assessment are:—

- (i) Only a minor fraction of the forest area has soils capable of giving sustained high cocoa yields without manuring.
- (ii) The area of unreserved forest previously considered available for new plantings is considerably reduced since this mainly remains in areas now considered unsuitable for cocoa production.

*Approximately 20 per cent of this area will be occupied by lowland soils which, in general, provide poor media for cocoa production.

- (iii) Provided manuring is practised (and other improved methods of husbandry are adopted), there is an ample area of good cocoa soils (First and Second class) to enable the country to maintain its present level of production and even increase it if desired. (At an average yield of 1,000 lb dry beans per acre, which improved methods of husbandry could easily make attainable, an area of some 800 square miles would be required to produce an annual crop of 230,000 tons. This is less than one-third of the combined area covered by First and Second class soils.)
- (iv) Agronomic trials should be concentrated on First and Second class soils.

SURVEYS

Map 1 shows the areas covered by soil surveys up to 31st July, 1957. Areas in which fieldwork was carried out during the period under review are indicated in heavy shading.

Forest-Zone Surveys

The Detailed Preliminary surveys of the Lower Tano and Pawmpawm Basins, commenced in 1954 and 1956 respectively, were completed by early February, 1957. Full accounts of these surveys were given in the Annual Report for 1956. No new regional surveys in the forest zone were undertaken, although in April, Mr. P. M. Ahn, Soil Survey Officer, paid a preliminary visit of a few days to the southern half of the Bia Basin in western Ashanti in order to examine road communications as an aid to planning a Detailed Preliminary survey of this region which it is hoped to commence later in 1957.

At the end of the period, the total area surveyed within the forest zone, including the larger of the areas covered by Special surveys, amounted to slightly more than 16,000 square miles.

Savannah-Zones Surveys

The northernmost part of the Pawmpawm Basin, which was surveyed during January and early February, 1957, actually falls within the interior savannah zone. The greater part of this region falls within the forest zone, however, and an account of the savannah soils was included in the report on the whole region given in the Annual Report for 1956 (Department of Soil and Land-Use Survey, 1958).

Mr. M. F. Purnell, the Soil Survey Officer who had commenced a Preliminary survey of the Mole-Lower Kulpawm-Daboya Region in August, 1956, was prevented on medical grounds from resuming this survey during the period under review and left Ghana on final leave in March. Shortage of senior staff prevented another officer being delegated to re-open this important survey.

No new regional surveys were undertaken in either of the savannah zones during the period.

Special Surveys

Re-survey of the Central Agricultural Station, Kwadaso, Kumasi

The site for this station was examined and described by C. F. Charter in 1946. Later in the same year a Detailed survey was carried out and a map issued. A re-survey of the station was decided upon to check the reliability of the previous work in the light of more advanced knowledge of the soils of the forest zone which has accrued in the subsequent decade. The station is located south of the Kumasi-Sunyani road some four miles west of Kumasi. It is roughly rectangular in shape and occupies an area of approximately 1,300 acres. Traverses were cut at 10-chain intervals with transverse check-lines where required. More detailed investigations were made in some areas. The fieldwork was carried out under Mr. Crosbie's direction between 22nd January and 19th March.

Annual rainfall averages 55-60 inches. Most of the station is underlain by medium-grained biotite granite. There is an abrupt boundary between this formation and the Lower Birrimian sediments (mainly phyllites) which occur in the extreme eastern portion. Topographically, the area forms part of the dissected Akumadan peneplain surface which here lies at a height of about 900 feet above sea level. Relief is for the most part gently rolling, but an extensive, flat-topped, ironpan crust caps the Lower Birrimian sediments in the residential area.

The most extensive soils on the station are reddish brown gritty loams which, under natural forest, have good nutrient and moisture relationships. The underlying granite is deeply weathered: a shaft excavated on the station had still not penetrated the zone of complete weathering at a depth of 55 feet.

Climate and topography are typical of conditions found in the semi-deciduous rain forest area and the soils are representative of those widely developed over medium-grained granite in the Forest Ochrosol belt. The upland soils provide the major cocoa-producing soils of the country. Work carried out on these soils at Kwadaso, therefore, is capable of a wide application.

