

A CHARACTERIZATION OF THE
SOIL RESOURCE OF THE RESEARCH STATION
AT FERKESSEDOUGOU
(NORTHERN COTE D'IVOIRE) WITH
RESPECTS TO SUITABILITY OF IITA'S
MAIZE SAVANNA SUBSTATION.

Consultancy report for IITA, IBADAN, NIGERIA

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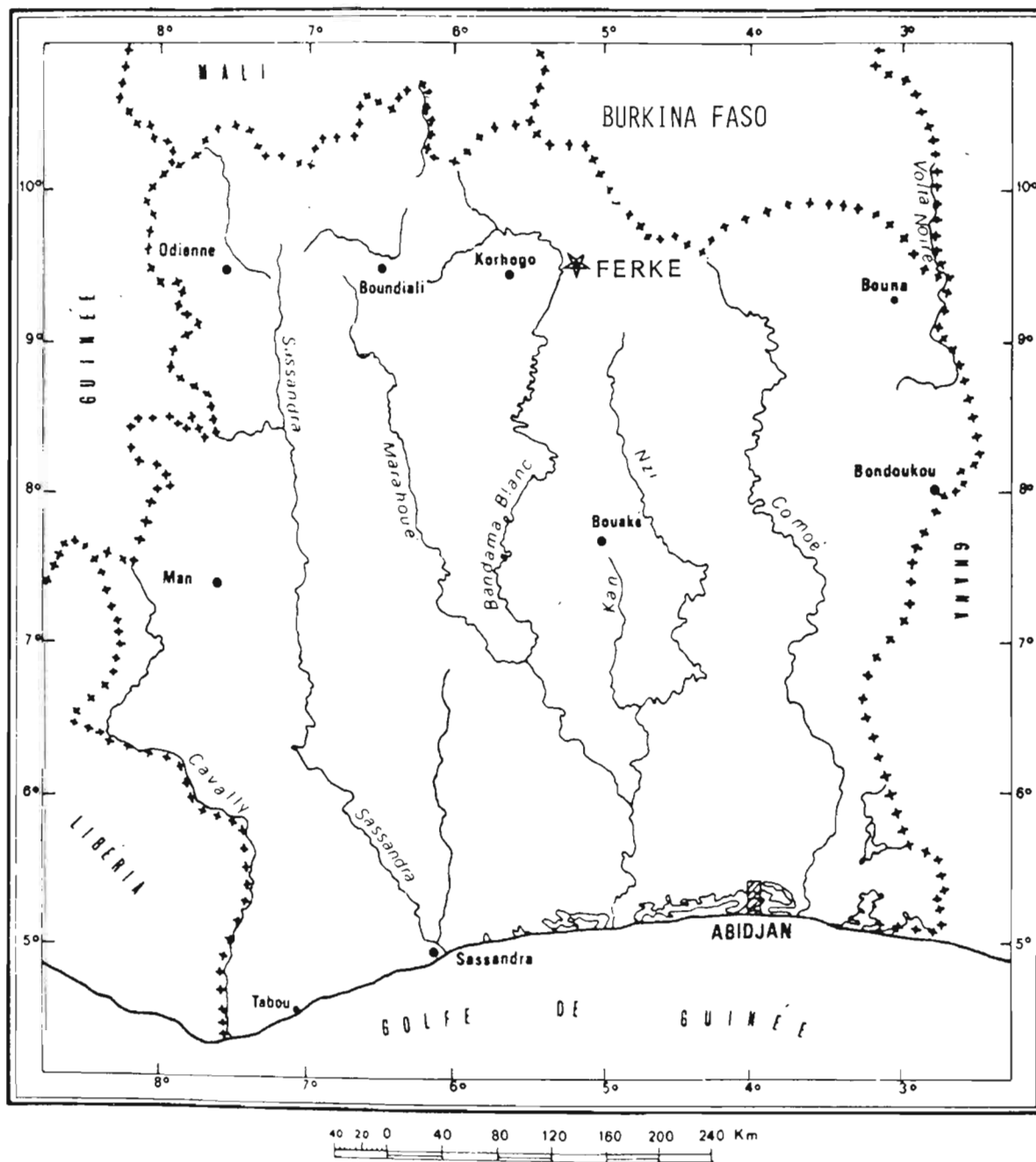
I. INTRODUCTION

