CHAPTER 1

INTRODUCTION

In connection with the Niger Dams Project investigations, a soil and agricultural survey of the present Niger flood plain between Jebba and Lokoja has been carried out in order to investigate, describe and map the soil conditions and to give an appraisal of the agricultural potential of the flood plain. This plain, of which the greater part is flooded every year, will be much less subject to annual flooding after the construction of the Niger Dams upstream of Jebba. As a result, possibilities for the development of irrigated agriculture will arise. The area studied comprises the entire flood plain on the river Niger between Jebba and Lokoja. This stretch has a length of approximately 300 km (186 miles) an average width of 16km (10 miles) and measures about 4,700 sq.km (1,815 sq. miles). The land area, including small creeks, lakes and pools, measures about 4,300 sq.km (1,660 sq.miles). The river Niger, its tributaries and the greater lakes occupy together about 400 sq.km (154 sq.miles). The area is sparsely populated. Small villages are indicated on the maps only by a symbol. As the greater part of the area is subject to annual flooding, hardly any track suitable for motor traffic and very few local footpaths exist. The red lines on Figure 7.6, indicating the traverses made for soil survey purposes, represent approximately 90 per cent of the existing footpaths in the area.

The Niger flood plain soil survey was carried out in two stages.

Stage 1 : A reconnaissance soil survey of the entire flood plain from Jebba to Lokoja.

Stage 2 : A semi-detailed soil survey of an area of approximately 30 sq. miles, which had to be situated somewhere in the flood plain upstream of the Kaduna confluence.

The 30 sq. miles area was intended to be an agricultural pilot area and the exact site was selected at the Kaduna meeting on March 21st 1960 between Northern Region Government officials and representatives of the Consultants, after a tentative reconnaissance soil map of the Jebba-Kaduna confluence area had become available. Location and accessibility of the surveyed flood plain and the selected pilot area are shown on the key map (Figure 7.6).

The reconnaissance soil survey and the semi-detailed soil survey are essentially of a different character. The reconnaissance survey was carried out during the first three months of 1960. Soil observations were made along local footpaths running across the flood plain at intervals of approximately 8 km (5 miles) and along traces which were cut to reach representative areas. An inaccessible part was surveyed with the help of a helicopter. Orientation in the field and afterwards the map compilation, depended entirely on the intensive use of aerial photographs and photo-mosaics. This survey enabled a reconnaissance soil map (scale 1:100,000) on (alluvial) soil series level to be produced (Figure 7.1 sheets 1-3).

The semi-detailed soil survey was carried out during April and May 1960 along more conventional lines. All observations were made along straight traces, cut through the area at regular intervals. Utilising the results of this survey a semi-detailed soil map (scale 1:20,000) on soil type level was produced (Figure 7.3) and additional to this survey, a fairly detailed vegetation survey of the pilot area was carried out enabling a vegetation map to a scale of 1:20,000 to be drawn (Figure 7.4).

During both surveys, a large number (some 750) of top and subsoil samples were taken for chemical and physical analysis in the Netherlands.

The soil survey party, consisting of 5 Dutch soil survey officers and their Nigerian staff, were accommodated on the houseboat "Nextnut". These floating headquarters proved to be ideally suited to the job as the whole team could move gradually downstream as the survey progressed. Moreover, the Niger flood plain is much easier to penetrate from the river than from the surrounding uplands. River transport was provided by Nigerian canoes with outboard motors. Although little of the area was flooded at the time of survey, the numerous muddy or waterfilled creeks, lakes and marshes which had to be crossed called for considerable endurance on the part of the field officers.

The agriculturist joined the soil survey party early on to make an examination of the fadamas and the existing agricultural pattern in and near the flood plain. As the survey had to be carried out during the dry season, a complete study in the field of the whole agricultural system and all the various types of crops was impracticable and hence much time was spent on supplementing field studies by the study of available documents and by discussions with officials and others connected with fadama agriculture.

Visits were paid to the Northern Region Ministry of Agriculture, the Research Stations at Samaru, Mokwa and Badeggi, and several agricultural extension and irrigation offices. It was not surprising to find divergent opinions about the future possibilities and potentials of fadama agriculture, as basic and exact knowledge on this subject is still rather scanty.

CHAPTER 2

RECONNAISSANCE SOIL SURVEY

2.1 General

The entire area studied, that is the flood plain from Jebba to Lokoja, was surveyed for the reconnaissance soil map. Although not belonging to the flood plain proper, some relatively high sandy terraces of obviously old alluvial origin were included in the survey.

2.2 Fieldwork

The necessary fieldwork in connection with the soil survey was carried out from January 6th to March 31st 1960.

The houseboat was always moored where the river bank was accessible to a Landrover. Nigerian canoes with outboard motors were used for daily transport of the soil survey officers and labourers to selected landing places on the river banks, which were previously pinpointed on the aerial photographs. These landing places were usually villages with footpath or sometimes road access to the flood plain. Fortunately these paths leading from the river bank into the surrounding uplands ran straight across and often at right angles with the main axis of sedimentation of the river deposits. This meant that footpaths could be used quite satisfactorily as sampling traverses and only little additional trace cutting was required. In a few cases the flood plain was approached from the uplands by Landrover, the final stage being on foot. Soil profile observations were made along the traverses by means of soil auger borings at representative sites to a depth of 120-250 cm (4-8 feet). These sites were pinpointed on the aerial photographs and numbered. The main soil profile properties such as texture class, clay and silt content, structure, colour and permeability were estimated and recorded on the spot. In addition a large number of surface and subsoil samples were taken for laboratory analyses and soil permeability tests carried out in the field. Soil profile pits were dug to a depth of 150 cm (5 feet) at representative sites for detailed profile description and sampling and soil permeability tests of subsoil strata were carried out in the field.

The soil survey party was split into two soil survey units, which operated independently. Each unit consisted of the following members and equipment :

Members	Equipment
2 Soil survey officers	1 Canoe and outboard motor
1 Nigerian canoeman	2 Soil augers (Edelman auger) with extension pieces
1 Nigerian river pilot	1 bag containing pedological and other equipment
3-4 Nigerian labourers	
1 Local guide	

The two field officers of the party were interchanged daily in order to ensure uniform and correct description of profile properties. As soon as the survey area extended beyond convenient reach of the motorboats the houseboat was moved nearer. As the houseboat was not self-propelled it had to be assisted in its passage downstream by the powered canoes. Moves were usually of the order of 20 miles.

A part of the flood plain near the Kaduna river could not be reached by conventional methods already described and this area was explored by means of a helicopter which was working in the district at the time.

2.3 Use of Air Photographs

2.3.1 General. Air photographs of good quality are indispensable for reconnaissance soil mapping of remote areas of which no large scale topographic maps exist. Fortunately, complete cover of the area was available. These air photographs were used for two different purposes to assist the soil survey.

(i) The selection of representative traverses and sample sites and for orientation in the field.

(ii) The compilation of a preliminary photo interpretation map for soil survey purposes.

2.3.2 Systematic analysis. Buringh (1, 2), Veenenbos (4), Van der Eyk (3)* and others have described how a map can be drawn from air photographs by systematic photo analysis which is not a soil map but only a photo interpretation map for soil survey purposes. A map of this type shows a panel of mapping units. Boundaries based on differences in physical, topographical, vegetation, cultural and other patterns as shown on the air photographs are drawn after intensive study and careful stereoscopic observation of the photo images. These boundaries are likely to coincide with the soil mapping unit boundaries. A photo interpretation map for soil survey purposes of the surveyed area was compiled by the staff of the International Training Centre for Air Survey at Delft. This map was at the disposal of the soil survey party after their return to the Netherlands and proved to be of great help in compiling the final reconnaissance soil map.

* The figures between brackets refer to the bibliography.

2.3.3 Photo material. The photographs taken in May and November 1959 have the usual overlap of 60 per cent and a side lap of 20 per cent. Photo mosaics (58 sheets) to a scale of 1:20,000 of the whole area were prepared from these photographs.

2.4 Soil Map Compilation

The final reconnaissance soil map (scale 1:100,000) was compiled in the Netherlands. Use was made of :

(i) all information collected in the field

(ii) the information provided by the tentative 'photo interpretation map for soil survey purposes', compiled at the I.T.C., Delft.

The photo mosaics to a scale of 1:20,000 were photographically reduced to scale 1:100,000 and from these an uncontrolled mosaic was composed. As no suitable topographic base was available, the photo mosaics to an approximate scale of 1:100,000 were used as base map for the soil map on 3 sheets. The absolute topographic accuracy of the soil map must be considered as approximate. However, the use of photo mosaics as a base map guarantees a high degree of relative accuracy of soil boundaries in relation to the adjacent topographic features.

2.5 Soils

2.5.1 Physiography. (i) The Niger valley. The geological history of Nigeria and its big rivers is a complicated one. For detailed information reference is made to the Niger-Benue River studies, Part III, Chapter 3. (5). With regard to the history of the surveyed area some information derived from that chapter is quoted below.

"During the Gamblian Pluvial (Würm I, approximately 60,000 BC) a deep and entrenched valley was eroded by the lower Niger (and the Benue) in response to a lowering sea level. The entrenched valley cuts through sedimentary deposits as well as Basement Rocks and across axes of elevation in the subsoil. However, this does not seem to have occurred to the same extent in the Niger valley upstream of Jebba. Between Yelwa and Jebba the river Niger crosses an axis of upheaval and the valley shows a considerable steepening with many rapids. When at the end of the Gamblian Pluvial the sea level rose again, eventually attaining a level of 2 to 4 m (6 - 13 feet) above the modern sea level, the lower Niger (and the Benue) in response filled their valleys in upstream sense in order to attain a new equilibrium in their gradients. At present, within Nigerian territory, the Niger flows alternatively through wide valleys with extensive flood plains, bordered by scarps and sedimentary plateaux (mainly consisting of sandstone of the cretaceous and eocene) capped with lateritic material and through narrow rocky sections eroded in the Basement Complex with numerous rapids upstream of Jebba".

(ii) The Niger flood plain from Jebba to Lokoja. The surveyed area from Jebba to Lokoja is one of the sand filled valleys, at present forming an extensive elongated and locally fairly narrow flood plain, bordered by sedimentary uplands which often have steep scarps to the flood plain. As mentioned above, the sea level attained a height of 2 - 4 m (6 - 13 feet) above present day sea level at the time the Niger filled up its valley with (probably sandy) sediments. It is considered that the Niger had the character of a so-called braiding river at that time. Large quantities of water rushed down annually through a system of numerous, ever changing "braiding" channels and only coarse textured material was sedimented. However, the sea level has dropped since and the Niger has cut a few shallow valleys through its former sandy plain. Attaining a certain equilibrium again the Niger apparently has become a relatively quiet meandering river which, overflowing its banks annually, has laid down a system of loamy and clayey sediments over its sandy shallow valley floor. The remnants of the old sandy valley floor are found now as sandy flat terraces still rising 2 - 4 m (6 - 13 feet) above the present flood level (see Figure 7.9). These terraces, although badly affected by recent erosion, still show locally very clearly a braiding pattern of ancient gullies giving evidence that the tops of the present terraces once used to be the valley floor of a braided river system. In this report these old terraces will be referred to as sandy terraces.

The loamy and clayey sediments, laid down by the meandering Niger, after the new equilibrium with the present sea level had been attained, are referred to in this report as Niger alluvium. In the area surveyed these rather recent sediments nowhere attain a thickness of more than 2 - 3 m (with a few exceptions of thick basin clay areas) and are often thinner. This is very little for a river which overflows its banks annually, but it might be explained by the fact that the river Niger is a clean river, carrying very little clay and silt. The present situation is illustrated by the block diagram in Figure 7.9.

Within the area mapped several tributaries of all sizes join the Niger. The biggest is the Kaduna river which discharges large amounts of water into the Niger annually (from October to December). At that time the Kaduna water affects the Niger gradient from its confluence to Baro. Except for its rather narrow sandy valley, running straight across the flood plain over only 5 miles, the Kaduna river has not given rise to any special land form in the surveyed area. Of course, its flood has a great bearing on the hydrological conditions of the flood plain.

The smaller sized tributaries, however, which have not enough discharge to transport all their rather coarse debris straight into the Niger have built up considerable cones of alluvium on top of the Niger alluvium. These deposits are referred to as alluvial fans. They fan out from the surrounding uplands in all sizes and shapes. The alluvial fans of the Egwar river near Lafiagi and the Oyi river near Eggan are fine examples.

Very small fans, in general consisting of colluvial material, are found in great quantities along the scarps of the flood plain fringe. They are referred to as the group colluvial fans and colluvial slopes. Summarising, the surveyed area can be classified into three main landscapes or soil associations viz:

1) Remnants of the old braiding river valley (Sandy terrace).

2) Deposits of the meandering Niger river (Niger alluvium).

3) Deposits of tributaries, streaming from the uplands down to the flood plain (Alluvial fans).

These three landscapes are shown on the schematic soil map 1 :500,000 (Figure 7.7). It appears that these landscapes are represented in the surveyed area in a fairly evenly distributed pattern.

(iii) The Niger alluvium. Like most alluvial landscapes all over the world the Niger alluvium as well as the alluvial fans are built up by two components: river levees and river basins.

Generally speaking, river levees border present or former river courses and consist of sandy or loamy material and the river basins, located often in between the levees are silted up with clayey sediments. A meandering river may break through its levees and may build up a fresh system of levees and basins on top and across the old one. Due to this an alluvial landscape shows a great variety in soils over short distances horizontally and vertically. The Niger alluvium is no exception in this respect. This is illustrated by the cross sections Figure 7.5 sheets 1 and 2.

River levees and river basins are found all over the mapped area in numerous patterns of very different composition. Even the sandy terraces show traces of an ancient levee basin system, but this has been disturbed a good deal by later erosion.

A small strip of relatively low Niger alluvium which borders the present river course and which is separated from the surrounding land by a small scarp can best be described as 'forelands of the Niger'. A small scarp often cuts right across a uniform looking sedimentation pattern. On its forelands the Niger is now building up another sedimentation pattern varying from mud flats and sand banks to a fairly mature looking levee basin system. These forelands are indicated on the soil map by a pattern of dots.

2.5.2 Classification of the mapped soils. It is widely recognised that, in general, the individual taxonomic soil unit cannot be shown on a small scale soil map in a pattern that can be mapped. It is, therefore, recommended to group these taxonomic units (series, types) into mapping units, usually called soil associations.

When mapping alluvial soils, however, special problems arise in defining soil series and soil types along conventional lines because alluvial soils happen to have no sequences of genetically related soils. With regard to this problem the Soil Survey Manual (6)* is quoted below:

"Materials laid down by water commonly have layers that differ widely in such characteristics as texture, but the occurence of those layers is governed by geological processes and is accidental insofar as genetic relationships of the soils to the present environment are concerned. If every difference in the occurence of such layers were used as a basis for separating series, an almost infinite number of series could be recognised among Alluvial soils alone. This would defeat the purpose of the soil series"; and hence: "As a general rule the differentiation of series on the basis of texture in Alluvial soils should be based on the texture of the material of the subsoil ....."(SSM p.284).

The alluvial soils of the surveyed area have been classified according to the above quoted principles. The result of this is that the most suitable mapping units for the Niger flood plain reconnaissance soil map to a scale of 1 : 100,000 appeared to be :-

a) Soil series
b) Soil complexes (mainly of series)
c) Miscellaneous land types.

These mapping units are defined as follows :-

a) A soil series (of alluvial soils) is a group of sedimentologically related soils having similar textured subsoils.

b) A Soil complex (of alluvial soils) is a group of named and defined taxonomic units (series), geographically associated, which cannot be separated individually on the scale mapped.

c) Miscellaneous land types are mapping units used in mapping of lands that are hardly accessible for orderly examinsation or where for other reasons it is not feasible to classify the soil.

* The figures between brackets refer to the bibliography.

of presumably recent loamy deposits. Unit T 2 is slightly affected by gully erosion. However, the soils of unit T 2 are still relatively high and dry, which is reflected in the vegetation as this is almost similar to the vegetation of unit T 1.

T 3. Loamy to clayey terrace soils.

These soils are eroded. The upper 2-3 m (6-10 feet) or even more of the original terrace soil are removed completely by the combined action of rain and river erosion. At present these terrace soils are covered by a shallow loamy surface soil, presumably a recent sediment. Due to its low topographic position unit T 3 is frequently liable to flooding but in the dry season the shallow soils overlaying coarse sand dry out quickly and this is reflected by the rather poor vegetation cover (see Figure 7.10).

T 4 Clayey terrace basin soils.

Extensive depression areas occur within the sandy terrace association. These depressions are in general bordered by higher terrace soils and, therefore, have acted as basins in which, during the flood season, silt and clay carried by the flood water could settle under quiet conditions. As a result, these units T 4 have uniform deep or moderately deep, occasionally heavy clayey soils. As the external drainage of these T 4 areas is rather poor, the soils are waterlogged for the greater part of the year and therefore, heavily gleyed. Soils of T 4 are not represented in the pilot area. Their chemical properties are described in 2.7.

TC. Complex of soils T 1, T 3 and T 4.

The composition of this complex is illustrated in Figure 7.11, showing a section of the TC complex scale 1 : 20,000. For a description of the various components reference is made to the descriptions of the single series as given above.

N. Niger alluvium soil association

N 1 Loamy Niger levee soils

The soils of this series are located mainly along the present and former courses of the river Niger and its branches. These soils have moderately deep to very deep loamy, occasionally sandy profiles. The texture becomes more coarse with increasing depth in general. The unit has a fairly elevated position, but the greater part of the unit is liable in some degree to annual flooding (see Figures7.10 and 7.5, sheets 1 and 2).

As the river Niger overflows its banks, unit N 1 is locally intersected by gullies and creeks. The porosity of the Niger levee soils is good, but in the transitional zones between the units N 1 and N 2 soils occur of clayey texture, but with a less porous and often cemented structure. The vegetation in these zones is rather poor. However, the vegetation on the levee soils proper is extremely rich indeed, and a high forest grows on the Niger banks. For detailed information reference should be made to the vegetation descriptions in Chapter 4. Unit N 1 is found scattered over the entire flood plain, but it never occupies an extensive area.

N 2. Clayey Niger basin soils

As described in 2.5.1 (iii), the basins in between the Niger levees are generally silted up with clayey material. These clayey soils are deposited under quiet conditions which has resulted in the formation of fairly uniform, moderately deep or deep profiles, overlaying the original sandy subsoil. The clay is abundantly mottled. The unit N 2 is intersected locally by small creeks, which may carry coarse material during the flood season. These creeks, therefore, usually have small strips of sandy or loamy (levee) soil on either side, which, because of their small size, are not mapped as separate units. The creeks, however, are shown on the soil map by a symbol and so the character of unit N 2 can be seen by the number of creeks running through it. The clayey basin areas are poorly drained and liable to flooding, which is reflected by their grassy vegetation. Unit N 2 is found scattered over the entire mapped area and it occupies quite an extensive area.

NC 1. Complex of soils N 1 and N 2, but more than 50 per cent occupied by levee soils N 1.

Large areas of the mapped flood plain show a complex pattern of small size creeks and rivers with basin areas in between. Neither levees nor basins can be mapped separately to a scale of 1:100,000. Therefore, soils are mapped as complexes. The composition of such a complex is illustrated by Figure 7.11, showing a map (scale 1:20,000) of a representative portion of unit NC 1.

The components show profiles similar to those of units N 1 and N 2 but the soils of both kinds tend to be somewhat more shallow. As a meandering creek changes its course every now and then it often occurs that levee soil is deposited on top of basin clay and, therefore, clayey soil may be found in the subsoil locally.

The vegetation, of course, is of a complex character as well.

NC 2. Complex of soils N 1 and N 2 but more than 50 per cent occupied by basin soils N 2.

See explanation of unit NC 1.

NC 3. Meander belt complex.

Mainly sandy ridges and loamy-clayey gullies. Although the components of this complex are essentially levees and basins as well, the complex is not included in NC 1 or NC 2 because of the fact that this pattern is differently associated geographically. The pattern of sandy ridges and loamy gullies of unit NC 3 is illustrated in Figure 7.12 at a scale of 1:20,000. The ridges and gullies run almost parallel and are alternating. This pattern of soils is typical for a deposition of a meandering river and is located always in the inner curve of an old or still meandering river course. In case a river course has several curves in succession, elongated meander belts are mapped.

The topography of this complex, seen at right angles with the above mentioned ridges and depressions, is very uneven and height differences of approximately 1-2 m (3-6 feet) occur within 10 m (30 feet) or even less.

The vegetation in the unit NC 3 is complex as well.

NC 4. Spillway complex.

This complex consists mainly of low clayey soils. Although the soils of unit NC 4 are very much like those of the soil series NC 2, this unit is differentiated because the areas in question are deepened by running water during the annual floods. These topographically low, long-shaped areas are generally silted up with clayey material like the common Niger basins, but the profiles are not at all uniform. Very shallow clayey soils alternate with very deep ones and the profile of both is interwoven with bands of different textured material. The unit is always intersected by deep parallel running sandy creeks. The vegetation of unit NC 4 is similar to the vegetation of unit NC 2.

F. Alluvial fan soil association

F.1. Sandy or loamy fan levee soils.

Due to the method of deposition by torrential tributaries streaming from the uplands into the Niger flood plain, the deposits of these streams generally consist of coarse material. Locally, shallow or moderately deep loamy levees are found overlaying the coarse deposits. The soils of unit F.1 often have very stratified profiles, sometimes with gravelly layers. The soils located at the apex of the alluvial fan tend to be more coarse than the F.1 soils towards its base. Moreover the apex is above average flood level, whilst the base of the fan is liable to annual flooding from the Niger. However, all F 1 soils, high and low, are supplied by water from the tributary from which they were deposited. Therefore, even on the high parts cultivated areas are found.

F 2. Clayey fan basin soils

In between the levees of the tributary, depressions are found in which heavier textured soils were sedimented under quiet conditions. In general the soils of series F 2 tend to be less heavy than the soils of units T 4 and N 2, but mainly they are still of the clayey type. The soils of unit F 2 consist of shallow or moderately deep clayey occasionally loamy soils overlaying coarse textured subsoil. The texture tends to become more heavy and uniform towards the base of the fan. Due to their relatively low topographic position the fan basin clays are strongly mottled and even waterlogged for part of the year. The chemical properties of these soils are discussed in 2.7.

FC 1. Complex of soils F 1 and F 2, but more than 50 per cent occupied by levee soil. F 1.

Some parts of the alluvial fan soil association show a complex pattern of levees and basins, which cannot be mapped to a scale of 1:100,000. A representative section mapped to a scale of 1:20,000 is given in Figure 7.12, showing the pattern of composite soil series. The soils of the components are described above.

FC 2. Complex of soils F 1 and F 2, but more than 50 per cent occupied by basin soil F 2

Otherwise see description FC 1.

Miscellaneous land types

CF Colluvial slopes, colluvial fans and coalescing fans

At the foot of the escarpment of the uplands which borders the flood plain on all sides, landslides and erosion gullies have deposited a narrow strip of colluvial material. This material is derived locally and consists of mainly coarse loamy sand of reddish colour, often mixed with gravel and rock fragments. Locally successive erosion gullies have given rise to strips of coalescing fans, each deposition being a small colluvial fan.

I. Islands, mudflats and sand banks.

The present Niger river bed is full of shifting sand banks. These sand banks have a sandy body, occasionally covered by a thin layer of more heavy textured material. Some sand banks have attained a fair height above flood level and so become more or less permanent islands. All relatively impermanent land types are mapped as unit I.

2.6 Vegetation

Little has been said about the vegetation of the area in the description of the soils of the mapping units as identified on the reconnaissance soil map. However, a fairly detailed study of the flood plain vegetation has been made in the pilot area. As this pilot area is a representative part of the flood plain reference should be made to Chapter 4 for the vegetation of other parts of the flood plain, but it should be noted that, due to changed climatic conditions, the pilot area is not representative of the Niger flood plain downstream of Baro as far as vegetation is concerned. No additional vegetation study was carried out downstream of Baro, this being far beyond the scope of the vegetation survey. The vegetation shown on the theoretical cross section (Figure 7.10) must be considered representative for the floodplain only from Jebba to Baro.

Downstream of Baro the area covered with forest seems to increase rapidly. This is illustrated by the general vegetation map on a scale of 1:500,000 (Figure 7.8).

2.7 Physical and chemical analyses of soil samples

2.7.1 General. At the request of the Soil Survey Officials of the Northern Region a large number of soil samples were taken both in the whole area between Jebba and Lokoja and in the so-called Jebba-Ogudu Triangle, where a more detailed survey has been carried out. The criteria of the units have been listed but from the nature of the reconnaissance survey it follows that deviations from these criteria will be found and these are shown by the analyses figures (Tables 7.20-29).

2.7.2 Discussion of the analyses for each soil unit.

T 1 Sandy Terrace Soils

These soils are locally intersected by gullies.

T2 Sandy Terrace Soils

The topsoil is partly removed by erosion and locally covered by a very shallow loamy to clayey layer.

The greater part of the sandy terrace soils show a sand texture, whereas to a smaller extent LS and SL textures are found. Occasionally L textures are encountered. The average textural composition of the above mentioned texture classes is shown below :-

Texture class	% Sand	% Silt	% Clay
Sand	90.5	6.5	3.0
Loamy Sand	83.0	9.7	7.3
Sandy Loam	66.0	21.0	13.0
Loam	31.0	46.0	23.0

The sandy terrace soils are characterised by their high content of sand with a particle size above 150 μ. This amounts to an average of 73 per cent of the sand fraction in S soils, to 60 per cent of the sand fraction in LS and to 43 per cent of the sand fraction in SL and L soils.

Without exception the sandy terrace soils are lime free. The organic matter content is relatively low and amounts to 0.9 per cent as an average for S and LS soils. In SL and L soils it is somewhat higher and amounts to 2.5 per cent in general. The pH values for the terrace soils vary within rather narrow limits. The average of the sandy terrace soil is 4.5 with maximum and minimum values of 5.5 and 3.5. The base saturation percentage, however, is high and amounts to 78 per cent as an average. This indicates that these soils are only weakly leached. It can, therefore, be assumed that they never have contained any lime. The individual cation adsorption rate shows the following values :-

	Cation adsorption in m.e./100 g. soil			
	Exch. Na	Exch. K	Exch. Mg	Exch. Ca
average	0.1	0.16	0.55	1.99
minimum	0.0	0.1	0.2	0.8
maximum	0.1	0.3	1.3	4.8

T 3 Loamy to clayey terrace soils

These soils have to be considered as a transitional phase between the sandy terrace soils, and the clayey terrace soils.

T 4 Clayey terrace basin soils

These soils are fine textured, most soils belonging to the C texture class. The average textural composition of the clayey terrace soils is shown below:-

Texture class	% Sand	% Silt	% Clay
Clay	16	20	64

Often really heavy soils are found, i.e. with a clay fraction of 87 per cent. From the nature of their texture it follows that the clayey terrace soils have a considerably lower sand content than the sandy terrace soils. Moreover the percentage sand with a particle size diameter above 150 µ is very low compared to the sandy terrace soils. Here it never exceeds 20 per cent. The lime content of the terrace basin soils never exceeds 0.1 per cent. Their organic matter content is somewhat higher than in the T 1 and T 2 soils, but still low (2% average). The base saturation percentage amounts to approximately 62 per cent; this is rather high. It indicates only weak leaching. The individual cation adsorption is shown by the following figures:-

	Cation adsorption in m.e./100 g. soil			
	Exch. Na	Exch. K	Exch. Mg	Exch. Ca
average	0.3	0.5	2.6	8.7
maximum	0.4	0.5	3.8	12.6
minimum	0.2	0.5	1.5	4.8

The exchangeable Na values are somewhat higher than in the T1 and T 2 soils, but are still so low as not to cause any alkalinity danger. Perhaps the Mg and Ca figures are somewhat low. The pH varies between 4.3 and 3.7 with an average value of 3.9.

TC Complex of soil units T1, T3 and T4

This mapping unit is a mixture of T1, T3 and T4 soils and does not possess any specific characteristic.

N 1 Loamy Niger levee soils

The loamy Niger levee soils occur along either side of the ancient and present river courses. The river levees consist essentially of a nucleus of relatively coarse textured sediments which form soil layers that belong to various texture classes (S, LS, SL, L, SiL). Since the formation of the river levees took place at various parts in the river plain all kinds of horizontal and vertical transitions are met.

The sand deposits are characterised by the following textural composition : 95% Sand 3% Silt and 2% Clay. The sand fraction as such consists mainly of particles with a diameter above 150 µ . The ratio between the 50-105, 105-150 and >150 µ fractions is 1 : 2.4 : 44.1. These sand deposits show a very low organic matter content (0.3% as an average, with maximum and minimum values of 0.6% and 0.1% respectively) and do not contain any lime. pH values vary between 4.6 and 5.5, the average pH being 5. The total cation exchange capacity of the sand deposits is extremely low. The loamy sand deposits show the following average textural composition : 78% Sand 15% Silt and 7% Clay. The sand fraction shows a fairly proportional division of the particle size diameter classes. The ratio between the 50-105; 105-150 and >150 µ fractions is 1: 1: 1.7. The loamy sand soils do not contain any lime, whereas the organic matter content is very low (average value 0.8%; maximum and minimum values 1.5% and 0.2% respectively). The pH varies between 3.9 and 4.7 and shows an average of 4.2. The total cation exchange capacity is extremely low.

Pure sand and loamy sand textures are only occasionally found; the greater part of the levee soils show a SL, L or SiL texture. In a transitional position towards the heavy basin soils SCL, SiCL, CL and even C and SiC textures are found. The average textural composition of the SL soils shows 61% Sand, 28% Silt and 11% Clay. The amount of sand particles with a diameter about 150 µ has decreased considerably and amounts to approximately 30% of the total sand fraction. The ratio between the 50-105; 105-150 and > 150 µ fractions is 1:0.4: 0.6. The organic matter content is low (1.2% average) and varies between 0.3% and 3%.

The lime content of the sandy loam soils never exceeds 0.1% but is in most cases lower than this amount. The pH varies between 3.8 and 4.4 and shows an average value of 4.3. The total cation exchange capacity is low and reaches an average of 7 m.e./100 g. soil. The adsorption complex is for 50% base saturated, which indicates a weak to moderate leaching. The individual cation adsorption is shown by the following figures:

	Cation adsorption in m.e./100 g. soil			
	Exch. Na	Exch. K	Exch. Mg	Exch. Ca
average	0.05	0.2	0.7	2.5
maximum	0.1	0.2	0.7	3.0
minimum	0.0	0.2	0.7	2.1

These figures do not comply with those of a productive soil. Heavy, well balanced dressing with an inorganic compound fertilizer is advised.

The loam deposits show the following average textural composition:

Texture class	% Sand	% Silt	% Clay
L	40	41	19

Approximately 65% from the sand fraction consistsof particles with a diameter between 50-105 μ. The ratio between the 50-105; 105-150 and > 150 μ diameter classes is here 3.7 :1 : 1. This illustrates the relative increase of the fine sand content. The pH varies between [illegible] and 4.5 and shows an average value of 4.1. The organic matter content is low (1.3% as an average) and varies between 0.5% and 2.7%. The loam soils do not contain any lime.

Although exact data on the total cation exchange capacity and base saturation percentage of the loam soils are not available, it is justified to assume that these agree with the figures for the silt loam soils since clay and organic matter content are the same.

The SiL and CL soils possess approximately the same sand content in their average textural composition, as shown by the following values:

Texture class	% Sand	% Silt	% Clay
SiL	21	59	20
CL	25	42	33

As compared with the S, LS, SCL and L textures the sand content (about 23%) has decreased considerably. Approximately 60-70% of the sand fraction possesses a diameter between 50 and 105 μ. The ratio between the 50-105; 105-150 and > 150 μ diameter classes is approximately 5:1 : 1, which again shows a relative increase of the fine sand content. The average pH amounts to 3.9, maximum and minimum figures are 4.6 and 3.6. The average organic matter content is 2%, whereas maximum and minimum values of 4% and 0.8% occur. The SiL and CL soils are lime free in general, although sometimes traces of lime, never exceeding 0.1%, are found. The base saturation percentage amounts to 61%, which is medium to high and indicates weak leaching. The individual cation adsorption figures are shown by the following figures.

	Cation adsorption in m.e./100 g. soil			
	Exch. Na	Exch. K	Exch. Mg	Exch. Ca
average	0.03	0.2	1.25	5.7
maximum	0.1	0.4	2.2	13.5
minimum	0.0	0.1	0.9	3.2

In comparison with the values of a 'productive soil' the above mentioned figures are too low. The SCL deposits show the same average pH, organic matter and lime content figures. The total cation exchange capacity reaches an average of 10 m.e./100 g. soil, but the base saturation percentage is much lower (approximately 40%), which indicates a moderate to strong leaching. The exch. Ca figures especially are low, amounting to 2.5 m.e./100 g. soil as an average. The SCL deposits possess a higher S content (46%)as compared with the SiL and Cl soils. Their average textural composition is 46% Sand, 25% Silt and 29% Clay. The content of sand particles with a diameter above 150 μ is fairly high; approximately 55% of the sand fraction consists of particles with a diameter above 150 μ.

N 2 Clayey Niger Basin Soils

The clayey Niger Basin soils generally show a fine texture. Clay deposits, often with a < 2 μ fraction of 80% are soils which occur most frequently.. SiC deposits are also frequently found. The topographically higher situated basin soils, more or less in a transitional position between levee or alluvial fan soils and heavy basin soils mostly show a less heavy texture. The average textural composition of the various classes within the Niger basin soils is shown below:

Texture class	% Sand	% Silt	% Clay
C	4	30	66
SiC	8	47	45

The sand content of the clay and SiC soils is very low. The greater part of the sand fraction (approximately 67%) shows a diameter of 50 - 105 μ. The ratio between the 50 - 105, 105 - 150 and > 150 μ diameter classes of the sand fraction is for the C and SiC soils 8 : 3 :1. The pH values of the Niger basin soils have an average of 3.8, whereas maximum and minimum figures of 4.4 and 3.5 are reached occasionally. As to the lime content of the Niger basin soils it is observed that these soils contain relatively more lime than the levee soils, although the lime percentage never exceeds 0.1%. The greater part of the levee soils, however, was lime free whereas nearly all samples of the basin soils showed some lime. The organic matter content is rather low and reaches an average value of 2.5% to 3.5%, although in very few cases organic matter percentages of 12% and 15% occur. The base saturation percentages of the C and SiC soils reaches an average value of 53%, which indicates a medium saturation and a weak to moderate leaching.

For the individual cation adsorption, average figures are as follows:-

Texture class	Exch. Na m.e./100 g.	Exch. K m.e./100 g.	Exch. Mg m.e./100 g.	Exch. Ca m.e./100 g.
C	0.2	0.4	2.9	7.0
SiC	0.1	0.4	2.0	7.6

From an agricultural point of view these figures are too low and relatively strong fertilizing is advised.

NC 1 <u>Complex of N 1 and N 2 soils, but with more than 50% levee soils (N 1)</u>

For description of the units see under N 1 and N 2.

NC 2 <u>Complex of N 1 and N 2 soils, but with more than 50% basin soils (N 2)</u>

For description of the units see under N 1 and N 2.

NC 3 <u>Meanderbelt complex, mainly sandy ridges and clayey gullies.</u>

The meanderbelt complex consists of more or less alternating strips of sandy ridges and clayey gullies. The average textural composition of the clay soils is shown below:

Texture class	% Sand	% Silt	% Clay
C	20	27	53

The pH varies between 3.8 and 4.0.
The lime content never exceeds 0.1%.
The organic matter content amounts to approximately 2%.
The base saturation percentage reaches a medium value (between 50% and 55%) which indicates a weak leaching.
The individual cation adsorption is shown below:

	Cation adsorption in m.e./100 g. soil			
	Exch. Na	Exch. K	Exch. Mg.	Exch.Ca
[illegible]	0.4	0.3	3.6	8.2
[illegible]	0.2	0.2	2.0	5.7
[illegible]	0.3	0.25	2.8	6.9

It will be observed that the exchangeable Na values are fairly high ...pared with the previously mentioned figures. Alkalinity need not ...ed because the exchangeable sodium percentage amounts to approxi... 0.75% only. The Ca and Mg figures are somewhat low.

The more sandy deposits in the meanderbelts are identical with ... described under N 1.

Spillway complex, mainly low situated clayey soils.

The spillway complex shows a variety of soils, which belong to ...s texture classes. The textural composition of the L, SL, SiL as ...s of the SiCL soils is identical with those described under N 1. ...clayey soils possess similar qualities to those described under N 2. ...H of the spillway soils varies between narrow limits 3.6 - 3.9.

The organic matter content shows considerable differences. In ... and clayey soils it reaches 3%, whereas in the more sandy soils ...percentages (approx. 1%) are found. The relatively coarse textured ...s do not contain any lime, whereas in clayey soils the lime content ... exceeds 0.1%.

Sandy or loamy fan levee soils.

The fan levee soils consist mainly of L, SL and LS deposits. The average textural composition is shown by the following figures:

Texture class	% Sand	% Silt	% Clay
LS	85	8	7
SL	60	27	13
L	44	39	17

The LS deposits, characterised by their high sand content, show ... percentage of sand with a particle size diameter above 150μ (70-80%

of the sand fraction). The ratio between the diameter classes 50-105 μ, 105-150 μ and > 150 μ within the sand fraction is approximately 1: 1½ :8. The SL deposits possess a lower sand content, whereas the > 150 μ diameter class is represented by 40-55%. The ratio between 50-105 μ, 105-150 μ and > 150 μ diameter classes within the sand fraction is approximately 3:2:5. These classes are proportionally distributed over the sand fraction. In the L deposits the content of sand with a particle size diameter above 150 μ is low and varies between 10 and 25% in general. The ratio between the 50-105, 105-150 and > 150 μ classes amounts in the L soils approximately to 2: 1 : 1. It will be evident that the content of relatively coarse sand has decreased considerably.

The pH of these deposits show somewhat higher values than the Niger levee and basin deposits:

Texture class	average pH
LS	5.1
SL	5.8
L	4.5

The greater part of the fan levee soils do not contain any lime. Some of the SL samples showed a lime content of 0.2%. The organic matter content varies between 0.8 and 5.6%. The SL deposits tend to contain the highest organic matter percentage (average 3.4%). The base saturation percentage is high; the soils are very weakly leached. The individual cation adsorption is shown by the following values:

	Cation adsorption in m.e./100 g. soil			
	Exch. Na	Exch.K	Exch. Mg	Exch. Ca
average	0.1	0.9	2.1	11.5
maximum	0.1	1.2	3.2	13.2
minimum	0.0	0.7	1.5	10.3

The exchangeable Mg values reach medium values here. The other figures are in fair agreement with the values for a productive soil.

F 2 Clayey Fan Basin Soils

These soils are identical with those described under N 2 (clayey Niger Basin soils). The average pH, however, is somewhat higher (4.4), whereas the organic matter content also shows a higher percentage. The average organic matter percentage amounts to 3.5%.