On the tractor block, a number of pits were dug to examine the influence of mechanical tillage on profile morphology. It is apparent that on the very gentle or flat summits there has been little change, although crumb structure in the surface layer has tended to disappear. On the slopes, however, which average 7 per cent, there has been a drastic change in profile morphology. Here there was originally 7 inches of gritty loam overlying 2 feet of gritty clay containing frequent quartz gravel. Following five years' mechanical cultivation of arable crops (maize, cassava and groundnut), there is now 2-3 inches of gravelly coarse sandy clay overlying 2-15 inches of gravelly coarse sand. It is apparent that almost all the fine material formerly present in the topsoil and upper subsoil has been washed through the former gravel zone which is normally the zone of subsurface drainage in these soils. Quartey-Papafio (1957) has reported that contour bunds on the station show an accumulation of fine material on their up-slope side, obviously washed out of the soils above.

A detailed report on the soils of the station had almost been completed by the end of the period.

Joint WACRI-Department of Agriculture cocoa manurial trial plots*

In 1953, sixteen yield-recorded peasant cocoa plots in Ghana were selected by WACRI and the Department of Agriculture on which fertilizer trials were to be carried out. For a variety of reasons, it was decided late in 1956 to reduce the number of these plots to nine located within convenient reach of Kumasi, Ashanti.

In 1957, Mr. Crosbie made more brief inspections of a number of the sites originally selected. No formal report on these surveys was produced but Mr. Crosbie made a verbal report on his findings at a meeting of the Fertilizers sub-committee of the Advisory Committee on Agriculture held in Kumasi on 2nd and 3rd April, 1957. Some of the sites were considered unsuitable for the purpose because of disturbance by former settlement, old roads or recent burials. Of the six sites eventually agreed upon, three are located on major cocoa soils and three on minor series.

Subsequently, one of the plots, at Juaso, was sampled by Mr. Crosbie before fertilizers were applied in April. Four fertilizer treatments are being used replicated eight times on circular plots of 1,600 square feet. Four topsoil samples were taken at approximately 10-foot radius from key trees in three replicate plots of each treatment. To overcome variations in the thickness of the topsoil the upper and lower layers of this horizon were sampled separately. The samples from each plot will be bulked and aliquot samples then analysed. The results will be correlated with recorded pre-treatment and post-treatment yields.

Bobiri Forest Reserve

A Semi-detailed survey of Bobiri Forest Reserve was carried out between 11th April and 22nd June by a field team under the charge of Mr. H. B. Obeng, Soil Survey Officer. This reserve is roughly rectangular in shape and covers an area of 21.14 square miles lying to the north of the Kumasi-Accra road some 20 miles east of Kumasi. In order to avoid unnecessary disturbance to vegetation in the reserve, traverses were laid out along compartment boundaries as far as possible to give a coverage approximately equivalent to a 20-chain grid. Detailed surveys were carried out on a 4-chain grid in certain parts of the reserve.

The survey was undertaken for two reasons. In the first place, it was designed to provide the Forestry Department with information on the soils of the reserve since Bobiri is their main research centre in the country, where the greater part of their work on restocking and regeneration is carried out. In the second place, the survey was undertaken to provide basic information on the soils of the reserve and relate them to conditions obtaining elsewhere in the forest zone for the benefit of a team of scientists from Imperial College, London, who arrived in Ghana on 26th July. Primarily, the object of the expedition was to spend three months in and around the reserve studying the changes which take place in forest soils when the natural forest vegetation is cleared for cultivation and during the successional vegetation phases following cultivation. This study is of great importance to the country since, *inter alia*, it may be expected to shed light on the reason why cocoa cannot satisfactorily be established on soils which have previously been cultivated but only on soils newly cleared from natural forest or old secondary forest vegetation. It may also provide further information on the role of bush fallowing in restoring soil fertility, of great importance since to all intents and purposes this is the only technique of maintaining soils in good agricultural condition employed by Ghana farmers. In view of the nature of farm units in this country, however, the team will this year be largely engaged in the delineation and preliminary investigation of sites for future detailed work to be carried out at annual intervals. Immediate investigations are concerned with rice cultivation and the ecology of swamp areas in forest with particular reference to soils and vegetation.