In 1982, maize was the first cereal cropped in Côte d'Ivoire in terms of production (470,000 metric tons), before paddy (420,000 tons) (MOYAL, 1988a). Due to the rapid growth of population, this production will have to be doubled before the end of the century. Research must therefore be strengthened for increased maize production. This meets the mandate of IITA (International Institute of Tropical Agriculture) which conducts research in partnership with the National Agricultural Research Services. One of its recently developed program strategies is to establish small research substations in the key ecological zones of West and Central Africa such as the moist savanna zone which includes almost 45 percent of the coastal West Africa, but only 30 percent of the population of the region. With a growing period ranging from 150 to 240 days, intense solar radiation during the growing season, this well-endowed region is supposed to have the greatest potential for future maize production.

In order to deal adequately with the research priorities of this environment and to produce technological advances that are appropriate to the farming systems of the region, a research substation will have been established in this region by 1989. The essential of the program will give high priority to the maize breeding and improvement and resource management research. Studies will be carried out as well on the soils which require careful management to sustain production. The loss in productivity, by the invasion of grass and other weeds, is also a high priority issue in these savanna areas.

IITA staff have had several preliminary meetings with the Ministre de la Recherche Scientifique, and Director of IDESSA and his maize staff to discuss possible locations for IITA substation in the "corn belt" of Côte d'Ivoire. It came out that the major thrust of the work for the savanna ecosystem will be at Ferkéssédougou station, even though some activity is developed in, or near Bouaké.

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MAP 1 : Location map

The objectives of this report are :

1. To provide a general classification of the soils of the Ferké station and an estimation for the land area suitable for maize breeding and maize production research.
2. To indicate the suitability of this site for more detailed research work on soil and crop management, especially to be representative of maize systems in the region.
3. To outline any particular advantages and disadvantages of the site to meet IITA objectives.
4. To highlight the opportunities at any other sites, to have an access to more diverse soil and land use system.

II. GENERAL FEATURES THE FERKESSEDOUGOU AREA

A. Location of the area (Map 1)

Ferkéssédougou (or "Ferké") is located in northern Côte d'Ivoire along the main tarred road and the railway that link Abidjan to Ouagadougou (Burkina Faso). The coordinates of the town are :

- 9° 36' N
- 5° 12' W

Distances from Korhogo (main city of northern Côte d'Ivoire), Bouaké and Abidjan are 53 km, 231 km and 584 km, respectively.

Senoufo People form the major ethnic group of the Ferkéssédougou area which is densely populated, yet less than the Korhogo area (Map 2). Their traditional agricultural practices are fairly advanced.

The area considered here is the geographical square degree located between the 9th and the 10th northern parallels and between the 5th and the 6th western meridians.