CF. Colluvial slopes, colluvial fans

The greater part of these soils show a LS texture. The average sand content of the LS amounts to 85%, whereas the silt and clay content amounts to 9% and 6% respectively. The percentage sand with a particle size diameter above 150 μ is high (80% as an average). The ratio between 50-105, 105-150 and > 150 μ diameter classes within the sand fraction is 1:1:8. The pH of the LS deposits varies between 4.2 and 5.9. SL and L deposits are also met frequently. They are also characterised by a high percentage of sand particles with a diameter above 150 μ (85%). pH values here reach an average of 4.2 and vary between very narrow limits. These soils appear to have no lime content. Clay deposits are sometimes found.

2.7.3 Determination of the Atterberg values

In order to know more about the consistency of the fadama soils the Atterberg values (liquid limit, sticky limit and plastic limit) of a number of samples were determined and results are shown in Table 7.1.

The whole of the soil samples have been divided into five groups within each of which the average Atterberg values are similar as shown below.

Group	Texture class	Liquid limit	Sticky limit	Plastic limit
I	C	65.0	48.3	31.5
	SiC	59.7	44.6	31.1
II	SiCL	53.3	43.0	24.6
	CL	51.1	39.4	23.2
III	C	49.7	39.6	25.5
	SiC	43.7	37.5	22.5
IV	CL	37.5	28.7	16.9
	L	39.4	29.5	19.6
V	SL	29.8	23.1	none
	LS	24.2	16.4	none
	S	26.1	17.9	none

It is striking that the soils with C, SiC and CL texture fall into two groups which have divergent values as can be seen by comparing Groups I and III and Groups II and IV. The other texture classes have a normal spread over the various values.

The reason for the divergent values could be explained by the difference in location of the samples but this is not so in this case as the phenomenon occurs over all the basin deposits. Therefore another explanation should be sought and this could be the difference in the ripening of the soil. Many of these low-lying heavy clay soils in marshy regions are hydro-morphically deposited. Whether the soil has fully ripened or not depends on the natural drainage. When the soil is not fully ripened the Atterberg values are high and the soil when cultivated will subside a good deal. From the figures it appears that the plasticity level of the soils is not unfavourable which correponds with the mineralogical analyses results. With regard to tillage the difference between the sticky limit and the plastic limit is relatively small in non-sandy soils and so the margin in which good tillage can take place is not wide. If there is a greater difference between the sticky limit and the plastic limit the margin in which tillage can be performed with favourable results not only becomes wider, but it is also possible to till without appreciable risk under various weather conditions. In this case, however, there is a rather small margin and it is, therefore, very important to determine the right moment at which tillage can start. With the sandy soils this problem is somewhat easier.

2.7.4 Salinity problems

Although no salinity problems are expected because of the amount of rainfall combined with the prevailing hydrological regime, 21 samples obtained from locations covering the whole valley were analysed using the conductivity method. Results show that the ECe of the soils varied from 0.1 to 0.7 mmhos/cm. The majority (15 out of 21) of the tests showed a conductivity of 0.1 to 0.2 mmhos/cm. Furthermore the adsorption complexes showed no Na influence. The conclusion was therefore reached that the valley soils are non saline and so no further investigations for ECe were made in the pilot area.

2.7.5. Fertility of the soils

From the content of exchangeable cations it can be concluded that the figures are moderate. N, P and K fertility figures were determined for 18 samples. The N content of the lower and heavier soils is satisfactory with in general C/N relations varying between 12 and 15. The P and K figures are all low. Furthermore it appears from the cation exchange capacity of the soils that the humus is of high chemical activity (humus fertility).

If, after some years of cultivation, the humus content reaches a low level, the fertility of the soils will be more unfavourable than the present figures show. It is, therefore, advisable to carry out new analyses after some five years of cultivation, as this will give a better insight into the fertility conditions. In any case some fertilizers will be necessary.

2.7.6 Mineralogical analyses

2.7.6 (i) Reserve of weatherable minerals A number of samples covering the whole of the surveyed area was analysed to determine the reserve of weatherable minerals. Results of the analyses, given in Table 7.3 show clear differences between samples. Though the profiles of the same soil unit are comparable, the mineralogical and consequently the chemical properties differ. The origin of the material, deposited in the flood plain by the Niger, by tributaries of the Niger or by colluviation, seems to be very important from a mineralogical point of view. In the reconnaissance survey of the area it was not always possible to distinguish between these differences in origin and from a standpoint of general soil suitability this is not of great importance. With regard to fertility and fertilizing, however, these differences will be found to be important in the future and fertilizer dressing will have to be applied in accordance with mineralogical (i.e. chemical) differences in the soils. The element potassium is particularly important because of variations in amounts of naturally occuring K felspar.

(ii) Clay minerals. The figures for the base exchange capacity of the soils show some variation (see Tables 7.20-40). Even when allowance has been made for humus content variation there remain differences of clay activity in these samples. X-ray investigations show that these soils contain kaolinite (both plastic and crystalline) as main clay mineral. This is due to the fact that all sediments in the flood plains originate from more or less latosolic weathered soils. The kaolinite is in general of a badly crystallised plastic type but some exceptions to this rule occur (indicated in Table 7.4 by +). The activity of the crystalline kaolinite is fairly low (about 5 m.e./100 g. clay), whilst the plastic kaolinite has a higher activity (about 20 m.e./100 g. clay).

There is a tendency for the basin soils to have a more active, thus a more plastic, kaolinite than the levee soils. The kaolinite is mixed with small quantities of illite and montmorillonite which increase the chemical activity somewhat, but are too small to influence the main differences caused by the higher or lower plasticity of the kaolinite. The inactive quartz and hydrargillite play a very unimportant role. The general conclusion is that kaolinite soils have a variable plasticity according to locality.

CHAPTER 3

SEMI-DETAILED SOIL SURVEY

3.1 General

The pilot area to be mapped in semi-detail to a scale of 1:20,000 was selected on March 21st 1960 at the Kaduna meeting between Northern Region Government officials and the Consultants' representatives. The decision to choose the Belle-Gbere area was based on examination of a tentative soil reconnaissance map (scale 1:100,000) of the Niger flood plain between Jebba and the Kaduna confluence, specially produced for this purpose. This map showed that an area of approximately 30 sq. miles in the N.W. part of the so called Jebba-Ogudu Triangle seemed to have comparatively favourable conditions with regard to its potential use for an agricultural pilot area, viz:

a) Fairly uniform and relatively deep clayey and loamy soils cover a high percentage of the area.

b) Although the relatively good soils prevail in the area, almost all soils and soil conditions found in the entire flood plain from Jebba to Lokoja are also represented in the pilot area.

c) Comparatively smooth topography.

d) Reasonable access by road and tracks from Bacita as well as from the river.

The soil survey of this pilot area was carried out after the field work of the reconnaissance soil survey had been finished. The floating headquarters had to be towed upstream from Jamata (near Lokoja) to Rabba before the second stage of the Niger flood plain soil survey could start. The village of Rabba appeared to be a good operational base because of its road connection with Mokwa and Jebba and its favourable position on the opposite bank of the river to the pilot area, which made it easily accessible by motorboat.

3.2 Fieldwork

The necessary field work was carried out during April and May 1960. Nearly all soil observations were made along parallel traces running N-S (magnetic) and cut at intervals of 5,000 feet. The trace cutting operations were carried out in cooperation with the Northern Region Irrigation Division. The soil profile was examined by making borings to a depth of 120 - 200 cm (4-6 feet) at 600 feet intervals. All boring sites were pinpointed on the air photographs and the main profile properties, such as texture, structure, clay and silt content, colour and permeability were estimated and recorded on the spot by the field officers. Extra borings were made where necessary. In addition some 30 profile pits were dug at representative sites to a depth of 6 feet and detailed soil profile descriptions were made. Surface soil samples, for chemical and physical analysis in the Netherlands, were taken at all observation points and a large number of permeability tests carried out in the field. Soil samples for laboratory analysis were also taken at depths of 60 and 90 cm (2 and 3 feet) in all soil profile pits. In addition in situ permeability tests were carried out at these depths. A series of borings at 1,200 feet intervals, to a depth of 12 feet each, was made along trace F (Figure 7.5, sheet 2, cross section F).

3.3 Soil map compilation

The final semi-detailed soil map to a scale of 1:20,000 was prepared in the Netherlands using all available soil data and the 1:20,000 scale air photographs with the uncontrolled photo mosaics as a topographic map base. In addition four cross sections along traces B, D, F and H were prepared in order to illustrate the topography of the area and the sedimentation sequence of the various soil strata (Figure 7.5, sheets 1 and 2). The level data for these four traces were obtained from the Northern Region Irrigation Division, Bida, who were levelling the whole pilot area for other purposes at the same time as the soil survey.

3.4 The soils

3.4.1 Physiography. The general geology and physiography of the Niger valley, the Niger flood plain and the Niger alluvium have already been discussed in Section 2.5.1. For the pilot area the following special points are of note:

In the pilot area all three main landscapes are represented,

a) the sandy terrace in the extreme south of the area,

b) the alluvial fan laid down by the river Oshin in the south-western corner, with spurs into the central part,

c) the Niger alluvium with its pattern of levees, basins and meander belts.

These levees and basins, deposited by the river Niger, prevail in the northwestern, the central and the eastern parts of the pilot area. The map (Figure 7.3) shows that an old meandering branch of the Niger running from Yelwa (Ilorin Province) to Fanagun has deposited fairly extensive areas of loamy levee and clayey basin soil, whereas east of the line Gbere-Fanagun a number of small meandering streams has given rise to a complicated pattern of small levee and basin areas. Due to its fairly torrential regime the river Oshin overflows its banks in the rainy season and has deposited its own fan-like pattern of levees and basins. These alluvial fan soils are of a more coarse sandy character than those laid down by the river Niger.

As discussed in Section 2.5.2 only the recognised soil series and complexes are given descriptive names. Proper series names may be given at a later date in order to fit them into the existing classification system of Nigerian soils.

3.4.2 Soil classification. The principles on which the classification of the alluvial soils of the Niger flood plain from Jebba to Lokoja is based, are discussed in Section 2.5.2. The soils of the pilot area, being a part of the flood plain, are classified according to the same principles. The recognized soil series and complexes of the pilot area are essentially similar to those mapped on the reconnaissance soil map of the same area.

Owing to the semi-detailed character of the pilot area soil survey, the various soil series were classified into soil units which were designated mapping units. The differentiation of the soil series into soil units is based mainly on the texture and the depth of the surface soil (approximately the top 60 cm - 2 feet), both factors being very important criteria in evaluating soils for irrigation suitability.

3.4.3 Terminology. For the terminology used in the descriptive legend, see Section 2.5.3.

3.4.4 Descriptive legend. On the legend of the semi-detailed soil map the soil units are only characterised in general terms. The soil conditions of the mapping units will be described in more detail below. A short description of the soil series will also be given. The vegetation of the area is described in Chapter 4.

The topography of the various mapping units is illustrated on cross sections (Figure 7.5, sheets 1 and 2), which also give a schematic picture of the soil profile strata for each mapping unit. Descriptions of representative soil profile pits are given in Section 3.4.5.

N.1 Niger levee soil series

This series consists of deep or moderately deep, brown, loamy or sandy soils, in general becoming more coarse with increasing depth. Soil series N.1 is represented on the map by 4 soil units.

Soil unit N.1.1

Deep and very deep, uniform, moderately coarse or medium textured grey brown or brown, porous soils. The profile is faintly mottled. Soils of this type are found on the medium high levees, located immediately along the river and its branches. The topography of this unit is intersected by gullies and creeks in the lower parts due to the river Niger overflowing its banks annually. Although confined to relatively small areas most of the peasant cultivations in the pilot area are located on the soils of unit N.1.1 because these soils are easy to work and water retentive. A representative soil profile of N.1.1 is described in profile description no. B 4 and H 8, see 3.4.5.

Soil unit N.1.2

Deep and very deep uniform, medium to fine textured, non-porous soils. The soils of this type are located mainly in the transitional zones between the soils of series N.1 and N.2. The unit is flooded more frequently than N.1.1 which is almost certainly the cause of the non-porous, sometimes even cemented structure. Occasionally moderately fine strata are found in the profiles of soil types N.1.2. The topography of unit N.1.2 is level or gently sloping towards a basin area. The unit must be considered a transition to the basin soils. A representative profile of soil unit N.1.2 is described in 3.4.5. (soil pit J 5).

Soil unit N.1.3

Shallow to moderately deep, moderately coarse or medium textured, grey-brown soils overlaying a coarse textured subsoil. The soils of this type are found in small areas in between the soils of unit N.1.1 and they form the highest parts of the river levees. Their topography is fairly smooth, occasionally intersected by creeks. Due to their position and profile these soils are very dry at present and therefore not suitable for peasant cultivation. A representative profile of soil type N.1.3 is described in 3.4.5. (soil pit F 3).

Soil unit N.1.4

Deep, coarse textured, light brown to yellow soil, occasionally covered by a very shallow layer of moderately coarse or medium textured material. Soils of type N.1.4 are mainly located close to and along the Niger bank on the highest parts of the levees, which are very seldom flooded. Less frequently, this soil type is found behind the levees, and in this case it is a spill deposit. The topography of N.1.4, consisting of isolated smooth areas amidst the lower levees of unit N.1.1, is similar to unit N.1.3.

N.2 Niger basin soil series

This series consists of deep to moderately deep, clayey soils overlaying a sandy subsoil. Series N.2, is represented on the soil map by 3 soil units.

Soil unit N.2.1

Deep and occasionally very deep, uniform fine textured, grey to grey-brown soil, often becoming more sandy with increasing depth. The profile is strongly mottled and locally even small iron concretions are formed. Unit N.2.1. is located in relatively low areas between river levees. The topography of unit N.2.1. is very flat and almost level but locally intersected by some shallow creeks. A representative soil profile of unit N.2.1., is described in section 3.4.5. (soil pits B 7a, F 17, D 16).

Soil unit N.2.2

Deep and often very deep, very fine textured soil on a sandy subsoil. The colour of the heavy clay is often blue grey with many yellow mottles or small iron concretions. Unit N.2.2. is located in the lowest, central parts of unit N.2.1. Permeability is low. A representative soil profile of this soil unit is described in section 3.4.5. (soil pit D 6).

Soil unit N.2.3

Shallow and moderately deep, moderately fine to fine textured, grey or brown-grey surface soil, gradually becoming coarse or moderately coarse textured with increasing depth. The topsoil is covered locally with a 5-10 cm (2" - 4") thick layer of undecomposed or partly decomposed organic material.

Unit N.2.3., occupies the relatively higher parts of the river basin areas and is situated mainly in the western part of the area. The topography of unit N.2.3. is flat, level and locally intersected by small creeks. A representative soil profile description is given in section 3.4.5. (soil pits F 22 and F 24).

F.1 Fan levee soil series

This soil series consists of soils with a loamy or sandy surface soil and a sandy subsoil, both having a very stratified profile and occasionally gravelly in subsoil. These soils are deposited by the river Oshin and its spill channels. Series F.1., is represented on the map by 2 soil units.

Soil Unit F.1.1.

Deep, coarse to moderately coarse textured soil, often with a stratified profile; some strata are occasionally moderately fine textured or gravelly. The soils of this unit occupy the greater part of the fan levee soil series in the pilot area. They are relatively high and their topography is undulating with a general slope towards the north and east. See cross section B, Figure 7.5, sheet 1. A fairly typical profile is given in section 3.4.5. (pit no. B 25 and D 23).

Soil Unit F.1.2.

See description F.1.1., but with a moderately deep, predominately medium textured surface soil. Unit F.1.2. is found in strips along the river Oshin and along its main branches. Description of a representative profile is recorded in section 3.4.5. (pit no. B 19).

F.2 Fan basin soil series

This soil series consists of soils with a loamy or clayey surface soil and coarse sandy subsoil. These soils are found in the basin as depressions between the levees of series F.1. Series F.2., is represented on the soil map by two units.

Soil Unit F.2.1.

Shallow to moderately deep, mainly moderately fine textured, brown-grey surface soil overlaying a coarse textured, stratified and sometimes gravelly subsoil. The profile is strongly mottled. This unit is found in fairly small patches in between the fan levee sediments, located in relatively low areas. The topography is flat and level, locally intersected by a few small creeks. For representative profile description see section 3.4.5. (pit no. B 23).

Soil unit F.2.2.

Moderately deep to deep, fine textured, grey (mainly hydromorphic) surface soil overlaying coarse textured subsoil. Strongly mottled or entirely gleyed profile. This unit is situated close to the river Oshin in the extreme south western part of the mapped area. Owing to difficulty of access, only relatively few observations were made. No detailed profile description is available.

T. 1 Sandy Terrace soil series

This series consists of deep uniform, sandy brown to reddish brown soils. The soils of series T. 1 are located in the southern part of the mapped area. Their surface lies approximately 3-5 m (10-20 ft.) higher than the surface of the Niger alluvium. This series is represented on the soil map by two units:

Soil unit T. 1. 1.

Very deep, coarse textured brown or reddish brown soil. The surface soil consists of 30 cm (1 ft.) locally loamy sand, the sub soil consists mainly of coarse sand of grain size 150-210 µ. No oxydo-reduction mottling within the top 50 cm (20"). This unit is located on the highest points of the sandy terrace. The topography is slightly undulating and is intersected by several gullies and elongated depressions, running mainly north-west to south-east. The soils of this unit are not subject to annual flooding as they lie above highest flood level. A representative profile is described in 3.4.5 (pit no. F 30 and F 31).

Soil unit T. 1. 2.

See T. 1. 1., but relatively lower and therefore subject to occasional flooding. Mottled up to the surface and more intensively intersected by gullies. See profile pit description in 3.4.5 (pit no. D 29).

T.3 Terrace gully soil series

This series consists of soils with a loamy, occasionally clayey surface soil and a sandy subsoil. The soils of this series are located in the erosion gullies of the sandy terrace. On the soil map this series is represented by one soil unit only.

Soil unit T.3.1.

Shallow, moderately coarse or medium textured (occasionally moderately fine textured) grey-brown or grey surface soil and coarse textured subsoil. Strongly mottled. Unit T.3.1 is confined to the shallow rather wide gullies or channels by which the sandy terrace soil series is intersected. In spite of the highly permeable subsoil the soils of unit T.3.1 are moist or even waterlogged which may be due to the water retentive and rather impermeable topsoil and to their relatively low topographic position. A representative profile of unit T.3.1 is described in 3.4.5 (pit no. D 28a).

NC.3 Meander belt complex

Complex pattern of parallel alternating soil series, namely sandy or loamy ridges (series N.1) and shallow clay filled depressions (series N.2.1). The topography of this soil complex, seen at right angles to ridges and depressions, is very uneven and differences in elevation of approx. 1-2 m (3-6 feet) occur within 10 or 20 m (30-60 feet) or even less. This pattern of soils typifies the deposition from a meandering river and is always located on the inner curve of an abandoned or existing river course. Where a river course has several bends in succession elongated belts can be mapped. NC.3.1 is the only representative unit of this series.

NC.4 Spillway soil complex

Complex pattern of several more or less parallel soil series, the main one comparable with the units N.2.1 and N.2.3 of series N.2 and unit N.1.1 of series N.1. This soil complex runs in wide depressions, possibly old river channels, through the mapped area. During the wet season these depressions become filled with flowing water. These elongated areas are relatively low and are intersected by many parallel deep creeks, which as a whole give the units NC.4 a different character from unit N.2.1 to which the spillway soil complex is somewhat related with regard to its soils. A typical cross section is shown on cross section D (Figure 7.5, sheet 1). This series is only represented by unit NC.4.1.

M. Mud flats.

Miscellaneous land type with fine or moderately fine textured, moderately deep, hydromorphic soils, located mainly along the river banks. The mud flats are exposed to flooding the greater part of the year. On the reconnaissance soil map these mud flats are included in unit I.

3.4.5 Profile pit descriptions

The profile pit descriptions given below were recorded on the spot. Descriptions and terminology accord with the Soil Survey Manual. Soil colours are described according to the Munsell Colour Chart.

The descriptions given apply to mapping units indicated in Section 3.4.4 above.

Pit B 4 (unit N.1.1.)
Soil profile

Layer	Depth	Description
1	0-35 cm	Grey brown (10 YR 5/2, dry) loam of moderately fine subangular blocky structure containing many medium distinct clear spots of dark brown colour (10 YR 3/3, dry). Many roots. Approximately 1% organic material. Gradual smooth boundary between 1 and 2.
2	35-50 cm	Grey (10 YR 6/1, dry) sandy loam of composite prismatic and medium subangular blocky structure containing common coarse distinct clear spots of yellowish brown colour (10 YR 5/6, dry). Many roots. No organic material. Gradual wavy boundary between 2 and 3.
3	50-120 cm	Light brown grey (10 YR 6/2, dry) loamy fine sand, structureless, massively cemented and containing common coarse distinct clear spots of yellowish brown colour (10 YR 5/6, dry). No roots.

Pit B 7a (unit N.2.1)
Soil profile

Layer	Depth	Description
1	0-70 cm	From 0-20 cm black (10 YR 2/1, moist) clay and from 20-70 cm grey (7.5 YR 5/0, moist) clay of very strong coarse prismatic structure containing many coarse prominent clear mottles of red colour (2.5 YR 5/6, moist). Few roots. In the upper 20 cm approximately 3% organic material. Gradual wavy boundary between 1 and 2.
2	70-90 cm	Grey (2.5 YR 5/0, moist) clay loam of moderately strong coarse subangular blocky structure containing common medium distinct clear mottles of red colour (2.5 YR 5/6, moist). Few roots. No organic material. Diffuse irregular boundary between 2 and 3.

Layer	Depth	Description
3	90-110 cm	Grey (5 Y 5/1, moist) sandy loam of weak medium subangular blocky structure containing common medium faint diffuse mottles of reddish yellow colour (7.5 YR 7/6, moist). Few roots. No organic material. Clear smooth boundary between 3 and 4.
4	110-150 cm	Light olive grey (5 Y 6/2, moist) loamy sand of weak medium crumb structure containing common medium prominent mottles of reddish yellow colour (7.5 YR 7/6, moist). No roots. No organic material.

Pit B 19 (unit F.1.2.)
Soil profile

Layer	Depth	Description
1	0-40 cm	Very dark grey (7.5 YR 3/0, moist) sandy loam of moderately strong medium angular blocky structure containing many coarse prominent clear mottles of strong brown colour (7.5 YR 5/8, moist). Many roots. The upper 10 cm has approximately 5% organic material. Abrupt smooth boundary between 1 and 2.
2	40-80 cm	Very pale brown (10 YR 7/3, moist) loam with gravel, structureless, single grain and containing many coarse distinct clear mottles of yellowish red colour (5 YR 5/6, moist). No roots. No organic material. Abrupt smooth boundary between 2 and 3.
3	80-100 cm	Pale brown (10 YR 6/3, moist) loamy sand structureless, cemented and containing many medium distinct clear mottles of yellowish red colour (5 YR 5/6, moist). No roots. No organic material. Clear wavy boundary between 3 and 4.
4	100-150 cm	Grey brown (10 YR 5/2, moist) loam structureless, cemented and containing many medium distinct clear mottles of red colour (2.5 YR 4/6, moist). No roots. No organic material.

[illegible] (unit F.2.1.)
[illegible] profile

Layer	Depth	Description
1	0-25 cm	Very dark grey (5 YR 3/1, dry) loam of weak, very fine crumb to structureless single grain structure and containing common medium faint diffuse mottles of yellowish red colour (5 YR 4/8, dry). Many roots. In the upper 15 cm approximately 5% organic material. Smooth diffuse boundary between 1 and 2.
2	25-100 cm	Grey brown (10 YR 5/2, dry) sandy loam to loamy sand structureless single grain and containing many coarse distinct diffuse mottles of strong brown colour (7.5 YR 5/6, dry). Many roots. No organic material.
3	100-110 cm	Light grey (10 YR 7/2, dry) sand with gravel, structureless, single grain and containing many coarse prominent diffuse mottles of yellowish red colour (5 YR 5/8, dry). Few roots. No organic material. Smooth abrupt boundary between 3 and 4.
4	110-130 cm	Dark brown (7.5 YR 4/3, moist) loam with gravel, structureless, cemented. No roots. No organic material. Smooth gradual boundary between 4 and 5.
5	130-150 cm	Dark brown (7.5 YR 4/2, moist) clay loam, structureless, clay cemented. No roots. No organic material.

Pit B 25 (unit F.1.1.)
Soil profile

Layer	Depth	Description
1	0-40 cm	Dark reddish brown (5 YR 3/2, dry) sand of moderately weak fine granular structure containing common medium distinct clear mottles of dark brown colour (7.5 YR 4/4, dry). Many roots. In the upper 10 cm approximately 5% organic material. Clear smooth boundary between 1 and 2.

Layer	Depth	Description
2	40-60 cm	Strong brown (7.5 YR 5/5, dry) sand, structureless, single grain and containing common medium faint diffuse mottles of brown colour (7.5 YR, dry). Many roots. No organic material. Gradual wavy boundary between 2 and 3.
3	60-150 cm	Light yellowish brown (10 YR, 6/4, dry) sand, structureless, single grain and containing common medium distinct clear mottles of yellowish red colour (5 YR 5/8, dry). Few roots. No organic material.

Pit D 6 (unit N.2.2.)
Soil profile

Layer	Depth	Description
1	0-50 cm	Dark grey (7.5 YR 4/0, moist) clay of moderately strong medium subangular blocky structure and containing common fine prominent diffuse mottles of red colour (10 R 4/6, moist). Many grass roots. In the upper 15 cm approximately 5% organic material. Diffuse smooth boundary between 1 and 2.
2	50-150 cm	Dark grey (7.5 YR 4/0, moist) heavy clay of moderately strong medium subangular blocky structure and containing common fine prominent diffuse mottles of red colour (2.5 YR 4/6, moist). Few grass roots. No organic material.

Pit D 16 (unit N.2.1.)
Soil profile

Layer	Depth	Description
1	0-90 cm	Very dark grey (10 YR 3/1, dry) clay of moderately strong coarse subangular blocky structure containing common fine distinct clear mottles of red colour (2.5 YR 4/8, dry). Many grass roots. In the upper 10 cm approximately 5% organic material. Diffuse smooth boundary between 1 and 2.
2	90-150 cm	Very dark grey (10 YR 3/1, dry) clay of moderately strong medium subangular blocky structure containing common fine distinct clear mottles of red colour (2.5 YR 4/8, dry). No roots. No organic material.

Pit D 23 (unit F 1.1.)
Soil profile

Layer	Depth	Description.
1	0-20 cm	Dark brown (7.5 YR 4/2, dry) sand of moderately weak medium crumb structure and containing common medium distinct clear mottles of strong brown colour (7.5 YR 5/6, dry). Many grass and tree roots. In the upper 10 cm approximately 3% organic material. Clear wavy boundary between 1 and 2.
2	20-55 cm	Dark brown (7.5 YR 4/4, dry) sand, structureless, single grain, containing common medium faint clear mottles of brown colour (7.5 YR 5/4, dry). Few roots. No organic material. Gradual wavy boundary between 2 and 3.
3	55-150 cm	Pale brown (10 YR 6/3, dry) sand, structureless, single grain, containing common medium faint diffuse mottles of light brown colour (7.5 YR 6/4, dry). No roots. No organic material.

Pit D 28a (unit T.3.1.)
Soil profile

Layer	Depth	Description
1	0-40 cm	Black loam (5 YR 2/1, moist) of moderately weak medium angular blocky structure containing many medium distinct clear mottles of red colour (2.5 YR 4/8, moist). Many grass roots. In the upper 10 cm approximately 4% organic material. Gradual wavy boundary between 1 and 2.
2	40-120 cm	Grey (10 YR 6/1, wet) sand; structureless, single grain. No roots. No organic material.

Pit D 29 (unit T.1.2.)
Soil profile

Layer	Depth	Description
1	0-20 cm	Dark brown (7.5 YR 4/2, dry) sand of moderately weak fine crumb structure containing common medium distinct clear mottles of strong brown colour (7.5 YR 5/8, dry). Many roots. No organic material. Clear wavy boundary between 1 and 2.

Layer	Depth	Description
2	20-35 cm	Light brown (7.5 YR 6/4, dry) sand; structureless, single grain, containing common medium distinct clear mottles of yellowish red colour (5 YR 5/8). Few roots. No organic material. Gradual wavy boundary between 2 and 3.
3	35-70 cm	Light yellowish brown (10 YR 6/4, dry) sand; structureless, single grain, containing many medium prominent clear mottles of yellowish red colour (5 YR 5/6, dry). No roots. No organic material. Gradual wavy boundary between 3 and 4.
4	70-150 cm	Very pale brown (10 YR 7/3, dry) sand; structureless, single grain, containing few medium prominent sharp mottles of yellowish red colour (5 YR 5/8, dry). No roots. No organic material.

Pit F 3 (unit N.1.3.)
Soil Profile

Layer	Depth	Description
1	0-40 cm	Dark brown (7.5 YR 4/2, dry) sandy loam of moderately strong medium subangular blocky structure containing common fine distinct clear mottles of yellowish red colour (5 YR 5/6, dry). Many tree and grass roots. In the upper 15 cm approximately 5% organic material. Clear wavy boundary between 1 and 2.
2	40-60 cm	Brown loamy sand (7.5 YR 5/4, dry) of moderately strong medium subangular blocky structure containing many medium distinct clear mottles of yellowish red colour. (5 YR 5/8, dry). Many roots. No organic material. Gradual wavy boundary between 2 and 3.
3	60-150 cm	Light yellowish brown sand (10 YR 6/4, dry) of moderately strong granular structure containing common medium prominent clear mottles of reddish yellow colour (5 YR 6/8, dry). Few roots. No organic material.

Pit F 17 (unit N 2.1.)
Soil profile

Layer	Depth	Description
1	0-25 cm	Black (2.5 Y 2/0, moist) clay of moderately weak fine subangular blocky structure containing few fine faint clear mottles of red colour (10 R 4/6, moist). Many grass and reed roots. In the upper 10 cm approximately 6% organic material. Gradual smooth boundary between 1 and 2.
2	25-140 cm	Very dark grey (7.5 YR 3/0, moist) clay of moderately strong coarse angular blocky structure containing many fine prominent clear mottles of red colour (10 R 4/8, moist). No roots. No organic material.

Pit F 22 (unit N.2.3.)
Soil profile

Layer	Depth	Description
1	0-20 cm	Dark grey (7.5 YR 4/0, moist) clay of moderately strong coarse angular blocky structure containing common medium distinct clear mottles of strong brown colour (7.5 YR 5/6, moist). Many grass roots. In the upper 10 cm approximately 4-5% organic material. Gradual wavy boundary between 1 and 2.
2	20-60 cm	Grey (7.5 YR 5/0, moist) silty clay loam of moderately weak medium angular blocky structure containing many medium prominent clear mottles of yellowish red (5 YR 5/8, moist) colour. Few roots. No organic material. Abrupt smooth boundary between 2 and 3
3	60-80 cm	Brown (7.5 YR 5/4, moist) loamy sand of moderately weak fine granular structure containing few medium faint clear mottles of strong brown colour (7.5 YR 5/6, moist). No roots. No organic material. Clear wavy boundary between 3 and 4.
4	80-150 cm	Strong brown (7.5 YR 5/8, moist) sand; structureless, single grain. No mottles, streaks, spots or variegations visible. No roots. No organic material.

Pit F 24 (unit N.2.3.)
Soil profile

Layer	Depth	Description
1	0-30 cm	Dark grey (7.5 YR 4/0, moist) clay of moderately strong coarse angular blocky structure containing common medium distinct clear mottles of brown colour (7.5 YR 5/4, moist). Many grass roots. In the upper 10 cm approximately 3% organic material. Clear wavy boundary between 1 and 2.
2	30-60 cm	Grey (10 YR 5/1, moist) loam of moderately strong coarse angular blocky structure containing many medium prominent clear mottles of strong brown colour (7.5 YR 5/6, moist). Few roots. No organic material. Abrupt smooth boundary between 2 and 3.
3	60-75 cm	Very pale brown (10 YR 7/3, moist) structureless single grain sand containing common medium prominent sharp mottles of yellowish red colour (5 YR 5/8, moist). No roots. No organic material. Abrupt smooth boundary between 3 and 4.
4	75-150 cm	Grey (7.5 YR 6/0, moist) loamy sand of moderately weak medium angular blocky structure containing common medium prominent clear mottles of yellowish red colour (5 YR 5/6, moist). No roots. No organic material.

Pit F 30 (unit T.1.1.)
Soil profile

Layer	Depth	Description
1	0-30 cm	Dark yellowish brown (10 YR 3/4, dry) sand of moderately weak medium crumb structure. Few grass and tree roots. No organic material. Diffuse smooth boundary between 1 and 2.
2	30-150 cm	Strong brown (7.5 YR 5/8, dry) sand; structureless, single grain. No roots. No organic material.

Pit F 31 (unit T.1.1.)
Soil profile

Layer	Depth	Description
1	0-20 cm	Dark grey brown (10 YR 3/2, dry) sand; structureless, single grain to weak fine crumb structure. Many roots. In the upper 10 cm approximately 3% organic material. Diffuse smooth boundary between 1 and 2.
2	20-45 cm	Brown (10 YR 5/3, dry) sand; structureless, single grain. Many roots. Approximately ½% organic material. Gradual smooth boundary between 2 and 3.
3	45-85 cm	Light yellowish brown (10 YR 6/4, dry) sand; structureless, single grain, containing many coarse distinct diffuse mottles of strong brown colour (7.5 YR 5/8, dry). Few roots. No organic material. Gradual smooth boundary between 3 and 4.
4	85-130 cm	Very pale brown (10 YR 8/4, dry) sand; structureless, single grain, containing common coarse medium diffuse mottles of reddish yellow colour (7.5 YR 7/8, dry). Very few roots. No organic material. Diffuse smooth boundary between 4 and 5.
5	130-150 cm	Very pale brown (10 YR 8/4, dry) sand; structureless, single grain, containing many coarse prominent clear vertical streaks of reddish yellow colour (5 YR 6/8, dry). No roots. No organic material.

Pit H 8 (unit N.1.1.)
Soil profile

Layer	Depth	Description
1	0-30 cm	Grey (10 YR 5/1, moist) loam of moderately weak medium angular blocky structure containing common fine distinct clear mottles of yellowish red colour. (5 YR 4/8, moist). Many tree roots. In the upper 10 cm approximately 3% organic material. Clear smooth boundary between 1 and 2.
2	30-50 cm	Dark grey (2.5 Y 4/0, dry) sandy loam of moderately weak coarse angular blocky structure containing many medium prominent clear mottles of red colour (2.5 YR 4/8, dry). Few roots. No organic material. Clear smooth boundary between 2 and 3.

Layer	Depth	Description
3	50-90 cm	Grey (2.5 Y 5/0, dry) loamy sand of medium sub-angular blocky structure containing many medium prominent clear mottles of yellowish red colour (5 YR 5/8, dry). Few roots. No organic material. Abrupt boundary between 3 and 4.
4	90-150 cm	Pale yellow (5 Y 7/3, moist) sand, very fine crumb structure to structureless single grain containing few faint clear spots of yellowish red colour (5 YR 5/8, moist). No roots. No organic material.

Pit J 5 (unit N.2.1.)
Soil profile

Layer	Depth	Description
1	0-15 cm	Grey (5 Y 6/1, dry) loam of moderately fine compound angular blocky and strong fine crumb structure. Many roots. Approximately 2% organic material. Clear smooth boundary between 1 and 2.
2	15-60 cm	Pinkish grey (7.5 YR 7/2, dry) clay loam of compound strong coarse prismatic structure and moderate medium angular blocky structure containing few fine distinct sharp spots of yellowish red colour (5 YR 5/8, dry). Many roots. No organic material. Gradual smooth boundary between 2 and 3.
3	60-110 cm	Light grey (10 YR 7/1, dry) clay loam of compound strong coarse prismatic structure and moderate medium angular blocky structure containing many medium distinct clear mottles of strong brown colour (7.5 YR 5/6, dry). No organic material. Diffuse smooth boundary between 3 and 4.
4	110-130 cm	Light grey (10 YR 7/2, dry) loam of compound strong coarse prismatic structure and moderate medium angular blocky structure containing many coarse prominent clear mottles of deep brown colour (7.5 YR 5/8, dry). No roots. No organic material. Diffuse smooth boundary between 4 and 5.

3.5 Physical and chemical analyses of soil samples.

3.5.1 General. The soil map is based on uncontrolled air photo mosaics to a scale of 1:20,000 and therefore the locations of the soil boundaries and observation sites are not as accurate as might be expected on a topographically correct map of this scale.

Details of the analyses are set out in Tables 7.30-40.

3.5.2 Discussion of the soil unit analyses

Fan levee soil units (symbols F.1.1 and F.1.2.)

The soils which make up the above mapping units generally show a coarse to moderately coarse texture; sand, sandy loam, loam, silt loam and occasionally clay loam and silty clay loam soils are encountered.

The average textural composition of the various texture classes is shown below:

Texture class	% S	% Si	% C	
S	89	9	2	) F.1.1.
SL	69	23	8	)
L	41	39	20	)
SiL	19	66	15	) F.1.2.
SiCL	16	52	32	)
CL	32	36	32	)

It may be noted from the particle size distribution figures given below that the percentages of fairly coarse sand are highest in the S and SL soils and amount to 74% and 40% respectively and that the L, CL and SiL soils have approximately the same proportions of coarse sand.

Texture class	% 50-105 μ	% 105-150 μ	% 150 μ	
S	6	9	74	) F.1.1
SL	16	13	40	)
L	18	11	12	)
SiL	4	3	12	) F.1.2
CL	10	8	14	)
SiCL	4	3	9	)

The organic matter content of these fan levee soils is not very high and varies between $1\frac{1}{2}\%$ - 5%. There is a rough correlation between the texture class and the organic matter content of the soils, in that the organic matter percentage increases with the silt and clay content, as illustrated by the following figures :

Texture class	Average organic matter %	
S SL	1.6 2.8	) F.1.1)
L SiL CL SiCL	4.7 4.8 4 6.4	)) F.1.2))

The lime content of the fan levee soils is low. The S and SL soils contain no lime at all, while the L, SiL, CL and SiCL soils of this series show a lime content that never exceeds 0.1%.

The base saturation percentage varies between 65% and 98%, which is considered to be high. Apparently the soils are leached to a fairly weak extent. The range of values for the exchangeable cations (in m.e./100 g. soil) for several texture classes is shown below.

Texture class	cation adsorption in m.e./100 g.							
	Exch. Na	Exch. K	Exch. Mg	Exch. Ca	C.E.C.	T.E.B.	B.S.P. in %	E.S.P. in %
S	0.0	0.2	1.0	4.1	6	5.5	88	0
SL	0.1	0.2	1.7	7.6	11	9.6	87	0.9
L	0.1	0.5	2.4	10.7	21	13.7	65	0.4

The exchangeable sodium percentages (E.S.P.) for all texture classes of the fan levee soils are low (not exceeding 0.9%). Saline or saline-alkaline conditions will not occur, therefore it may be assumed that there is also no salinity. The pH varies between 4.5 and 6.8.