Environmental conditions within the reserve are fairly representative of those experienced over the greater part of the forest zone. Rainfall recorded in the reserve over the past five years has averaged 60 inches per annum. Lower Birrimian phyllites underlie most of the area but there are small acid igneous (granite) intrusions in the north and south-east surrounded by well marked contact zones occupied by biotite schists. Topographically, the reserve covers part of a gently undulating peneplain at a height of 850 feet above sea level lying a few miles south of the Mampong-Kwahu scarp, the major watershed in the country. Tributary streams of the river Anum running north-east to south-west through the area have cut steep-sided valleys into this surface, but extensive areas of peneplain drifts remain on the flat-topped interfluvies. Colluvial and alluvial deposits are relatively minor in extent.

The soils of the reserve are typical of those developed elsewhere in the Ochrosol belt over similar geological and topographical formations. Soils of Bekwai/Akumadan Oda Complex Association, developed over Lower Birrimian phyllites, occupy approximately two-thirds of the area. Here, the upland soils comprise red and brown silty clays containing abundant ironstone concretions; ironpan may occur on the summits. The associated valley bottoms contain yellow and grey clays. Morphologically similar soils occur over the biotite schist, but here the sedentary upland soils have a higher inherent fertility and the lowland soils are more sandy. The medium-grained granite gives rise to red and brown gritty loams on the uplands and yellow and grey coarse sands or fine gravels in the depressions. Peneplain drifts overlying the granite consist of red, very deep (10-15 feet) sandy loams; these have a low moisture-retaining capacity.

Detailed surveys were carried out of some of the silvicultural plots in the west of the reserve and of an area where the tree *Turraeanthus vignei* is particularly common. Accounts of those areas are included in the report on the whole reserve which was in preparation at the end of the period.

Asukese Forest Reserve

At the request of the Forestry Department, a description of the soils of this reserve was prepared by Mr. A. J. Crosbie for inclusion in the Working Plan. The reserve had been surveyed in part during the Detailed Preliminary survey of the Upper Tano Basin and the soil series present identified and described.

* West African Cocoa Research Institute.

Located as it is on a major watershed between the Bia and Tano basins, the reserve mainly occupies well preserved remnants of the Akumadan peneplain surface. In the west, deep drift soils occur over granite. In the east, there is widespread sheet ironpan overlying Lower Birrimian phyllite.

A report on the area was in preparation at the end of the period.

Poanu Cocoa Station

This station, belonging to the Department of Agriculture, comprises some 243 acres of land lying south of the Bekwai-Manso Nkwanta road in Ashanti. A Detailed survey of this site was commenced by Mr. Crosbie on 24th July. Traverses were being cut at 5-chain intervals.

Annual rainfall recorded at the station amounts to 60 inches falling in two well-marked rainy seasons. The area overlies metamorphosed Lower Birrimian sediments, predominantly phyllites, which are locally impregnated with quartz veins. Flat-topped summits occur at the northern and southern ends of the station which is bisected by the Abomosu stream.

The soils belong to the Mim/Oda Compound Association mapped during the Detailed Preliminary survey of the Kumasi Region in 1953-54 (Department of Soil and Land-Use Survey, 1957). The predominant upland soils are red and brown silty clays which are locally very stony where quartz veins are numerous in the underlying rock. None of the soils is inherently very fertile, and the stony soils are strongly leached even in the topsoil.

This survey was still in progress at the end of the period.

CORRELATION SECTION

Correlation of soils sent in by field parties continued. Due to the temporary cessation of regional surveys it has been possible to bring up-to-date the correlation of profiles sent in from all previous surveys. By 31st July, records for 6,200 profiles representing soils from all parts of the country had been filed and tabulated. The number of boxed profiles in the museum, at over 3,000, increased slightly.

The rock collection was re-classified during the period. On the completion of each survey all specimens are compared with those in the museum. If not previously recorded, they are retained; if similar to specimens already in the collection, their source is mapped and they are then discarded.

All available field and analytical data on all soil series recognised have now been correlated. Generalised descriptions of more than 100 of the major series have been prepared for issue in loose-leaf form. In the Correlation Manual*, more than half the 600 soil series recognised have been indexed and classified, and the remainder have been prepared in draft form awaiting final checking. Work commenced on the preparation of official descriptions of the soil associations mapped throughout the country; the first of these have already been incorporated in the Correlation Manual. Work was also commenced on the classification of all the great soil groups and soil series of the forest zone with respect to their suitability for cocoa production.