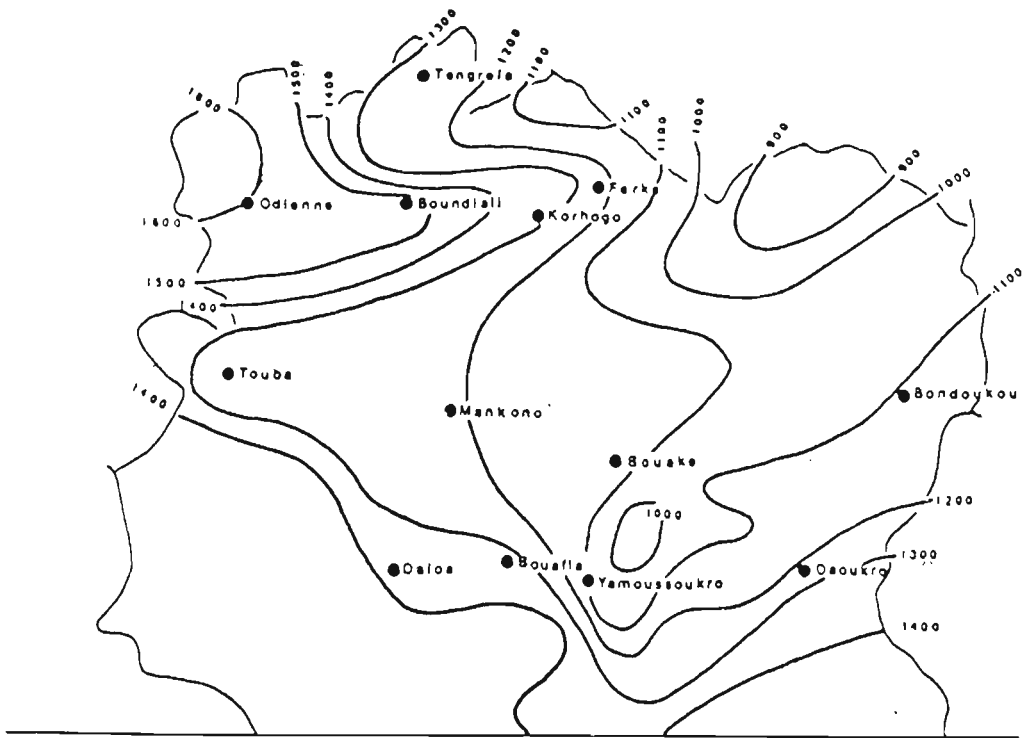
B. Climate

Whereas Bouaké belongs, as Ibadan, to a climatic zone with two rainy seasons, in Ferkéssédougou most the rain falls during one well-defined wet season from June to October. Mean annual rainfall (Map 3) ranges from 1129 mm in Tafire to 1496 mm in Boundiali, with 1332 mm in Ferkéssédougou (BEAUDOU and SAYOL, 1980). Since rainfall is rather well distributed, Ferkéssédougou does not seem the best location for studying resistance to drought stress. This risk is higher in Bouaké due to the erratic climate (Map 4). Mean annual temperature is 27.1° C in Ferkéssédougou. Potential evapotranspiration reaches 1847 mm.

C. Geology

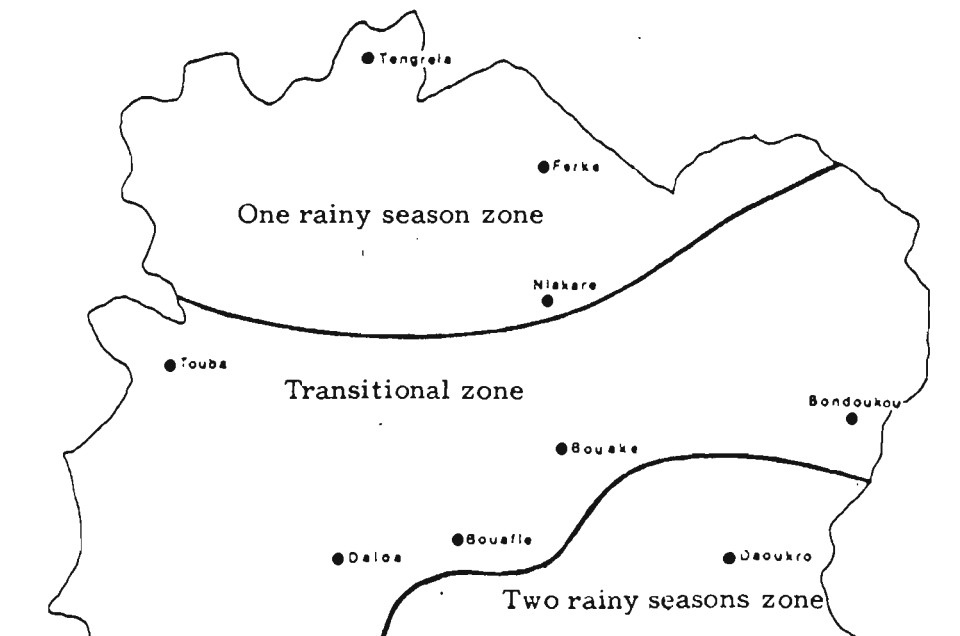
Most of the soils are derived from felsic or intermediate rocks (granites, gneisses, phyllites, schists) of the underlying Precambrian