Sandy Terrace soil units (T.1.1 and T.1.2.)

The majority of the soil samples taken from the sandy terrace soil series show a sandy texture; some, although very few, samples show a SL or LS texture. The average textural composition of the S, LS and SL soils is shown below.

Texture class	% S	% Si	% C	sand fraction %		
				50-105 μ	105-150 μ	>150 μ
S	92	6	2	12	18	62
LS	81	15	4	10	7	64
SL	58	34	8	-	-	-

The sand fraction of the sandy terrace soils is characterised by its high content of sand with a particle size above 150 μ (62%). This is a specific characteristic of the terrace soils. The sandy terrace soils do not contain any lime and show a low organic matter content (between 1% and 1.5%). The pH varies between 4.3 and 5.8 (average value 5.2).

If the base saturation figures are considered as an indication of the intensity of leaching, it can be stated that the sandy terrace soils are moderately to weakly leached. The value range of the exchangeable cations (in m.e./100 g. soil) for sandy terrace soils is given below.

Cation adsorption	in m.e./100 g. soil			
	Exch. Na	Exch. K	Exch. Mg	Exch. Ca
Average	0.0	0.1	0.5	1.5
Minimum	0.0	0.1	0.1	0.9
Maximum	0.0	0.1	0.9	2.1

The figures show that the exchangeable Ca, K and Mg values are very low. Deficiency phenomena are to be expected. Neither salinity nor alkalinity will occur.

Niger levee soils (unit N.1.1)

The Niger levee soils consist essentially of light textured soil material, although locally some finer textured layers are encountered, especially at the surface and the deeper parts of the profiles.

The average textural composition of the N.1.1 soils mainly belong to the L and SiL texture class, but in some cases belong to the SiCL texture class, as shown in the following figures.

Texture class	% S	% Si	% C
L	46	42	12
SiL	24	60	16
SiCL	6	60	34

The particle size distribution within the sand fraction for the several textured classes is shown below.

Texture class	% 50-105 µ	% 105-150 µ	% > 150 µ
L	36	5	5
SiL	15	6	3
SiCL	2.8	0.7	1.5

The lime content never exceeds 0.1%, approximately 25% of the samples did not show any free lime. The organic matter content amounts to an average of 3% with maximum and minimum values of 5½% and 1½%.

The pH varies between 3.7 and 5.7, with an average of 4.2. The average base saturation percentage amounts to 64% with maximum and minimum values of 83 and 48 m.e./100 g, indicating a weak leaching. The individual cation adsorption is shown below.

Cation adsorption	in m.e./100 g. soil			
	Exch. Na	Exch. K	Exch. Mg	Exch. Ca
Average	0.2	0.3	2.2	6.2
Minimum	0.1	0.2	1.3	3.9
Maximum	0.4	0.4	3.3	9.7

The values are medium to low.

Niger levee soils (unit N.1.2)

The soils of this unit show a fine texture; C and SiC being the most frequently found texture classes. From this it appears that these soils must be considered as a transition from the levee soils to the basin soils. During the fieldwork these soils had been estimated as a CL to SiCL. This appears to have been somewhat too light a texture. The average textural composition of these soils is shown below.

Texture class	% S	% Si	% C
C	3	37	60
SiC	8	52	40

The particle size distribution of the sand fraction is as follows:

Texture class	% 50-105 µ	% 105-150 µ	% > 150 µ
C	1.4	0.2	0.2
SiC	4.7	0.6	0.7

The lime content never exceeds 0.1%. The organic matter content is relatively low (average 1.9%; maximum 3.8%, minimum 1.3%). The pH values vary between 4.2 and 3.8 (average 3.9).

The base saturation percentage amounts to 59% on an average with 46% and 75% as minimum and maximum values, which is medium to high. This indicates a weak leaching.

The individual cation adsorption is shown below.

Cation adsorption	in m.e./ 100 g. soil			
	Exch. Na.	Exch. K	Exch. Mg.	Exch. Ca
Average	0.4	0.3	2.7	8.3
Minimum	0.4	0.2	1.1	7.4
Maximum	0.4	0.5	4.2	9.8

These figures show that the exchangeable cation values are of a medium rate.

Niger levee soils (unit N.1.3.)

The soils of this unit correspond with those of unit N.1.1., SL soils, however, are more frequently found. The average textural composition is given below.

Texture class	% S	% Si	% C
SL	54	39	7
L	34	49	17
SiL	21	61	18
SiCL	10	59	31

The particle size distribution of the sand fraction is as follows.

Texture class	% 50-105 μ	% 105-150 μ	% ⪢ 150 μ
SL	36	12	6
L	16	9	9
SiL	9	6	6
SiCL	5	2	3

These figures show that the ratio between the sand fractions is more or less the same for all texture classes. The lime content of the soils never exceeds 0.1%. The organic matter content is relatively low (average 2%; maximum and minimum values 3.5 and 1.1%). The pH varies between 3.9 and 4.5 with 4.2 as an average. The base saturation percentage amounts to 65% as an average, varying between 60 and 70%. This is a high value, indicating a weak leaching.

Cation adsorption	In m.e./100 g. soil			
	Exch. Na	Exch. K	Exch. Mg	Exch. Ca
Average	0.1	0.2	1.6	5.1
Minimum	0.1	0.1	0.9	3.1
Maximum	0.1	0.3	2.1	7.2

The values are medium (Mg + Ca) to low (Na + K).

Niger levee soils (unit N.1.4)

In general these soils have a profile with a sandy structure; sometimes the surface soil is somewhat heavier, but it is always lighter than the other units of the levee soils. In the pilot area these soils are only found in scattered places.

The textures of the surface soils vary from SiL to L and it is striking that the clay percentages are small (11-19)%. The other properties, such as pH, CaCO3 percentage and exchangeable cations of the adsorption complex fully agree with the other units of the Niger levee soils.

Niger basin soils (unit N.2.1.)

The N.2.1. soils are characterised by their fine texture. The greater part of the soils consist of clay, although occasionally SiC textures are found. The average textural composition is as follows: 3% S, 36% Si and 61% C. Heavier soils with 2% S, 19% Si and 79% C are found, as well as lighter ones with 4% S, 54% Si and 42% C. The percentage of sand in these soils is very low and shows the following average particle size distribution:

% 50 - 105 μ	% 105 - 150 μ	% > 150 μ
1.4	0.5	1.1

The pH of the N.2.1. soils amounts to 4 as an average, but varies between 3.7 and 4.3. The organic matter content is high (6% as an average, with maximum and minimum values of 12 and 1.5% respectively). The N.2.1. soils show a lime content that never exceeds 0.1%. The base saturation figures vary between 63% and 56% with an average of 58%. This is a medium value, which indicates weak leaching.

The individual cation adsorption is represented in the following table:

Cation adsorption	in m.e./100 g. soil			
	Exch. Na	Exch. K	Exch. Mg	Exch. Ca
Average	0.4	0.7	5.2	13.1
Minimum	0.3	0.5	3.2	9.4
Maximum	0.5	0.8	6.2	15.2

The exchangeable sodium values are somewhat higher than those of the fan levee and sandy terrace soils. However, the E.S.P. figures are very low. Alkalinity need not be feared.

Niger basin soils (unit N.2.2.)

The soils of the N.2.2. unit are characterised by their high clay content. The average textural composition of these heavy basin soils, with maximum and minimum clay figures is given below.

Texture class	% S	% Si	% C	
C	3	20	77	Average
C	6	26	68	Minimum
C	1	16	83	Maximum

The particle size distribution of the sand fraction is as follows:

% 50 - 105 μ	% 105 - 150 μ	% > 150 μ
1.1	0.6	1.3

The latter is similar to the distribution of the particle sizes in the N.2.1. soils. The organic matter content is very high and amounts to 9% as an average with maximum and minimum values of 12% and 8%. The adsorption figures (C.E.C., T.E.B., B.S.P.) correspond with the values of the N.2.1. soils. This also applies to lime and pH values.

Niger basin soils (unit N.2.3.)

The soil samples - taken from the surface soil - show a C or SiCL texture. This variation in texture is caused by the shallow profile. In some cases there is no clay surface soil at all. The clay soils correspond,as far as their average textural composition is concerned, with those of the N.2.1. unit. Textural composition values for C and SiCL soils giving average, minimum and maximum clay content are shown below.

	Texture class	% S	% Si	% C
Average	C	3	31	66
Minimum	C	9	39	52
Maximum	C	1	30	69
Average	SiCL	10	55	35
Minimum	SiCL	16	51	33
Maximum	SiCL	7	53	40

The particle size distribution of the sand fraction is shown below.

Texture class	% 50 - 105 μ	% 105 - 150 μ	% ≫150 μ
C	1.3	0.5	1.3
SiCl	5.5	1.6	4

It will be observed that the ratio between the various particle size percentages is the same.

The pH of the N.2.3. soils shows an average of 4 with minimum and maximum values of 3.9 and 4.3. These values correspond with those of the N.2.1. and N.2.2. units. The lime content amounts to 0.1%. The organic matter content of the clay soils is high (7% average; 9-3% as maximum and minimum values). For SiCL these values are considerably lower (3% average; 4-2% as maximum and minimum values).

The base saturation percentages for both texture classes vary between 57 and 61%, which are medium to high values, indicating a weak leaching.

The following figures show the individual cation adsorption.

	Texture class	Cation adsorption in m.e./100 g. soil			
		Exch. Na	Exch. K	Exch. Mg	Exch. Ca
Average Minimum Maximum	SiCL SiCL SiCL	0.2 0.2 0.3	0.2 0.2 0.3	2.5 1.9 3.2	7.8 6.5 9.2
Average Minimum Maximum	C C C	0.4 0.3 0.6	0.6 0.2 1.0	4.0 1.2 6.4	11.5 7.4 15.2

It can be seen that the exchangeable Mg and Ca figures are not very high.

3.5.3 Determination of Atterberg values

The remarks of Chapter 2.7.3 on the Atterberg values for the samples of the reconnaissance survey between Jebba and Lokoja also apply to the pilot area samples. The values for the pilot area are set out in Table 7.2.

3.5.4 Mineralogical analyses

For mineralogical analyses concerning the semi-detailed soil survey reference should be made to Chapter 2.7.6 and Table 7.3.

It is evident that the Oshin deposits have a considerably different composition to the Niger deposits and the favourable values of the complex saturation of the alluvial fan soils (the Oshin deposits) can be explained by their more favourable mineral reserve compared to that of the Niger deposits.

3.6 Conclusions drawn from the soil survey

This section gives a summary of the conclusions drawn from the soil survey of the fadamas, both for the area between Jebba and Lokoja and the so called Jebba-Ogudu triangle.

1. The soils of the Niger alluvium are partly very complex and partly of a sufficiently uniform structure, with not too unfavourable physical properties. The permeability of the heavier soils

leaves much to be desired in saturated condition but the initial intake rate is fairly favourable.

2. The soils of the alluvial fans are partly complex, but in general they have fairly favourable physical properties.

3. The terrace soils have in general unfavourable physical and chemical properties.

4. The pH of the soils is low, but the alluvial fans are somewhat more favourable than the soils of the Niger alluvium.

5. With the lighter soils the sand fraction of the alluvial fans is clearly coarser than that of the Niger alluvium.

6. A part of the basin soils has not yet fully ripened and is still in a more or less hydromorphic condition. After some years of cultivation there will be subsidence.

7. The present fertility of the soils is 'humus-fertility', at a moderate to low level. After some years of cultivation this fertility will disappear and the soils will become chemically poor. Much attention will have to be paid to fertilizing.

8. There are no salinity or alkalinity problems.

CHAPTER 4

VEGETATION SURVEY OF THE PILOT AREA

4.1 General

A soil survey cannot be considered complete if no information about the natural vegetation of the surveyed area is provided. Especially for those who are familiar with the local relationships between soil condition and plant growth, knowledge of the present vegetation of a surveyed area may give some important additional information on the soils of that area. However, when deducing soil conditions from the composition of the vegetation cover of an area, it should be realised that the vegetation, although looking very natural, is often highly modified by human activity. Systematic grass burning, shifting cultivation and persistent collecting of firewood and useful plants for hundreds of years will result in a composition of plants and trees which do not at all represent the climax vegetation under the prevailing soil and other conditions. Also, the kind of vegetation in an area is very often determined by the prevailing hydrological condition and not by the soil profile.

The fact that in the mapped alluvial plain, grass land areas are located on clayey soils and trees and woods mainly on loam or sand, is primarily a result of the hydrological condition and hence of the topography. After a change in hydrological condition, through simple drainage measures for instance, the character of the natural vegetation may change completely, but the texture of the soils, being an inherent property, will remain the same.

As stated above the knowledge of the relationships between soil condition and vegetation cover may give additional information and may contribute to a better understanding of the soil. The knowledge of those relationships has always to be obtained locally and, once obtained, it can be applied to similar surrounding areas.

The importance of a fairly detailed vegetation survey to be carried out simultaneously with the semi-detailed soil survey of the pilot area was stressed at the Kaduna meeting on 21st March 1960. The purpose of this vegetation survey was to investigate the relationships between vegetation, soil and topography of a part of the Niger flood plain. The pilot area is supposed to be a representative part of the Niger flood plain from Jebba to Lokoja. On the whole this holds good as far as the soils are concerned. With regard to the vegetation, however, it appears that the vegetation of the flood plain downstream of Baro is not represented in the pilot area. This is presumably due to a change in climatic conditions. The relationships between vegetation, soil and topography, as discussed in 4.6, are also not applicable to the flood plain below Baro.

The vegetation survey of the pilot area was carried out during the months of April and May 1960. It was possible to study intensively the relationship between soil and topography in this area because the vegetation was recorded and samples were collected along the traverses, which had been cut for the detailed soil survey.

4.2 Field Work

Observations on the vegetation of the area were taken along the traces cut through the area at regular intervals of 5,000 feet and running in magnetic N-S direction. All vegetation observations were pinpointed and indicated on air photographs (scale 1:20,000). Very useful information was obtained from a local Nigerian, who appeared to be familiar with the botany of the flood plain vegetation.

The following vegetation characteristics were observed and located on the air photographs (scale 1:20,000) and recorded on the spot by the botanist:

a) The composition of the various vegetation layers (tree canopy, shrub layer, grass layer).

b) The estimated height and the relative cover of these layers.

c) The local names of the most common plants to each layer as well as an estimate of their relative number (for the tree and shrub layer) or relative occupied area (for the grasses).

The great majority of the species could be recognised and recorded under their Latin names. Those species, however, which lacked sufficient significant material (flowers of some grasses and shrubs were not available in April and May) for identification by Latin names were given their local Nupe names. This is indicated by the word 'Nupe' in brackets. Wherever possible local names were counterchecked because similar local names are frequently used to indicate different species and different names are given to various stages of developement of the same species. Leaves, flowers and fruits of all species were collected, dried and fumigated before being taken to the Netherlands for further study.

4.3 Map Compilation

The vegetation map of the pilot area has been compiled using all data collected in the field as described above. Stereoscopic study of air photographs of the area, which were available to scales of 1:20,000 and 1:10,000 proved to be of great use. These photographs were taken respectively in November 1959 and in March 1960.

The topographic base of the vegetation map is similar to that of the semi-detailed soil map of the area. Both maps are derived from an air photomosaic (scale 1:20,000).

4.4 Classification

The vegetation of the pilot area is differentiated into vegetation units, each unit having a relatively uniform composition of species. A further differentiation is made according to height and density of the observed vegetation layers. These vegetation units were designated mapping units on the vegetation map.

It should be mentioned here that it is far beyond the scope of the survey to differentiate the vegetation of the area into proper ecological communities. A very comprehensive and specialised recording technique would be required to do so.

4.5 Descriptive Legend

4.5.1 General

As outlined above, the mapping units are not equivalent to defined plant communities. Therefore, the names do not refer to the most characteristic species of the unit, but to the most common ones. However, descriptive names in general terms are given to the majority of units. Although the uplands, which surround the flood plain, were not included in the survey and were consequently not mapped, a short description of the upland vegetation near the pilot area is also given. The composition of the units is summarised in Tables 7.5-8.

4.5.2 Description of vegetation units

Upland savannah (unit 1)

This landscape is covered with open tree savannah. The tree canopy has a height of approximately 40 feet. The commonest trees are Daniellia oliveri, Terminalia avicennioides and Terminalia glaucescens, Butyrospermum parkii, Parinari polyandra and Hymenocardia acida. In the fairly well developed grass layer Hyparrhenia and Andropogon spp. are particularly common. They may attain a height of 10 feet.

Sandy terrace savannah (unit 2)

This landscape mainly consists of very open savannah with trees and shrubs not higher than 20 feet to 25 feet and with a very light grass layer. The commonest trees are Terminalia avicennioides, Gardenia ternifolia, Combretum bauchiense and Pterocarpus erinaceus, associated with Parinari polyandra, Butyrosperum parkii and Prosopis africana. Where the landscape is intersected by erosion gullies the vegetation changes, Daniellia oliveri, Vitex doniana and Piliostigma thonningii predominating. The commonest grasses are Hyparrhenia and Andropogon spp. Of the Cyperaceae, Bulbostylis pilosa, Bulbostylis filamentosa and Lipocarpa albiceps, are frequently found. Octodon setosum also occurs quite often. Asparagus pauliguilemii and Croton lobatus also occur.

Alluvial fan savannah (unit 3)

An open tree savannah of which the canopy reaches 35 to 40 feet. Under it there is a light to moderate shrub layer with shrubs and young trees up to 15 to 20 feet. The soil is covered with a moderately heavy grass layer often reaching a height of 6 feet. The commonest tree is Terminalia avicennioides. Piliostigma thonningii, Daniellia oliveri, Vitex doniana, Pterocarpus erinaceus and Sarcocephalus esculentus are also common. In the lower parts of this landscape there are many Mitragyna inermis. Trees and shrubs that take a less important place but which are common are Prosopis africana, Kulongi (Nupe), Ficus capensis, Anogeissus leiocarpus, Combretum bauchiense and Gardenia ternifolia. In the grass layer Hyparrhenia rufa predominates, accompanied by Buganna (Nupe) and Imperata cylindrica in the less open parts and by Eleusine indica in the more open parts. There are several Cyperus spp. particularly C. esculentus and C. subumbellatus. In the medium dense parts of the savannah Dalbergia sp. and Paullinia pinnata are often found.

Alluvial fan forest (unit 4)

South of the large westerly basin area there is a forest occupying a wide strip within unit No. 3. The dense canopy is 50 to 60 feet high with a fairly heavy undergrowth consisting of shrubs, lianes and young trees reaching to 20 feet. Only locally has a very light grass layer developed. In most cases Daniellia oliveri occur. Sarcocephalus esculentus, Terminalia avicennioides, Vitex doniana, Pterocarpus erinaceus, Landolphia florida and, at lower places Mitragyna inermis, are also common. Less prominent are Piliostigma thonningii, Prosopis africana, Ficus capensis and Borassus aethiopum. Combretum spp. and Anogeissus leiocarpus occur only locally. The shrub Dalbergia sp. is frequently found. In the less dense parts of the woodland in the grass layer Hyparrhenia rufa is predominant but in the denser parts Buganna (Nupe) and Imperata cylindrica predominate although Cyperus esculentus and Cyperus subumbellatus are also common. The commonest climbers are, in descending order of importance : Paullinia pinnata, Gymnema sylvestra and Cissus ibuensis.

Mixed Mitragyna woodland (unit 5)

This consists of woodland with an open canopy at 30 to 40 feet with an open to medium open undergrowth with shrubs and young trees of 10 to 15 feet and an open to medium grass layer of tall grasses. A very prominent tree in this unit is Mitragyna inermis, nearly always accompanied by Piliostigma thonningii, Terminalia avicennioides, Daniellia oliveri, which are often found in groups. Anogeissus leiocarpus, Sarcocephalus esculentus and Vitex doniana, also occur in groups. Combretum bauchiense, Acacia sieberiana, Ficus capensis, Strychnos innocua, Zaborukuchi (Nupe) and Balanites aegyptiaca, are found locally. In the grass layer Hyparrhenia rufa is commonest and is associated with Setaria longiseta and various Cyperaceae, especially C. esculentus, C. haspan and C. zollingeri. The grasses Buganna (Nupe), Eleusine indica and Imperata cylindrica occur only locally. Paullinia pinnata, various Ipomoea spp. Merremia hederacea and Dalbergia sp. are found frequently in the grass. Urginea altissima is particularly common in the south eastern part of the unit.

Mitragyna-Hyparrhenia woodland (unit 6)

In this very open woodland the only tree is Mitragyna inermis. The open to medium, sometimes heavy grass layer mainly consists of Hyparrhenia rufa, accompanied by Setaria longiseta, Tsabaruwa (Nupe) Eleusine indica and the Cyperus spp. which are also found in mapping unit 4. In the lower parts Gini (Nupe) and to a lesser extent Cyperus digitatus, Leersia hexandra, Echinochloa pyramidalis and Oryza barthii occur locally. Typical of this landscape is the prominence of Urginea altissima. The most important creepers are Ipomoea aquatica and other Ipomoea spp. and Cissus ibuensis.

Mitragyna-Echinochloa woodland (unit 7)

This is also very open woodland in which only the Mitragyna inermis occurs but this unit differs from mapping unit 6 in that the soil is covered with a fairly heavy vegetation of the sword-grass Echinochloa pyramidalis. This sword-grass is always accompanied by Leersia hexandra, Tsabaruwa (Nupe), Gini (Nupe), especially in the south-east and Cyperus digitatus and often by Oryza barthii. Only at higher places Hyparrhenia rufa and Cyperus esculentus are found. Many creepers grow in the sword grass, especially Ipomoea aquatica and other I. spp., Cissus ibuensis and Merremia hederacea. The herbs Cassia mimosordes and Aeschynonema afraspera were often noticed and sometimes Mimosa pigra.

Echinochloa grassland (unit 8)

There are hardly any trees in this unit and only locally a few bushy

Mitragyna inermis. The soil is covered with a mostly very heavy vegetation of Echinochloa pyramidalis, Cyperus digitatus and Phragmites. On lower ground the growth is Saccharum spontaneum and on the higher parts Gini (Nupe), Leersia hexandra and Oryza barthii. Many creepers grow in the sword-grass, especially Ipomoea aquatica and Ipomoea lilacina. There are also many hydrotroph herbs such as Polygonum pulhtrum, Mimosa pigra and Cassia mimosordes.

High Niger forest (unit 9)

This forest is situated on the right bank of the Niger between Belle and Gbere. It has a high closed, fairly heavy, canopy at a height of 60 to 70 feet and a heavy undergrowth of shrubs, lianes and creepers. The commonest trees and shrubs are Celtis integrifolia, Zaborukuchi (Nupe), Erithrococca anomala, Tasa (Nupe), Morelia senegalensis, Landolphia florida, Sarcocephalus esculentus, Kulongi (Nupe) and Terminalia avicennioides, Kpakagichi (Nupe), Combretum spp., Spondias monbin, Strychnos inocua and Tamarindus indica. The shrubs Dalbergia sp. and Psychotria Vogeliana and Cassipourea congoensis are also fairly common. The most prominent creepers are Commelina sp., Cissus quadrangularis, Paullinia pinnata and Adenia cissampeloides.

Low Niger forest (unit 10)

Bounded by unit 9 there is a low, medium dense forest on the banks of the Niger and of the larger creeks in the east of the area. A more appropriate term would perhaps be shrubby wood as the dense canopy is no higher than 25 to 35 feet and is often even lower. The undergrowth is mostly very light and consists mainly of some shrubs and creepers. The commonest trees in this landscape are Magunchi (Nupe), Morelia senegalensis and Zaborukuchi (Nupe). There are also many Alchornea cordifolia, Mitragyna inermis, Songbaraci (Nupe) and Tasa (Nupe) and Landolphia florida is often seen.

Above this low, dense forest or brushwood there is often an open to very open canopy of high trees, mostly consisting of Celtis integrifolia and Ceiba pentandra. Closer to unit 9 the denser wood or brushwood gradually changes into the undergrowth of unit 9. In the mostly very light undergrowth there are small shrubs called Dalbergia sp. and the creepers Ipomoea spp. and Paullinia pinnata.

High Oshin forest (unit 11)

Towards its confluence with the river Niger the river Oshin is bordered by a forest with a height of approximately 50 feet and a heavy undergrowth of young trees, shrubs and lianes. Tasa (Nupe) and Elaeis guineensis are typical for this forest. In the undergrowth many Landolphia florida are found. There is also a great variety of trees, among which are many Alchornea cordifolia and Zaborukuchi (Nupe). The most prominent shrubs are Dalbergia sp. and Cassipourea congoensia and amongst the creepers Paulinia pinnata and Cissus ibuensis.

Low Oshin forest (unit 12)

Further upstream the river Oshin has a low dense forest without undergrowth bordering its banks. Although only limited survey of this forest was carried out it was differentiated from the other units as the ecology appeared to warrant separate classification. The dense forest has Tasa (Nupe), Magunchi (Nupe) and Zaborukuchi (Nupe) and many open spots where Mitrogyna inermis is found. The air photographs show that the density is greatest along the river banks and tails off into brushwood with occasional taller trees further away from the river although on the vegetation map the uniform colour for the area does not indicate this gradual change in density.

The cultivated areas (unit 13)

The soil is either in cultivation or shows remnants of recently abandoned cassava and yam fields. Most of the original natural forest trees have been cut. Only useful trees, such as Parkia clappertoniana, have survived. Near the villages Mangifera indica is found. Nearer the basins there is Mitragyna inermis and there is also Borassus aethiopum, Sarcocephales esculentus, Vitex doniana, Terminalia avicennioides and Elaeis guineensis. The soil is covered with Imperata cylindrica, some Hyperrhania rufa and Buganna (Nupe) and all kinds of herbs.

4.5.3 Tabular Summary

The most important characteristics of various mapping units are summarised in Tables 7.5-8.

4.6 Relation Vegetation-Soil-Topography

Due to prevailing climatic conditions the vegetation of the part of Nigeria in which the pilot area is situated is termed 'derived savannah'. Although the climax vegetation is generally thought to be closed woodland with little grass, practically the whole vegetation belt is now covered by grasses. Grass fires are liable to occur every dry season and most of the trees are fire-tolerant in a greater or less degree. On the upland and on the highest parts of the sandy terraces no other source of water but rainfall is available and, therefore, units 1 and 2 are examples of a typical savannah vegetation on relatively high sandy soils. In the flood plain proper the rainfall is supplemented by flood water from the river

Niger and from the numerous off-springs and small rivers running from the upland scarps into the plain. Therefore, the vegetation of the other units of the pilot area is somewhat different from those of the derived savannah which is entirely dependent on rainfall.

The alluvial fan savannah of unit 3 mainly occupies the relatively high and sandy fan soils as deposited by the river Oshin, but is also occasionally found on the transitional zones between levees and basins. These zones, although relatively low, are very well drained, due to their sloping topography towards the basins. Owing to annual grass burning unit 3 consists mainly of fire-tolerant trees and grasses.

The alluvial fan forest vegetation of unit 4 is located on the loamy levees of the Oshin branches which, due to their favourable profile and location close to the waterbearing fan channels, are fairly moist throughout the greater part of the year.

The vegetation of unit 5 is mainly confined to the highest parts of the basin clay areas, which are subject to annual flooding. This is indicated by the presence of the tree Mitragyna inermis. However, the presence of other tree species indicates that the period of flooding is unlikely to exceed 2-3 months per year. The growth of fire-resistant grasses, such as Hyparrhenia, points to annual burning. The vegetation of unit 5 also prevails in the clayey fan basin soils, which seem to have similar hydrological conditions to the basin clay areas above.

The vegetation of units 6, 7 and 8 is confined to the low clayey basin areas and is entirely dependent on the degree of flooding. In the areas of units 6 and 7 there is so much flooding that only the tree Mitragyna inermis can survive. These vegetation units, together with unit 5, occupy the greater part of soil mapping unit N.2.3, which represents the areas with moderately deep clayey soils, overlaying sand.

The vegetation of unit 8, almost pure Echinochloa grass land, exclusively occupies the very low deep clayey basin areas, which are flooded or waterlogged all through the year.

The high Niger levee forest vegetation of unit 9 is confined to the loamy, relatively well drained soils of the Niger levees (mainly soil unit N.1.1). Levee soils are often of a loamy nature gradually coarsening with increasing depth. This type of profile, in combination with a reasonable supply of fresh groundwater, guarantees a very good capillary water supply to the plant roots which, due to the topographic field situation, never lack aeration. These favourable soil conditions result in the development of a high levee forest.

A very dense, but less high forest, is found on the lower parts of soil unit N.1.1. The soils of this unit are subject to flooding by running water for part of the year. However, as they lie close to the river, drainage is rapid once the river level has dropped.

The vegetation of unit 11 is mainly located on the loamy levees of the river Oshin. The soil profile of these levees is very much the same as those of soil unit N.1.1, but the sub-soil is more coarse or gravelly and, owing to the gradient of the Oshin river, there might presumably be a considerable flow of groundwater in the sub-soil. This is reflected by the typical occurrence of many Elaeis guineensis trees.

The vegetation of unit 12 is entirely confined to the area occupied by soil unit F.2.2, which is located in the extreme south-west corner of the area. Presumably the soils of this area consist of hydromorphic clay and the existence of forest instead of grasses may be explained by the regular supply of fresh running water from the nearby uplands.

The relationship between soil and vegetation units is illustrated by cross sections B, D, F and H, Figure 7.5 sheets 1 and 2.

CHAPTER 5

THE PRESENT AGRICULTURAL SITUATION

5.1 Climate

The area studied is located in the belt with a tropical savannah climate (classification of Köppen : Aw), which is a transition between the arid desert climate to the north and the tropical rain climate to the south.

A short description of rainfall, temperature and evaporation characteristics will be given (see also Figure 7.13).

5.1.1 Rainfall

Table 7.9 shows the mean monthly and annual rainfall data for a number of observation stations in or near the studied area. It appears that most of the rainfall is concentrated within the months of April to October inclusive. All stations show a dry season of 4 successive months with an average rainfall of 20 mm or less. The average monthly rainfall gradually increases during the months of March, April or May. The heaviest average rainfall occurs in September towards the end of the rainy season. Immediately afterwards in October the average rainfall falls sharply and November is a dry month. Fluctuations from the mean annual rainfall can be considerable as is shown by the data of Table 7.10.

The observed minimum yearly rainfall is about half the observed maximum at Lokoja and Ilorin, two stations which have the longest period of observation records.

The monthly data for the stations at Lokoja and Ilorin have been analysed for frequency distribution as shown in Table 7.11. Though the average rainfall in September for these stations is 210 mm and 243 mm respectively, rainfall of 355 mm and 335 mm may be expected with an average recurrence period of 40 years. Even for these long recurrence periods the rainfall in the months November to February inclusive remains low. In the wettest year in a period of ten years (90% wet year) the maximum monthly rainfall is 292 mm (Ilorin - September), while the minimum monthly rainfall is only 4 mm (Lokoja - December)

A comparative study of the monthly statistics throughout the year has indicated that although there is a considerable variation in total rainfall from year to year, it is normal for a dry year to be experienced at all stations in the same year. The same conclusion holds for a wet year. Thus a dry growing season will affect the whole area.

Tables 7.41 and 7.42 show the 1, 2, 3, 5 and 10 day rainfalls exceeded in different recurrence periods for all months of the year for various stations. From these tables duration curves for rainfall, exceeded once in 5 and once in 10 years, have been constructed for a few selected months and stations (Figure 7.14). The graphs show that during these months - April and September - the rainfall over short periods is lower in Lokoja than in Pategi and Mokwa. The lower rainfall over short periods in September in Lokoja agrees with a lower monthly average compared to Mokwa and Pategi. In April the average monthly totals are about equal, but apparently the rainfall is more evenly distributed over the month in Lokoja than in Mokwa and Pategi, resulting in lower short period rainfalls. Drainage factors for the discharge of excess rain water for different drainage requirements can be calculated using the above data.

In Tables 7.13 and 7.12 the monthly rainfall at Lokoja and 10 day rainfalls at Lokoja, Bida and Mokwa in 90 per cent, 80 per cent and 67 per cent dry years are shown for all months of the year. It may be seen that a month of low rainfall also has a relatively much lower ten day rainfall, e.g. at Lokoja in July in a 90 per cent dry year the monthly rainfall is 62 mm or less, whereas the ten day rainfall amounts only to 10 mm or less. The Mokwa figures and especially those of a 90 per cent dry year are less reliable than the figures for the other stations due to the short period over which data have been recorded. The data from these tables are used for computation of water requirements in Chapter 7.5.3.

5.1.2 Temperature

The temperature regime varies only slightly throughout the area and there is also little appreciable variation in both mean and absolute monthly temperatures.

The mean maximum temperature increases progressively from January reaching a peak in March. The mean maximum falls after the onset of the wet season proper. Mean minimum temperatures are lowest in December and January and remain very steady throughout the rainy season.

Mean temperature (average of day observations), mean maximum and mean minimum temperatures, highest recorded maximum and lowest recorded minimum temperatures for several stations are shown graphically in Figure 7.13.

5.1.3 Evaporation

Penman's method has been used to calculate the potential evaporation (E_o) from an infinitely thin free water layer for a number of stations. The values obtained are given in Table 7.14 and indicated in Figure 7.13.

The highest values of E_o occur towards the end of the dry season. The values E_o are used to calculate water requirements for different crops by using various coefficients (see Section 7.5.3).

5.2 Population

The population density of the riverain provinces is very low, especially when compared with provinces such as Kano and Katsina, which have a considerable surplus of agricultural products.

Some statistics of the population of the Northern Region, the provinces and divisions bordering the Niger river, and for comparison those of the provinces of Kano and Katsina, are shown in Table 7.15 giving the 1952 figures for total population, male working population and males engaged in agriculture and fishing, rural population and the respective densities per square mile.

The rate of population growth is estimated to be about 2 per cent per annum for the Northern Region as a whole. Exact figures on the actual rate of growth and its trend in the recent past for the various provinces are not available. * It is thought that the population in the riverain provinces does not increase rapidly. No appreciable migration appears to take place from the northern provinces, which are more densely populated and suffer from unemployment which is mostly seasonal. The annual trek of labour to coastal regions, as reported by Prothero (10) for Sokoto Province is purely seasonal and only passes through the riverain region towards the south and back again to the north. There is no record of any similar seasonal movement of labour in the studied area, except for the very few onion farmers near Lafiagi (see Section 5.4.2).

Therefore, it can be assumed that the present population of the area is approximately 15 to 20 per cent higher than the figures listed in Table 7.15.

The number of inhabitants in the fadama itself is very limited. Owing to annual flooding the people live in small villages on the higher parts or levees mostly located above high flood level. In places living quarters are artificially raised above flood level.

The people living along the river mainly belong to the Nupe tribe (see Table 7.15). Their principal means of subsistence is fishing and they

* Some estimates are given in the "Report on the Population and Natural Resources of the Area in the vicinity of the Proposed Niger Dam" prepared jointly by the Economic Planning Division, Ministry of Finance, Northern Region, Nigeria and Ilaco Ltd.

sell the dried fish to buy foodstuffs. Local agriculture is generally believed to be less developed than for instance that of the Hausas, who produce large quantities of groundnuts and cotton for export in Kano and Katsina provinces. Nevertheless, locally, Nupes have acquired some skill in utilising small quantities of water from upland streams for additional irrigation of their rice fields during dry spells in the rainy season and the beginning of the dry season.

More people live in the uplands along the river valley where pressure of population has not as yet become a problem. The population density of the divisions bordering the Niger, i.e. Bida, Lafiagi, Pategi and Koton Karifi Divisions, is less than 40 persons per square mile. From knowledge of similar conditions in other parts of the world this density is thought to be about the limit for a shifting cultivation population.

5.3 The agricultural system

Unless specifically stated otherwise the terms 'studied area' or 'region' etc. are intended to embrace the flood plain and adjacent uplands taken as a whole for there is no sharp physical or economic division between them. People living on the border of the uplands farm there and/or in the flood plain and vice versa.

In places the transition between upland and plain is very smooth, particularly where there are alluvial fans (e.g. Lafiagi) and older terraces (e.g. between the river Kaduna confluence and Katcha). These older terraces are no longer subject to flooding but, as they belong to the Niger valley proper, they are included in the survey. Their agricultural pattern is similar to that encountered in the real uplands.

Farming is still at subsistence level and methods are little changed from those of centuries ago. All cultivation is done by hand using short handled locally forged hoes. Application of fertilizers and insecticides etc. is almost unknown. A small amount of fertilizer (sulphate of ammonia) is used in rice cultivation.

Cultivations of farmers living on the flood plain are mainly located in the uplands. When circumstances are favourable they grow rice in the fadama as a cash crop. An estimate of the acreage under cultivation in the plain is given in Chapter 7.1.

In the uplands shifting cultivation is the normal practice. The occupation period is 3 to 6 years and the fallow period from 10 years where the population is denser, up to as much as 20 or more years in the sparsely populated areas. Each farmer cultivates various plots, up to 10 sometimes, with a total acreage of 3 to 6 acres. Their plots are often remote from the village, distances of 4 to 6 miles not being uncommon.

Normally no permanent or casual labour is employed. The growing of food crops is entirely carried out with family labour. In the case of rice some casual labour may be employed during planting and weeding, but it is more usual to form a 'co-operative' of 10 to 15 people, friends and neighbours, who alternately help each other during critical periods. There are no monetary rewards for labour. The farmer who has the benefit of help provides the food for the day.

As the whole area is infested with tsetse, cattle raising is not practised. For the same reason the introduction of small implements for animal draught has not yet become practicable. A local strain of small cattle, more or less resistant to Trypanosomiasis has proved to be unsuitable for draught purposes. Cross breeding with other strains is already practised.

Small livestock consists mainly of poultry and goats and almost everybody raises some of both. Poultry is susceptible to various diseases and serious epidemics occur regularly. Goats are only raised for local meat consumption (mainly at ceremonial occasions).

Most cultivating is done in the wet season and goats are kept inside the compounds, their owners being responsible for any damage done outside. During the dry season, however, the goats are released and free to graze anywhere. This means that the casual farmer who is growing a second crop has to protect his crop against damage by wandering goats. This does not stimulate the expansion of dry season farming. A change of attitude is only possible when most farmers grow a second crop and are able to exercise sufficient pressure on the whole community to keep the goats fenced in. The provision of green fodder and the distance between the village and the place where it grows are important considerations.

The introduction of irrigation especially for crops other than rice, requires abandonment of long fallow periods, inherent to shifting cultivation. The best form of permanent agriculture has to include some form of mixed farming as farm manure and leguminous fodder crops play an important part in the adoption of permanent agriculture. In the natural process of gradual development in indigenous agricultural practice the lack of farm manure has been a constant drawback. Any programme, therefore, has to take into account a solution of the Trypanosomiasis problem.

5.4 Crops

5.4.1 General

The crops are mainly such basic food crops as grains (guinea corn, millets, maize) and tubers (cassava, yams, sweet potatoes). Minor food crops are cowpeas, pigeon peas, onions, groundnuts and vegetables. Cash crops are of minor importance to the area as a whole; locally, however, they often become of significant importance. The cash crops are· rice, cotton, groundnuts, bennised (sesame) and onions. Some income is also derived from gathered sheanuts and palm kernels. In the immediate vicinity of the villages the population grow fruit (mango, papaya, bananas) and fibres (Rama = Hibiscus and Urena) for local use.