The compilation of the soil associations map, referred to in the Annual Report for 1956, continued. The area falling within the forest zone has already been completed and was used as a basis for Map 2 showing the distribution of soils *vis-a-vis* their suitability for cocoa production. It was also used as a basis in the preparation of a simplified soil map of the south-eastern part of the country for display in Ministry of Agriculture publicity kiosks.

Classification of the country's soils into higher categories continued. Representative profiles of the country's major great soil groups were despatched to Rothamsted Experimental Station, Harpenden, England. Arrangements were in hand to donate similar collections to the University College of Ghana Faculty of Agriculture for the benefit of students reading agriculture.

As in previous years, there were many visitors to the soil and rock museum. These included numerous parties of school children as well as agricultural students from the University College of Ghana. Officers from a number of government departments also made reference to soil and rock specimens held in the museum.

In the herbarium, the mounting and indexing of specimens continued. Little collecting was possible during the period. Through the generosity of Mr. R. Rose Innes of the University College Faculty of Agriculture, duplicate specimens of 237 grasses and sedges collected by him and identified for him at the Kew herbarium were received and added to the Department's reference collection.

ECOLOGY SECTION

No work was possible in the Ecology Section during this period due to the vacancies in the two professional Ecologist posts. Grass, sedge, herb and shrub specimens sent in by field parties and officers of other departments were identified by the herbarium staff when required.

LABORATORY SECTION

Buildings and equipment

The furnishing and equipment of the Kjeldahl house were completed and water, gas and electricity services installed during the period.

The insulation of the original electric wiring of the main laboratory, installed in 1952, was discovered to have deteriorated, thus endangering the safety of personnel and equipment and interfering with reliable supply. The complete re-wiring of this building was therefore commenced towards the end of the period.

With funds provided by the Department of Agriculture, a four-core underground cable is now being installed from the power-house to the Department's laboratories as well as those of the Department of Agriculture. This will ensure undisturbed supply to these premises should a fault develop elsewhere in the system and provide increased protection against lightning damage.

*A loose-leaf compilation issued for the guidance of Departmental officers.

Routine analyses

A thorough review of analyses carried out in previous years revealed that the scope of routine analyses was unsatisfactory in a number of cases. In the original scheme the first four horizons of each profile sent to the laboratory were analysed in considerable detail. This assumed that the morphological horizons sampled in the field coincided with the true pedogenic horizons. Experience has shown that this assumption has not been correct in all cases due to the differentiation and sampling of subhorizons in the field. This has resulted in some profiles being analysed only to a depth of 18 inches whereas others have been analysed to depths exceeding three feet, with consequent difficulties in the statistical treatment of data. Close scrutiny of a great number of analyses indicated that only insignificant changes in chemical composition occur below a depth of three feet in the majority of the country's soils, and the scheme of routine analyses was accordingly modified as follows:—

- (i) Separation of the fine earth (gross mechanical analysis): carried out on all samples since this provides essential information for the calculation of nutrient contents on an areal basis.
- (ii) pH: determined on all samples.
- (iii) CaCO_3 : determined on all samples in profiles where it is liable to occur.
- (iv) Electrical conductivity (as a measure of salt content): determined on all samples where salts are considered liable to occur.
- (v) Organic carbon and nitrogen: determined on all samples down to at least three feet.
- (vi) Exchangeable cations Ca, Mg, Mn and K, together with Na where this is likely to be important: determined on all samples down to at least three feet.
- (vii) Total phosphorus: determined on all samples down to at least three feet.

The estimation of total base exchange capacity by the ammonia absorption method has been found to give unreliable results and has been abandoned. Where required, this quantity is determined by the barium acetate method which appears to give reliable results. This method is somewhat lengthy, however, and cannot conveniently be fitted into the routine scheme.

As indicated in the Annual Report for 1956, it was found necessary to determine the amount of exchangeable manganese present in soils in order to correct the values for exchangeable magnesium obtained by the versenate method. In this way, a considerable amount of data on exchangeable manganese was collected. Study of this information revealed that there were characteristic differences in content between various soils, some soils being found to contain very large amounts of exchangeable manganese—as much as 300–400 p.p.m. Mn, a level normally regarded as toxic—but yet supporting healthy cocoa. Because of its possible importance in this respect, it was decided to determine exchangeable manganese within the routine scheme.

An innovation during the period has been the provision to field officers of nutrient data for their soils calculated on an areal basis; i.e. giving the amount of the major nutrients in the uppermost three feet of the profile calculated in lb per acre. In these calculations, account is taken of the thickness of individual horizons; the dry density of individual horizons (no actual determinations of this quantity have yet been made, but values of 1.2 have been assumed for forest topsoils, 1.3 for savannah topsoils and 1.6 for subsequent horizons in both forest and savannah soils except where these lower horizons contain more than 3 per cent organic matter, when a value of 1.5 is assumed); the amount of oven-dry fine earth; and the amount of nutrients determined in the fine earth sample. The presentation of the data in this way makes easier the comparison of nutrient status and the distribution of nutrients in different soils. For instance, it is now apparent that the Black Clays of the Accra Plains, generally regarded as containing only low amounts of organic matter, actually contain similar total amounts to most forest soils within the surface 3 feet, although, of course, differently distributed within this depth. At first, the quantities were given for each horizon as a whole; but since the thickness for comparable horizons differs between profiles, it has subsequently been found more useful to supply the data in terms of lb per acre per 1-inch layer within each layer (i.e. weight of nutrients in lb/acre divided by thickness of horizon in inches). This gives an index of the rate of change in nutrient contents down the profile, thus facilitating the comparison of trends in different soils.

Special investigations

Work continued on the elaboration of reliable methods for determining exchangeable bases, particularly calcium and magnesium. (An account of earlier stages of these investigations was given in the Annual Report for 1956). All possible shortcomings of the versenate method were investigated. Some 100 soil profiles, comprising 800 profile samples, were re-analysed, the figures obtained now being considered reliable to 0.1 m.e. where small amounts are present and to 0.3 m.e. where large amounts occur.

As indicated in the Annual Report for 1956, the results now obtained give an entirely new picture of the calcium/magnesium balance of forest soils from that previously considered to be the case. Except in the case of surface horizons and in certain profiles developed over parent materials rich in calcium reserves, there is now seen to be remarkable uniformity in calcium: magnesium ratios throughout the whole forest zone. Depletion of bases with increasing rainfall principally affects calcium since, when the absolute total of bases falls to a low level, plants apparently tend to retain magnesium preferentially. The picture appears to be similar in the upland soils of the savannah zones but there is generally a relative accumulation of magnesium in the lower horizons of the heavy clays of the south-eastern coastal plains due to impedance of drainage. 'Ratio deficiency' of magnesium versus calcium does not now appear to be probable, but a few cases of very narrow magnesium: potassium ratios have been observed which may have some significance. Investigations were also conducted into the question of base saturation versus pH, but final results have not yet been obtained. A detailed account of this work on the base status of Ghana soils is in the course of preparation for publication by Dr. A. S. de Endredy, Soil Analyst.

A good start has been made in plant analysis. It is intended to determine the mineral content of cocoa leaves from known localities on different soils over two growing periods.

Extensive use was made of the X-ray equipment for the determination of clay minerals occurring in Ghanaian soils. With the installation of two additional cameras, making a total of three, this work can now be speeded up and there can be greater economy in the use of the X-ray tube. The photographs obtained are now undergoing critical examination.

COMPILATION AND RECORDS SECTION

The staff of this section has continued the search of relevant literature for publications likely to assist field and laboratory staff in their work and has dealt with a number of requests for information relating to Ghanaian soils, vegetation and land-use from persons and institutions in Ghana and abroad. During this period, the Records store was put into effective operation on the completion of the shelf racks and map cabinet.

The Library continued to receive purchased and donated material, both from local and overseas sources, and now comprises some 1,300 volumes, 2,300 pamphlets and 33 microfilms. The number of currently received periodicals has been increased to 81. Five steel cabinets obtained for the Library have considerably improved the storage of pamphlets and periodicals. The binding of back numbers of certain periodicals has continued satisfactorily. There were few additions to the map collection, the total of which now stands at some 200 special subject and 500 topographical sheets.