Agricultural research is carried out at several stations in the Northern Region but only one station is partly working under fadama conditions, viz. the Federal Rice Research Station at Badeggi, near Bida. The principal station of the Northern Region is at Samaru and from here all research throughout the Region is planned, supervised and the results analysed. The research outside Samaru is done at the sub-station in Mokwa and on scattered fields in the various divisions. The divisional Agricultural Officers keep logbooks for each experiment and are supervised by the Provincial Investigation Officer.

Mokwa is the nearest station to the plain that carries out research on crops other than rice and is situated on part of the former Niger Agricultural Project land. Started in 1955, the number and scope of the experiments were limited during the first years. The crops under investigation are guinea corn, maize, cassava, yams, groundnuts, cotton, soyabeans, cowpeas, benniseed and pigeon peas (fallow crop) and fibres (Urena, Hibiscus and Sunnhemp).

To a certain degree the results obtained at Mokwa in a series of trials will be applicable to fadama agriculture between Jebba and Pategi or perhaps even to Baro. The climate is much the same although humidity may be somewhat higher in the fadamas. The soil conditions in the plain are likely to be more favourable. On an average the fadama soils are of better quality, are less leached and generally have a higher water retention capacity than those of Mokwa.

5.4.2 The various crops

Guinea corn

When the rains start the land is cleared and ridged. Planting is carried out from April to June. The number of weedings depends on weed-growth and normally amounts to 2 or 3. Harvesting takes place in November-January. Yields are low; as a rule about 600 lbs per acre, sometimes above 1,000 lbs. Occasionally on newly opened land with good care and sufficient rain yields of more than 2,000 lbs per acre are obtained.

Millets

The rainfall in the area is normally sufficient for growing the more productive crops like maize and guinea corn. Millets, however, are a traditional crop. There are two main types: the gero and the maiwa or dauro type. The gero matures 100 days after planting, thus providing food in the scarcity period before the guinea corn and yam harvests. It is planted after the first rains as early as March. The maiwa type is planted late and has a longer growing period of about the same length as guinea corn. Millets are normally interplanted with guinea corn, cowpeas and cotton. Yields of gero are low; 200 - 500 lbs per acre, those of maiwa are around 1,000 lbs per acre.

Maize

Maize is not popular in the area. Though the total rainfall may be sufficient its distribution is sometimes so irregular that a long dry spell during the flowering stage of the crop will ultimately result in failure. If planted immediately after the October flood on islands and banks of the Niger, which are just above black flood level, a good crop is almost a certainty. The acreage, however, is limited and of minor importance in comparison with the total fadama area. Yields are up to 1,000 lbs of threshed dry grain per acre but often reach only half this figure.

Yams

Yams are usually the initial crop on a new piece of land because they require a fairly fertile soil. The crop can be planted throughout the whole dry season, i.e. from November to March. Most of the planting is done early in the dry season as there is more time available for cultivation and a good deal of the clearing can be done during the latter part of the rains, before the soil begins to harden. Yams are always planted in individual hills, which are capped with organic matter. The material resulting from the necessary 4 to 5 weedings is also put on the hills. Harvesting takes place in October/November or in September in places subject to flooding. Yields are usually 2-3 tons per acre but with careful tending and control of yam beetle attack, yields of 5-8 tons per acre are attainable.

Cassava

Generally cassava is the last crop in the rotation of a field before it is left fallow. Cassava can be planted at any time provided there is sufficient soil moisture to allow cuttings to take root. In the fadamas near Pategi - the main rice growing area of the Niger valley - farmers plant a short season cassava immediately after the rice harvest. This crop has to be harvested before the start of the rains and the planting of the rice crop. The advantage of upland cassava is that it has no definite harvest period. A farmer can dig out some tubers any time he is short of food. Sometimes a part of the crop is never harvested, if for example the grain supply has been sufficient for a number of years. Yields vary within wide margins. At

Ilorin farm centre, for example, the yield throughout the last 7 years has been between 1 and 7 tons of tubers per acre per year.

Sweet potatoes

Sweet potatoes are cultivated in the uplands during the wet season and in the fadamas after the flood has receded. The cultivated acreage is not very extensive. Yields are approximately 2 tons of tubers per acre.

Rice

According to Hardcastle (12) indigenous West African species of 'red' rice (O. glaberrima) have been grown since the sixteenth century in the inundated flood plains of Northern Nigeria where they have adapted themselves to a wide range of flood depths and soil types. The earliest recorded introductions of white rice are those made by the Department of Agriculture after 1919. Shallow swamp varieties from British Guiana and Ceylon have been successfully established in the shallow flooding valleys of the smaller tributaries of the Kaduna, Niger and Benue rivers. Throughout Northern Nigeria rainfall is inadequate for rice cultivation under normal dry land conditions. Two thirds of the total (in the south of the Region 50 to 60 inches) falls between July and September and rainfall in October is markedly reduced and irregular. For this reason rice cultivation has been confined to the fadamas where the period of inundation extends beyond the end of the rains and into the critical period when the rice is heading. The Niger floods, however, are characterised by a rapid rise and vary from year to year in time of onset, duration and depth. Deep flooding precludes the use of much valuable land. This situation has led to the growing of two main crops. The first (early crop) is planted above anticipated flood level. The nurseries are sown in May, after the first rains. Transplanting is in June/July and harvesting from October onwards. It is most unusual for this crop to be subject to flooding of more than a few inches. The second main (late) crop is planted after the flood has receded. It is transplanted in the last inches of flood water and further transplanting follows as the flood recedes from the land. There is always the risk of an unexpected new flood, which may wash out the whole crop. As it is only transplanted in October-December, i.e. after the end of the rains it can only be grown where water is available from upland streams to irrigate it. This late crop is harvested in February-April.

There is also a minor crop of only very small importance. It is grown on the very small strips bordering the Niger and locally on those islands which are flooded to a nicety by the second (black) flood. The nurseries are sown in November-December and the harvest takes place about April.

Cultivation methods are very simple; everything is done by hand. This limits the acreage which can be handled by one farmer to 1-1.5 acres. Casual labour is generally not available when he may need it during transplanting and harvesting time. He also has his upland fields with food crops to look after. If possible the seed is sown in nurseries and transplanted after about six weeks. This gives better results than direct sowing. There are two or three weedings. The use of fertilizers is spreading very slowly. A few years ago the Rice Research Station and the Extension Service started trial and demonstration plots all over the country. The results of the experiments have shown very large increases in yield and good profit margins resulting from the application of sulphate of ammonia. Nevertheless, the demand for fertilizers is still not very high, even in districts where the Extension Services provide the fertilizer on easy terms such as rebagging in smaller bags suitable for use on small acreages and payment after harvesting. It is to be hoped that the results obtained by some pioneer farmers will weaken the resistance of the others.

Several irrigation schemes have been initiated in the Northern Region. Such schemes are still experimental and usually take the form of a diversion weir in a perennial stream and a distribution canal network over the area (e.g. the Duku scheme near Pategi). The tertiary canals to the fields have to be constructed by the farmers themselves. Normally they are very simple and do not always make for the most economical use of water. No large water storage reservoirs have been included in the schemes so far constructed. Several schemes include flood protection embankments such as the Edozhigi scheme situated in the Kaduna river fadama a short distance from the confluence with the Niger. Here the protective bund has a height of 10 to 12 feet but it has already proved to be too low. The lowering of the maximum Niger flood level will also lower the top levels in the Kaduna river close to the confluence. The risk of overtopping will become negligible and similar schemes may be constructed with even lower bunds. The resulting lower construction costs are a great advantage. The Edozhigi scheme cost £ 25 per acre (original estimate: £ 7 per acre) and with a water rate of £ 1 per cultivated acre the Native Authority can hardly meet current running costs, even if all farmers participating pay their dues.

It was hoped that with the construction of these bunded schemes, in areas where only one (late) crop is grown, farmers would start earlier with rice cultivation, but they continued with late planting or even planted still later for two reasons :

1) They prefer to give more attention to their upland crops (especially guinea corn) as these form their basic food supply.

2) Early planting before the major part of the (still flooded) area is planted with rice means early maturing and consequently a concentrated attack of birds will result.

Therefore, research is now also aimed at a short season variety which will be able to compete in productivity with the existing varieties, such as the common variety BG 79, which shows a varying duration of its growing period since it is influenced by day length. Early planted it matures in about 5 months, late planted in less than $4\frac{1}{2}$ months. The growing period is also shortened by lack of water with a consequent reduction in yield of about one third.

The problem of late planting will partly be solved when in future the dam controls the flood. By then all rice can be planted early, but the question arises whether water supply will always be adequate. The soil will no longer be saturated by flooding and the amount of water in the upland streams might be insufficient to irrigate the greater area of early and former late crop together, especially in years with average or less than average rainfall. This aspect requires a more detailed study and preventive measures have to be taken in time. Perhaps some pumped irrigation will be required by then. Steps should be taken so that the inhabitants of the area are ready to meet changed conditions and an early study of the problems and solutions involved by the Irrigation Division of the Northern Region Ministry of Agriculture is strongly recommended.

Yields show a wide variation from 800 - 1,000 lbs per acre for non-irrigated fields up to 1,400 lbs per acre for irrigated non-fertilized fields and 2,000 lbs or more per acre for irrigated and fertilized fields.

After harvesting the grain is dried and threshed in the field. Almost all the paddy is parboiled before milling. Milling is performed locally by diesel-driven private mills. The charge varies between £ 2 and £ 3 per ton of paddy. Notwithstanding parboiling the percentage of broken grain is still very high due to the great diversity of varieties used in any one locality.

In the studied area rice is a pure cash crop. Almost all the grain is sent to southern markets. Local consumption of rice is limited to special occasions and ceremonies. In some districts rice earnings amount to 50 per cent or more of the total cash income. The price of rice is very good compared to world market prices for equivalent qualities. The local price varies from £40 to over £50 a ton of milled rice depending on the time of the year.

Cotton

Extensive areas of cotton are planted in the far north of the Northern Region. In the uplands bordering the Niger it is a crop of minor importance. The farmers plant the crop rather late, usually not before August. This has the advantage that they obtain a clean crop of high quality because the pest infestation is then far less than in an early crop. Yields are, however, very low. They seldom reach more than 500 lbs seed cotton per acre and are generally about 250 lbs per acre (the ginning rate is approximately 30 per cent).

There is controversy as to whether cotton can be grown in the fadamas. Cultivation difficulties are indeed considerable. Research at Samaru Research Station is principally directed towards cotton growing districts in the north and research at Mokwa Agricultural Station is only of recent date. However, the first results are promising. At Mokwa early planting (June) and regular spraying with insecticides resulted in good yields normally at least twice as high as the usual yield obtained by local farmers who plant in August. Spraying can be done with simple equipment of low depreciation value. Early planting also means early maturing, which can conflict with the late rains in October. It is likely that water conditions in the fadama soils will be such that later planting will still yield big plants. The cotton then matures well into the dry season. Much research under the new conditions will be necessary. Substantially higher yields are considered to be obtainable.

Nigerian cotton lint (American Middling 1" staple) has a ready market in Europe. The internal market is controlled by the Marketing Board, which buys the seed cotton through licensed buying agents at minimum prices, announced in advance.

Groundnuts

Groundnuts are not such an important crop in this area as in the northern provinces of the Region. The climatic conditions in the north are more suitable.

In recent years Nigeria exported more than 500,000 tons of shelled groundnuts. Normally the Marketing Board purchases about 20,000 tons a year from the river areas of the Niger and Benue. Of this quantity only a minor proportion comes from the Niger area. The major disease is a virus disease, called rosette, and is transmitted by an insect vector, Aphis craccivora. Late sown crops are less resistant to infection than early sown crops, this probably being due to the increase in the vector population later in the season. Prevention of rosette attack thus requires early planting. According to the findings at Mokwa Agricultural Station the planting there should be done about mid April. Maturity, however, is then reached in the wet season (September). Owing to lack of drying facilities farmers delay the harvesting and the mature nuts then start to germinate in the wet soil with consequent heavy loss. Thus the improvement in yield obtained by early planting is offset by sprouted nuts and nuts that remain in the soil. Late planting, i.e. after mid May, causes a heavy attack of rosette which can lower the yield by as much as 50 per cent. Actual yields are about 800 - 1,000 lbs of shelled kernels per acre but with good farming practice higher yields are obtainable. Research is already directed towards a long season variety which can be planted early and harvested in the dry season without losses.

Onions

Onions are an excellent cash crop but their cultivation is not favoured by the Nupe people. The only one growing centre observed is on the banks of the river Oro (or Egwar) near Lafiagi and occupies less than 1 per cent of the cultivated area around the village. The cultivations are worked by immigrant farmers (Hausas) from the north. Every year around October they arrive with their families and occupy their own plots, the average size of which is usually 1 - 1.5 acres. All cultivation work is done by hand and the necessary irrigation water is obtained by shaduf, i.e. hand lifted from the river, 12 feet or more below the level of the river bank. The farmer's wife or another member of the family regulates the flow of water to the small field units (10 to 20 square feet). The ashes of rice chaff and straw are used as fertilizer and more recently nitrate fertilizers have been applied.

The crop is harvested at the end of the dry season and in April the farmers return north. The yield is about 3 tons per acre with a gross value of £40 per ton. A near-by irrigation agronomy project included some experiments with onions during the 1959/60 season. Some of the tentative results show a significant response to heavy nitrogen dressings, a probable reaction to potassium and phosphate dressings and no apparent difference between the Hausa ashes and plots where no dressings were applied. Experiments in irrigation showed that the Hausa spacing of irrigation intervals is probably near the optimum. They start with a 21 days interval and gradually shorten it to 7 days or less as the season progresses. Yields obtained in various tests ranged from 7 to 10 tons per acre from the best plots.

Fibres

Some fibre (locally named Rama) is grown near villages for local use only. The consumption of sacks for bagging of export produce amounts to-day to some 25,000,000 a year, which all have to be imported. Since a small factory with an annual output of at least 4,000,000 sacks is a potentially profitable undertaking, opportunities for fibre-growing and sack-making enterprises clearly exist.

In the past various attempts have been made to expand the growing of fibres, mainly Hibiscus. At several places the culture did well but owing to lack of an organised buying market the enthusiasm of farmers faded away together with the acreage under fibres. In 1953/54 firms in Bida (Niger Province) bought 8,519 coils (500 feet) of one inch rama rope and 3,750 hanks of rama twine; in 1958/59 these amounts were reduced to 1,603 coils and 200 hanks.

The Fibre Research Office of the Ministry of Trade and Industry believes that there are good prospects for the culture of Hibiscus and Urena on fadama soils where the groundwater table remains reasonably high after the end of the rains. For superior yields (viz. longer and more stalks) the growing period should be prolonged until the end of November, which is impossible on the Mokwa soils where the actual experiments are carried out. The crop should also be still alive at harvest time due to the wet condition of the soil as a result of previously supplied irrigation or groundwater. A second important point is the supply of water for the retting process. A fibre plantation in the plain can draw its water fairly easily from the Niger or locate the retting tanks close to the river and transport the green material to the retting place. An essential condition is that production costs must be kept low and this can only be achieved by high yields or cheap harvesting methods. This means that the bulk of the raw material has to be grown by a sack-making enterprise and that the share of local producers can only be very limited, at least in the initial stage. According to the Research Officer yields of over 2,000 lbs fibre per acre are necessary. Yields obtained from trials at Mokwa are hardly half of this figure but, as already pointed out, this can be improved considerably under better conditions of water supply. Extensive trials under conditions comparable to those anticipated in the fadamas should be carried out. It is also recommended that research should be carried out on crop rotation and on the establishment of grass fallows on which cattle could be fattened before delivery to the southern markets. It is possible to immunise cattle against Trypanosomiasis if it stays for only a short grazing period in tsetse infected areas.

Sunnhemp (Crotolaria juncea) is also attractive because it is a leguminous crop; it keeps the soil free of weeds, it can be processed without retting by decorticating and it has a ready market as raw material for cigarette paper.

Sugar cane

Throughout Nigeria sugar cane is only grown on a very limited scale and is only used for chewing. All the white sugar consumed in Nigeria is still imported. Imports during 1955/59 averaged 47,500 tons annually and are rapidly increasing.

The Nigerian Sugar Syndicate, which is comprised of representatives of the Federal and Northern Region Governments, the Northern Region Development Corporation and Bookers Sugar Company, plans to start a sugar estate in the flood plain and is engaged in experimental cane growing at a trial plot near Bacita. The results obtained so far indicate that the cane grows well and that it will be feasible to establish a factory when the required acreage has been found. The Syndicate estimates that 5,000 - 6,000 ha (12,000 to 15,000 acres) are needed for economic operation of the factory. Assuming an annual yield of 80 - 90 tons of cane, or 10 tons of sugar per ha, the total output will be about 50,000 tons of white sugar. By the time the factory is in operation the domestic market can easily absorb the estimated output.

It is not expected that local people will immediately start growing sugar cane on their own farms. Enthusiasm and productivity of labour employed on the trial plot is still very low. It is likely that farmers will prefer to stick to rice growing which is easier and at present a more profitable crop. When they eventually start to cultivate sugar cane it should be bought by the factory for processing.

Other annual crops

The other annual crops are only of local importance. Cultivation of benniseed is principally located in the districts near Lokoja and along the Benue river. The crop is bought by the Marketing Board at gazetted prices.

Soya beans, cowpeas and pigeon peas are generally interplanted with other food crops. Their cultivation is as yet insufficiently widespread to ensure the populace a balanced diet. A proportion of the pepper crop and some green vegetables are dried and find a market outlet in neighbouring villages.

5.4.3 Tree crops

The Northern Region Ministry of Agriculture has started a tree crop scheme for the middle belt to which the Niger flood plain between Jebba and Lokoja also belongs. The scheme envisages the introduction of oil palm, cocoa, kola nut, coffee and fruit trees. In the real fadamas, of course, tree vegetation is chiefly limited to the higher parts and the useful trees encountered consist mainly of mango. The kola plantation at Labozhi (half-way between Mokwa and Bida) belonging to the Emir of Bida is the only area of significance on the uplands close to the river. The existing scattered oil palms and shea nut trees are wild and their fruit is occasionally gathered when ripe.

Experimental planting is carried out at various places. One of the pilot areas is situated at Nupeko (near the Kaduna confluence) close to flood level. Part of the area has already been flooded for a short time. During the first dry season, however, the young cocoa and oil palm trees had to be watered regularly and it is unlikely that farmers will be able to afford the cost of necessary wells. Furthermore, the climatic conditions prevailing in the flood plain make it seem questionable if crops like cocoa and oil palm could thrive in this region, since these are usually grown under humid tropical conditions.

Conditions appear to be more favourable for cultivation of citrus and other fruits like mango. The strip of land lying between plain and uplands is likely to have sufficient groundwater supplies in the dry season of reasonable depth to encourage fruit tree cultivation.

The effect on groundwater levels of regulating the river Niger is difficult to predict. It is likely to be lowered in more elevated parts close to the uplands but this is likely to be more than offset by increased utilisation of land hitherto subject to flooding.

Native Authorities encourage the growing of citrus trees and are responsible for distribution of trees from their various nurseries. Their campaign is chiefly directed towards the planting of citrus trees in village compounds. Very little fruit finds a market outside the area.

CHAPTER 6

IRRIGATION

Several parts of the fadamas downstream of Jebba can be developed profitably if low cost irrigation is available. To bring irrigation water to the fadamas there are two principal alternative methods that can be applied. Either water is brought by a gravity canal system direct from the future Jebba reservoir or it can be pumped up from the river by erecting electric pumping stations at the most advantageous points along the fadamas.

A pumped irrigation system is likely to show distinct advantages in initial and ultimate costs for the following reasons :

1) For the gravity system large canals would be required on both sides of the Niger right from Jebba dam over the whole length of the fadamas, the cost of which would be extremely high due to the geological and topographic nature of the terrain, particularly the many tributaries which join the Niger downstream of Jebba dam, whereas pumping stations placed near the centres of irrigation require only a minimum of header canals to the distribution networks. Experience elsewhere has shown that initial and operating costs of pumping stations are relatively small in comparison to cost of large canals.

2) As irrigation water has to be pumped up only to the height of the fadamas above river level power economy is effected, since the pumping head is only a fraction of the 85-90 feet head of Jebba dam, which is otherwise by-passed by a gravity system and use can be made of cheap off peak power.

3) The development programme for the fadamas can be made gradual by construction of electric pumping stations in stages and need not await the construction of Jebba dam, necessary to the gravity system, which in the sequence of stage development recommended elsewhere in this report is scheduled for construction 15 years after Kainji dam, but can start as soon as Kainji dam provides flood control.

In the absence of detailed maps with one foot contour intervals it has not been possible to prepare preliminary irrigation designs to estimate the basic cost of irrigation, but in neighbouring countries where schemes have recently been carried out in similar fadamas, indications are that this figure is of the order of £120 per ha. Taking into account various influential factors the conservative estimate of £200 per ha. for unit cost of irrigation has been adopted in the following calculations or £250 per ha. inclusive of cost of pumping stations and their capitalized operating costs.

In Section 7.5.2, three tentative potential cropping patterns, based on three alternative irrigation schemes, are discussed. Alternative I is considered as the first stage of development of the agricultural potentialities in the flood plain.

The costs of this irrigation scheme (public and private investment) are estimated as follows:

(i) 30,000 ha irrigated agriculture (pump irrigation)

Public : main irrigation + drainage	£250 per ha	
Private : clearing, trees	£ 80 " "	
detail irrigation		
drainage		
levelling	£125 " "	
	£455 " "	
Total : 30,000 x 455		£13,650,000

(ii) 30,000 ha irrigated agriculture (tributaries)

Public : main irrigation + drainage	£ 30 per ha	
Private : clearing, grass	£ 25 " "	
detail irrigation		
drainage		
levelling	£125 " "	
	£180 " "	
Total : 30,000 x 180		£ 5,400,000

(iii) 80,000 ha dry land

Private : clearing, trees	£ 80 per ha	
Public : main drainage works	£ 5 " "	
	£ 85	
Total : 80,000 x 85		£ 6,800,000

(iv) Additional public and private investment for settlement costs, roads etc.

	£ 30 per ha	
Total : 140,000 x 30		£ 4,200,000
		£30,050,000

If the irrigated agriculture alone is considered, the costs of the scheme are estimated to be:

(i)	as above	£13,650,000
(ii)	as above	5,400,000
(iv)	additional public and private investment for settlement costs, roads etc. 60,000 x 30	£ 1,800,000
		£20,850,000

CHAPTER 7

APPRAISAL OF THE AGRICULTURAL POTENTIAL OF THE NIGER FLOOD PLAINS BETWEEN JEBBA AND LOKOJA

7.1 General

The area under review in this chapter covers about 4,700 sq.km (1,815 sq.miles). Of this area about 4,300 sq.km (1,660 sq.miles) is land, including small creeks, lakes and pools. The remaining 400 sq.km (154 sq.miles) are occupied by the Niger river, the Kaduna river and other tributaries, larger lakes and creeks. Using air photographs an estimate has been made of the present total area of cultivation in the flood plains. The results are as follows :

AREA	RICE LAND	OTHER CULTIVATED LAND (PERMANENT AND SHIFTING CULTIVATION)
I. From Jebba to Kaduna confluence		
North Bank	80 ha	1,760 ha.
South Bank (incl. Pategi)	2,850 ha.	1,470 ha.
II. From Kaduna confluence to Lokoja	1,030 ha.	5,170 ha
Total	3,960 ha. (9,800 acres)	8,400 ha. (20,800 acres)

The total cultivated area covers less than 0.3 per cent of the total area. Small islands where food crops such as maize, cassava, sweet potatoes and guinea corn are grown after the October flood and during the black flood in January to March are not included in the totals.

An important feature of the new situation will be the regulated flow of the Niger. The anticipated difference between the maximum and minimum water level of only 1 . 0 - 1.5 metres (3 - 5 feet) upstream of the Kaduna river confluence instead of the existing range of 5 - 7 metres (15 - 20 feet) means an important improvement in the water economy of the fadamas. This improvement is twofold, firstly large areas are no longer flooded and secondly minimum river levels will be raised on an average by approximately 4 feet. Under regulated flows the supply to the area, not only of supplementary water during the wet season but also of irrigation during the dry season, becomes a practical proposition.

7.2 The Land Suitability Map

To assist an assessment of the agricultural production potential of the flood plains a land suitability map (Figure 7.2. 1-3) has been prepared in which the soils are divided into five classes with particular reference to their suitability for estate and peasant agriculture. These divisions are based on the fact that availability of large areas of good, uniform, unintersected land is more favourable to the establishment of estate agriculture than it is for peasant agriculture.

The suitability classes are as follows:

Class 1 - Soils suitable for peasant and estate agriculture.
Class 2 - Soils suitable for peasant agriculture, but moderately suitable for estate agriculture.
Class 3 - Soils predominantly suitable for peasant agriculture, but not suitable for estate agriculture.
Class 4 - Soils locally suitable for peasant agriculture, but not suitable for estate agriculture.
Class 5 - Soils not suitable for peasant or estate agriculture.

The land suitability map is based on the soils map and is to the same scale (1: 100, 000). A soil map as such is a valuable source of information but for the agricultural appraisal of an area a number of non-pedological factors also play an important part, such as the macro and micro topography and drainage and irrigation problems. Necessary data for assessment of these factors were obtained from the results of the field observations made during the soil reconnaissance survey. Apart from those features determining suitability for estate and peasant agriculture, other economic features, such as accessibility of the area, distances to markets etc., have not been taken into account in preparing the land suitability map. Thus, on the land suitability map, due to classification being based on technical grounds, there are isolated areas of high quality soil that are shown as suitable for estate agriculture when in fact due to their location they are far from attractive for that purpose. For peasant agriculture the disadvantage of small isolated areas counts for much less.

It should be emphasized that the land evaluation made in this Report applies to the future when the Niger dam will have been constructed and a regulated flow has been obtained but it should be pointed out that the degree to which the flow will be regulated is not exactly known for all stretches of the river. As stated previously, the difference between the maximum and minimum water level is expected to be 1 - 1.5 metres but this figure should be regarded as a general average. Downstream of the confluence with a tributary, particularly the Kaduna river, the flow will be less regulated than upstream. Since at present no data are available concerning river regulation this phenomenon could not be taken into account in preparing the land suitability map.

In drawing up the land suitability map the following technical points have been reviewed :

a) Pedologically

1. Profile
2. Texture of the topsoil with regard to tillage
3. Structure of the topsoil
4. Heterogeneousness of the deposits
5. Permeability

b) Non-pedologically

1. Macro and micro topography
2. Drainage problems
3. Irrigation problems
4. Specific suitability for wet rice

Most of these points are self-explanatory, but some brief explanations will be given below.

a) 4 Heterogeneousness of the deposits

At several places the variation in characteristics of the soil is very irregular over short distances. This irregularity may prove a serious disadvantage to agricultural suitability because it occurs both in vertical and horizontal directions. The extent of this phenomenon is illustrated by the large number and widespread distribution of these soil complexes on the soil map.

b) 1 Macro and micro topography

Major topographical differences such as the difference between the young Niger alluvium and the older terraces in the flood plain are determining factors in the macro topography of this region.

Micro topographical differences are particularly encountered in those complexes where the heterogeneousness in the deposits involves differences in height over short distances.

b) 4 Specific suitability for wet rice

The soil requirements for wet rice cultivation are in many respects different from those for other irrigated and dry land crops.

The five suitability classes include the following mapping units of the reconnaissance soil map:

Class 1 : T4 - N1 - N2 - F2
Class 2 : F1 - FC1 - FC2
Class 3 : NC1 - I
Class 4 ; T2 - T3 - TC - NC2 - CF
Class 5 : T1 - NC3 - NC4

In allocating mapping units to their respective suitability classes the following have been taken into account:

Class 1
T4:

Good heavy clayey soils with a fairly low permeability. For peasant agriculture perhaps somewhat difficult to cultivate, but this is compensated by good suitability for wet rice cultivation. Much attention will have to be paid to drainage due to basin-shaped topography and the low permeability. As this soil unit is situated on a terrace an extra lift of 3 to 4 metres will be necessary to provide these soils with irrigation water.

N1 :

Good medium textured soils. No cultivation problems to be expected, but locally some drainage problems may occur. There are places where the topography does not lend itself to irrigation.

N2 :

The same remarks referring to T4 apply to this unit, except for the extra lift of irrigation water.

F2 :

Here again the same remarks referring to T4 apply but drainage will be less of a problem since the unit has a shallower sandy subsoil and is more elevated.

Class 2

All the soil units of this class belong to the alluvial fans. An extra lift of 10 to 12 metres will be necessary to provide these soils with irrigation water.

F1 :

In general the soil of this unit is of good quality but the profile is fairly heterogeneous and stratified. The high elevation will also require extra works for irrigation.

FC1 :

The quality of the soil is fairly favourable to agriculture but as it is very heterogeneous this on the whole makes it more suitable for peasant rather than estate cultivation.

FC2 :

The same remarks referring to FC1 apply to this unit, but in general the soils are heavier.

Class 3
NC1 :

In this complex the N1 soils predominate. The alternation of different soil units in the complex and the topography are considerable obstacles to application of estate agriculture. The topography would also impose severe limitations on the layout of any irrigation system.

I :

The islands and other parts belonging to this unit can be compared with group NC1.

Class 4
T2 :

Generally the abundance of poor, coarse sandy profiles makes this unit unsuitable for any form of agriculture. Irregular topography is an additional drawback amongst others although in places there are some thin loamy surface layers which could be used for peasant cultivation.

T3 :

The same remarks referring to T2 apply.

TC :

This unit comprises T2, T3 soils and in addition T1 soils, which are referred to below. Here also the soil is only suitable locally for peasant agriculture. In view of soil conditions and its heterogeneousness the soil is considered to be unsuitable for estate agriculture.

NC 2:

In this heterogeneous complex of levee and basin soils in which the latter predominate, unfavourable topography, which would seriously limit any irrigation layout, is a contributory factor towards this unit being considered only locally suitable for peasant agriculture and unsuitable for estate agriculture.

CF :

The colluvial fans are very heterogeneous and have an unsuitable topography. Locally there are patches suitable for peasant agriculture, but on the whole the soils are considered to be unsuitable for estate agriculture.

Class 5

T1 :

Owing to the poor quality of these coarse sandy soils they are considered to be unsuitable for any form of agriculture.

NC 3:

In view of the very irregular and heterogeneous character of the meander belt complex these soils are considered to be unsuitable for any form of agriculture.

NC 4:

Owing to its low location and heterogeneous character the spillway complex is considered to be unsuitable for any form of agriculture.

Table 7.19 shows the areas of various soil mapping units classified into the five suitability classes. It also shows the area embraced by the survey divided into two main parts extending from Jebba to the Kaduna confluence and from the Kaduna confluence to Lokoja. The latter part is considered to offer less favourable conditions, partly due to uncertain knowledge concerning the influence of the river Kaduna (and to a certain extent the influence of the river Benue on the downstream part) on river levels and the more scattered distribution of small areas of Class 1 and 2 soils which is likely to restrict their development.

A further subdivision of the part between Jebba and the Kaduna confluence has been made into areas north and south of the river since the south bank shows greater promise for early development, the soils on this bank being predominantly suitable for agriculture. The survey shows 50 per cent of this south bank area as being in Classes 1 and 2.

7.3 The Potentials for Estate Agriculture

7.3.1 The stretch from Jebba to the Kaduna confluence

a. The North Bank

The soils belonging to Classes 1 and 2 are fairly closely grouped so that estate agriculture could easily be developed. The soils of Class 1 mainly consist of clayey Niger basin soils (unit N2) and are very suitable for the cultivation of sugar cane. Owing to their lower elevation irrigation will not be difficult; locally even provision for drainage may have to be made. Assuming that 80 per cent of the area is attractive, 0.8 x (31,600 + 3,700) = 28,200 ha. are available for estate agriculture.

b. The South Bank

The soils of Class 1 between Belle and Tada are predominantly loamy Niger levee soils (unit N1) and clayey Niger basin soils (unit N2) and, therefore, suitable for crops like sugar cane and fibres. Irrigation of these soils is not difficult as far as soils and topography are concerned though the gullies and creeks, with which the area concerned is intersected, will cause some practical difficulties. No study has yet been made of the kind of engineering works required. The soils belonging to the alluvial fan of the Egwar river located near Lafiagi form an uninterrupted, through heterogeneous, complex. Their elevation is such that pump irrigation from the Niger is possible but at certain places the pumping head may be as much as 10 metres although the average is more likely to be 3 - 5 metres.

The area of good soils near Pategi is too small to be attractive for estate agriculture. It is rather to be expected that rice cultivation will extend here. Taking into account the heterogeneousness of the Lafiagi soils, it is assumed that 60 per cent of the soils of Classes 1 and 2 can be used for estate agriculture. An area of 0.6 x (23,500 + 23,100) = 28,000 ha. would then be available.

c. North and South Bank

Between Jebba and Kaduna confluence 28,200 + 28,000 = 56,000 ha. approximately are estimated to be suitable for estate agriculture, being approximately 30 per cent of the whole area.

7.3.2 The stretch from Kaduna confluence to Lokoja

Inspection of the reconnaissance soil map and the suitability map shows that the average quality of the soils is lower than those upstream of the Kaduna confluence. The plots belonging to Class 1 are less concentrated and fairly scattered in relatively small areas. The uninterrupted plots along the Gbako and Kampe rivers are classified in Class 2 for the same reason as the similar alluvial fan of the Egwar river. Only 30 per cent of the total of 39,900 + 33,200 ha. is estimated to be suitable for estate agriculture, which is about 22,000 ha. or less than 10 per cent of the total area of the whole stretch.

7.3.3 Whole area between Jebba and Lokoja

Summarising it is estimated that 56,000 + 22,000 = 78,000 ha. (195,000 acres) or about 20 per cent of the total area could be used for estate agriculture.

At present Nigeria imports about 50,000 tons of sugar annually. An area of about 5,000 ha. estate grown sugar cane would be sufficient to produce that quantity. The plans of the company, experimenting in the vicinity of Bacita, provide for an area of that size. In addition to the anticipated large increase in Nigerian consumption, the contract price for raw sugar paid by the U.K. Government to Commonwealth producers seems attractive enough for the sugar industry to think of further expansion. Contract prices in recent years were as follows:

up to the end of 1957	:	£42. 3. 4. per long ton
in 1958	:	£43. 16. 8. " " "
in 1959	:	£45. 2. 0. " " "
from January 1st, 1960	:	£44. 8. 10. " " "

By comparison the recent price of Cuban sugar for destinations other than U.S. (No. 4 contract) amounted to about U.S.$ 0.03 per lb. f.o.b., or about £24 per ton.

Other important items which could be produced in Nigeria are bags and sacks for packing of such items as groundnuts, cotton and rice. In 1955 about 20,000,000 were imported and this figure will now have increased with augmented production of export crops. Assuming that present imports amount to 25 million sacks and bags and that 2,000 kg of fibre (jute or urena) per hectare can be produced, a harvested area of 10,000 ha. will be sufficient to provide for present needs. As in the case of sugar cane there seem to be good prospects for further expansion in view of increasing domestic consumption.

7.4 The Potentials for Peasant Agriculture

7.4.1 The stretch from Jebba to Kaduna confluence

On the north bank approximately 20 per cent of Classes 1 and 2 is considered unsuitable for estate agriculture. Half of this part is estimated to be suitable for peasant agriculture, that is 10 per cent of 31,600 + 3,700 ha. = 3,500 ha. The soils of Class 3 are of fairly good quality (levee basin complex and islands), but heterogeneous and scattered. About 60 per cent of these soils can be cultivated, that is 0.6 x 18,100 = 11,000 ha. The soils of Class 4 are both topographically and texturally (coarse sand or heavy clays in the basins of complex NC2) not very attractive. If an estimated 40 per cent is suitable for peasant agriculture it would provide 0.4 x 27,400 = 11,000 ha.

On the south bank in Classes 1 and 2 an area of 18,600 ha. remains for peasant agriculture. Of this area only an estimated 85 per cent is actually suitable which makes 0.85 x 18,600 ha. = 16,000 ha. The same percentages apply to Classes 3 and 4 on the south bank as to the similar classes on the north bank, so that 0.6 x 11,500 ha. = 7,000 ha. and 0.4 x 22,500 ha. = 9,000 ha. are available for peasant agriculture. Thus between Jebba and Kaduna confluence there are roughly about 57,500 ha. or 30 per cent of the total area available for peasant agriculture.

7.4.2 The stretch from Kaduna confluence to Lokoja

In Classes 1 and 2, 30 per cent was considered suitable for estate agriculture. The remaining area of 51,000 ha. is of reasonable quality and so for the most part suitable for peasant agriculture. It is estimated that 40,000 ha. are actually suitable.

For Classes 3 and 4, 60 and 40 per cent respectively again apply thus 0.6 x 57,100 ha. = 35,000 ha. and 0.4 x 77,700 ha. = 30,000 ha. are estimated to be suitable. Over this stretch of the Niger valley a total of 105,000 ha. or about 40 per cent of the total area is estimated to be suitable for peasant agriculture.

7.4.3 Whole area between Jebba and Lokoja

Summarising it is estimated that of the whole area between Jebba and Lokoja 57,500 + 105,000 = 162,500 ha. (400,000 acres) or about 35 per cent of the total area is available for peasant agriculture. It should be emphasised that part of the total area recommended as suitable for estate agriculture that is unlikely to be utilised for this purpose in the foreseeable future, could be added to this figure. The prospects for establishment of a sugar estate and a fibre estate have been referred to. If the areas of

5,000 and 10,000 ha. set aside for those estates were doubled in order to provide for future needs (domestic consumption and in the case of sugar, domestic consumption and export), out of the total area suitable for estate agriculture of 78,000 ha. there would still remain 48,000 ha which could be allocated to peasant agriculture, making a total area of 162,500 + 48,000 = 210,000 hectares (approximately) available for peasant agriculture. Apart from the usual food crops such as guinea corn, millets, maize, cassava, yams and sweet potatoes, in planning for the development of peasant agriculture it would seem advisable to pay due attention to more valuable cash crops, such as rice, groundnuts, cotton, fibres, tobacco, soyabeans and benniseed. Also the cultivation of tree crops, such as cocoa, citrus, mango and kola should be introduced or improved. If Trypanosomiasis can be effectively controlled then settled (as opposed to wandering herds of cattle of the nomadic Fulani of the north) animal husbandry and mixed farming could be introduced. It is obvious that much expensive and time consuming research work will have to be carried out before most of the new crops and settled animal husbandry can be successfully introduced on a large scale.