Microfilms and photostats of articles not available in Ghana were obtained, as in previous years, from the Association of Special Libraries and Information Bureaux (Aslib) and the Science Museum Library in London. In addition, use was made of the Department's own microfilm camera and photocopier for the copying of articles borrowed from local libraries. Bibliographical cards continued to be received from the Bureau Interfrancain des Sols in Paris. These, after selection of those of particular interest to members of staff, have been added to the Department's own card indexes to articles on technical subjects relevant to its work and on inter-tropical botanical species.

The principal work of the Drawing Office was the production of transparencies for the duplication of maps accompanying reports published during the period. To assist in the production of these, a black-and-white shading scheme has been drawn up and brought into use. It was found impossible to devise a scheme sufficiently comprehensive to accommodate all the various units employed in departmental maps and the scheme is therefore designed for *ad hoc* use. Diagrams were prepared to accompany two of the chapters contributed by the Department for the forthcoming official publication "Agriculture and Land Use in Ghana".

Towards the end of the period, Mr. J. B. Wills, Compilation Officer, assumed the duties of sub-editor of the official publication referred to above which is due to go to press during 1958. Earlier in the period Mr. Wills completed his chapter on "The general pattern of land use in Ghana" and Mr. Brammer submitted a chapter on "Soil erosion and conservation" for inclusion in this publication. Various members of staff assisted in the reading and criticism of chapters for this publication.

TRAINING SECTION

Mr. S. V. Adu, Assistant Soil Survey Officer Grade I, continued his studies at the University of Aberdeen where he is expected to take his honours degree in Geography in June, 1958.

As reported in an earlier section, three learners successfully completed their training during the period and were subsequently appointed to posts in the junior technical officer grade.

On the other hand, the increasing wastage of senior professional staff necessitated a review of the training programme since the number of senior officers at post determines the scale on which field surveys can be undertaken and the number of junior technical staff that can effectively be supervised. It was reluctantly decided that, since prospects of being able to employ more than the present complement of junior officers in another year's time appeared to be small, it would be necessary to close down the course for learner Assistant Soil Survey Officers. Five second-year learners were therefore declared redundant in June. Happily, it was possible to arrange for all these men to be transferred immediately to the Forestry Training School at Sunyani.

At the end of the period under review there remained on the training course one learner Assistant Soil Analyst and one learner Assistant Compilation Officer, both now in their final year of studies.

CONFERENCES, VISITS AND COURSES

Dr. A. S. de Endredy, Soil Analyst, read a paper on "Some aspects of the chemistry of Gold Coast soils" to a meeting of the West African Science Association held in the University College, Achimota, on 26th February. Mr. A. J. Crosbie, Soil Survey Officer, read a paper on "The Ecology of the Yenahin Range with particular reference to the occurrence of grass meadows in the closed forest zone" at a joint colloquium of the Botany and Zoology Faculties in the University College on 27th February. Mr. Brammer read a paper on "The Soils of the Accra Plains" and led one of the field excursions during the West African Science Association's symposium on the Accra Plains held in the University College at Easter.

Dr. de Endredy and Messrs. Montgomery and Crosbie attended the British West African Conference of Research Workers on Soil and Plant Nutrition organised by the West African Inter-Territorial Secretariat in the University College of Ghana on 26th to 27th March, 1957.

VISITORS TO THE DEPARTMENT

Amongst numerous visitors to the Department during the period under review were the following:—

Professor Lancelot Hogben, University of Birmingham; Mr. D. H. Urquhart, Cadbury Bros., Birmingham; Mr. A. J. Smyth, Acting Principal Research Officer, Division of Chemistry and Soils, Department of Agriculture, Western Nigeria; Mr. A. F. W. Sheffield, Director of Agriculture, Eastern Nigeria; members of the mission from the Western Region Marketing Board, Ibadan, Nigeria; Mr. M. Brunt, Land Utilization Officer, Directorate of Colonial Surveys, England; and Dr. H. L. Richardson, Imperial Chemical Industries Ltd., Lagos, Nigeria.

PUBLICATIONS

The following article, paper and reports were published during the period. The Miscellaneous Paper and the Technical Reports are cyclostyled and have been issued for Restricted distribution only. They can be made available on request to *bona fide* official enquirers.

JOURNAL ARTICLE

- CHARTER, C. F. The aims and objects of tropical soil surveys. *Soils and Fertilizers* **20**, 127-8. (*This paper was written by the late Director in 1954*).

MISCELLANEOUS PAPER

No.

4. CHARTER, C. F. Suggestions for the classification of tropical soils. pp.12. (*The full text of a paper presented by the late Director to a symposium on soil classification held during the Fifth International Congress of Soil Science, Leopoldville, 1954*).

TECHNICAL REPORTS

22. PURNELL, M. F. Report on a survey of Princes Coconut Station, Ahanta-Nzima District, Western Region. pp.21, 3 maps, bibl.
 23. PURNELL, M. F. Report on a Semi-detailed survey of the proposed Dumbai Agricultural Station. pp.14, 3 maps.
 27. MOULD, A. W. S. Report on a Semi-detailed soil survey of Akaa Cocoa Research Station. pp.34, figs., 5 maps.

H. BRAMMER
Senior Soil Scientist.

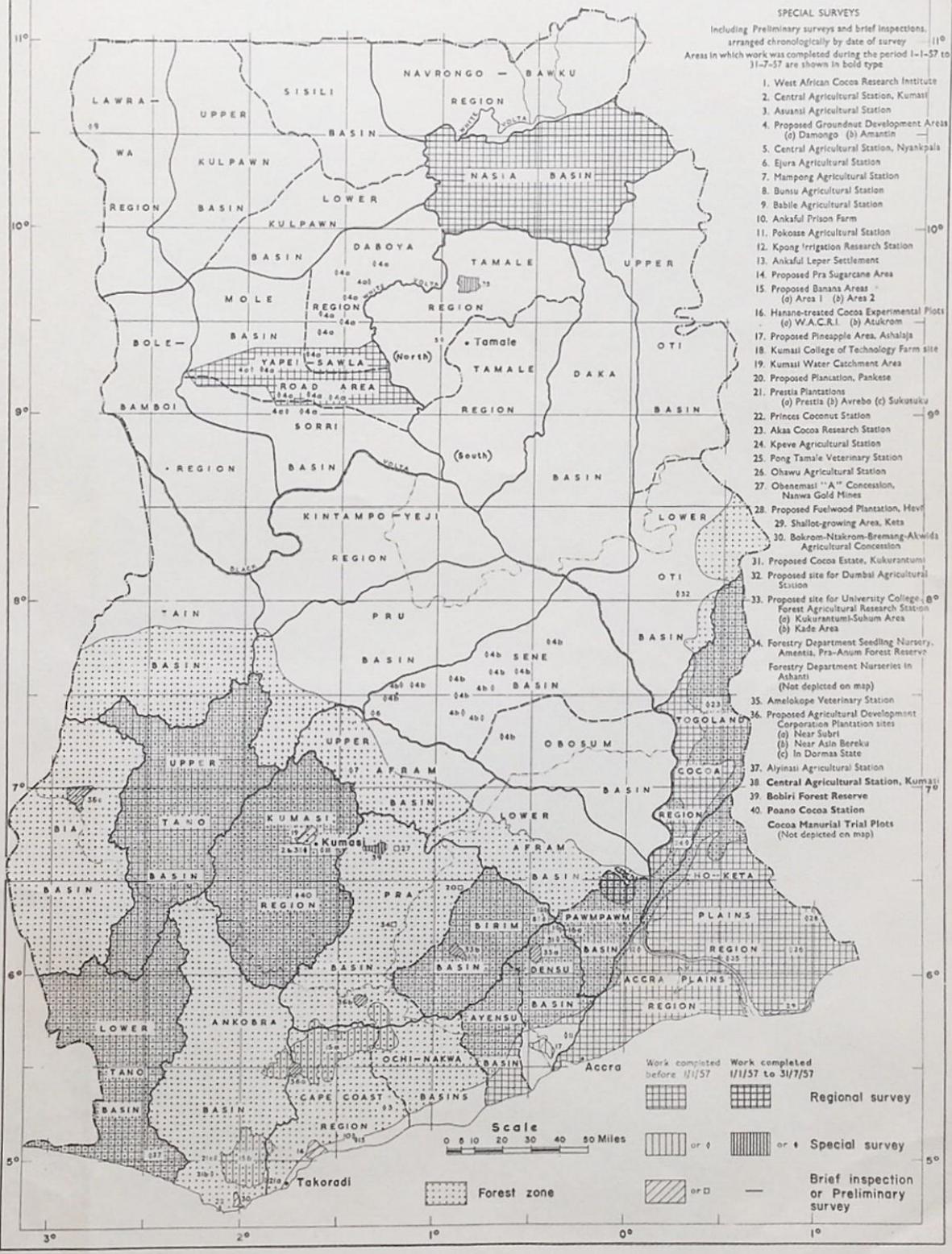
CASTLEFORD, YORKSHIRE.
 September, 1957.