7.5 Technical and Economic Aspects of Irrigated Agriculture

7.5.1 General

At present the ordinary method of gravity irrigation by deriving water from a river by means of diversion structures is only possible for the tributaries coming down from the uplands. In view of topographical conditions it is hardly possible at any place in the flood valley to utilise Niger water in this manner and under the new circumstances this will not alter fundamentally. In order to make full use of Niger water, recourse will have to be made to pumping. Due to the fluctuations in level of the Niger, pump irrigation from the river has met with technical difficulties so far. A few years ago an attempt in this direction was made in the vicinity of Rabba by placing a pump installation on a barge. In addition a number of wells were sunk, from which water was pumped to irrigate a few higher elevated plots of the experimental area.

Once the Niger flow becomes regulated, the technical problems of pumped irrigation diminish. Potentially it would be possible to irrigate the whole calculated agricultural area of 240,000 ha. From this gross area a proportion, say 15 per cent, has to be deducted for villages, factory sites (estates), roads, canals, ditches, and waste ground. A nett area of about 200,000 ha. would thus remain. It is estimated that about 50 per cent of this area could be irrigated by pumping from the Niger at reasonable and economic cost, certainly as far as estate crops are concerned and most probably also for peasant crops. Owing to topographical conditions the remaining 50 per cent can only be expected to be irrigated at high cost. The question whether irrigation of this latter 50 per cent will be an economic proposition can only be definitely answered when a more detailed investigation of the area is carried out.

7.5.2 Tentative potential cropping patterns

In drawing up potential cropping patterns three alternative cases will be considered.

I. Pump irrigation from the Niger and drainage facilities for 30,000 ha. estate crops. No pump irrigation for peasant crops. However, since the floods will largely disappear the wet rice area could expand to an estimated 30,000 ha. by diverting water from the Niger tributaries by means of simple diversion structures (gravity irrigation). For lack of water during the dry season no second crop on this rice area would be possible.

On the non-irrigated areas, which to a large extent will also become free of floods, dry land agriculture during the wet season could also expand to an estimated 80,000 ha. The tentative cropping pattern is as follows :

<u>Wet season</u>

Estate crops :	
sugar cane	10,000 ha.
fibres	20,000 ha.
Peasant crops :	
rice	30,000 ha.
other peasant crops (dry land)	80,000 ha.
	140,000 ha.

<u>Dry season</u>

Estate crops :	
sugar cane	10,000 ha.
fibres	20,000 ha.
Peasant crops :	
other peasant crops (dry land)	5,000 ha.
	35,000 ha.

II. Pump irrigation from the Niger and gravity irrigation from the tributaries and in addition drainage provision for 100,000 ha. of which 30,000 ha. would be estate crops and 70,000 ha. peasant crops. Gravity irrigation of the area concerned would be supplemented by pumped irrigation from the Niger during the dry season, so that double cropping would be possible on the whole area of 100,000 ha. Dry land agriculture during the wet season will still be possible on an estimated 50,000 ha.

In this case the tentative cropping pattern is as follows :

Wet season

Estate crops :	
sugar cane	10,000 ha.
fibres	20,000 ha.
Peasant crops :	
rice	60,000 ha.
other peasant crops and pastures (irrigation)	10,000 ha.
other peasant crops (dry land)	50,000 ha.
	150,000 ha.

Dry season

Estate crops :	
sugar cane	10,000 ha.
fibres	20,000 ha.
Peasant crops :	
rice	20,000 ha.
other peasant crops and pastures (irrigation)	50,000 ha.
	100,000 ha.

III. Pumped irrigation from the Niger and gravity irrigation from the tributaries supplemented by pumped irrigation from the Niger for the whole area of 200,000 ha. and in addition drainage provision for the whole area.

The tentative cropping pattern is as follows :

Wet season

Estate crops :	
sugar cane	10,000 ha.
fibres	20,000 ha.
Peasant crops :	
rice	100,000 ha.
other peasant crops and pastures	70,000 ha.
	200,000 ha.

Dry Season

Estate crops :	
sugar cane	10,000 ha.
fibres	20,000 ha.
Peasant crops :	
rice	30,000 ha.
other peasant crops and pastures	140,000 ha.
	200,000 ha.

It should be emphasised that full double cropping as assumed above for alternatives II and III is, of course, not a matter of immediate implementation according to a ready and simple programme. It will certainly take a number of years of field research work on growing seasons, varieties, crop rotation, crop maintenance and plant pathology before a proper detailed cropping pattern emerges which can be demonstrated and introduced to farmers.

With regard to the social aspects of double cropping it should be emphasised that this system would entail all the year round employment which would be a great improvement on the present single cropping system with its seasonal unemployment.

7.5.3 Tentative calculation of water requirements

To arrive at water requirements for the three alternative cropping patterns as outlined under 7.5.2 above, it is assumed that during the dry season not more than about two thirds of the crops other than rice, sugar cane and pastures require water at any given time and that the rice harvest is concentrated in the last month of the rice seasons which implies that during these months (April and October) no additional irrigation water is required.

Water is then required for the following crop areas in hectares:

Wet season (May to October incl.)

Alternative	I	II	III
rice	-	60,000	100,000
sugar cane	10,000	10,000	10,000
pastures	-	3,000	10,000
other crops	20,000	27,000	80,000

Dry season (November to April incl.)

Alternative	I	II	III
rice	-	20,000	30,000
sugar cane	10,000	10,000	10,000
pastures	-	3,000	10,000
other crops	20,000	45,000	100,000

The calculations are made on a monthly basis.

To simplify these tentative calculations only the rainfall figures for the Lokoja station are used because these are fairly representative for the flood plain. As a rough approximation the mean rainfall (see Table 7.9) and the rainfall in an 80 per cent dry year with a recurrence of 1 in approximately 5 years (see Table 7.13) is reduced by 20 per cent to arrive at effective rainfall. The potential evaporation (E_o) for various stations (see under Section 5.1.3) is calculated from meteorological data and the mean value is used to arrive at water requirements for different crops by using various coefficients. Figure 7.15 shows the mean effective rainfall and the effective rainfall in an 80 per cent dry year at Lokoja, together with calculated evaporation for various crops - rice (1.3 E_o), pastures (1.0 E_o), sugar cane (0.85 E_o) and other crops (0.7 E_o).

The monthly shortages between crop requirements and effective rainfall are as follows (in mm) :

Average shortage

	J	F	M	A	M	J	J	A	S	O	N	D
Rice (1.3 E_o)	203	242	212	-	110	86	37	32	16	-	222	203
Pastures (1.0 E_o)	156	186	154	120	56	37	-	-	-	55	171	156
Sugar cane (0.85 E_o)	133	158	126	91	29	12	-	-	-	30	146	133
Other crops (0.7 E_o)	110	130	96	61	2	-	-	-	-	6	120	110

1 in 5 'dry' year shortage

	J	F	M	A	M	J	J	A	S	O	N	D
Rice (1.3 E_o)	203	242	250	-	174	154	110	116	106	-	222	203
Pastures (1.0 E_o)	156	186	192	169	120	105	70	78	63	116	171	156
Sugar cane (0.85 E_o)	133	158	164	140	93	80	50	60	42	91	146	133
Other crops (0.7 E_o)	110	130	134	110	66	56	30	40	21	67	120	110

Assuming that field efficiency and distribution losses account for an additional 100 per cent (roughly) of the calculated crop requirements, the following total requirements are arrived at for the various alternative cropping patterns:

Alternative I

	Average m^3/sec	requirement $10^6 m^3/month$	1 in 5 'dry' year requirement m^3/sec	$10^6 m^3/month$
J	28	72	28	72
F	32	83	32	83
M	24	62	32	83
A	17	44	28	72
M	2	5	17	44
J	1	3	14	36
J	-	-	8	21
A	-	-	11	28
S	-	-	7	18
O	2	5	17	44
N	29	75	29	75
D	28	72	28	72
TOTAL:		421		648

Alternative II

	Average m^3/sec	requirement $10^6 m^3/month$	1 in 5 'dry' year requirement m^3/sec	$10^6 m^3/month$
J	106	275	86	220
F	121	310	100	260
M	92	240	100	260
A	44	114	54	135
M	57	148	102	265
J	44	114	92	240
J	18	47	65	170
A	12	31	69	180
S	6	15	57	148
O	3	8	102	62
N	109	280	89	230
D	106	275	86	220
TOTAL:		1857		2390

Alternative III

	Average m^3/sec	requirement $10^6 m^3/month$	1 in 5 'dry' year requirement m^3/sec	$10^6 m^3/month$
J	160	415	160	415
F	183	475	183	475
M	140	360	184	475
A	66	170	113	290
M	96	250	186	480
J	74	192	166	430
J	30	78	115	300
A	20	52	125	325
S	10	26	104	270
O	6	15	56	145
N	165	430	165	425
D	160	415	160	415
TOTAL:		2878		4445

It appears that the peak demand will normally occur in February, but once in approximately 5 years it may also occur in March or May. The maximum demand will be of the order of 185 $m^3/sec.$, measured at the intake of the canals or pumping stations. The total quantity of water required annually will ultimately reach $3 \times 10^9 m^3$ for mean conditions and $4.5 \times 10^9 m^3$, if all months suffer from an 80 per cent dryness. Of these quantities some 30 per cent is expected to return to the river by return flow and seepage.

7.5.4 Estimates of quantity and value of present and future agricultural production and of surplus available for marketing outside the area

(i) Quantity and value of agricultural production

In Tabels 7.16 - 7.18 an attempt has been made to estimate :

(a) the quantity and gross value of the present annual agricultural production

(b) the quantity and gross value of the future (three alternatives) annual agricultural production

(c) the future (three alternatives) increase over present level in quantity and gross value of the annual agricultural production, (b) minus (a).

As far as the area is concerned, the figures for present agriculture are based on the area figures of Section 7.1 where the annually harvested rice area is estimated at 4,000 ha. and the area of other crops at 8,000 ha. of which the annually harvested figure will actually be less in view of shifting cultivation. The area figures for future agriculture are based on estimates referred to in Section 7.5.2.

The figures for yields and local prices are based on the, sometimes very scanty and rough, information that could be gathered. In several cases the figures are no more than a fair guess, consequently several figures have a fairly wide margin of error and the whole picture has to be seen as the best possible rough approximation.

(ii) Surplus available for marketing outside the area

To obtain a figure for the potential surplus of the whole area that would be available for marketing outside the area (transport by river, road or railway), local human consumption, seed for the next crop, animal feed and storage losses and waste, have to be deducted from the total production.

It is assumed that the population of the newly developed area in the three alternative cases would ultimately amount to :

Alternative I

30,000 ha. all year roung irrigation at 2.5 persons per ha.	=	75,000
110,000 ha. wet season irrigation and dry land at 1.5 persons per ha.	=	165,000
Total		240,000

Alternative II

100,000 ha. all year round irrigation at 2.5 persons per ha.	=	250,000
50,000 ha. dry land at 1.5 persons per ha.	=	75,000
Total		325,000

Alternative III

200,000 ha. all year round irrigation at 2.5 persons per ha.	=	500,000

Assuming that annual food consumption per head would amount to the equivalent of 250 kg. of rice the following quantities would be needed for local food consumption:

Alternative I	240,000 x 250 kg.	=	60,000 tons rice equivalent
Alternative II	325,000 x 250 kg.	=	81,250 tons rice equivalent
Alternative III	500,000 x 250 kg.	=	125,000 tons rice equivalent

This food would mainly have to come from other grains, rice (paddy), tubers, other leguminous crops, vegetables and groundnuts. A rough assumption is that a given quantity of rice equivalent can be obtained from double the quantity of substitutes referred to, also allowing for waste and storage losses.

This would mean that the following quantities have to be deducted for local consumption:

Alternative I	-	120,000 tons
Alternative II	-	160,000 tons
Alternative III	-	250,000 tons

The following quantities could be set aside for seed and animal feed, also making some further allowance for waste and storage losses :

Alternative I - 30,000 tons
Alternative II - 40,000 tons
Alternative III - 60,000 tons

The quantities available for marketing outside the region are than as follows :

	Alternative I	Alternative II	Alternative III
Production in tons	360,000	510,000	800,000
Food, feed, seed, waste and losses in tons	150,000	200,000	310,000
Available for external market in tons	210,000	310,000	490,000

In addition it should be noted that the production of both estate crops, viz. sugar cane and fibres, would provide for present and immediate future needs of the Federation of Nigeria in the field of sugar and sacks. A substantial saving on foreign exchange for imports could thus be obtained. The present import of sugar amounts to more than 55,000 tons with a value of more than £3 million, whereas a future production of 100,000 tons is envisaged. The present import of sacks amounts to about 25,000,000 (approx. 20,000 tons) with a value of more than £2 million, whereas a future production of 40,000 tons is planned.

7.6 Evaluation of Benefits to Agriculture

In Chapter 7, Section 5.2, three tentative potential cropping patterns, which are based on three alternative irrigation schemes for the Niger plain between Jebba and Lokoja have been discussed. This flood plain, the greater part of which is flooded every year, will be less subject to annual flooding after the construction of Kainji dam and the way will then be open to development of irrigated agriculture.

Of the three cropping patterns the first one, referred to as Alternative I, is to be considered as the first stage of the agricultural development of the flood plain. It consists of:

30,000 ha (75,000 acres) irrigated agriculture,	served by pump irrigation.
30,000 ha (75,000 acres) irrigated agriculture,	(irrigation from tributaries).
80,000 ha (200,000 acres) dry land agriculture.	

As laid down in Chapter 7.5.4 and Table 7.18 the gross value of the future annual agricultural production of this 140,000 ha (350,000 acres) area is estimated to be £12,567,500. As the present annual agricultural production has only a gross value of £642,500 the increase in annual gross value amounts to £11,925,000. This figure will be reached towards the end of the first stage of the development. In order to calculate the nett returns, the costs of manufacturing sugar and fibre from the raw materials and the farmers' costs for the agricultural products should be subtracted from the annual gross value.

In Chapter 6, the costs of all necessary land clearing and additional works for the main irrigation and drainage scheme for developing the area of 350,000 acres, are estimated to be £30,050,000. To simplify the calculation of the returns only the irrigated areas have been taken into consideration and it is assumed that they are used for rice growing. The benefits from dry land agriculture are thus neglected together with the further benefits which could accrue from replacing rice cultivation by estate crops.

If only the irrigated part of the Alternative I scheme is considered, the gross annual crop value after full development of the scheme is :

75,000 acres (30,000 ha) irrigated agriculture (pump irrigation)		
wet season	£2,625,000	
dry season (80%)	£2,100,000	£4,725,000
75,000 acres (30,000 ha) irrigated agriculture (from tributaries)		£2,625,000
		£7,350,000
present agricultural production		£ 642,500
		£6,707,500

Thus, if only the irrigated part of Alternative I is considered the increase in annual gross crop value is estimated to be £6,707,500 whilst the necessary investment to reach this gain is estimated to be £20,850,000 (see Chapter 6, Irrigation).

The above means that by investing £20,850,000 spread over the development period a £6,707,500 increase in annual gross value of production could be achieved. This is made possible by flood control resulting from construction of Kainji dam, and by comparing these figures the importance of the overall benefits to the country are clear.

The 1967 value of the capitalized benefits to the country of the irrigated area has been calculated by the Netherlands Economic Institute at Rotterdam under the direction of Professor J. Tinbergen, at between £5 and £20 million depending on the assumed development period and the ratio between average and marginal value of labour.

CHAPTER 8

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TABLE 7.42

1,2,3,5 & 10 DAY RAINFALLS EXCEEDED IN DIFFERENT RECURRENCE PERIODS

LOKOJA	J	F	M	A	M	J	J	A	S	O	N	D
1 day												
Once a year	0	0	14	18	36	32	40	34	41	26	0	0
Once in 2 years	0	8	29	27	46	46	54	46	53	35	5	0
Once in 3 years	0	15	36	31	54	55	62	54	63	40	9	0
Once in 5 years	0	24	43	36	60	74	76	60	73	50	15	3
Once in 10 years	10	34	51	41	65	95	92	69	80	63	25	9
Once in 15 years	16	38	56	44	70	105	105	74	86	69	30	14
2 days												
Once a year	0	0	16	20	40	36	45	37	46	31	0	0
Once in 2 years	0	9	30	29	52	51	64	50	60	42	6	0
Once in 3 years	0	16	38	34	60	60	74	58	70	48	10	0
Once in 5 years	0	25	47	40	66	80	89	65	80	59	17	3
Once in 10 years	10	35	56	46	73	100	109	74	90	73	27	10
Once in 15 years	17	40	62	49	79	110	122	78	95	80	34	15
3 days												
Once a year	0	0	17	21	43	43	50	40	51	35	0	0
Once in 2 years	0	9	32	31	55	60	72	55	66	48	6	0
Once in 3 years	0	16	41	36	65	70	83	64	75	54	11	0
Once in 5 years	0	26	50	42	70	90	100	71	87	66	18	4
Once in 10 years	10	36	62	49	79	110	121	80	97	80	30	11
Once in 15 years	17	42	69	54	83	120	138	85	104	87	36	17
5 days												
Once a year	0	0	17	22	50	50	56	46	60	39	0	0
Once in 2 years	0	10	33	34	65	70	82	62	75	54	6	0
Once in 3 years	0	17	42	40	75	80	97	70	85	62	11	0
Once in 5 years	0	26	53	48	85	98	118	79	100	74	19	4
Once in 10 years	11	37	65	56	96	120	140	88	110	89	32	11
Once in 15 years	17	43	73	61	105	130	159	91	120	98	38	17
10 days												
Once a year	0	0	18	24	58	64	70	55	78	48	0	0
Once in 2 years	0	10	34	39	76	90	105	73	100	68	6	0
Once in 3 years	0	18	45	46	89	100	125	84	112	77	12	0
Once in 5 years	0	26	56	56	100	120	150	95	130	90	21	4
Once in 10 years	11	38	70	66	105	140	173	103	140	106	33	12
Once in 15 years	17	44	80	71	125	150	200	110	150	116	40	18

PATEGI	J	F	M	A	M	J	J	A	S	O	N	D
1 day												
Once a year	0	0	10	26	38	48	48	40	50	26	0	0
Once in 2 years	0	0	22	35	51	62	60	52	64	36	5	0
Once in 3 years	2	0	34	41	60	70	68	60	72	42	10	0
Once in 5 years	4	6	44	50	71	80	75	72	80	52	15	0
Once in 10 years	8	13	58	60	84	90	84	82	94	62	21	0
Once in 15 years	11	16	66	67	90	98	90	92	100	70	26	0
2 days												
Once a year	0	0	10	27	40	53	52	42	55	28	0	0
Once in 2 years	0	0	25	38	55	67	64	55	72	41	5	0
Once in 3 years	2	0	40	47	65	76	70	64	80	49	10	0
Once in 5 years	4	6	50	56	74	88	76	76	90	60	16	0
Once in 10 years	9	14	60	70	90	102	88	91	100	73	24	0
Once in 15 years	12	18	68	80	95	110	93	102	105	81	29	0
3 days												
Once a year	0	0	10	28	42	56	55	46	63	30	0	0
Once in 2 years	0	0	26	40	60	72	67	60	81	46	5	0
Once in 3 years	2	0	41	50	70	82	75	70	92	57	10	0
Once in 5 years	4	6	52	62	80	95	82	85	100	69	16	0
Once in 10 years	9	15	62	80	93	108	93	100	112	85	24	0
Once in 15 years	12	20	71	90	100	117	100	115	120	92	30	0
5 days												
Once a year	0	0	10	29	45	66	58	50	73	30	0	0
Once in 2 years	0	0	27	43	63	85	73	69	96	50	5	0
Once in 3 years	2	0	42	55	75	97	81	80	108	61	10	0
Once in 5 years	4	7	54	69	85	110	90	98	115	75	16	0
Once in 10 years	9	15	64	85	97	120	98	120	130	90	25	0
Once in 15 years	14	20	72	98	105	128	107	135	135	98	31	0
10 days												
Once a year	0	0	10	30	58	85	75	60	98	32	0	0
Once in 2 years	0	0	28	48	84	112	95	98	123	54	5	0
Once in 3 years	2	0	44	61	94	128	105	115	140	65	10	0
Once in 5 years	4	7	55	78	105	136	117	140	149	82	17	0
Once in 10 years	10	15	66	96	120	150	128	165	162	102	26	0
Once in 15 years	15	21	75	112	130	155	135	180	170	115	31	0

BIDA	J	F	M	A	M	J	J	A	S	O	N	D
1 day												
Once a year	0	0	4	23	40	38	34	41	42	23	0	0
Once in 2 years	0	0	16	26	52	48	44	60	52	32	0	0
Once in 3 years	0	0	22	36	61	54	48	72	57	38	4	0
Once in 5 years	3	2	32	40	74	61	58	90	67	46	9	0
Once in 10 years	7	2	38	46	83	70	66	105	76	53	14	2
Once in 15 years	11	2	44	50	93	74	72	118	84	60	19	6
2 days												
Once a year	0	0	5	24	42	39	40	46	49	28	0	0
Once in 2 years	0	0	16	31	56	52	52	68	60	38	0	0
Once in 3 years	0	0	24	41	67	57	58	82	68	44	4	0
Once in 5 years	3	2	36	48	80	65	71	100	80	52	9	0
Once in 10 years	7	2	46	54	92	72	77	122	91	62	14	2
Once in 15 years	12	3	54	57	102	77	83	140	100	70	19	7
3 days												
Once a year	0	0	5	25	43	42	44	50	57	30	0	0
Once in 2 years	0	0	17	34	60	56	58	75	72	42	0	0
Once in 3 years	0	0	26	45	70	62	65	92	80	50	4	0
Once in 5 years	3	2	40	52	85	70	80	113	95	58	9	0
Once in 10 years	8	3	56	60	99	78	85	138	108	71	15	2
Once in 15 years	12	3	65	70	105	85	92	156	118	78	20	7
5 days												
Once a year	0	0	5	26	45	50	51	58	65	31	0	0
Once in 2 years	0	0	18	37	66	67	66	90	81	37	1	0
Once in 3 years	0	0	27	48	78	76	75	107	92	55	4	0
Once in 5 years	3	2	41	57	93	83	90	130	105	63	10	0
Once in 10 years	8	3	64	70	105	93	93	160	120	78	16	2
Once in 15 years	13	3	73	80	120	98	100	180	128	82	21	7
10 days												
Once a year	0	0	5	27	51	66	66	72	93	32	0	0
Once in 2 years	0	0	18	44	81	90	82	112	112	52	1	0
Once in 3 years	0	0	28	53	94	100	105	129	124	61	4	0
Once in 5 years	3	2	42	64	110	120	110	155	139	75	10	0
Once in 10 years	9	3	67	84	130	125	118	185	150	90	17	2
Once in 15 years	14	4	77	105	140	130	120	200	158	98	21	7

TABLE 7.42

TABLE 7.41

1,2,3,5 & 10 DAY RAINFALLS EXCEEDED IN DIFFERENCE RECURRENCE PERIODS

	BARO 1956/59 incl.											
	J	F	M	A	M	J	J	A	S	O	N	D
in 1 day												
once a year	0	0	6	27	24	49	36	21	45	28	0	0
once in 2 years	0	0	16	44	31	62	46	27	59	42	4	0
once in 3 years	5	2	19	52	36	70	54	32	69	50	12	0
once in 5 years	15	6	23	60	43	80	61	38	82	61	21	0
once in 10 years	19	8	29	68	48	86	68	43	92	73	27	16
in 2 days												
once a year	0	0	7	30	27	56	40	23	54	32	0	0
once in 2 years	0	0	17	47	36	70	54	30	70	49	5	0
once in 3 years	6	2	21	56	41	78	62	35	82	58	13	0
once in 5 years	16	6	26	67	48	88	70	42	95	71	22	0
once in 10 years	20	9	32	75	54	98	78	46	06	84	30	20
in 3 days												
once a year	0	0	8	33	30	60	43	26	59	34	0	0
once in 2 years	0	0	18	51	40	75	59	35	76	53	5	0
once in 3 years	6	2	23	61	46	83	68	40	88	64	13	0
once in 5 years	16	6	28	73	53	94	78	47	103	80	24	0
once in 10 years	21	9	35	82	60	102	88	52	116	93	32	23
in 5 days												
once a year	0	0	8	38	36	67	50	29	74	38	0	0
once in 2 years	0	0	20	56	48	84	70	41	97	60	5	0
once in 3 years	7	2	25	66	54	91	80	47	105	74	14	0
once in 5 years	17	7	30	79	61	100	90	54	120	90	25	0
once in 10 years	22	10	38	90	70	110	100	60	135	106	36	26
in 10 days												
once a year	0	0	9	40	45	85	60	34	95	42	0	0
once in 2 years	0	0	20	60	62	105	87	50	120	73	5	0
once in 3 years	7	2	27	70	68	115	97	57	130	90	15	0
once in 5 years	17	7	33	84	76	126	113	66	140	110	27	0
once in 10 years	23	10	41	95	85	136	130	73	150	130	40	28

	BADEGGI Jan.1955/June 1960 incl.											
	J	F	M	A	M	J	J	A	S	O	N	D
in 1 day												
once a year	0	0	7	36	22	51	43	41	56	39	0	0
once in 2 years	0	2	10	46	28	56	54	52	73	48	3	0
once in 3 years	0	4	12	52	30	64	59	58	82	54	6	0
once in 5 years	0	5	13	57	33	73	65	65	90	60	8	0
once in 10 years												
in 2 days												
once a year	0	0	7	41	25	56	50	45	64	45	0	0
once in 2 years	0	2	11	51	32	64	62	57	80	57	3	0
once in 3 years	0	4	13	57	36	72	67	65	89	64	6	0
once in 5 years	0	5	15	63	40	80	74	73	98	70	8	0
once in 10 years												
in 3 days												
once a year	0	0	7	44	28	64	54	50	70	50	0	0
once in 2 years	0	3	12	55	37	73	68	65	87	65	3	0
once in 3 years	0	4	14	62	41	83	75	74	97	74	6	0
once in 5 years	0	6	16	68	45	92	83	83	105	80	8	0
once in 10 years												
in 5 days												
once a year	0	0	8	49	33	74	62	56	79	59	0	0
once in 2 years	0	3	12	60	44	84	79	75	95	77	3	0
once in 3 years	0	5	15	66	50	101	86	85	103	87	6	0
once in 5 years	0	6	17	73	54	112	95	96	113	97	8	0
once in 10 years												
in 10 days												
once a year	0	0	8	52	43	85	75	64	89	70	0	0
once in 2 years	0	3	13	63	56	120	96	89	108	91	3	0
once in 3 years	0	5	17	70	61	130	105	100	115	101	6	0
once in 5 years	0	6	20	80	67	145	115	112	125	111	8	0
once in 10 years												

	MOKWA (Agricultural Station Dec.1953/June 1960 incl)											
	J	F	M	A	M	J	J	A	S	O	N	D
in 1 day												
once a year	0	0	2	25	27	44	52	33	47	24	1	0
once in 2 years	0	0	16	42	34	54	65	47	60	36	8	0
once in 3 years	24	27	22	52	38	61	70	51	67	43	13	0
once in 5 years	43	54	28	60	43	68	75	58	76	51	18	0
once in 10 years												
in 2 days												
once a year	0	0	3	27	30	50	58	39	55	28	1	0
once in 2 years	0	0	17	46	58	64	75	53	70	41	9	0
once in 3 years	26	28	24	58	42	73	80	58	78	48	13	0
once in 5 years	46	56	30	68	47	83	87	67	86	56	19	0
once in 10 years												
in 3 days												
once a year	0	0	3	29	33	56	63	43	64	33	1	0
once in 2 years	0	0	18	51	41	73	80	58	80	49	9	0
once in 3 years	27	29	25	62	46	83	87	64	87	57	14	0
once in 5 years	47	58	33	74	52	90	95	73	97	66	20	0
once in 10 years												
in 5 days												
once a year	0	0	3	32	36	63	70	50	77	36	2	0
once in 2 years	0	1	19	54	46	82	93	68	97	55	9	0
once in 3 years	28	30	27	66	51	91	100	75	105	65	14	0
once in 5 years	48	60	35	80	56	101	110	85	115	·76	20	0
once in 10 years												
in 10 days												
once a year	0	0	4	33	42	80	85	58	108	42	2	0
once in 2 years	0	1	20	58	55	110	120	82	133	67	10	0
once in 3 years	29	31	29	70	60	120	130	90	140	78	14	0
once in 5 years	48	61	38	88	66	135	145	100	150	90	20	0
once in 10 years												

TABLE 7.40

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes:
1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	
T.1.1	E 23	A242155Z	0-20	5.5	0.1	1.1	1.5	1	4.5	14	17	62	S					
	E 24	A242156Z	0-20	4.8	0.1	0.9	2	3	2.5	12	16	65	S	0.0	0.1	0.5	0.9	2.6
	E 25	A242157Z	0-20	5.3	0.0	1.6	1	1	4.5	13	24	57	S	0.0	0.1	0.8	1.9	4.4
	E 26	A242158Z	0-20	5.4	0.1	0.9	0.5	1	3	5	21	69	S					
	F 29	A242010Z	0-20	5.7	0.1	1.5	4.5	3	5	11	21	55	S					
	F 30	A242011Z	0-20	5.8	0.0	1.1	1.5	2	4	8	19	65	S	0.0	0.1	0.4	1.6	3.8
	F 31	A242012Z	0-20	5.8	0.0	1.5	0	1	10	19	15	56	S					
	F 32	A242013Z	0-20	5.8	0.0	1.1	0.4	0.4	5	8	18	69	S	0.0	0.1	0.3	1.9	2.4
	F 30 *	A242898Z	0-20	5.6	0.0	0.9	0	1	6	6	17	71	S	0.0	0.1	0.3	1.4	1.8
	F 30 *	A242899Z	120-140	4.2	0.0	0.6	4	1.5	0.5	6	19	69	S					
	F 31 *	A242900Z	0-20	5.5	0.0	1.8	1	3	10	20	16	49	S					
	F 31 *	A242909Z	50-60	4.5	0.0	0.7	0	2.5	6	16	15	60	S					
	F 31 *	A242910Z	100-120	4.5	0.0	0.3	0	1	9	29	16	45	S					
T.1.2	B 21	A242081Z	0-20	5.2	0.0	1.6	2.5	1.5	7	11	13	65	S	0.0	0.3	0.6	2.8	5.0
	D 25	A242095K	0-20	4.4	0.1	5.9	53	23	10	3.5	2	9	C	0.2	0.4	7.4	14.6	29.2
	D 26	A242096Z	0-20	4.8	0.0	1.6	3.5	4	11	8	10	65	LS	0.1	0.3	0.9	2.1	4.8
	D 27	A242097Z	0-20	4.6	0.1	2.4	42	20	23	3.5	2	9	SiC	0.1	0.4	5.9	10.8	23.0
	D 28	A242098K	0-20	4.1	0.0	2.1	8	9	25	28	20	10	SL					
	D 29	A242099Z	0-20	4.6	0.0	0.9	1	0.5	6	12	18	63	S	0.0	0.1	0.1	0.8	1.8
	D 29 *	A242998Z	120-140	4.6	0.0	0.3	0	1.5	7	13	15	64	S					
	D 29 *	A242995Z	0-20	4.3	0.0	1.3	2	2.5	5	13	15	63	S	0.1	0.1	0.2	1.4	3.0
	D 29 *	A242996Z	20-40	4.3	0.0	0.4	0	0.2	8	11	16	65	S					
	D 29 *	A242997Z	60-80	4.7	0.0	0.2	0	0.2	5	10	17	67	S					
	E 27	A242159Z	0-20	4.3	0.1	1.5	2.5	3	5	9	21	60	S	0.0	0.1	0.4	1.2	3.9

TABLE 7.39

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes: 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	
F.1.2	B 17	A242058	0-20	5.8	0.1	3.6	8	7	31	26	17	12	SL					
	B 18	A242059	0-20	4.5	0.1	2.7	11	12	27	6	6	37	SL					
	B 19	A242079K	0-20	4.2	0.1	5.9	39	24	23	4	2.5	7	SiC					
	B 19*	A243016K	0-20	4.3	0.1	4.9	33	29	24	4	3	7	SiCL	0.1	0.5	3.8	12.6	24.6
	B 19*	A243017K	40-60	4.3	0.0	0.5	6	7	8	6	12	61	LS	0.2	0.1	1.0	2.6	5.0
	B 19*	A243018K	100-120	4.8	0.1	0.6	25	17	38	14	2.5	3.5	SiL					
	B 26	A242086K	0-20	5.2	0.1	6.4	36	16	21	9	6	13	CL					
	B 27	A242087K	0-20	4.5	0.1	3.7	23	17	30	13	7	12	L	0.1	0.5	2.4	10.7	20.6
	B 28	A242088K	0-20	4.8	0.1	3.5	24	10	23	20	11	11	L					
	B 29	A242089K	0-20	4.8	0.0	6.9	21	18	21	15	11	14	L					
	C 22	A242124	0-20	4.3	0.1	2.6	27	24	33	9	3.5	3	SiCL/SiL					
	C 24	A242126	0-20	4.9	0.0	2.1	20	20	32	11	6	12	SiL					
	C 25	A242127	0-20	5.7	0.1	5.1	25	15	35	13	3	9	L/SiL	0.1	0.6	4.2	15.6	23.4
	C 26	A242128	0-20	4.1	0.1	3.9	23	14	23	15	10	15	L	0.1	0.1	2.5	7.0	17.2
	D 22	A242092K	0-20	5.0	0.1	4.8	15	31	35	4	3.5	12	SiL					
	E 19	A242150K	0-20	4.5	0.1	3.0	32	28	25	2.5	1.5	11	SiCL					
F.2.1	B 20	A242080K	0-20	4.6	0.1	6.8	58	19	15	2.5	2	3.5	C	0.2	0.7	6.3	20.2	35.6
	B 22	A242082K	0-20	4.7	0.1	5.3	31	10	14	11	12	23	CL					
	B 23	A242083K	0-20	4.8	0.1	7.3	29	17	19	9	10	17	CL					
	B 23*	A243019K	0-20	4.2	0.0	0.2	15	6	16	18	15	30	SL	0.1	0.1	1.1	9.3	10.8
	B 23*	A243020Z	90-100	4.7	0.0	0.4	0	0.2	4.5	3	13	79	S					
	B 23*	A243021K	120-130	4.4	0.0	0.3	9	0.4	9	4	8	69	LS					
	C 17	A242119	0-20	4.1	0.1	3.5	46	30	21	1.5	0.5	1.5	SiC					
	C 27	A242129	0-20	4.0	0.1	7.6	72	10	14	2	0.5	1.5	C	0.3	0.6	6.0	15.0	32.3
	C 28	A242130	0-20	4.2	0.1	6.3	60	10	12	4	2.5	12	C					
	E 20a	A242152K	0-20	4.5	0.1	10.4	68	15	12	2	1.5	2	C	0.3	1.2	7.8	18.7	38.7
	E 21	A242153K	0-20	4.2	0.1	3.5	33	16	29	11	5	6	CL					
F.2.2	A 17	A243056K	0-20	4.4	0.1	5.5	58	27	15	0.2	0	0	SiC					
	A 18	A243057K	0-20	5.1	0.1	5.8	56	27	17	0.1	0	0.1	SiC	0.1	0.8	5.8	20.7	35.3
	A 19	A243058K	0-20	5.0	0.1	6.0	56	26	17	0.2	0.1	1	SiC	0.1	0.9	5.0	21.5	35.3

TABLE 7.38

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes: 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	
F.1.1	B 24	A242084K	0-20	5.7	0.0	2.9	11	6	18	13	14	39	SL	0.1	0.2	1.7	7.6	11.1
	B 25	A242085Z	0-20	5.8	0.0	1.5	1.5	0.5	7	5	5	81	S	0.0	0.2	0.6	4.1	5.0
	B 25*	A243022Z	0-20	5.2	0.0	1.6	0.4	2.5	6	5	6	81	S					
	B 25*	A243023Z	40-60	5.0	0.0	0.4	0	0	2.5	1	4.5	92	S					
	B 25*	A243024Z	90-120	4.7	0.0	0.3	0	0	2	0.5	5	92	S					
	C 16	A242118	0-20	6.3	0.1	3.6	7	8	18	18	17	32	SL	0.0	0.4	2.4	10.7	13.8
	C 18	A242120	0-20	4.4	0.1	4.0	19	17	16	11	13	24	L					
	C 19	A242121	0-20	4.5	0.1	5.3	11	24	18	9	9	29	L					
	C 20	A242122	0-20	4.3	0.1	3.1	8	12	15	5	5	55	SL					
	C 21	A242123	0-20	4.7	0.1	1.9	14	16	18	8	6	38	SL					
	C 23	A242125	0-20	4.8	0.1	2.0	16	10	37	19	8	10	L					
	D 20a	A242090K	0-20	4.3	0.0	2.4	16	19	22	6	5	32	L	0.1	0.2	1.5	6.1	13.5
	D 21	A242091K	0-20	5.7	0.0	2.5	5	7	15	13	14	47	SL					
	D 24	A242094K	0-20	4.4	0.0	1.4	4.5	8	25	17	15	31	SL					
	E 20	A242151Z	0-20	6.8	0.1	1.9	1.5	4.5	7	4.5	8	74	S	0.0	0.3	1.2	4.0	6.0
	E 21a	A242154K	0-20	4.7	0.1	5.1	31	22	29	8	4.5	7	SiCL					
	E 22	A242385	0-20	4.2	0.1	9.3	68	19	9	1.5	0.5	1	C					
	F 19	A242000K	0-20	4.7	0.1	3.7	13	4.5	7	2.5	6	66	SL					
	F 28	A242009Z	0-20	4.2	0.1	1.3	4.5	4.5	6	1	2	81	LS	0.2	0.1	0.3	1.5	3.6
F.1.1/ 1.2	D 23	A242093Z	0-20	6.0	0.0	1.7	1.5	2	6	9	15	66	S	0.0	0.2	1.2	4.4	5.9
	D 23*	A242929Z	0-20	6.7	0.1	2.6	1.5	1	6	9	14	69	S	0.0	0.3	1.4	6.4	8.0
	D 23*	A242930Z	60-80	5.4	0.0	0.5	1.5	1	2.5	4	16	75	S					
	D 23*	A242931Z	100-120	5.2	0.0	0.3	0.5	0.2	5	4	14	76	S					
F.1.2	A 9	A243048K	0-20	5.4	0.0	1.3	13	8	25	17	10	26	SL					
	A 10	A243049K	0-20	5.6	0.0	1.8	5	3	15	13	11	24	LS					
	A 11	A243050K	0-20	4.0	0.1	3.9	46	22	21	3.5	1.5	8	SiC					
	A 12	A243051K	0-20	5.0	0.0	2.7	20	15	26	11	4.5	24	L	0.1	0.4	2.6	9.0	14.8
	A 13	A243052K	0-20	6.2	0.1	7.5	19	12	20	18	13	19	L					
	A 14	A243053K	0-20	5.6	0.1	6.7	40	29	21	3.5	2.5	4.5	SiCL/ SiC					
	A 15	A243054K	0-20	5.8	0.1	10.9	39	27	24	4	2	3.5	SiCL					
	A 16	A243055K	0-20	5.9	0.1	9.5	42	23	27	4.5	1	3	SiC					

TABLE 7.37

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes: 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil
3. Profile pits are marked thus : *

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part <2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ	Texture class	Exchangeable cations in m.e./100 g. soil Na	K	Mg	Ca	c.e.c.
NC.3.1	G11	A242173K	0-20	3.8	0.1	3.8	57	17	18	6	1.5	1	C					
	G22a	A242183K	0-20	4.2	0.1	1.4	23	12	51	13	0.5	1	SiL					
	G23a	A242184K	0-20	4.0	0.1	4.4	58	26	12	3	1.5	1	C					
	G24	A242185K	0-20	4.2	0.1	9.4	69	15	14	1.5	0.2	0.5	C	0.9	0.5	1.7	15.2	35.7
	G25	A242186K	0-20	4.1	0.1	3.1	62	20	17	1	0.2	1	C					
	G26	A242187K	0-20	4.3	0.0	2.6	42	15	29	12	1.5	0.5	SiC	0.3	0.3	0.9	9.5	19.8
	G27	A242188K	0-20	3.7	0.1	8.6	75	10	13	1	0.3	0.5	C					
	J 1	A242193Z	0-20	4.8	0.0	3.0	2	6	13	7	8	64	LS	0.1	0.3	1.0	4.2	8.3
	J 3	A242195K	0-20	4.0	0.0	2.8	17	15	24	18	15	12	L					
	J 4	A242196K	0-20	4.0	0.1	3.5	47	25	22	3	1.5	2.5	SiC					
	K 3	A242918K	0-20	3.7	0.0	2.2	33	19	15	1.5	2	29	CL	0.1	0.2	1.5	5.0	15.3
	K 4	A242919K	0-20	3.7	0.1	2.1	45	29	16	6	1.5	2.5	SiC	0.1	0.2	2.3	8.0	19.6
	K 5	A242920K	0-20	3.8	0.0	4.3	51	31	16	0.5	0.1	2	SiC					
NC.4.1	B 5	A242018K	0-20	4.0	0.1	5.5	41	29	25	3	0.5	1	SiC					
	C10	A242112	0-20	3.9	0.1	8.7	80	6	11	1	0.5	1	C					
	C11	A242113	0-20	4.3	0.1	12.9	82	6	9	1	0.5	1.5	C					
	C12	A242114	0-20	4.1	0.0	10.0	78	8	10	1.5	0.5	2	C					
	D 6 *	A242925K	0-20	3.9	0.1	8.5	71	11	14	2	1	2	C	0.3	0.4	8.9	11.1	37.3
	D 6 *	A242926K	100-120	4.0	0.1	1.0	68	14	13	4	0.5	1	C	0.2	1.2	7.0	16.5	37.1
	D 6	A242066	0-20	4.2	0.1	11.9	77	9	8	2	1.5	4	C					
	D 8	A242067	0-20	4.1	0.1	10.4	79	10	8	1.5	0.5	1	C					
	D 9	A242068	0-20	4.1	0.1	9.3	83	6	9	1	0.5	1	C					
	G30	A242191K	0-20	4.0	0.1	8.7	74	6	15	2	1	2	C	0.5	0.5	1.6	12.4	34.3
	I 1	A242938K	0-20	3.7	0.1	2.7	42	30	24	2	0.5	1.5	SiC					
	I 2	A242939K	0-20	3.9	0.1	4.4	70	17	10	1.5	1	0.3	C					
	J 2	A242194K	0-20	4.0	0.1	5.3	51	23	23	2	0.1	0.3	SiC					
	K 6	A242921K	0-20	4.0	0.0	5.8	65	21	12	0.5	0.2	1.5	C	0.2	0.5	5	10.7	29.1
	K 7	A242922K	0-20	3.8	0.0	4.4	56	28	15	1	0.2	0.3	C					
	K 8	A242923K	0-20	3.9	0.0	2.4	51	28	18	2.5	0.5	0.5	SiC					
	K 8a	A242924K	0-20	3.9	0.0	1.2	20	5	19	27	19	10	SCL					

TABLE 7.36

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes:
1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	
N.2.3	F 22	A242003K	0-20	4.7	0.1	3.2	34	18	35	11	0.5	2	SiCL					
	F 23	A242004K	0-20	4.4	0.1	4.3	60	14	22	3.5	0.5	0.5	C					
	F 24	A242005K	0-20	4.3	0.1	4.0	52	20	22	1	4	1.5	SiC	0.3	0.8	5.0	15.1	28.0
	F 26	A242007K	0-20	3.9	0.1	1.5	39	13	33	15	1	0.4	SiCL	0.4	0.2	3.3	7.4	15.1
	F 27	A242008K	0-20	3.9	0.1	1.5	58	15	24	2.5	0.2	0.5	C	0.4	0.3	4.2	9.8	22.4
	F 22*	A242888K	0-20	4.2	0.0	4.8	46	27	21	3.5	0.5	2.5	SiC	0.4	0.7	3.7	9.5	21.4
	F 22*	A242889K	30-50	5.3	0.1	1.0	35	25	33	4	0.4	4	SiCL	0.3	0.2	3.9	9.1	15.8
	F 22*	A242890K	100-120	5.6	0.0	<u>0.5</u>	0.1	0.2	2	1	2	95	S					
	F 24*	A242891K	0-20	4.3	0.0	4.7	51	20	22	4.5	1	1.5	SiC	0.5	0.7	4.2	14.5	28.1
	F 24*	A242892K	30-50	5.7	0.1	0.6	24	10	38	23	2.5	2.5	L	0.4	0.4	3.1	7.3	10.9
	F 24*	A242893K	70-90	4.9	0.0	<u>0.7</u>	2	2	6	8	11	71	S					
	F 24*	A242894K	110-130	4.0	0.0	0.4	19	13	44	22	2	1.5	SiL					
	G 3	A242164K	0-20	4.1	0.1	3.7	36	35	21	1.5	1	6	SiCL					
	G 4	A242165K	0-20	4.0	0.1	3.4	40	29	24	2.5	0.4	4	SiCL	0.3	0.2	3.2	9.2	20.8
	G 5	A242166K	0-20	4.1	0.1	1.8	33	20	31	11	2.5	3.5	SiCL	0.2	0.3	1.9	6.5	14.4
	G 6	A242167K	0-20	4.3	0.1	3.4	30	24	34	7	2.5	2	SiCL					
	G 17	A242179K	0-20	3.9	0.1	3.5	51	31	16	0.5	0.1	1	SiC	0.4	0.4	3.2	9.2	22.2
	G 29	A242190K	0-20	4.0	0.0	<u>3.7</u>	31	25	34	9	1	0.5	SiCL					
	H 25	A242982	0-20	3.8	0.0	2.1	67	17	15	1	0.1	0.2	C	0.5	0.4	3.7	9.3	22.3
	H 26	A242983	0-20	4.1	0.0	5.3	37	15	31	14	1.5	1	SiCL					
	H 27	A242984K	0-20	3.9	0.1	5.5	62	19	17	3	0.3	0.4	C	0.4	0.5	3.8	10.0	27.5
	H 28	A242985K	0-20	3.8	0.1	2.9	52	17	24	6	0.5	0.5	SiC					
	H 29	A242986K	0-20	3.9	0.0	2.6	48	16	27	8	0.5	0.4	SiC	0.3	0.3	2.3	7.3	19.5
	J 14	A242206K	0-20	3.9	0.1	3.0	46	31	18	2	1	3	SiC	0.3	0.2	2.3	7.1	20.4
	J 15	A242207K	0-20	3.8	0.1	3.2	60	26	12	1	0.2	0.3	C	0.4	0.3	1.2	10.4	27.0
	J 16	A242208K	0-20	3.7	0.1	3.1	60	21	17	1.5	0.4	1	C	0.3	0.2	3.4	10.1	27.8
NC.3.1	B 6	A242019K	0-20	4.2	0.1	8.2	54	19	20	4.5	1.5	1.5	C					
	C 9	A242111	0-20	3.9	0.1	<u>4.3</u>	36	14	24	20	3.5	2	CL	0.1	0.2	2.5	7.1	19.3
	E 14	A242145K	0-20	3.9	0.1	<u>8.0</u>	72	13	10	2.5	0.5	1.5	C					
	E 15	A242146K	0-20	4.2	0.1	<u>7.6</u>	73	10	12	1.5	0.5	2	C					
	E 16	A242147K	0-20	3.9	0.1	<u>5.3</u>	36	12	21	11	6	15	CL					
	E 17	A242148K	0-20	4.4	0.1	<u>3.6</u>	22	11	15	12	14	26	SCL					

TABLE 7.35

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes:
1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	
N.2.2	B 8	A242021K	0-20	4.1	0.1	9.3	77	9	11	1	0.5	1	C					
	B 9	A242050	0-20	3.9	0.1	8.7	83	3.5	12	0.5	0.4	0.5	C					
	B 10	A242051	0-20	4.2	0.1	10.1	77	6	14	1	0.5	1	C					
	C 4	A242107	0-20	4.1	0.1	6.2	75	13	12	0.3	0.1	0.2	C					
	C 7	A242109	0-20	4.2	0.1	7.6	79	11	9	0.5	0.3	0.5	C					
	D 13	A242072	0-20	4.1	0.1	9.5	82	9	8	0.5	0.2	0.4	C					
	D 14	A242073	0-20	4.2	0.1	8.5	83	6	11	0.2	0.1	0.3	C					
	D 15	A242074	0-20	4.1	0.1	6.0	77	11	11	0.5	0.2	0.4	C					
	F 16	A241997K	0-20	4.2	0.1	10.0	77	10	10	1	0.5	0.5	C					
	F 25	A242006K	0-20	4.1	0.1	7.8	75	15	8	1	0.2	0.5	C					
	H 21	A242978	0-20	4.3	0.1	12.5	70	17	12	1	0.2	0.4	C	0.2	0.4	6.5	14.5	98.3
	I 23	A243001K	0-20	4.1	0.0	4.8	66	19	15	0.3	0.1	0.2	C	0.5	0.6	5.3	10.3	26.6
N.2.3	A 5	A243044K	0-20	3.9	0.0	7.8	67	19	12	0.5	0.2	0.5	C					
	A 6	A243045K	0-20	3.9	0.0	8.3	69	18	12	0.3	0.1	0.5	C	0.5	1.0	4.2	15.5	36.0
	A 7	A243046K	0-20	4.1	0.1	5.3	56	25	17	1.5	0.3	1	SiC					
	A 8	A243047K	0-20	5.0	0.1	3.6	34	19	28	3.5	2	14	SiCL	0.2	0.5	3.9	17.2	30.8
	B 2	A242015K	0-20	3.9	0.1	6.9	51	27	21	0.1	0	0.2	SiC					
	B 12	A242053	0-20	3.8	0.1	8.5	67	12	18	1	0.3	2	C	0.3	1.1	0.9	3.3	4.6
	B 13	A242054	0-20	3.9	0.1	6.9	69	23	4.5	1	0.5	2	C					
	B 14	A242055	0-20	3.9	0.1	8.8	81	10	6	1	0.5	1.5	C					
	B 16	A242057	0-20	4.0	0.1	4.5	40	28	23	3	2.5	4	SiC					
	C 2	A242105	0-20	4.2	0.1	6.9	58	23	16	2	0.4	0.5	C/SiC	0.3	0.8	4.8	10.6	28.4
	C 13	A242115	0-20	4.3	0.1	8.5	72	13	9	3	1.5	1.5	C					
	C 14	A242116	0-20	4.2	0.1	7.6	69	18	10	2	0.5	1.5	C	0.7	1.1	6.5	14.7	35.2
	D 5	A242065	0-20	4.0	0.1	7.4	63	21	14	1	0.3	1	C	0.4	0.7	3.6	9.8	28.3
	D 18	A242077K	0-20	4.1	0.1	9.4	71	14	12	1.5	0.5	1	C					
	D 19	A242078K	0-20	4.2	0.1	7.9	68	20	10	0.5	0.2	0.5	C	0.6	1.0	6.3	14.5	36.4
	E 6	A242137K	0-20	4.0	0.1	9.1	71	11	14	2	1	0.5	C	0.3	0.8	5.4	15.2	37.0
	E 7	A242138K	0-20	4.1	0.1	8.5	69	10	16	3	2	0.5	C	0.3	0.9	5.5	15.2	35.7
	E 11	A242142K	0-20	3.8	0.1	6.3	63	11	21	4	0.3	1	C					
	E 12	A242143K	0-20	4.0	0.1	9.1	73	14	10	2	0.5	1.5	C	0.5	0.9	6.4	14.0	36.9
	E 13	A242144K	0-20	4.0	0.1	5.5	52	17	22	6	1	1.5	C					
	E 18	A242149K	0-20	4.5	0.1	13.4	10	13	9	17	14	36	SL					

TABLE 7. 34

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes :
1. Where underlined the percentage of organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	
N.2.1	H 4	A242961	0-20	3.8	0.1	5.5	49	32	18	1	0.2	0.3	SiC					
	H 5	A242962	0-20	4.1	0.1	4.7	55	27	17	0.5	0.1	0.2	SiC	0.3	0.4	4.5	8.0	22.9
	H 10	A242967	0-20	4.1	0.1	<u>10.6</u>	74	18	7	0.5	0.1	0.4	C	0.3	0.5	5.0	15.5	38.0
	H 11	A242968	0-20	4.0	0.1	2.6	49	25	25	1	0.1	0.4	SiC	0.2	0.4	3.0	7.7	18.7
	H 12	A242969	0-20	4.0	0.1	3.5	60	25	14	0.5	0.1	0.4	C					
	H 13	A242970	0-20	4.1	0.1	6.6	51	30	17	1	0.2	0.5	SiC	0.3	0.5	3.7	9.9	24.2
	H 14	A242971	0-20	4.1	0.1	5.2	54	26	19	1	0.1	0.2	SiC					
	H 19	A242976	0-20	4.0	0.1	4.9	66	23	10	0.4	0.1	0.2	C	0.3	0.8	5.4	10.7	29.7
	H 20	A242977	0-20	4.1	0.0	<u>13.8</u>	74	12	13	0.5	0.2	0.5	C					
	H 22	A242979	0-20	3.8	0.1	4.6	73	15	11	0.5	0.2	0.2	C					
	H 23	A242980	0-20	3.8	0.1	3.9	80	11	9	0.2	0.1	0.1	C					
	J 17	A242209K	0-20	3.7	0.1	3.5	72	16	10	0.5	0.2	0.3	C					
	J 18	A242210K	0-20	3.7	0.0	2.6	59	29	14	1	0.1	0.2	SiC					
	J 7	A242199K	0-20	3.7	0.1	1.5	58	25	16	1	0.2	0.4	SiC					
	J 8	A242200K	0-20	3.8	0.1	3.9	60	23	16	0.4	0.1	0.2	C					
	J 9	A242201K	0-20	4.0	0.0	3.4	58	30	12	0.5	0.1	0.2	SiC					
	I 6	A242943K	0-20	4.0	0.1	5.4	75	13	10	0.5	0.2	0.5	C					
	I 7	A242944K	0-20	4.2	0.1	<u>15.2</u>	77	11	11	0.5	0.3	0.4	C	0.2	0.5	5.5	12.5	38.4
	I 8	A242945K	0-20	4.2	0.1	<u>10.3</u>	76	6	15	1.5	0.4	1	C					
	I 14	A242951K	0-20	3.7	0.1	2.2	69	20	10	0.3	0.1	0.5	C					
	I 15	A242952K	0-20	3.9	0.1	4.4	69	17	13	1	0.1	0.5	C	0.3	0.7	4.6	10.2	28.9
	I 16	A242953K	0-20	3.8	0.1	2.5	58	26	15	0.5	0.1	0.2	SiC					
	I 17	A242954K	0-20	4.0	0.1	3.8	57	25	16	1.5	0.1	0.2	SiC					
	I 18	A242955K	0-20	3.8	0.1	1.8	41	25	27	6	0.5	0.3	SiC					
	I 24	A243002K	0-20	3.8	0.0	2.6	48	30	19	2.5	0.1	0.3	SiC					
	I 25	A243003K	0-20	3.7	0.1	<u>4.3</u>	53	29	15	1.5	0.3	0.4	SiC	0.6	0.3	3.1	6.8	17.8
	I 26	A243004K	0-20	3.8	0.1	1.9	53	28	17	1.5	0.2	0.5	SiC					
	B 7a*	A243008K	20-40	4.1	0.1	1.8	58	24	16	1	0.4	0.3	SiC/C	0.4	0.3	4.9	10.7	23.4
	B 7a*	A243009K	70-90	5.1	0.1	0.5	32	15	26	12	8	6	CL					
	B 7a*	A243010K	90-110	5.1	0.0	0.3	14	4	22	26	21	14	SL					
	B 7a*	A243011Z	110-130	5.1	0.0	0.2	1	5	22	40	19	12	LS					
	D 16*	A242927K	0-20	4.2	0.1	<u>11.1</u>	81	4	11	1	0.5	3	C	0.2	1.2	7.0	16.5	37.0
	D 16*	A242928K	90-110	3.9	0.1	0.9	71	14	11	2	1	1.5	C	1.0	0.4	7.9	11.5	28.2
	F 17*	A242886K	0-20	4.1	0.1	<u>8.3</u>	72	12	14	1	0.5	1	C	0.3	0.7	5.2	15.8	34.2
	F 17*	A242887K	100-120	4.2	0.1	1.0	53	29	15	1	0.5	2	C	1.7	0.3	5.8	9.8	23.2

TABLE 7.33

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes:
1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							< 2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	
N.2.1	A 2	A243041K	0-20	3.9	0.1	6.8	62	19	17	1	0.3	1	C					
	A 3	A243042K	0-20	4.1	0.0	9.1	67	17	11	2	1	2	C					
	A 4	A243043K	0-20	4.3	0.0	10.4	73	10	14	1.5	1.5	1.5	C	0.7	1.8	4.2	16.0	39.1
	B 7	A242020K	0-20	4.1	0.1	11.9	72	10	14	1.5	0.5	1.5	C					
	B 11	A242052	0-20	4.0	0.1	8.8	75	6	15	1.5	0.5	1.5	C					
	B 15	A242056	0-20	3.9	0.1	8.3	78	13	6	1.5	1	1.5	C					
	C 3	A242106	0-20	4.0	0.1	7.3	71	18	10	0.5	0.1	0.2	C	0.4	0.7	6.6	12.6	33.7
	C 6	A242108	0-20	4.2	0.1	6.8	81	7	11	0.3	0.2	0.2	C					
	C 8	A242110	0-20	4.1	0.1	7.7	80	9	11	0.5	0.2	0.5	C					
	D 10	A242069	0-20	4.0	0.1	6.8	60	17	18	2	2	1	C	0.5	0.7	4.0	11.6	30.3
	D 11	A242070	0-20	4.1	0.1	7.7	77	12	9	1.5	0.5	0.5	C					
	D 12	A242071	0-20	4.1	0.1	9.0	70	11	15	2	0.5	1	C	0.6	0.7	5.9	13.6	36.7
	D 16	A242075	0-20	4.1	0.1	8.9	79	11	8	1	0.2	1	C					
	D 17	A242076K	0-20	4.3	0.1	9.4	78	10	10	1	0.2	1	C					
	E 3	A242134K	0-20	3.9	0.1	7.2	55	22	21	2	0.2	0.5	SiC					
	E 4	A242135K	0-20	4.1	0.1	8.1	72	13	14	1	0.3	0.5	C	0.5	0.6	6.2	14.2	34.1
	E 5	A242136K	0-20	3.9	0.1	9.4	68	13	17	1	0.3	1	C					
	F 13	A241994K	0-20	4.0	0.1	9.5	72	10	15	1	1	1	C					
	F 14	A241995K	0-20	4.1	0.1	2.8	8	8	10	4.5	8	62	LS	0.0	0.2	0.4	2.5	9.8
	F 15	A241996K	0-20	4.1	0.1	11.9	78	10	10	1.5	0.5	1	C					
	F 17	A241998K	0-20	4.3	0.1	10.3	73	13	10	2	1	1.5	C					
	F 18	A241999K	0-20	4.1	0.1	10.5	68	14	12	3	1	2.5	C	0.4	1.5	4.7	12.9	34.6
	F 21	A242002K	0-20	4.3	0.1	6.9	71	15	12	1	0.3	0.5	C					
	G 15	A242177K	0-20	4.1	0.1	3.3	47	25	25	1.5	0.4	1.5	SiC	0.3	0.5	9.4	3.2	24.1
	G 16	A242178K	0-20	4.0	0.1	4.8	53	31	13	0.4	0.1	2	SiC					
	G 18	A242180K	0-20	4.1	0.1	7.9	76	15	7	0.5	0.2	0.5	C					
	G 19	A243025K	0-20	4.0	0.0	10.0	77	10	12	0.5	0.2	0.5	C					
	G 20	A242181K	0-20	4.0	0.1	3.5	69	22	9	0.2	0.1	0.1	C					

TABLE 7.32

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes :
1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	
N.1.2	J 5	A242197K	0-20	3.9	0.1	3.8	40	24	34	1	0.3	1	SiC	0.4	0.5	2.3	7.4	22.1
	J 5*	A243026K	0-20	3.9	0.1	5.3	51	28	18	1	0.2	0.5	SiC	0.4	0.4	2.2	7.8	20.0
	J 5*	A243027K	40-60	3.8	0.1	3.6	46	31	21	1	0.2	1	SiC	0.8	0.3	2.7	6.7	16.8
	J 5*	A243028K	110-130	3.9	0.0	2.1	23	12	43	20	2	0.4	SiL					
	J 6	A242198K	0-20	3.8	0.1	1.3	64	24	10	0.5	0.2	0.5	C	0.3	0.2	1.1	8.8	22.7
	J 10	A242202K	0-20	3.9	0.1	3.5	51	31	15	2.5	0.2	0.4	SiC					
	J 11	A242203K	0-20	3.9	0.1	4.6	54	29	14	1.5	0.4	0.5	SiC					
N.1.3	B 3	A242016K	0-20	4.5	0.1	3.5	19	18	46	10	4	2.5	SiL	0.1	0.3	2.1	7.2	15.4
	C 0	A242103	0-20	3.9	0.0	1.7	13	17	34	20	7	8	SiL					
	C 1	A242104	0-20	4.2	0.0	1.2	10	10	23	24	19	13	SL	0.1	0.1	1.2	3.4	7.8
	D 1	A242060	0-20	4.2	0.1	1.1	7	9	30	36	13	6	SL	0.0	0.1	0.9	3.1	6.0
	D 1a	A242061	0-20	3.9	0.1	2.6	31	30	29	5	1.5	2.5	SiCL					
	D 2	A242062	0-20	4.3	0.1	1.6	17	16	33	16	9	10	L	0.1	0.2	1.7	5.2	10.6
	D 3	A242063	0-20	4.2	0.1	1.7	16	11	47	7	8	12	SiL					
	E 8	A242139K	0-20	4.0	0.1	7.5	57	10	22	6	2	3.5	C					
	E 9	A242140K	0-20	4.0	0.1	5.4	53	13	21	10	2	2	C					
	E 10	A242141K	0-20	3.9	0.1	6.2	56	12	19	8	1	3.5	C	0.2	0.4	4.0	10.5	26.8
	F 2	A241983K	0-20	4.7	0.0	8.8	28	24	28	9	3	8	CL	0.1	0.7	2.7	16.1	26.8
	F 3	A241984K	0-20	4.6	0.1	4.7	20	24	31	14	4.5	6	SiL					
	F 3*	A242880K	20-40	4.0	0.1	1.7	24	22	31	14	4.5	5	SiL	0.1	0.2	2.2	6.6	13.8
	F 3*	A242881K	40-60	3.8	0.0	0.8	15	16	35	21	8	4	SiL	0.1	0.2	1.5	4.3	10.1
	F 3*	A242882K	100-120	3.8	0.0	0.4	9	11	43	27	8	3	SL					
	F 5	A241986K	0-20	4.2	0.1	2.1	15	17	36	18	7	7	SiL					
	F 6	A241987K	0-20	4.2	0.0	1.5	6	11	44	23	6	10	SiL	0.0	0.2	1.2	1.6	7.3
N.1.4	A 1	A243040K	0-20	4.8	0.0	6.9	12	15	45	19	5	4	SiL	0.1	0.3	1.7	11.5	17.5
	E 0	A242131K	0-20	4.2	0.1	1.1	13	13	34	19	12	10	L	0.0	0.2	2.0	3.7	9.4
	G 13	A242175K	0-20	4.8	0.1	4.7	19	25	33	19	2.5	1	SiL					
	G 14	A242176K	0-20	4.2	0.1	1.7	34	23	33	8	1.5	1	SiCL	0.2	0.2	2.4	7.3	14.8
	I 3	A242940K	0-20	5.2	0.0	2.3	11	11	40	32	3.5	1	SiL	0.0	0.3	2.5	6.4	12.9
	I 9	A242946K	0-20	4.4	0.0	1.0	7	4.5	20	16	9	45	SL	0.0	0.2	0.7	2.5	4.9
	I 10	A242947K	0-20	4.7	0.0	1.9	9	9	47	27	6	3	SiL					

TABLE 7.31

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes :
1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *

Mapping unit	Sample site or Profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical compostion in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	
N.1.1	H8 *	A242992K	30-50	4.2	0.1	0.6	25	11	36	22	4.5	1	L	0.4	0.1	2.3	6.0	9.9
	H8 *	A242993K	50-70	4.3	0.0	0.4	9	1.5	15	30	25	19	SL					
	H8 *	A242994Z	120-140	4.8	0.0	$\underline{0.3}$	0	0	1	1.5	1	96	S					
	H9	A242966	0-20	4.0	0.1	4.0	31	33	25	5	1.5	4.5	SiCL					
	H15	A242972	0-20	3.9	0.1	1.8	24	18	30	16	7	6	L					
	H16	A242973	0-20	4.4	0.0	2.9	9	6	56	24	2.5	2	SiL	0.0	0.2	1.3	5.1	11.4
	I 0	A242937K	0-20	3.6	0.0	1.8	13	9	43	30	4.5	1	SiL					
	I 10	A242947K	0-20	4.7	0.0	1.9	9	9	47	27	6	3	SiL					
	I 11	A242948K	0-20	3.7	0.0	2.4	53	17	23	5	1	1	C/SiC					
	I 12	A242949K	0-20	4.2	0.0	1.7	32	23	34	8	2.5	1	SiCL	0.2	0.3	2.1	6.3	13.0
	I 19	A242956K	0-20	3.9	0.1	$\underline{8.4}$	74	9	11	2	0.5	3	C					
	I 20	A242957K	0-20	3.9	0.1	5.1	52	32	14	1.5	0.3	0.4	SiC	0.3	0.4	4.1	11.1	27.4
	I 21	A242999K	0-20	4.0	0.1	4.1	53	23	23	1	0.1	0.2	SiC	0.4	0.5	4.3	9.3	24.0
	J 0	A242192K	0-20	4.7	0.0	3.0	12	14	39	21	6	9	SiL	0.1	0.2	1.6	6.4	12.0
	J 12	A242204K	0-20	4.1	0.1	3.4	33	26	38	1	0.4	0.5	SiCL					
	J 13	A242205K	0-20	3.8	0.1	3.5	32	35	28	3	0.5	1.5	SiCL					
	K 0	A242915K	0-20	4.7	0.0	1.1	5	4	15	30	26	20	LS					
	K 1	A242916K	0-20	4.5	0.1	3.8	41	25	26	4.5	1.5	2	SiC	0.1	0.5	2.9	11.5	23.9
	K 2	A242917K	0-20	3.8	0.0	5.5	47	34	17	0.5	0.5	0.5	SiC					
N.1.2	D 4	A242064	0-20	3.8	0.1	$\underline{7.2}$	53	26	17	2.5	0.4	1	SiC	0.3	1.0	2.2	7.0	25.2
	F 12	A241993K	0-20	4.3	0.1	3.7	25	22	45	6	1	1.5	SiL					
	G 21	A242182K	0-20	3.8	0.1	2.3	48	21	25	5	0.2	0.3	SiC	0.5	0.3	2.5	6.9	18.0
	H 3	A242960	0-20	3.8	0.1	2.2	37	34	26	1	0.2	0.5	SiCL	0.2	0.2	2.0	6.2	18.3
	H 6	A242963	0-20	4.1	0.0	3.7	38	39	21	1	0.2	0.3	SiCL	0.1	0.5	3.5	9.3	21.5
	H 17	A242974	0-20	4.4	0.0	1.8	12	9	47	29	2.5	0.5	SiL					
	H 18	A242975	0-20	3.9	0.1	5.0	51	36	12	1	0.1	0.2	SiC					
	H 24	A242981	0-20	3.8	0.1	2.7	50	19	24	6	1.5	1	SiC					
	I 4	A242941K	0-20	4.0	0.0	1.9	27	30	28	4	2.5	10	SiCL					
	I 5	A242942K	0-20	3.7	0.1	2.1	52	29	17	1.5	0.5	0.4	SiC	0.4	0.3	2.8	7.4	20.9
	I 13	A242950K	0-20	3.8	0.1	1.6	48	28	16	6	1.5	1	SiC					
	I 22	A243000K	0-20	4.1	0.0	2.7	57	24	18	0.4	0.1	0.2	SiC					

TABLE 7.30

SOIL SAMPLE ANALYSES DATA OF THE SEMI-DETAILED SOIL SURVEY

Notes:
1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.
3. Profile pits are marked thus : *.

Mapping unit	Sample site or profile pit	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical Composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.
							< 2 µ	2-16µ	16-50µ	50-105µ	105-150µ	> 150 µ		Na	K	Mg	Ca	
N.1.1	B 1a	A242014K	0-20	3.7	0.1	4.2	47	26	27	0.5	0.1	0.2	SiC					
	B 4	A242017K	0-20	4.1	0.1	4.8	38	27	30	3.5	1	1	SiCL	0.2	0.4	2.6	9.7	23.6
	B 4*	A243014K	60-70	4.3	0.0	0.3	7	4	17	27	29	16	SL					
	B 4*	A243015K	100-120	4.0	0.1	1.0	26	31	31	6	2.5	3	SiL					
	E 1	A242132K	0-20	4.2	0.1	2.8	21	26	38	10	2	4	SiL					
	E 2	A242133K	0-20	3.8	0.1	1.8	23	18	43	9	1.5	7	SiL					
	F 1a	A241982K	0-20	3.9	0.0	2.0	16	11	39	30	3	0.4	L/SiL	0.2	0.3	1.3	4.1	12.2
	F 4	A241985K	0-20	3.7	0.1	2.9	31	26	31	6	0.5	8	SiCL					
	F 7	A241988K	0-20	3.9	0.1	3.0	30	23	42	5	0.4	0.5	SiCL					
	F 8	A241989K	0-20	3.8	0.0	5.8	35	28	28	4.5	2.5	2.5	SiCL	0.1	0.4	3.1	7.6	17.9
	F 9	A241990K	0-20	3.7	0.1	2.6	29	28	29	7	2	5	SiCL					
	F 10	A241991K	0-20	3.7	0.1	4.5	42	28	28	1	0.2	0.5	SiC	0.1	0.3	2.2	6.0	16.9
	F 11	A241992K	0-20	5.4	0.1	2.6	11	12	42	26	6	3	SiL					
	F 20	A242001K	0-20	4.3	0.1	3.8	35	28	30	3	1	3	SiCL					
	G 0	A242161K	0-20	5.0	0.1	3.2	10	18	52	15	1.5	4	SiL					
	G 1	A242162K	0-20	4.3	0.1	2.3	13	18	35.	22	8	3.5	SiL	0.4	0.3	3.3	7.2	13.5
	G 2	A242163K	0-20	3.9	0.1	2.6	32	27	33	6	1.5	1.5	SiCL	0.1	0.4	2.3	3.9	11.7
	G 6a	A242168K	0-20	3.8	0.1	3.5	45	24	20	7	2	2	SiC	0.2	0.2	2.5	7.3	19.1
	G 7	A242169K	0-20	3.7	0.1	3.2	44	24	29	2	0.1	0.4	SiC					
	G 8	A242170K	0-20	3.7	0.1	2.7	50	24	20	2	1	3	SiC					
	G 9	A242171K	0-20	3.8	0.1	3.2	42	32	22	0.5	0.3	3.5	SiC					
	G 10	A242172K	0-20	4.0	0.1	2.0	44	33	21	0.5	0.5	1	SiC					
	G 12	A242174K	0-20	5.7	0.0	2.9	8	8	40	34	7	3	L					
	G 28	A242189K	0-20	4.0	0.0	2.2	16	5	31	37	7	3.5	L					
	H 1	A242958	0-20	4.9	0.0	1.8	10	14	43	20	8	5	SiL					
	H 2	A242959	0-20	3.9	0.1	2.9	22	17	48	12	0.3	0.5	SiL	0.0	0.1	1.7	5.9	10.2
	H 7	A242964	0-20	3.7	0.1	4.6	33	21	30	10	2	4.5	SiCL					
	H 8	A242965	0-20	3.7	0.1	3.6	26	20	25	14	6	9	L	0.1	0.3	1.2	2.8	12.4

TABLE 7.29

TABLE OF SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral parts						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.	Mapping unit
							< 2 u	2-16u	16-50u	50-105u	105-150u	>150 u		Na	K	Mg	Ca		
55	Y3,7902, 4	A241674K	0-20	3.9	0.1	5.6	51	27	14	1.5	0.3	6	SiC	0.1	0.4	2.4	7.9	17.9	NC 2
	Y3,7902, 5	A241675K	0-20	3.8	0.1	5.2	70	15	12	1.5	0.2	2	C						NC 2
	Y3,7904, 1	A241677K	0-20	4.2	0.1	3.6	48	28	17	4	1	2	SiC						NC 2
	Y3,7904, 2	A241678K	0-20	4.0	0.1	2.0	34	26	29	8	1.5	1.5	SiCL						NC 2
	Y3,7904, 3	A241679K	0-20	3.6	0.1	4.1	39	13	23	20	4	2	CL						NC 2
	Y3,7904, 4	A241680K	0-20	4.0	0.1	4.1	48	13	24	13	0.5	0.5	C						CF
	Z4,8710,K1	Z241620	0-20	3.7	0.1	4.1	34	29	26	4.5	1	6	SiCL	0.0	0.4	1.5	4.0	15.2	NC 2
56	Z1,7924,K1	A241617	0-20	3.5	0.1	4.3	78	16	4.5	1	0.1	0.4	C	0.1	0.3	2.5	1.7	19.9	NC 1
	Z2,7940,K1	A241615	0-20	3.7	0.1	5.2	76	14	10	0.4	0.1	0.4	C	0.1	0.5	3.3	7.8	21.5	NC 2
	Z2,7940,K2	A241616	0-20	3.6	0.0	4.9	77	17	5	0.2	0.1	0.5	C						NC 2
	Z3,8758,K2	Z241618	0-20	3.6	0.1	11.5	79	15	2.5	0.5	0.2	2.5	C						NC 1
	Z4,8718,K1	Z241619	0-20	5.2	0.0	1.1	9	4	5	14	13	55	LS						CF
	Z2,7942,K1	Z241621	0-20	3.7	0.0	3.9	53	26	15	4	0.5	1.5	SiC	0.1	0.5	2.3	7.0	18.6	NC 2
	Z2,7942, 2	A241622	30-60	3.7	0.1	0.9	31	21	35	11	1.5	0.5	SiCL	0.1	0.1	1.4	3.3	10.6	NC 2
	Z2,7942,K1	A241623	60-90	3.6	0.1	0.7	23	19	37	9	4	9	SiL						NC 2
	Z2,7942,K1	A241624	90-120	3.9	0.1	0.2	8	5	9	15	27	36	LS						NC 2
	Z2,7942,K1	A241625	0-20	3.8	0.1	3.4	20	29	25	14	8	4	SiL						NC 2
	Z2,7942,K1	A241626	30-60	3.9	0.1	0.8	16	9	21	31	15	8	SL						NC 2
	Z2,7942, 2	A241627	60-90	4.0	0.1	0.3	11	7	22	34	21	5	SL						NC 2
	Z2,7942, 2	A241628	90-120	4.0	0.0	0.3	12	7	24	36	16	5	SL						NC 2
	Z2,7944, 6	A241634	0-20	3.6	0.1	5.4	52	22	24	1	0.3	1	SiC	0.2	0.4	1.4	2.7	18.7	NC 2
	Z2,7944, 1	A241629	0-20	3.7	0.1	3.5	56	25	9	0.5	0.3	9	C	0.1	0.4	2.7	6.6	18.6	NC 2
	Z2,7944, 2	A241630	0-20	3.5	0.1	3.3	60	32	6	0.4	0.2	1	C						NC 2
	Z2,7944, 3	A241631	0-20	3.6	0.1	2.9	60	31	8	0.3	0.1	0.3	C						NC 2
	Z2,7944, 5	A241633	0-20	3.7	0.1	2.7	26	21	32	13	2.5	4.5	SiL						N 1
	Z2,7944, 4	A241632	0-20	4.0	0.0	4.0	24	21	41	9	1.5	4.5	SiL	0.1	0.4	1.4	5.0	13.5	N 1
	Z2,7944, 7	A241635K	0-20	3.9	0.0	2.3	9	6	23	24	22	16	SL	0.0	0.2	0.7	2.1	6.6	NC 1
	Z2,7944, 8	A241636K	0-20	4.0	0.0	2.1	17	2.5	23	32	15	11	SL	0.1	0.2	0.7	3.0	7.4	NC 1
57	Z4,8720, 1	A241637Z	0-20	5.9	0.0	1.0	3	4	4	9	8	71	S	0.0	0.1	0.6	2.0	2.9	CF
	Z2,7936,K1	A241609	60-80	3.7	0.1	0.5	29	18	32	18	2.5	1.5	CL						NC 2
	Z2,7936,K1	A241610	0-20	3.7	0.1	9.7	61	21	14	1.5	0.5	1.5	C	0.0	0.6	2.0	7.3	23.6	NC 2
	Z2,7936,K1	A241611	80-100	3.7	0.1	0.6	28	22	32	13	4.5	1	SiCL						NC 2
	Z2,7936,K1	A241612	40-60	4.0	0.1	0.9	51	29	19	0.4	0.4	0.3	SiC						NC 2
	Z2,7936,K2	A241613	0-20	3.9	0.1	1.7	52	21	18	6	2.5	1	C	0.0	0.3	2.4	6.3	15.0	NC 2
	Z2,7936,K4	A241614	0-20	3.7	0.1	4.2	64	12	13	7	1.5	2	C						NC 1