References

- DEPARTMENT OF SOIL AND LAND-USE SURVEY. 1957. *Report for the period 5th June, 1951, to 31st December, 1955.*
 ————1958. *Report for the year 1956.*
 QUARTEY-PAPAFIO, E. 1957. Control of soil erosion with particular reference to the Central Agricultural Station, Kwadaso. *New Gold Coast Farmer* **1**, 92-3.

GHANA DEPARTMENT OF SOIL AND LAND-USE SURVEY

Progress of Surveys: 1/1/57 - 31/7/57



- SPECIAL SURVEYS**
Including Preliminary surveys and brief inspections, arranged chronologically by date of survey. Areas in which work was completed during the period 1-1-57 to 31-7-57 are shown in bold type.
1. West African Cocoa Research Institute
 2. Central Agricultural Station, Kumasi
 3. Asansi Agricultural Station
 4. Proposed Groundnut Development Areas (a) Damongo (b) Amantin
 5. Central Agricultural Station, Nyankpala
 6. Ejura Agricultural Station
 7. Mampong Agricultural Station
 8. Bunsu Agricultural Station
 9. Babile Agricultural Station
 10. Ankaful Prison Farm
 11. Pokosco Agricultural Station
 12. Kpong Irrigation Research Station
 13. Ankaful Leper Settlement
 14. Proposed Pra Sugarcane Area
 15. Proposed Bananas Areas (a) Area 1 (b) Area 2
 16. Hanano-treated Cocoa Experimental Plots (a) W.A.C.R.I. (b) Atokrom
 17. Proposed Pineapple Area, Ahiakpa
 18. Kumasi College of Technology Farm site
 19. Kumasi Water Catchment Area
 20. Proposed Plantation, Pankese
 21. Prestia Plantations (a) Prestia (b) Avrebo (c) Sukuruku
 22. Princes Coconut Station
 23. Akaa Cocoa Research Station
 24. Kpeve Agricultural Station
 25. Pong Tamale Veterinary Station
 26. Ohawu Agricultural Station
 27. Obenemasi "A" Concession, Nanwa Gold Mines
 28. Proposed Fuelwood Plantation, Hevi
 29. Shallo-growing Area, Keta
 30. Bokrom-Ntakrom-Bremang-Akwida Agricultural Concession
 31. Proposed Cocoa Estate, Kukurantumi
 32. Proposed site for Dumbal Agricultural Station
 33. Proposed site for University College, Forest Agricultural Research Station (a) Kukurantumi-Suhum Area (b) Kade Area
 34. Forestry Department Seedling Nursery, Amentia, Pra-Anum Forest Reserve, Forestry Department Nurseries in Ashanti (Not depicted on map)
 35. Amelokepe Veterinary Station
 36. Proposed Agricultural Development Corporation Plantation sites (a) Near Subri (b) Near Asin Bereku (c) In Dormaa State
 37. Aiyinasi Agricultural Station
 38. Central Agricultural Station, Kumasi
 39. Bobiri Forest Reserve
 40. Poano Cocoa Station, Cocoa Manurial Trial Plots (Not depicted on map)

Scale
0 5 10 20 30 40 50 Miles

	Work completed before 1/1/57		Work completed 1/1/57 to 31/7/57	Regional survey
	or		or	

Forest zone