TABLE 7.28

TABLE OF SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Notes 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.	Mapping unit
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca		
50	Y2, 6796, 1	A241657Z	0-20	4.1	0.0	0.9	7	2.5	8	14	23	47	LS						N 1
	Y2, 6796, 2	A241658K	0-20	3.7	0.1	2.9	39	22	25	7	2.5	4.5	SiCL						N 1
	Y2, 6796, 3	A241659K	0-20	3.6	0.0	2.1	34	20	24	5	3	14	CL						N 1
	Y3, 6820, 1	A241710K	0-20	3.6	0.1	2.7	42	24	32	2	0.1	0.3	SiC						NC 2
	Y3, 6820, Kla	A241711K	20-50	3.5	0.0	0.9	37	30	32	0.5	0.2	0.1	SiCL	0.1	0.1	1.6	2.8	13.5	NC 2
	Y3, 6820, 2	A241712Z	0-20	4.6	0.0	0.6	3.5	2.5	0	0.3	1	93	S						NC 2
	Y3, 6820, Kla	A241713	0-20	3.6	0.0	2.4	40	23	33	3	0.5	0.4	SiC						NC 2
	Y3, 6820, Kla	A241936	60-80	3.5	0.0	0.7	45	23	30	1	0.1	0.2	SiC						NC 2
	Y3, 6820, K3	A241714	0-20	4.1	0.0	0.4	6	1.5	1	3.5	4	84	S						T 1
	Y3, 6820, K3	A241937	10-30	4.1	0.0	0.6	2	2	3	2.5	6	85	S						T 1
	Y3, 6820, K3	A241938	50-70	4.2	0.0	0.2	8	3.5	0.2	4	7	78	S/LS						T 1
	Y3, 6820, K3	A241939	110-130	4.1	0.0	0.8	14	3.5	0.1	2.5	4.5	75	SL						T 1
	Y3, 6820, 4	A241709K	0-20	3.7	0.1	5.1	49	9	9	8	9	17	C	0.2	0.5	1.5	4.8	16.9	T 2
	Y3, 6820, 5	A241676Z	0-20	5.1	0.0	1.1	5	4.5	0.2	5	9	77	S						T 1
51	Y3, 6814, 1	A241666K	0-20	3.9	0.0	1.3	14	8	45	27	3	1.5	SiL						N 1
	Y3, 6814, 2	A241667K	0-20	3.7	0.0	3.5	37	27	27	4.5	0.5	3	SiCL						N 1
	Y3, 6814, 3	A241668K	0-20	3.6	0.1	3.4	67	21	11	0.4	0.1	0.4	C						N 1
	Y3, 6814, 4	A241669K	0-20	3.9	0.1	3.2	53	25	16	1.5	0.5	3.5	C						N 1
	Y3, 6814, 5	A241670K	0-20	3.9	0.0	2.1	50	18	25	4	1	2	C						N 1
	Y5, 8826, 1	A241743	0-20	3.8	0.0	3.9	60	24	12	1.5	0.5	2.5	C						NC 2
53	Y3, 7898, 1	A241688K	0-20	4.0	0.1	4.2	46	32	20	1.5	0.3	0.4	SiC						N 1
	Y3, 7896, 1	A241686K	0-20	4.9	0.1	3.0	11	9	15	8	4	54	SL						NC 1
	Y3, 7896, 2	A241687K	0-20	4.0	0.1	3.5	23	26	34	9	1.5	2	SiCL	0.1	0.2	1.4	4.9	13.9	NC 1
	Y3, 7898, 2	A241689K	0-20	4.9	0.1	2.1	46	34	20	1.5	0.3	0.3	SiC						NC 1
	Y3, 7898, 3	A241690K	0-20	4.6	0.0	3.5	24	23	31	13	3	6	SiL						NC 1
	Y3, 6810, 1	A241661K	0-20	3.6	0.0	2.1	30	13	21	20	8	9	CL						NC 2
	Y3, 6810, 2	A241662K	0-20	3.8	0.0	2.4	31	12	21	16	13	8	CL	0.1	0.1	0.9	3.2	11.6	NC 2
	Y3, 6810, 3	A241663K	0-20	3.9	0.0	1.4	21	13	32	12	4	19	L						F 1
	Y5, 8822, 1	A241740	0-20	4.1	0.0	2.8	21	11	31	15	7	15	L	0.1	0.3	0.4	3.0	9.5	F 1
	Y3, 6810, 4	A241664K	0-20	4.1	0.0	0.3	7	3	8	21	23	39	LS						F 1
	Y3, 6810, 5	A241665K	0-20	3.6	0.0	3.0	29	11	26	14	6	26	CL	0.1	0.4	0.9	2.5	10.1	NC 2
54	Y3, 7902, 1	A241671K	0-20	4.1	0.0	3.7	26	17	34	10	3.5	9	SiL						NC 2
	Y3, 7902, 2	A241672K	0-20	3.9	0.1	5.1	45	29	18	1.5	0.4	6	SiC						NC 2
	Y3, 7902, 3	A241673K	0-20	4.1	0.1	5.3	68	12	16	2	1	1.5	C						NC 2

TABLE 7.27

SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Notes: 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.	Mapping unit
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca		
47	Y1,6562, 1	A241928	0-20	3.6	0.0	2.0	53	26	16	2.5	1	1	SiC						NC 1
	Y1,6562, 1	A241924	80-100	4.1	0.0	0.7	23	11	26	33	1	6	L						NC 1
	Y1,6562, 2	A241925	0-20	3.8	0.0	1.3	25	20	39	11	2.5	3.5	SiL						NC 1
	Y1,6562, 2	A241927	60-90	3.9	0.0	0.5	17	8	22	31	15	8	SL						NC 1
	Y2,6786, 2	A241656K	0-20	3.7	0.1	4.3	51	21	25	2	0.2	1.5	SiC	0.4	0.5	3.6	7.9	21.9	N 1
	Y4,7058, 1	A241734	0-20	3.7	0.1	3.6	68	15	13	1.5	0.4	1.5	C						FC 2
	Y4,7058, 3	A241735	0-20	6.2	0.0	2.9	11	9	18	16	12	34	SL	0.0	0.8	1.5	10.3	12.3	FC 2
	Y4,7058, 2	A241693K	0-20	4.1	0.0	3.7	29	31	21	12	3	5	SiCL	0.1	0.4	1.7	2.1	15.2	FC 2
	Y4,7058, 4	A241736	0-20	6.3	0.0	5.5	13	14	22	23	11	16	SL	0.1	1.2	3.2	13.2	16.9	F 1
	Y4,7058, 5	A241737	0-20	7.5	0.4	3.3	6	10	7	6	4.5	68	SL	0.1	0.7	1.7	11.0	12.5	F 1
48	Y1,6562, 3	A241732	0-20	3.8	0.0	1.7	29	15	42	12	0.5	2	SiCL	0.0	0.2	0.5	3.3	9.1	NC 1
	Y1,6562, 3	A241926	50-70	3.6	0.0	0.8	53	19	24	2	0.5	1.5	SiC						NC 1
	Y1,6566, 1	A241727	0-20	3.7	0.0	1.6	15	9	55	20	0.5	0.5	SiL						N 1
	Y1,6566, 1	A241728	40-70	3.6	0.0	1.1	35	14	31	16	2	1	CL/SCL						N 1
	Y1,6566, 2	A241726	0-20	3.6	0.0	3.4	27	10	40	20	2	1	CL/L	0.1	0.1	0.4	2.5	9.0	NC 2
	Y1,6566, 4	A241895	0-20	3.8	0.0	3.0	44	18	28	8	1	1	SiC						NC 2
	Y1,6566, 3	A241896	0-20	3.8	0.0	1.5	18	14	38	25	4.5	1	SiL						NC 2
	Y2,6792, 1	A241660K	0-20	3.7	0.0	1.7	31	15	34	16	2	2	CL	0.1	0.2	1.7	4.4	11.7	NC 2
	Y2,6792, 2	A241929	0-30	3.6	0.0	2.2	36	17	37	9	0.5	1	SiCL						NC 2
	Y2,6792, 3	A241930	0-20	3.9	0.0	3.2	45	29	22	3	0.2	0.5	SiC	0.1	0.4	3.0	8.0	18.0	NC 2
	Y3,8870, 1	A241931	0-20	3.9	0.0	2.9	31	7	36	24	1.5	1.5	CL						NC 2
	Y3,8874, 1	A241715	0-20	3.7	0.0	6.3	44	20	10	6	2.5	17	C						NC 2
	Y3,8870, 1	A241719	50-80	3.5	0.0	0.9	47	12	31	8	0.5	1.5	SiC						NC 2
	Y3,8872, 4	A241717	0-20	3.9	0.0	5.7	21	15	10	7	5	42	SCL						T 4
	Y3,8872, 3	A241718	0-20	3.7	0.0	1.1	31	10	13	13	10	24	SCL						T 4
	Y3,8872, 2	A241933	0-20	4.6	0.0	1.1	3	1.5	7	18	30	40	S						T 2
	Y3,8872, 1	A241932	0-20	4.5	0.0	1.0	2	4.5	8	9	18	59	S	0.0	0.1	0.2	0.8	2.2	T 2
	Y3,8872, 5	A241716	0-20	5.6	0.0	0.6	4.5	1.5	11	4.5	5	73	LS	0.0	0.1	0.4	1.1	2.4	T 1
	Y3,6822, 1	A241934	0-20	5.2	0.0	1.3	2.5	2.5	8	5	7	75	S	0.0	0.1	0.4	1.9	3.4	T 1
	Y3,6822, 5	A241935	0-20	3.5	0.0	1.0	2	1	0	1	0.5	95	S						T 1
50	Y1,6572, 2	A241897	0-20	3.7	0.0	2.2	25	15	31	15	4	9	L						N 1
	Y1,6572, 3	A241918	0-20	3.7	0.0	2.4	28	17	30	17	4	4	CL						NC 2
	Y1,6572, 1	A241919	0-20	3.8	0.0	2.0	24	17	27	15	7	11	L	0.0	0.2	1.5	2.7	9.3	NC 2
	Y1,6572, 4	A241692K	0-20	3.7	0.0	2.6	23	13	36	22	5	2	L						NC 3

TABLE 7.26

SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Notes: 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.	Mapping unit
							<2 μ	2-16 μ	16-50 μ	50-105 μ	105-150 μ	>150 μ		Na	K	Mg	Ca		
41	X8,8656, 5	A241960K	0-20	4.0	0.1	3.1	44	14	20	4	3.5	14	C	0.1	0.2	0.1	0.9	4.4	TC
	X8,8658, 1	A241961K	0-20	4.0	0.0	2.1	7	7	20	27	19	22	SL						TC
	X8,8658, 2	A241962Z	0-20	5.5	0.0	1.2	4	2.5	4	15	31	43	S	0.1	0.2	0.5	0.9	2.5	TC
	X8,8658, 4	A241876	0-20	4.6	0.0	0.8	6	5	18	21	11	38	SL	0.2	0.9	3.6	7.4	18.7	T1
	Y1,6548, 1	A241691K	0-20	4.2	0.0	4.9	40	15	21	18	3.5	3	C						NC1
	Y1,6548, 1	A241729	50-80	3.4	0.0	1.1	39	7	25	22	4	2	CL						NC1
	Y2,6776, 3	A241733	0-20	3.6	0.1	9.6	73	10	11	1	0.5	5	C						NC2
	Y4,8922, 5	A241739	0-20	5.9	0.0	0.9	3	3	2.5	2.5	9	81	S	0.1	0.2	0.3	2.0	3.4	T1
	Y4,8922, 1	A241738	0-20	4.3	0.0	0.7	9	3.5	7	17	17	47	LS						T1
42	Y2,6776, 4	A241708K	0-20	3.8	0.0	1.0	21	6	16	23	14	21	SCL						NC4
	Y3,6844,K1	A241721	0-20	3.6	0.0	0.7	33	13	36	4.5	1.5	13	SiCL						I
	Y3,6844, 1	A241682K	0-20	3.5	0.0	4.3	35	22	19	4	3	17	CL						I
	Y3,6844,K1	A241685Z	25-45	4.9	0.0	0.2	2.5	1.5	0.5	2	9	84	S	0.0	0.0	0.3	0.5	0.3	I
	Y3,6844,K2	A241683Z	80-100	5.3	0.0	0.0	2	2.5	4	1	7	84	S						NC1
	Y3,6844, 5	A241722	0-20	3.7	0.1	3.4	43	23	18	2.5	2	12	SiC						N1
	Y3,6844, 5	A241684K	50-80	3.5	0.0	0.5	33	15	8	5	9	30	SCL						N1
	Y3,6844, 6	A241681K	0-20	3.6	0.1	4.0	62	27	9	1	0.2	1	C						NC1
	Y3,6844, 6	A241720	60-90	3.6	0.1	1.0	64	20	11	1.5	0.4	3	C						NC1
	Y5,8856, 1	A241741	0-20	3.7	0.0	1.9	36	18	39	7	0.3	0.5	SiCL						NC1
44	Y1,6556,K1	A241920	40-50	3.7	0.1	0.8	42	24	32	2	0.3	0.5	SiC						NC4
	Y1,6556,K1	A241921	0-20	3.8	0.0	2.7	31	25	40	3.5	0.3	0.5	SiCL						NC4
	Y1,6556,K1	A241922	100-110	3.9	0.1	0.4	10	5	21	12	5	46	SL						NC4
	Y1,6556, 2	A241923	0-20	3.8	0.0	2.9	26	19	34	·11	4	6	SiL						NC4
	Y1,6556, 3	A241730	0-20	3.7	0.0	3.3	45	18	16	9	3.5	10	C	0.2	0.1	0.6	6.6	9.2	NC4
	Y1,6556,K1	A241731	60-70	3.6	0.0	0.4	32	22	34	8	1.5	2.5	SiCL						NC4
	Y2,6782, 1	A241646K	50-60	3.5	0.1	1.5	67	20	10	1	0.5	1.5	C						NC2
	Y2,6782, 3	A241647K	0-20	3.8	0.1	1.9	79	13	8	0.1	0	0.1	C						N1
	Y2,6782, 3	A241648K	60-80	3.6	0.1	2.6	78	16	6	0.1	0.1	0.3	C						N1
	Y2,6782, 4	A241649K	0-20	3.6	0.0	2.3	35	5	7	15	17	21	SC/SCL	0.5	0.2	3.2	8.0	25.6	NC2
	Y2,6782,K1	A241650K	0-20	3.4	0.1	1.6	73	18	8	0.2	0.2	0.3	C						NC2
	Y2,6782,K1	A241651K	30-40	3.4	0.1	1.3	77	16	7	0.3	0.3	0.5	C						NC2
	Y2,6782,K1	A241652K	60-70	3.5	0.2	1.1	72	17	9	0.5	0.4	1.5	C	0.2	0.5	6.2	11.0	27.9	NC2
	Y2,6782,K2	A241653K	0-20	3.9	0.1	4.1	80	15	4	0.3	0.1	0.3	C						NC2
	Y2,6782,K2	A241654K	40-50	3.8	0.1	1.5	81	12	6	0.3	0.2	0.1	C						NC2
	Y2,6782,K2	A241655K	80-90	3.8	0.1	1.1	78	16	6	0.4	0.2	0.2	C						

TABLE 7.25

SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Notes : 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil					Mapping unit
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca	c.e.c.	
38	X2,6753, 2	A241940	0-25	6.6	0.1	3.5	67	18	14	0.2	0.1	0.3	C						FC 2
	X2,6753, 3	A241705K	0-25	3.7	0.1	3.2	74	14	9	1	0.5	2	C	0.6	0.3	3.4	8.6	28.8	NC 1
	X2,6753, 3	A241706K	80-110	4.4	0.1	0.9	68	25	5	1	1	0.5	C						NC 1
	X2,6753, 4	A241707K	0-25	3.6	0.1	4.1	61	11	16	8	2.5	2	C						NC 1
	X3,9902, 1	A243065	0-20	3.7	0.0	5.4	41	24	32	2.5	0.2	0.3	SiC						NC 1
	X3,9902, 2	A243066	0-25	3.6	0.1	4.8	85	5	10	0.1	0.1	0.1	C	0.3	1.4	2.3	4.8	25.3	NC 4
	X3,9902, 3	A241780K	0-20	3.6	0.0	1.1	34	5	15	19	7	19	SCL						N 1
	X3,9902, 5	A243067	0-25	3.8	0.0	3.0	50	3	3	8	14	22	C						NC 1
	X3,9906, 1	A241781K	0-25	3.7	0.0	2.0	32	19	23	16	1.5	8	CL						NC 1
	X4,8376, 4	A243062	0-25	4.9	0.1	2.9	23	20	35	5	3	13	SiL	0.0	0.4	3.1	8.5	15.9	F 1
	X4,8374, 1	A243063	0-25	4.4	0.0	1.3	6	4	22	12	9	47	SL	0.0	0.2	0.4	2.4	5.1	F 1
	X4,8374, 2	A241753	0-20	5.3	0.0	1.2	8	8	21	13	12	38	SL	0.1	0.1	1.0	3.1	4.4	T 1
	X4,8376, 2	A241754	0-25	4.2	0.1	2.5	35	42	14	1	2	6	SiCL						F 1
	X4,8376, 3	A241755	0-25	5.2	0.0	1.5	10	9	20	18	13	30	SL	0.0	0.3	1.5	4.6	7.4	F 1
39	X2,6758,K1	A241701K	0-30	3.6	0.1	1.6	25	21	47	5	0.2	2	SiL	0.0	0.1	1.0	8.9	9.0	NC 2
	X2,6758, 1	A241699K	30-50	3.7	0.0	0.8	23	18	50	7	1	1.5	SiL						NC 2
	X2,6758,K1	A241700K	60-80	3.7	0.0	0.3	15	11	58	16	0.2	0.4	SiL						NC 2
	X2,6758, 4	A241702K	0-25	3.6	0.1	1.7	79	11	7	2	0.4	0.5	C						NC 1
	Y5,8856, 2	A241742	0-20	3.8	0.0	2.3	48	12	12	4.5	2.5	21	C	0.0	0.5	1.2	4.3	14.1	NC 4
41	X6,8422, 3	A241758	0-20	5.2	0.0	1.1	8	2.5	5	8	16	62	LS						FC 1
	X6,8426, 1	A241759	0-25	4.4	0.0	3.2	57	27	12	1.5	1	1.5	C	0.0	0.8	1.4	9.3	22.3	FC 1
	X6,8422, 2	A241966K	0-20	7.0	0.2	5.6	14	7	25	20	15	18	SL						F 1
	X8,8656, 4	A241765Z	0-20	5.1	0.0	0.8	1.5	1.5	3	2	5	86	S						T 1
	X8,8656,K1	A241767K	0-20	4.0	0.1	2.3	77	14	7	0.5	0.5	1	C	0.6	0.4	1.3	9.3	23.4	TC
	X8,8656,K1	A241766K	30-50	4.4	0.2	1.0	54	19	14	4.5	3.5	6	C						TC
	X8,8656,K1	A241768K	60-80	4.6	0.0	0.4	18	6	11	25	20	20	SL						TC
	X8,8654, 1	A241769K	0-20	4.8	0.0	1.7	15	25	17	16	5	22	L						FC 2
	X8,8654, 2	A241770K	0-20	4.3	0.0	4.1	32	29	22	7	4.5	6	SiCL						FC 2
	X6,8422, 1	A241757	0-25	5.6	0.0	1.6	7	5	7	14	16	52	LS	0.0	0.3	1.3	2.8	4.8	T 1
	X8,8656, 2	A241760	0-20	4.8	0.1	2.0	23	29	17	5	5	22	L						T 1
	X8,8656,K3	A241761	60-80	4.5	0.1	0.6	23	9	27	26	11	3	L						FC 1
	X8,8656,K3	A241763	40-60	4.5	0.0	0.8	15	14	29	23	12	7	L						FC 1
	X8,8656,K3	A241764	10-30	4.6	0.0	1.3	10	12	28	26	12	11	L						FC 1
	X8,8656, 3	A241959K	0-20	5.3	0.0	1.5	13	6	40	19	6	22	L						FC 1
	X8,8658, 3	A241875	0-20	4.1	0.0	1.5	20	16	20	17	14	13	L	0.1	0.2	0.9	2.1	7.0	TC

TABLE 7.24

SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Notes: 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.	Mapping unit
							<2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150 µ		Na	K	Mg	Ca		
32	X1,6502, 2	A242236K	0-25	3.8	0.1	2.4	51	27	21	0.5	0.1	0.5	SiC						N 1 •
	X3,6884, 2	A242234K	0-25	4.0	0.1	1.9	30	22	36	10	1	0.5	SiCL						N 1
	X3,6884, 4	A242237K	0-25	4.0	0.1	4.0	50	27	8	1	1	13	C	0.1	0.5	1.6	5.5	18.2	NC 2 •
33	X3,6872, 1	A241973K	0-20	3.7	0.0	3.7	45	13	32	8	1	1.5	SiC	0.1	0.3	1.3	3.5	13.5	NC 1 •
	X3,6872, 2	A243064	0-20	3.7	0.0	3.4	77	11	12	0.2	0.1	0.4	C						NC 1 •
	X3,6872, 3	A241776K	0-20	3.9	0.1	3.3	74	12	14	0.2	0.1	0.3	C						NC 1 •
	X3,6872, 4	A241777K	0-20	3.8	0.0	3.1	12	6	33	23	9	16	L						NC 1
	X3,6876, 1	A241778K	0-25	3.8	0.1	4.2	54	22	20	3.5	0.2	1	SiC						NC 2 •
	X3,6876, 2	A241779K	0-25	3.8	0.1	3.2	68	13	16	2	0.2	0.5	C						NC 2 •
	X7,9880, 2	A241790K	0-25	3.7	0.0	5.1	75	13	10	1	0.1	1.5	C	0.2	0.3	2.3	7.3	23.0	F 2 •
	X5,7764, 1	A241724	0-25	3.6	0.1	2.6	80	9	10	0.5	0.1	0.3	C						NC 2 •
	X5,7764, 4	A241725	0-25	3.7	0.1	2.5	55	12	23	6	2.5	1.5	C	0.1	0.6	1.3	5.0	16.4	NC 2 •
34	X3,9906, 2	A241782K	0-25	3.8	0.0	2.9	26	16	45	9	1.5	2.5	SiL						NC 1
	X3,9906, 3	A241783K	0-25	3.8	0.1	2.6	37	21	27	6	3	6	SiCL						NC 1
35	X2,6722, 1	A241694K	0-25	4.2	0.0	1.0	6	7	3.5	6	7	71	LS						CF
	X2,6722, 4	A241965K	0-25	4.0	0.0	1.7	23	23	37	8	2.5	7	SiL						CF
	X2,6722, 6	A241695K	0-25	3.8	0.0	1.4	16	6	7	16	22	33	SL						NC 1
36	X2,6726, 1	A241942	0-25	4.1	0.0	1.9	23	16	21	4	2	34	L						CF
	X2,6726, 2	A241697K	0-25	4.3	0.0	1.0	11	5	2.5	9	11	61	LS	0.0	0.2	0.8	4.8	5.4	NC 1
	X2,6726, 4	A241698Z	0-25	4.8	0.0	0.4	3	1.5	0	0.4	2	93	S						NC 1
37	X1,6514, 2	A241968K	0-25	3.7	0.0	2.7	19	8	25	31	8	9	L						N 1
	X1,6514, 3	A241944Z	0-25	4.2	0.0	1.2	7	5	11	24	18	34	SL						N 1
	X2,6744, 1	A241941	0-25	3.9	0.0	1.1	11	2	4	5	13	65	LS						N 1
	X2,6744, 2	A241704K	0-25	3.8	0.1	1.9	46	34	14	2	0.2	3.5	SiC						N 1
	X2,6744, 4	A241963K	0-25	4.0	0.0	4.8	23	3.5	6	1.5	1.5	65	SCL						N 1
	X2,6744, 6	A241943	0-25	4.3	0.0	1.7	6	2	10	13	18	52	LS	0.0	0.2	0.4	1.7	4.4	T 1
38	X1,6526, 1	A241747	0-20	4.1	0.0	1.2	7	6	18	11	8	49	SL						NC 2
	X1,6526, 3	A241748	0-20	3.7	0.0	2.2	41	15	20	12	6	7	C						NC 2 •
	X1,6526,K5	A241749	0-15	4.0	0.0	3.2	27	15	25	19	6	8	CL/L	0.0	0.3	1.3	5.7	13.4	NC 2
	X1,6526,K5	A241750	15-40	3.9	0.0	0.6	14	4.5	34	29	8	11	L						NC 2
	X1,6526,K5	A241751	60-80	4.6	0.0	0.3	4.5	1.5	2.5	6	10	76	S						NC 2
	X1,6528, 1	A241752	0-25	3.6	0.0	1.4	38	9	25	20	3	5	CL	0.0	0.1	0.9	4.2	10.8	N 1
	X4,8382, 1	A241756	0-25	4.3	0.1	3.4	41	28	25	4.5	0.3	1.5	SiC						NC 1
	X2,6750, 1	A241703K	0-20	3.7	0.1	2.3	51	36	11	1	0.3	0.5	SiC						N 1 •
	X2,6753, 1	A241964K	0-25	3.6	0.1	5.9	80	4	15	0.5	0.2	0.5	C						NC 1 •

TABLE 7.23

SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Notes: 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCL	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.	Mapping unit
							<2 u	2-16 u	16-50 u	50-105 u	105-150 u	>150 u		Na	K	Mg	Ca		
24	W5,8116, 2	A241975K	0-25	3.8	0.0	6.1	43	15	32	8	1.5	1.5	SiC						N 2
	W2,7640, 4	A241773Z	0-25	5.2	0.0	0.4	6	2	1	7	14	71	S						T 1
	W1,6928,K1	A241786K	0-20	5.8	0.0	2.3	11	11	17	8	9	44	SL						T 2
	W1,6928,K1	A241971K	30-50	5.3	0.0	1.7	16	11	8	6	8	52	SL						T 2
	W1,6928,K1	A241785Z	60-80	5.3	0.0	0.7	5	3.5	2	6	16	68	S	0.0	0.1	0.4	3.1	3.0	T 2
	W1,6928,K1	A241972Z	120-140	5.6	0.0	0.2	5	1	1.5	7	16	69	S						T 2
25	W3,7726, 2	A242221K	0-25	3.6	0.1	1.7	81	8	10	0.3	0.1	0.2	C						NC2
	W3,7728, 2	A242223K	0-25	3.6	0.0	4.8	59	26	12	1.5	0.4	0.5	C						NC2
	W3,7728, 2	A241852Z	60-90	4.6	0.1	0.6	6	3.5	1.5	15	17	57	S						NC2
	W3,7728, 3	A242220K	0-25	3.7	0.0	3.8	56	20	12	3	3.5	7	C	0.4	0.3	2.7	7.9	21.3	NC2
	W3,7728, 1	A242224K	0-25	3.7	0.0	4.7	57	23	19	1	0.2	0.5	SiC						NC2
	W11,9745, 1	A242903K	0-20	4.2	0.0	2.1	7	15	54	19	3	3	SiL						T 4
	W11,9747, 1	A242904K	0-20	4.6	0.0	2.5	8	21	44	9	8	12	SiL	0.0	0.3	0.5	2.0	4.4	T 4
	W11,9747, 2	A242905K	0-20	4.9	0.0	7.1	43	12	27	9	2	6	C						T 4
	W11,9749, 1	A242906K	0-20	4.5	0.0	2.4	70	7	12	2	2	7	C	0.5	0.4	3.4	9.9	18.8	T 4
	W9,8541, 1	A242907K	0-20	5.6	0.0	0.8	1.5	2	5	1.5	4	86	S	0.0	0.1	0.3	0.9	1.6	T 1
	W9,8543, 1	A242908K	0-20	5.3	0.0	0.9	0	2	1	7	14	77	S	0.0	0.1	0.1	1.2	1.8	T 1
30	W2,7642, 5	A241771K	0-20	4.1	0.0	3.3	29	29	20	3	1.5	17	CL						TC
	W2,7642, 1	A241772K	0-25	3.9	0.1	6.3	83	9	6	1	0.2	1	C	0.4	0.5	1.0	12.7	32.6	T 2
	W4,8148, 2	A241892	0-25	4.0	0.0	3.6	24	34	20	7	5	11	SiL	0.1	0.4	0.7	2.5	9.4	FC2
31	X2,6722, 8	A241696K	0-25	3.7	0.0	4.6	42	15	27	13	1	1	SiC						NC1
	X5,7748, 1	A241946K	0-20	4.5	0.0	1.9	31	19	40	8	0.5	0.5	SiCL	0.2	0.2	1.8	6.0	11.9	N 1
	X5,7748, 2	A241723	0-20	4.8	0.0	2.9	21	18	55	5	0.2	0.4	SiL	0.0	0.2	2.2	7.3	12.8	N 1
	W2,7648, 2	A241774Z	0-25	6.3	0.0	1.4	6	5	4	5	5	75	LS	0.0	0.2	0.8	5.2	6.1	CF
	W2,7652, 2	A241775K	0-25	3.9	0.0	2.2	20	16	8	6	4.5	46	SL/SCL	0.0	0.1	0.4	3.7	7.3	FC2
	W2,7652, 1	A241974Z	0-25	4.0	0.0	1.5	3	2.5	8	35	28	23	S						T 2
32	X3,6888, 1	A242235K	0-25	3.8	0.1	3.2	60	23	16	2	0.4	0.5	C						NC2
	X5,7754, 2	A242238	0-25	3.7	0.1	3.2	63	26	9	0.5	0.3	1	C	0.2	0.5	2.0	5.6	19.0	NC1
	X5,7758, 1	A242239	0-25	3.6	0.1	3.9	63	20	15	0.4	0.2	2.5	C						NC2
	X1,6502, 3	A242240	0-25	4.0	0.0	4.5	35	25	30	4.5	1.5	4	SiCL						N 1
	X1,6502, 3	A242241	60-90	3.9	0.0	0.6	13	9	29	17	10	22	L						N 1
	X1,6502,K1	A241967K	25-50	3.7	0.1	2.8	48	24	26	1	0.3	0.3	SiC						N 1
	X1,6502,K1	A241744	0-25	4.1	0.0	3.7	37	26	28	7	1.5	0.5	SiCL	0.1	0.2	1.4	7.3	14.7	N 1
	X1,6502,K1	A241745	70-85	3.6	0.0	1.2	33	19	40	8	0.2	0.3	SiCL						N 1
	X1,6502,K1	A241746	90-120	3.7	0.0	1.4	43	29	26	2.5	0.1	0.3	SiC						N 1

TABLE 7.22

SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Notes:
1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.	Mapping unit
							< 2 μ	2 - 16 μ	16 - 50 μ	50 - 105 μ	105 - 150 μ	> 150 μ		Na	K	Mg	Ca		
19	W5,8108, 2	A241853K	0-20	4.0	0.1	3.0	42	11	33	8	0.5	6	SiC	0.1	0.3	2.2	6.4	14.7	NC1
	W5,8108, 3	A241854Z	0-25	4.0	0.0	1.1	6	4	8	9	9	65	LS	0.0	0.1	0.1	0.8	2.7	NC1
	W5,8108, 4	A241855K	0-25	3.8	0.0	1.5	38	4.5	36	17	1.5	2	CL	0.1	0.1	1.0	3.8	9.9	NC1
	W5,8108, 6	A241856K	0-25	3.7	0.1	2.3	49	10	30	10	1	1	C/SiC	0.1	0.2	1.7	5.8	16.5	NC1
	28,8962, 2	A241883	0-25	3.7	0.1	2.1	65	12	9	4.5	4	4.5	C	0.3	0.3	4.2	8.8	26.6	NC1
	28,8962, 3	A241881	0-25	4.0	0.1	3.8	83	9	7	0.4	0.2	0.4	C	0.3	0.7	6.3	13.9	33.1	TC
	28,8962, 3	A241882	60-80	3.8	0.1	1.9	87	6	6	0.3	0.1	0.3	C						TC
	28,8959, 5	A241879	90-120	4.0	0.0	0.7	57	12	12	5	2	14	C						FC2
	28,8959, 5	A241880	0-30	4.1	0.0	2.8	83	5	10	1	0.2	0.5	C						FC2
	28,8959, 3	A241979Z	0-20	4.7	0.0	1.1	2.5	3	3	12	18	62	S						FC2
	W1,6946, 3	A241789K	0-25	4.0	0.0	0.8	12	7	4.5	13	9	55	SL						N 2
	W3,7706, 1	A242217K	0-20	3.8	0.0	3.1	26	17	33	19	3.5	1.5	L/SiL						N 1
20	W3,7716, 1	A241851K	0-25	3.8	0.1	2.0	22	9	29	18	11	12	L						NC 3
	W5,8112, 2	A241858K	0-25	3.6	0.1	4.8	70	10	13	2.5	0.5	3.5	C						NC 1
	W5,8112, 6	A241889	0-20	3.9	0.0	2.0	30	16	32	9	4.5	9	CL	0.1	0.5	2.8	8.2	26.4	NC 1
	W5,8112, 1	A241890	0-25	3.7	0.0	3.3	55	22	18	3	0.5	1.5	C/SiC	0.1	0.2	1.4	3.8	10.2	NC 1
	W5,8112, 5	A241857K	0-25	3.9	0.1	1.1	13	1.5	7	21	23	34	SL						N 1
23	27,8658, 1	A241862K	0-25	4.4	0.0	3.5	16	7	19	20	15	25	SL	0.0	0.1	0.3	2.1	4.5	T 3
	28,8954, 1	A241887	0-25	5.1	0.0	2.4	24	20	28	15	6	7	L						FC 1
	27,8660, 1	A241867K	0-20	4.3	0.0	1.9	12	12	25	8	7	37	L						CF
	27,8660, 2	A241868K	0-20	3.9	0.1	2.7	70	9	13	1	1	6	C						F 2
	27,8660, 2	A241869K	50-60	3.9	0.0	0.8	87	7	2.5	0.5	0.4	3	C	0.2	0.3	2.7	8.2	20.8	F2
	W6,8242, 1	A241888	0-25	4.6	0.1	2.2	29	26	28	7	2	8	SiCL						F2
24	W1,6930, 1	A241945Z	0-25	4.2	0.0	1.2	2.5	1	7	2.5	6	81	S						T2
	W2,7640, 1	A241893	0-25	3.9	0.0	7.8	48	8	10	6	6	23	C	0.1	0.1	0.2	0.8	2.4	T2
	W2,7640, 2	A241894	0-25	3.9	0.0	2.8	39	6	13	4	3	34	CL						T2
	W3,7714, 1	A241846K	90-120	3.8	0.0	0.8	34	16	26	15	6	3.5	CL	0.1	0.3	1.1	4.7	13.3	NC 1
	W3,7714, 1	A241847K	0-25	4.0	0.0	3.3	22	11	14	20	19	14	SCL	0.8	0.1	1.6	6.4	13.9	NC 1
	W3,7718, 1	A241848K	0-25	3.6	0.0	3.7	53	24	20	2	0.3	0.3	SiC						NC 1
	W3,7714, 3	A242218K	0-25	3.7	0.0	5.1	59	26	14	0.4	0.2	0.4	C						NC 1
	W3,7714, 2	A242219K	0-25	3.7	0.0	4.4	42	21	30	4	1	1.5	SiC						NC 1
	W3,7720, 1	A242222K	0-25	3.7	0.0	5.5	58	26	15	0.5	0.2	0.3	SiC	0.1	0.2	2.0	7.8	22.6	NC 1
	W5,8116, 1	A241891	0-25	4.0	0.1	4.7	21	9	31	24	6	9	L						N1
	W1,6936, 4	A242215K	0-25	4.8	0.1	2.7	32	32	16	4	3.5	12	CL	0.1	0.3	1.5	5.4	13.3	FC 1

TABLE 7.21

SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Notes: 1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis.
2. c.e.c. : cation exchange capacity in m.e. per 100 g. soil.

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral part						Texture class	Exchangeable cations in m.e./100 g. soil				c.e.c.	Mapping unit
							<2 u	2-16u	16-50u	50-105u	105-150u	>150 u		Na	K	Mg	Ca		
13	27,8640, 9	A241866K	0-25	3.9	0.0	2.1	27	14	35	19	2.5	3	CL/L						N 2
	27,8642, 2	A241870K	0-25	3.9	0.1	3.5	65	19	15	0.5	0.1	0.4	C						N 2
	27,8642, 3	A241871K	0-25	4.0	0.0	3.5	79	11	9	0.5	0.2	0.3	C						N 2
	27,8642, 3	A241872	60-85	5.0	0.1	1.2	84	10	6	0.2	0.1	0.3	C						N 2
	24,8260, 1	A241981K	0-20	5.7	0.0	1.4	3.5	5	28	36	14	13	SL						T 1
	26,8932-1	A684090Z	0-25	5.8	-	1.3	0	2	5	1.5	2	90	S						U
	26,8932, 1	A241860Z	80-100	4.6	0.0	0.2	4	2.5	3.5	3.5	2.5	85	S	0.1	0.1	0.1	1.3		U
	24,8260, 3	A242228K	0-20	5.5	0.0	2.6	6	13	27	27	15	13	SL						TC
14	26,8932, 2	A241861Z	0-25	3.8	0.0	1.5	11	0	2.5	6	11	69	LS	0.0	0.1	0.1	0.9	2.1	NC 1
	26,8932-3	A684091K	0-25	3.8	-	3.2	45	4	14	12	9	16	C	0.2	0.2	0.5	4.4		NC 1
	28,8968-1	A684096K	0-25	4.4	-	1.7	11	9	44	25	6	5	SiL	0.1	0.2	2.1	4.3		N 1
	28,8968-1	A684097Z	100-120	4.2	-	0.5	3.5	1.5	16	42	21	16	LS	0.2	0.1	0.7	2.2		N 1
	28,8968-2	A684098K	0-25	3.8	-	4.1	48	27	24	0.4	0.2	0.2	SiC	0.1	0.4	3.4	9.7		N 2
	28,8968, 2	A241885	100-120	3.8	0.1	1.5	65	22	13	0.4	0.2	0.2	C						N 2
	28,8968, 3	A241884	0-25	3.8	0.0	2.8	50	29	18	2	0.4	1.5	C						N 1
	28,8968-4	A684099K	0-25	4.0	-	4.9	75	13	12	0.2	0.2	0.4	C	0.3	0.4	6.7	10.9		N 2
	28,8968-5	A684100K	0-25	3.6	-	1.1	57	18	18	2	1	5	C	1.5	0.3	3.8	6.0		N 2
	28,8968-6	A684101K	0-25	3.8	-	1.3	15	2.5	11	14	8	50	SL	0.2	0.1	0.4	1.9		N 1
	W3,7700-4	A684105Z	0-25	4.8	-	2.1	2.5	3	9	13	25	48	LS	0.0	0.2	0.7	3.2		T 3
	W3,7700-5	A684106K	0-25	3.8	-	2.5	19	10	22	9	6	33	L	0.1	0.1	0.5	3.0		NC 2
	W3,7700-6	A684107K	0-25	3.5	-	3.5	35	11	33	17	3.5	2	CL	0.1	0.1	1.3	4.8		N 2
	W3,7700, 3	A241850K	0-25	3.8	0.1	2.5	41	7	6	3	5	38	SC						T 3
18	26,8934-K1	A684092K	0-25	3.6	-	4.9	53	19	26	1	0.3	0.5	SiC	0.2	0.4	2.1	6.9		NC 1
	26,8934,K1	A241977K	30-50	3.8	0.0	1.1	44	19	31	3	1	2	SiC						NC 1
	26,8934-K1	A684093Z	60-80	4.6	-	0.2	4	1.5	8	6	27	53	S	0.1	0.0	0.5	1.4		NC 1
	26,8934-K1	A684094Z	80-100	5.1	-	0.2	4.5	1.5	5	6	22	61	S	0.1	0.1	0.6	1.7		NC 1
	W3,7700, 1	A241849K	0-25	3.8	0.0	3.7	76	11	10	1	0.5	2	C	0.1	0.6	4.5	9.9	27.3	NC 1
	W1,6946, 1	A241970K	0-25	4.0	0.0	1.6	26	8	44	19	2	1.5	SiL	0.4	0.2	1.1	3.7	9.6	N 1
	W1,6948-K1	A684102K	0-30	3.8	-	1.5	12	9	18	7	3.5	50	SL	0.2	0.1	0.3	2.8		N 1
	W1,6948-K1	A684103K	30-50	3.9	-	0.4	7	3	9	9	2	71	LS	0.1	0.0	0.1	1.2		N 1
	W1,6948-K1	A241787K	95-110	5.5	0.0	0.3	10	3.5	20	19	5	43	SL						N 1
	W1,6948-K1	A241788Z	50-70	5.5	0.1	0.1	2.5	0.4	0	1	2	94	S						N 1
	W3,7700-2	A684104Z	0-25	4.4	-	1.1	0	0	4	2.5	9	85	S	0.0	0.0	0.2	0.7		T 2
	27,8658, 3	A241978Z	0-25	4.9	0.0	1.0	2	2.5	4	6	8	77	S						T 1
	27,8658, 6	A241863K	0-25	4.2	0.0	3.6	10	7	8	9	16	51	SL						TC
	27,8658, 8	A241864K	0-25	4.1	0.0	1.1	13	3.5	12	6	4.5	61	SL						T 4

TABLE 7.20
SOIL SAMPLE ANALYSES DATA OF THE RECONNAISSANCE SOIL SURVEY

Notes
1. Where underlined the percentage organic matter of the sample was determined by ignition loss and in all other cases by elementary analysis
2. c.e.c. : cation exchange capacity in m.e. per 100 g soil.

Mosaic number	Sample number	Laboratory number	Soil layer in cm	pH-KCl	$CaCO_3$ in %	Organic matter in %	Mechanical composition in percentages of mineral parts. < 2 µ	2-16µ	16-50µ	50-105µ	105-150µ	>150µ	Texture class	Exchangeable cations in m.e./100 g.soil Na	K	Mg	Ca	c.e.c.	Mapping unit
4	36,8592, 2	A241980K	0-25	4.7	0.0	1.6	13	6	50	23	3.5	5	SiL	0.0	0.1	0.7	2.1	4.8	CF
	36,8592, 3	A241877	0-20	4.2	0.0	3.6	48	19	30	2	0.1	0.2	SiC						* N2
	36,8592, 2	A241878	60-90	4.2	0.0	0.8	12	8	27	23	15	15	SL						CF
7	34,8604,K13	A241951K	50-75	4.2	0.0	0.4	10	5	26	37	12	9	SL						N1
	34,8604,K13	A241952K	0-25	4.4	0.0	1.7	15	12	40	20	7	6	SiL						N1
	34,8604, 7	A241953Z	25-50	5.5	0.0	<u>0.1</u>	3	1.5	0.3	4	8	83	S						N1
	34,8604, 11	A241954K	100-120	4.5	0.0	0.4	17	10	35	32	3.5	1.5	L						N1
	34,8604, 11	A241955K	0-20	4.2	0.0	1.7	15	16	40	21	6	2.5	SiL						N1
	34,8604, 7	A241956K	0-25	4.3	0.0	3.7	33	7	12	3	10	36	SCL						N1
	34,8604,K11	A241957K	25-50	4.1	0.0	0.7	16	8	36	27	8	5	L						N1
	34,8604,K13	A242226K	75-100	4.4	0.0	0.6	2.5	10	31	38	15	3.5	SL						N1
	34,8604,K11	A241958K	40-60	4.0	0.0	0.5	13	14	28	35	7	2	L						N1
	23,8582, 3	A242231K	0-20	4.3	0.0	1.8	56	14	15	4.5	2.5	8	C	0.4	3.8	0.5	12.6	22.4	* FC2
8	25,8054, 1	A242214K	0-25	4.0	0.0	<u>7.7</u>	71	14	12	1	0.5	1	C						* N2
	23,8580, 2	A242229K	0-25	3.8	0.0	<u>1.1</u>	19	7	19	22	16	17	SL	0.5	0.2	0.9	4.0	8.9	FC2
	23,8582, 1	A241873	0-25	3.8	0.0	1.4	12	7	16	13	10	42	SL						FC2
	23,8582,K1	A242232Z	0-20	4.7	0.0	1.5	4.5	4.5	21	36	22	13	SL						FC2
	23,8582,K1	A242233K	110-130	6.1	0.0	0.5	16	12	25	25	13	10	L						FC2
	23,8582, 2	A241969K	0-25	4.2	0.0	3.1	29	24	31	11	3	2.5	SiCL	0.3	0.3	2.5	8.0	17.3	T4
	34,8600,K1	A241947K	0-20	4.2	0.0	1.7	13	8	33	26	12	8	L						N1
	34,8600,K1	A241948K	100-120	4.3	0.0	0.3	14	0.5	12	26	15	32	SL						N1
	34,8600,K1	A241949K	20-40	4.1	0.0	0.4	13	3.5	31	34	11	8	SL						N1
	34,8600,K6	A241950K	0-20	4.0	0.0	6.8	70	18	11	1	0.1	0.3	C						N2
	26,8922, 1	A241874	0-25	3.6	0.0	1.5	48	25	24	1.5	0.3	1.5	SiC						* NC1
	25,8052, 2	A242213Z	0-25	5.4	0.0	<u>1.0</u>	2.5	3	6	15	22	51	S						T1
	26,8922, 3	A241859K	0-25	3.8	0.0	1.9	46	7	20	20	2.5	3	C						* NC3
	25,8052, 1	A242212K	0-25	4.0	0.1	<u>11.0</u>	60	13	14	4	1.5	8	C	0.2	0.2	2.0	5.7	14.3	* NC3
	26,8923, 3	A241976K	0-25	4.0	0.0	<u>7.2</u>	71	17	10	1	0.2	0.2	C	0.4	0.3	3.6	8.2	25.6	NC1
9	27,8640, 3	A241865K	0-25	3.9	0.0	1.4	36	10	29	16	5	3.5	CL						N1

TABLE 7.19

CLASSIFICATION OF THE UNITS OF THE SOIL RECONNAISSANCE MAP INTO SUITABILITY CLASSES

Soil mapping unit and suitability class	From Jebba to Kaduna confluence						From Kaduna confluence to Lokoja		Total flood plain	
	North Bank		South Bank		Total					
	ha.	%	ha.	%	ha.	%	ha.	%	ha.	%
Soil mapping unit T 4	4,800		5,200		10,000		8,800		18,800	
Soil mapping unit N 1	9,700		9,400		19,100		22,000		41,100	
Soil mapping unit N 2	17,100		6,100		23,200		7,200		30,400	
Soil mapping unit F 2	-		2,800		2,800		1,900		4,700	
Suitability class 1	31,600	32.0	23,500	25.4	55,100	28.8	39,900	16.4	95,000	21.8
Soil mapping unit F 1	700		6,400		7,100		11,000		18,100	
Soil mapping unit FC 1	400		5,100		5,500		12,700		18,200	
Soil mapping unit FC 2	2,600		11,600		14,200		9,500		23,700	
Suitability class 2	3,700	3.8	23,100	25.0	26,800	14.0	33,200	13.7	60,000	13.8
Soil mapping unit NC 1	14,000		10,100		24,100		48,600		72,700	
Soil mapping unit I	4,100		1,400		5,500		8,500		14,000	
Suitability class 3	18,100	18.2	11,500	12.4	29,600	15.5	57,100	23.5	86,700	20.0
Soil mapping unit T 2	4,700		5,800		10,500		6,200		16,700	
Soil mapping unit T 3	4,700		5,700		10,400		6,900		17,300	
Soil mapping unit TC	1,000		5,000		6,000		6,600		12,600	
Soil mapping unit NC 2	13,200		2,000		15,200		38,400		53,600	
Soil mapping unit CF	3,800		4,000		7,800		19,600		27,400	
Suitability class 4	27,400	27.8	22,500	24.3	49,900	26.1	77,700	32.0	127,600	29.4
Soil mapping unit T 1	12,200		9,300		21,500		25,600		47,100	
Soil mapping unit NC 3	5,800		2,100		7,900		4,100		12,000	
Soil mapping unit NC 4	-		500		500		5,400		5,900	
Suitability class 5	18,000	18.2	11,900	12.9	29,900	15.6	35,100	14.4	65,000	15.0
TOTAL :	98,800	100.0	92,500	100.0	191,300	100.0	243,000	100.0	434,300	100.0

Note: Areas have been determined by planimeter on the reconnaissance soil map (scale 1:100,000) and the figures therefore have relative value only.

TABLE 7.19

TABLE 7.18

QUANTITY AND VALUE OF FUTURE AGRICULTURAL PRODUCTION FOR ALTERNATIVES I, II AND III

	Yield per ha.	Price per ton	ALTERNATIVE I			ALTERNATIVE II			ALTERNATIVE III		
			area	production	gross value	area	production	gross value	area	production	gross value
	tons	£	ha.x 10^3	tons	£	ha.x 10^3	tons	£	ha.x 10^3	tons	£
Sugar cane (sugar)	10.0	47	10	100,000	4,700,000	10	100,000	4,700,000	10	100,000	4,700,000
Fibres	2.0	60	20	40,000	2,400,000	20	40,000	2,400,000	20	40,000	2,400,000
Rice paddy	2.5	35	30	75,000	2,625,000	80	200,000	7,000,000	130	325,000	11,375,000
Other grains	1.5	15	30	45,000	675,000	35	52,500	787,500	55	82,500	1,237,500
Groundnuts kernels	1.0	32	10	10,000	320,000	12	12,000	384,000	30	30,000	960,000
Cotton (unginned)	1.0	56	10	10,000	560,000	12	12,000	672,000	25	25,000	1,400,000
Benniseed	0.5	45	5	2,500	112,500	6	3,000	135,000	10	5,000	225,000
Other leguminous crops	1.0	20	5	5,000	100,000	6	6,000	120,000	10	10,000	200,000
Tubers	5.0	10	10	50,000	500,000	12	60,000	600,000	27	135,000	1,350,000
Vegetables (incl. onions)	3.0	30	5	15,000	450,000	7	21,000	630,000	13	39,000	1,170,000
Tree crops	1.0	25	5	5,000	125,000	7	7,000	175,000	10	10,000	250,000
Pastures (meat)	0.075	200	-	-	-	3	225	45,000	10	750	150,000
Totals				357,500	12,567,500		513,725	17,648,500		802,250	25,417,500

TABLE 7.16

QUANTITY AND VALUE OF PRESENT AGRICULTURAL PRODUCTION

crop	area ha	yield per ha tons	production tons	price per ton £	gross value £
rice (paddy)	4,000	2.5	10,000	35.0	350,000
other grains	4,000	1.5	6,000	15.0	90,000
tubers	3,000	5.0	15,000	10.0	150,000
other crops	1,000	1.5	1,500	35.0	52,500
TOTAL :	12,000		32,500		642,500

TABLE 7.17

INCREASE OVER PRESENT LEVEL IN QUANTITY AND VALUE OF AGRICULTURAL PRODUCTION

	Quantity tons	Gross Value £
Present	32,500	642,500
Alternative I	357,000	12,567,500
Alternative II	513,725	17,648,500
Alternative III	802,250	25,417,500
Alternative I Increase over present level	324,500	11,925,000
Alternative II Increase over present level	481,225	17,006,000
Alternative III Increase over present level	769,750	24,775,000

TABLE 7.15

NUMBER AND DENSITY OF TOTAL POPULATION, MALE OCCUPATIONAL POPULATION AND RURAL POPULATION - TRIBAL GROUPS (1952)

	Land area in square miles	Total population 3)		Male working population				Rural population 2)		Tribal groups			
					occupied in agriculture and fishing					Nupe		Hausa	
		Number	per square mile	Total 1)	Number	% of total occupied	per square mile	Number	per square mile	Number	%	Number	%
Northern Region	281,782	16,840,479	60	4,667,049	3,876,048	83	14	15,350,549	54	348,979	2.1	5,488,446	32.6
Ilorin Province	17,719	530,723	30	172,531	139,355	81	8	469,061	26	65,525	11.8	8,531	1.6
Ilorin Division	4,164	398,673	96	130,370	103,386	79	25	337,011	81	7,369	1.9	4,778	1.2
Lafiagi-Pategi Div.	2,647	55,600	21	19,653	16,297	83	6	55,600	21	53,115	95.6	524	0.9
Kabba Province	10,953	644,037	61	163,458	147,154	90	13	585,090	53	32,686	4.9	8,169	1.3
Igbirra Division	1,146	156,787	137	35,304	29,461	83	26	92,479	81	4,462	3.0	3,901	2.5
Kabba Division	3,651	110,325	30	25,184	21,933	87	5	103,020	28	299	0.3	583	0.5
Koton-Karifi Div.	1,174	33,237	28	10,312	9,155	89	8	33,237	28	8,421	25.3	1,143	3.4
Niger Province	28,666	715,914	25	200,432	163,130	81	6	658,533	23	217,237	30.3	75,313	10.5
Abuja Division	3,950	101,429	26	26,882	23,532	87	6	93,585	24	3,541	3.5	8,800	8.7
Bida Division	5,741	221,437	38	64,596	48,842	76	9	202,151	35	197,398	89.1	5,923	2.7
Kano Province	16,630	3,397,695	204	1,091,438	874,808	81	53	3,061,988	184	1,945	0.1	2,109,654	62.1
Katsina Province	9,466	1,483,484	157	368,583	317,579	86	34	1,376,976	145	1,789	0.1	612,130	41.3

Source: Population census of the Northern Region of Nigeria, 1952.

1) This total has been obtained by subtracting from the total male population the persons not in the "labour force" such as young boys, old men, the crippled, etc. constituted in the census as "other males".
2) Obtained by subtracting the urban population from the total population. An urban centre contains a population of 5,000 or more in one compact unit.
3) Population figures throughout include non-Africans, who only number a few hundred.

TABLE 7.13

MONTHLY RAINFALL NOT REACHED IN DIFFERENT RECURRENCE PERIODS (MM)

LOKOJA (1916/1953 incl.)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Once in 3 years	0	0	17	50	89	83	100	79	120	76	0	0
Once in 5 years	0	0	8	32	75	75	81	60	97	61	0	0
Once in 10 years	0	0	0	18	62	58	62	43	76	47	0	0

TABLE 7.14

POTENTIAL EVAPORATION (Eo) FOR VARIOUS STATIONS IN OR NEAR THE FLOOD PLAIN (MM PER 24 HOURS)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Mean
Lokoja	5.8	6.5	6.8	6.4	5.3	5.0	5.0	3.8	5.0	5.5	5.6	5.4	5.5
Ilorin	5.8	6.4	6.3	5.7	5.3	5.5	3.7	3.8	3.8	5.0	5.4	5.5	5.2
Badeggi	4.3	5.7	6.6	6.1	5.9	5.1	4.1	4.1	4.4	5.7	5.6	5.1	5.2
Bida	5.4	6.4	7.0	7.0	6.6	5.2	3.9	4.0	4.0	5.1	6.0	5.6	5.5
Mokwa	4.8	5.9	5.5	7.3	7.0	6.6	5.7	5.5	6.4	6.3	5.7	4.5	5.9
Average	5.2	6.2	6.4	6.5	6.0	5.5	4.5	4.2	4.7	5.5	5.7	5.2	5.5

TABLE 7.12

10 DAY RAINFALL NOT REACHED IN DIFFERENT RECURRENCE PERIODS IN MM.

LOKOJA (1945/1959 incl.)

	J	F	M	A	M	J	J	A	S	O	N	D
Once in 3 years	0	0	1	7	34	33	33	18	47	23	0	0
Once in 5 years	0	0	0	2	23	22	20	8	34	15	0	0
Once in 10 years	0	0	0	0	13	13	10	2	20	8	0	0

BIDA (1946/1959 incl.)

Once in 3 years	0	0	0	7	29	35	38	29	63	8	0	0
Once in 5 years	0	0	0	1	17	23	25	15	50	1	0	0
Once in 10 years,	0	0	0	0	1	15	14	5	30	0	0	0

MOKWA (Dec. 1953/June 1960 incl.)

Once in 3 years	0	0	0	19	19	50	23	14	47	2	0	0
Once in 5 years	0	0	0	12	11	34	12	7	30	1	0	0
Once in 10 years	0	0	0	7	6	20	7	4	18	0	0	0

TABLE 7.11

MONTHLY RAINFALL EXCEEDED IN DIFFERENT RECURRENCE PERIODS IN MM.

LOKOJA

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Once in 5 years	4	21	60	112	150	164	185	178	216	152	15	0
Once in 10 years	11	39	71	137	178	196	223	223	254	190	24	4
Once in 15 years	16	47	76	150	193	216	241	249	279	211	28	6
Once in 20 years	19	51	78	157	203	223	254	256	318	229	32	8
Once in 25 years	22	54	79	163	213	236	267	269	330	239	34	10
Once in 30 years	24	56	79	168	218	241	274	279	335	249	37	11
Once in 35 years	27	57	80	173	223	249	284	292	350	254	38	13
Once in 40 years	28	58	81	178	229	254	292	300	355	260	40	14

ILORIN

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Once in 5 years	7	25	76	109	175	203	152	155	254	168	42	11
Once in 10 years	17	41	81	137	208	239	191	173	292	203	55	28
Once in 15 years	21	48	83	142	223	254	203	229	305	216	61	38
Once in 20 years	23	53	85	150	236	255	216	249	318	229	65	44
Once in 25 years	25	56	86	155	241	255	223	254	325	236	69	49
Once in 30 years	26	58	87	157	249	256	229	272	330	241	71	53
Once in 35 years	27	60	87	163	254	257	234	279	333	249	74	56
Once in 40 years	28	61	88	165	267	257	239	292	335	254	76	58

TABLE 7.10

OBSERVED MAXIMUM AND MINIMUM ANNUAL RAINFALL (MM)

	Observation period (years)	Minimum	Average	Maximum
Lokoja	38	760	1,175	1,870
Ilorin	38	855	1,270	1,685
Baro	4	955	1,220	1,500
Pategi	13	870	1,268	1,600
Badeggi	5.5	940	1,220	1,480
Bida	14	935	1,240	1,530
Mokwa	9.5	990	1,130	1,340

TABLE 7.9

MEAN DEPTH OF RAINFALL FOR STATIONS LOCATED IN OR NEAR THE NIGER FLOOD PLAIN (MM)

Station	Observation period (years)	Latitude North	Longitude East	Altitude m	Altitude ft	J	F	M	A	M	J	J	A	S	O	N	D	Year
Lokoja	42	7°48'	6°44'	44	140	5	12	48	94	155	160	173	165	210	137	13	3	1175
Koton Karifi	15	8°05'	6°47'	76	250	3	10	33	69	180	208	216	210	236	142	15	3	1325
Ilorin	50	8°30'	4°35'	285	935	7	17	56	105	171	195	140	123	243	176	29	8	1270
Abugi	12	8°33'	6°13'	122	400	0	3	35	84	132	160	241	236	216	115	8	0	1230
Baro	4	8°34'	6°23'	122	400	18	6	24	94	133	172	210	200	213	130	12	7	1220
Pategi	13	8°44'	5°46'	107	350	4	4	32	82	150	230	215	175	260	98	8	0	1268
Lafiagi	8	8°53'	5°22'	92	300	0	8	46	97	170	221	175	137	226	115	15	5	1215
Bacita	1.5	9°04'	4°56'	107	350	0	0	62	65	96	185	250	150	165	106	4	0	1080
Badeggi	5.5	9°05'	6°07'	70	230	20	3	34	95	115	195	210	155	275	105	11	0	1220
Bida	30	9°06'	6°01'	144	473	3	7	25	76	150	185	206	208	256	114	7	3	1240
Mokwa	9.5	9°18'	5°04'	152	500	3	5	28	91	132	200	180	125	255	98	9	4	1130

TABLE 7.8

Mapping unit	2	3	4	5	6	7	8	9	10	11	12	13
Gramineae or Cyperaceae sp.:												
Hyparrhenia spp.	■	■	■	■	■	0	*		*			x
Andropogon spp.	x	-										
Bulbostylis pilosa	x											
Bulbostylis filamentosa	x											
Setaria longiseta	0	0		0	x	*	*					
Buganna (Nupe)		0	0	-				0	*			0
Imperata cylindrica		0	0	*								
Eleusine indica		0		-	0	*						
Cyperus esculentus		0	x	x	x	*						
Cyperus subumbellatus		*	0	*				*				
Leersia hexandra				*	*	x	0					
Tsabaruwa (Nupe)		*		*	x	x	*					
Cenchrus biflorus					0	0	0					
Cyperus digitatus subsp. aurecomus					*	0	x					
Vetiveria nigritana					*							
Echinochloa pyramidalis					*	■	■		*			
Oryza barthii					*	*	*					
Phragmites sp.							0					
Saccharum spontaneum							*					

Legend: ■ = predominant in the unit
x = frequently occurring in the whole unit
0 = frequently occurring locally in the unit
- = occasionally occurring locally in the unit
* = very occasionally and locally occurring in the unit
blank = not observed in the unit

TABLE 7.7

THE OCCURRENCE OF TREES AND SHRUBS IN THE VARIOUS MAPPING UNITS

Mapping unit / Tree or shrub:	2	3	4	5	6	7	8	9	10	11	12	13
Mitragyna inermis		0	x	■	■	■	-	*	0		x	0
Piliostigma thonningii	0	x	0	x				*				
Terminalia avicennioides	■	■	x	x				-				0
Daniellia oliveri	x	x	■	0								*
Anogeissus leiocarpus		-	*	0				*				
Sarcocephalus esculentus	0	x	x	0				0				0
Vitex doniana	1	x	x	-				-	*	*	1	0
Zaborukuchi (Nupe)			*	*				x	x	x		
Combretum bauchiense	0	*	*	-								
Strychnos innocua								*				
Acacia sieberiana			*	-								
Ficus capensis		-	0	*						0		
Gardenia ternifolia	x	-	*	*								
Kulongi (Nupe)	-	-		*				-				
Spondias monbin.	*			*				-				*
Celtis integrifolia		*	*	*				■				
Pterocarpus erinaceus	x	x	x					0				
Prosopis africana	1	0	0									
Parkia clappertoniana		*	*									■

Mapping unit / Tree or shrub:	2	3	4	5	6	7	8	9	10	11	12	13
Entada abyssinica		*										
Borassus aethiopum			*	-								x
Combretum nigricans			*	*				-		1		
Landolphia florida				0				x	0	x		
Erythrococca anomala								0				
Tasa (Nupe)				*				x	0	■	■	
Morelia senegalensis				*				0	x	0		
Ceiba pentandra										*		
Elaeis guineensis								-	*	x		x
Magunchi (Nupe)									x		*	
Alchornea cordifolia									0	x	*	
Songbarachi (Nupe)									0			
Butyrospermum parkii	x	-										
Parinari polyandra	0											
Mangifera indica												0
Kigelia africana										*		
Dalbergia sp.	0	x	x	0				x	*	x		-
Balanites Aegyptiaca		-	*	0								
Antidesma venosum		-	-	-								

Legend:
- ■ = predominant in the unit
- x = frequently occurring in the whole unit
- 0 = frequently occurring locally in the unit
- 1 = occasionally occurring in the whole unit
- \- = occasionally occurring locally in the unit
- * = very occasionally and locally occurring in the unit
- blank = not observed in the unit

TABLE 7.5

DENSITY OF THE VARIOUS VEGETATION LAYERS

mapping unit	2	3	4	5	6	7	8	9	10	11	12	13
vegetation layer												
tree layer	o	o-md	md	o	o-vo	vo	a	md-d	o	md-d	d-vd	o
shrub layer	o-vo	o-md	md	o-vo	a	a	a	d	d-vd	md-d	a	o
minor vegetation layer	o	md	o-md	o-md	o-md	md-d	d-vd	vo	vo-a	o-vo	a	md-d

Legend:
vd = very dense
d = dense
md = medium dense
o = open
vo = very open
a = absent

TABLE 7.6

ESTIMATE OF THE AVERAGE HEIGHTS OF THE VEGETATION LAYERS

Heights are indicated in feet

mapping unit	2	3	4	5	6	7	8	9	10	11	12	13
vegetation layer												
tree canopy	25	35	50	35	25	15	-	60	45	60	30	30
shrub layer	10	20	20	10	-	-	-	20	30	20	-	15
minor vegetation layer	2-5	5	2	6	6	4	4	-	-	2	-	2

TABLE 7.4

PERCENTAGE COMPOSITION OF THE CLAY FRACTION OF NIGER FLOOD PLAIN SOILS

Sample number	Laboratory number	Kaolinite	Illite	Montmo-rillonite	Quartz	Hydrar-gillite
X5-7748-1	A 241946	90	<10	5	3	-
34-8604-11	-	70	10-20	10	3	-
Y2-6792-3	A 241930	70	10-20	5	3	5
W3-7714-3	A 242219	80	10-20	5	3	*
Z2-7936-K1	A 241610	90	<10	-	3	-
36-8592-2	A 241878	90+	<10	-	5	-
28-8962-3	A 241881	80	10-20	-	3	-
W2-7648-2	A 241774	60	20-30	10	5	*
25-8052-1	A 242212	80	10-20	5	3	-
Y4-8922-1	A 241738	70	10-20	10	5	-
X1-6526-K5	A 241749	80	10-20	-	3	-
23-8580-2	A 241873	70+	<10	20	10	*
B25	A 242085	70-80	10-20	5	5	-
C15	A 242117	60-70	20-30	5	5	*
D21	A 242081	60-70	20-30	5	5	*
G26	A 242187	80	10-20	-	3	5
F 7	A 242898	80	10-20	-	5	*
C 3	A 242106	80	10-20	5	3	-
E 4	A 242135	70	10-20	-	3	10
F24	A 242005	80	10-20	-	3	5
G14	A 242176	60	10-20	10	3	10
C14	A 242116	70	20-30	5	3	*
E24	A 242156	80	10-20	-	5	*
F32	A 242013	50-60	20-30	5	10	5

Notes * signifies less than 5%

+ refers to the text

TABLE 7.3

MINERALOGICAL ANALYSES

Sample	Laboratory number	K felspar %	Na-Ca felspar %	Quartz %	Aggregates (mainly quartz) %	Heavy minerals %	Muscovite %	Opaque %	Non-determinable %
X5-7748-1	A241946	12	11	54	3	1	17	1	1
Y2-6792-3	A241930	15	10	69	2	1	2	-	1
G14	A242176	10	14	69	2	1	2	1	1
G26	A242187	14	2	80	2	1	-	1	-
34-8604-11		15	10	70	4	-	1	-	-
Y4-89922-1	A241738	6	6	82	5	1	-	-	-
36-8592-2	A241878	-	-	94	4	1	-	1	-
X1-6526-k5	A241749	13	9	75	1	1	-	1	-
D21	A242081	9	1	82	5	2	1	-	-
W2-7648-2	A241774	24	11	58	4	2	-	1	-
23-8580-2	A241873	6	4	87	1	1	-	1	-
F32	A242013	4	2	89	5	-	-	-	-
F7	A242898	3	2	89	5	-	-	1	-
C15	A242117	26	27	40	2	3	-	2	-
E24	A242156	4	2	91	2	1	-	-	-
B25	A242085	18	18	57	4	2	-	1	-
W3-7714-3	A242219	19	6	67	5	1	2	-	-
25-8052-1	A242212	10	3	82	4	1	-	-	-

TABLE 7.2

ATTERBERG VALUES OF SOME SOIL SAMPLES OF THE SEMI-DETAILED SOIL SURVEY.

Sample site	Laboratory number	Texture class	Liquid limit	Sticky limit	Plastic limit	Mapping unit	Sample site	Laboratory number	Texture class	Liquid limit	Sticky limit	Plastic limit	Mapping unit
A 1	A243040K	SiL	52.4	41.6	29.9	N.1.4	H 5	A242962	SiC	56.8	43.7	25.1	N.2.1
A 4	A243043K	C	79.1	57.7	40.7	N.2.1	H 6	A242963	SiCL	47.2	40.7	22.1	N.1.2
A 6	A243045K	C	64.1	47.0	32.8	N.2.3	H 8	A242965	L	40.1	34.6	18.2	N.1.1
A 8	A243047K	SiCL	54.6	38.5	23.6	N.2.3	H 8	A242992K	L	36.2	27.3	15.3	N.1.1
A12	A243051K	L	46.2	31.3	20.1	F.1.2	H10	A242967	C	71.1	49.9	32.0	N.2.1
A18	A243057K	SiC	66.0	51.7	34.5	F.2.2	H11	A242968	SiC	47.5	38.2	22.4	N.2.1
A19	A243058K	SiC	65.3	48.6	36.1	F.2.2	H13	A242970	SiC	58.3	47.9	30.2	N.2.1
B 7a	A243008K	SiC/C	63.2	41.4	27.8	N.2.1	H16	A242973	SiL	31.4	22.9	20.3	N.1.1
B16	A243012K	C	62.5	41.6	28.6	N.2.3	H19	A242976	C	64.9	47.1	28.2	N.2.1
B19	A243016K	SiCL	51.7	40.1	25 1	F.1.2	H21	A242978	C	81.6	66.2	42.5	N.2.2
B19	A243017K	LS	19.1	14.6	nil	F.1.2	H25	A242982	C	57.2	37.5	28.1	N.2.3
B23	A243019K	SL	33.3	23.4	19.1	F.2.1	H27	A242984K	C	57.8	45.2	26.2	N.2.3
D 6	A242925K	C	69.3	50.8	35.2	NC.4.1	H29	A242986K	SiC	48.6	34.8	21.3	N.2.3
D 6	A242926K	C	61.9	43.7	31.3	NC 4.1	I 3	A242940K	SiL	41.2	31.8	23.6	N.1.4
D16	A242927K	C	90.8	68.4	44.3	N.2.1	I 5	A242942K	SiC	47.2	37.8	27.0	N.1.2
D16	A242928K	C	59.6	39.0	28.0	N.2.1	I 7	A242944K	C	89.7	70.9	51.0	N.2.1
D23	A242929Z	S	35.0	25.0	nil	F.1.1/1.2	I 9	A242946K	SL	24.4	19.6	nil	N.1.4
D29	A242995Z	S	22.0	nil	nil	T.1.2	I 12	A242949K	SiCL	45.6	33.7	21.4	N.1.1
F 3	A242880K	SiL	36.2	31.2	10.2	N.1.3	I 15	A242952K	C	63.2	46.4	30.0	N.2.1
F 3	A242881K	SiL	30.6	24.3	6.6	N.1.3	I 20	A242957K	SiC	33.6	23.6	18.8	N.1.1
F17	A242886K	C	76.1	54.1	38.2	N.2.1	I 21	A242999K	SiC	61.8	46.5	25.8	N.1.1
F17	A242887K	C	50.7	36.2	21.8	N.2.1	I 23	A243001K	C	65.4	40.0	28.0	N.2.2
F22	A242888K	SiC	47.3	36.9	23.1	N.2.3	I 25	A243003K	SiC	48.8	39.2	23.2	N.2.1
F22	A242889K	SiCL	46.2	28.0	17.1	N.2.3	J 5	A243026K	SiC	50.7	41.2	28.0	N.1.2
F24	A242891K	SiC	47.2	36.4	26.0	N.2.3	J 5	A243027K	SiC	44.8	32.9	22.2	N.1.2
F24	A242892K	L	32.6	26.9	13.1	N.2.3	J15	A243029K	C	53.8	40.1	30.3	N.2.3
F30	A242898Z	S	20.3	nil	nil	T.1.1	J15	A243030K	SiC	41.6	33.6	19.5	N.2.3
H 1	A242958	SiL	55.1	46.2	23.8	N.1.1	K 1	A242916K	SiC	56.8	46.1	28.5	N.1.1
H 2	A242988K	SiCL	43.9	33.0	19.4	N.1.1	K 3	A242918K	CL	42.4	31.5	21.8	NC.3.1
H 3	A242960	SiCL	44.7	36.7	20.3	N.1.2	K 4	A242919K	SiC	49.5	37.9	23.8	NC.3.1
							K 6	A242921K	C	66.1	48.9	33.8	NC.4.1

TABLE 7.1 (Continued)

Laboratory number	Texture class	Liquid limit	Sticky limit	Plastic limit	Mapping unit
A241969K	SiCL	17.3	41.2	33.5	T4
A241744	SiCL	57.6	46.8	26.0	N1
A241946K	SiCL	54.1	35.1	20.4	N1
A241732	SiCL	36.5	31.6	26.3	NC1
A241846K	SiCL	38.5	32.7	17.1	NC1
A241687K	SiCL	51.1	48.0	27.1	NC1
Z241620	SiCL	59.9	50.4	27.7	NC2
A241622	SiCL	49.6	41.6	23.5	NC2
A241711K	SiCL	42.5	37.1	22.5	NC2
A241731	SiCL	42.0	33.0	12.6	NC4
A241693K	SiCL	59.0	46.4	35.1	FC2
A241894	CL	40.7	26.1	16.6	T2
A241752	CL	34.4	30.2	17.5	N1
A684107K	CL	47	39	25	N2
A241855K	CL	34.9	28.8	15.8	NC1
A241889	CL/SiCL	39.4	28.4	15.9	NC1
A241662K	CL	51.0	37.9	23.5	NC2
A241726	CL	38.0	30.0	18.8	NC2
A241660K	CL/L/SiL	51.2	40.9	23.0	NC2
A241891	L	43.2	27.3	18.4	N1
A241740	L	39.7	33.6	22.2	F1
A241749	L/CL	42.7	36.3	20.9	NC2
A241875	L	32.1	20.9	17.2	TC
A241726	L/CL/SiCL	38.1	30.1	18.9	NC2
A684106K	L	33	25	14	NC2
A241919	L	40.9	26.6	17.3	NC2
A242904K	SiL	33.6	26.4	20.1	T4
A684096K	SiL	35	26	21	N1
A241970K	SiL	32.0	27.7	16.1	N1
A241723	SiL	45.4	39.2	24.0	N1
A241632	SiL	57.3	44.9	26.6	N1
A241701K	SiL	42.9	36.5	23.2	NC2
A241892	SiL	47.0	34.4	31.9	FC2
A243062	SiL	42.4	37.5	23.2	F1
A241980K	SiL	25.1	19.8	16.0	CF
A241665K	SCL	43.6	33.6	20.9	NC2
A241775K	SL/SCL	33.6	22.6	12.0	FC2

TABLE 7.1

ATTERBERG VALUES OF SOME SOIL SAMPLES OF THE RECONNAISSANCE SOIL SURVEY

Laboratory number	Texture class	Liquid limit	Sticky limit	Plastic limit	Mapping unit	Laboratory number	Texture class	Liquid limit	Sticky limit	Plastic limit	Mapping unit
A241709	C	53.0	45.1	24.8	T2	A241753	SL	27.5	22.3	nil	T.1
A241772K	C	71.2	49.2	34.2	T2	A241876	SL	24.8	15.7	nil	T.1
A242906K	C	47.6	37.5	21.6	T4	A241961K	SL	28.6	25.0	nil	TC
A241767K	C	74.0	48.6	31.8	TC	A241857K	SL	28.1	18.8	nil	N.1
A241881	C	67.1	47.8	33.8	TC	A684101K	SL	25	16	nil	N.1
A241656K	C	55.0	41.8	28.7	N1	A684102K	SL	24	18	nil	N.1
A684099K	C	68	53	34	N2	A241635K	SL	35.4	28.4	nil	NC.1
A684100K	C	43	33	18	N2	A241636K	SL	37.5	29.5	nil	NC.1
A241617	C	65.0	53.3	35.1	NC1	A241736	SL	47.9	44.2	nil	F.1
A241691K	C	46.5	39.5	25.6	NC1	A243063	SL	27.1	22.8	nil	F.1
A241705K	C	60.7	54.1	37.8	NC1	A241753	SL	29.1	21.9	nil	F.1
A241856K	C/SiC	45.9	31.4	21.6	NC1	A241737	SL	27.5	22.7	nil	F.1
A241858K	C	58.5	41.5	30.9	NC1	A242229K	SL	27.1	19.5	11.8	FC.2
A241883	C	59.3	41.9	30.9	NC1	A241735	SL	32.4	27.5	nil	FC.2
A242238	C	61.9	46.4	30.1	NC1	A241943	LS	31.9	20.4	nil	T.1
A241849	C	69.0	49.0	32.2	NC1	A241716	LS	25.4	19.3	nil	T.1
A684091K	C	49	33	24	NC1	A241757	LS	25.1	18.9	nil	T.1
A241645K	C	70.7	49.6	32.1	NC2	A241738	LS	24.5	15.4	nil	T.1
A241629	C	60.5	47.1	28.5	NC2	A684105Z	LS	24	18	nil	T.3
A241610	C	67.8	50.6	31.8	NC2	A684097Z	LS	26	19	nil	N.1
A241613	C	64.3	47.6	20.7	NC2	A241854Z	LS	19.4	13.2	nil	NC.1
A241615	C	71.8	53.0	30.0	NC2	A241861Z	LS	23.2	14.0	nil	NC.1
A241650K	C	60.0	45.4	31.9	NC2	A241697K	LS	22.3	16.5	nil	NC.1
A241653K	C	66.9	56.9	36.7	NC2	A241774Z	LS	21.7	19.8	nil	CF
A241725	C	52.3	41.9	25.7	NC2	A242907Z	S	19.1	nil	nil	T.1
A242220K	C	44.3	34.4	24.6	NC2	A242908Z	S	18.4	nil	nil	T.1
A242237K	C	56.5	49.1	30.6	NC2	A241934	S	26.4	18.4	nil	T.1
A242212K	C	75.2	52.0	38.5	NC3	A241932	S	25.5	15.2	nil	T.2
A241859K	C	52.5	31.8	20.9	NC3	A241945Z	S	26.6	18.3	nil	T.2
A241742	C	42.1	37.1	22.2	NC4	A684104Z	S	21	14	nil	T.2
A243066	C	66.9	52.8	22.9	NC4	A241785Z	S	23.4	13.1	nil	T.2
A241790K	C	56.5	50.1	31.4	F2	A684093Z	S	20	15	nil	NC.1
A241868K	C	62.0	35.6	26.4	F2	A684094Z	S	18	12	nil	NC.1
A241759	C	65.3	43.7	28.5	FC1	A241683Z	S	26.1	20.0	nil	NC.1
A242231K	C	41.0	34.3	22.9	FC2	A241637Z	S	22.2	14.2	nil	CF
A684098K	SiC	56	44	28	N2	A684090Z	S	16	6	nil	U
A684092K	SiC	55	39	25	NC1	Z241621	SiC	63.7	50.4	30.2	NC2
A241973K	SiC	49.2	45.5	26.9	NC1	A241634	SiC	61.4	53.0	35.2	NC2
A242219K	SiC	46.0	38.8	25.7	NC1	A241930	SiC	57.8	36.1	24.3	NC2
A241853K	SiC	42.8	36.8	19.3	NC1	A241677K	SiC	56.0	39.0	34.8	NC2