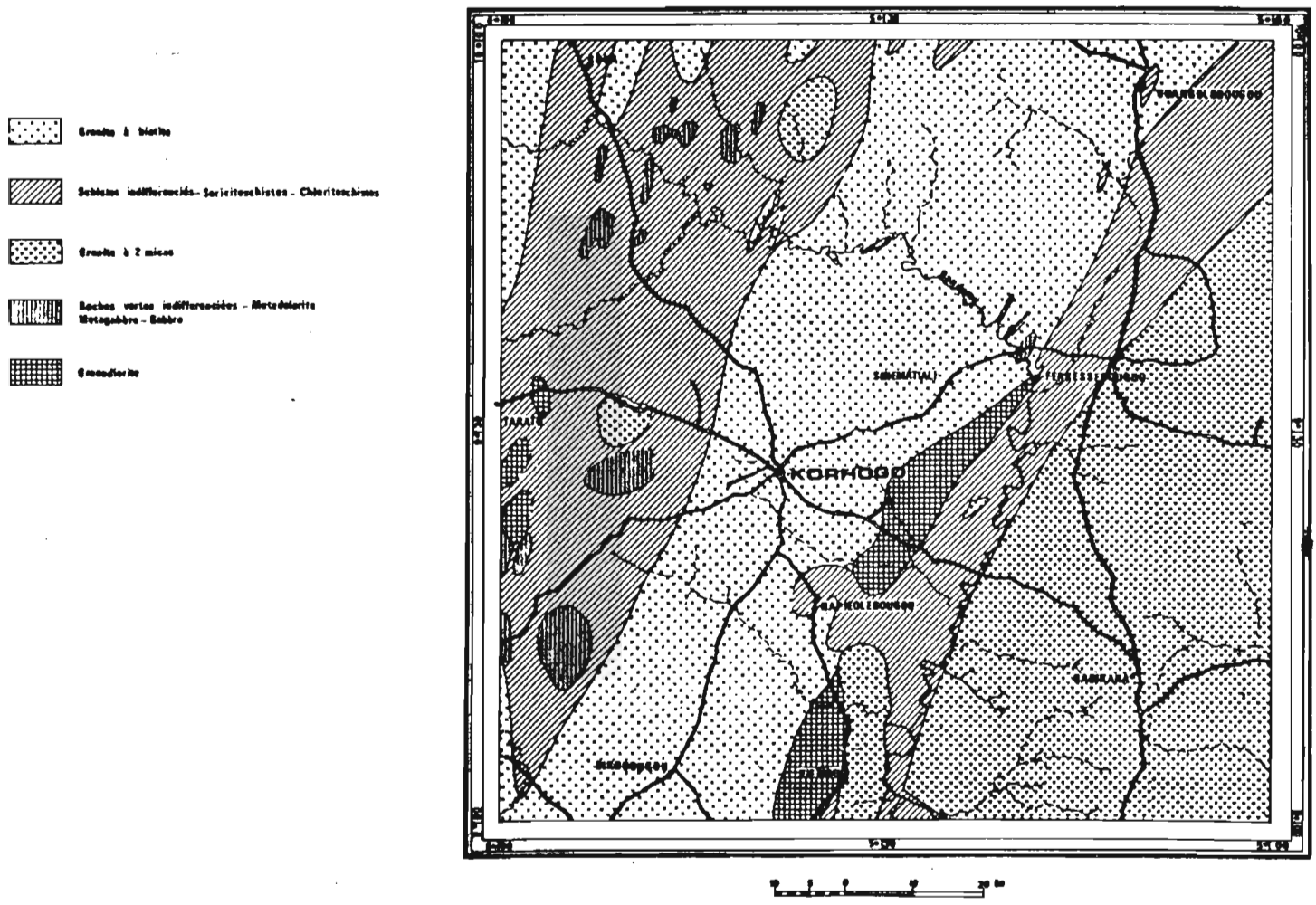


MAP 3 : Isohyets in central and northern Côte d'Ivoire. (after MOYAL, 1988a).

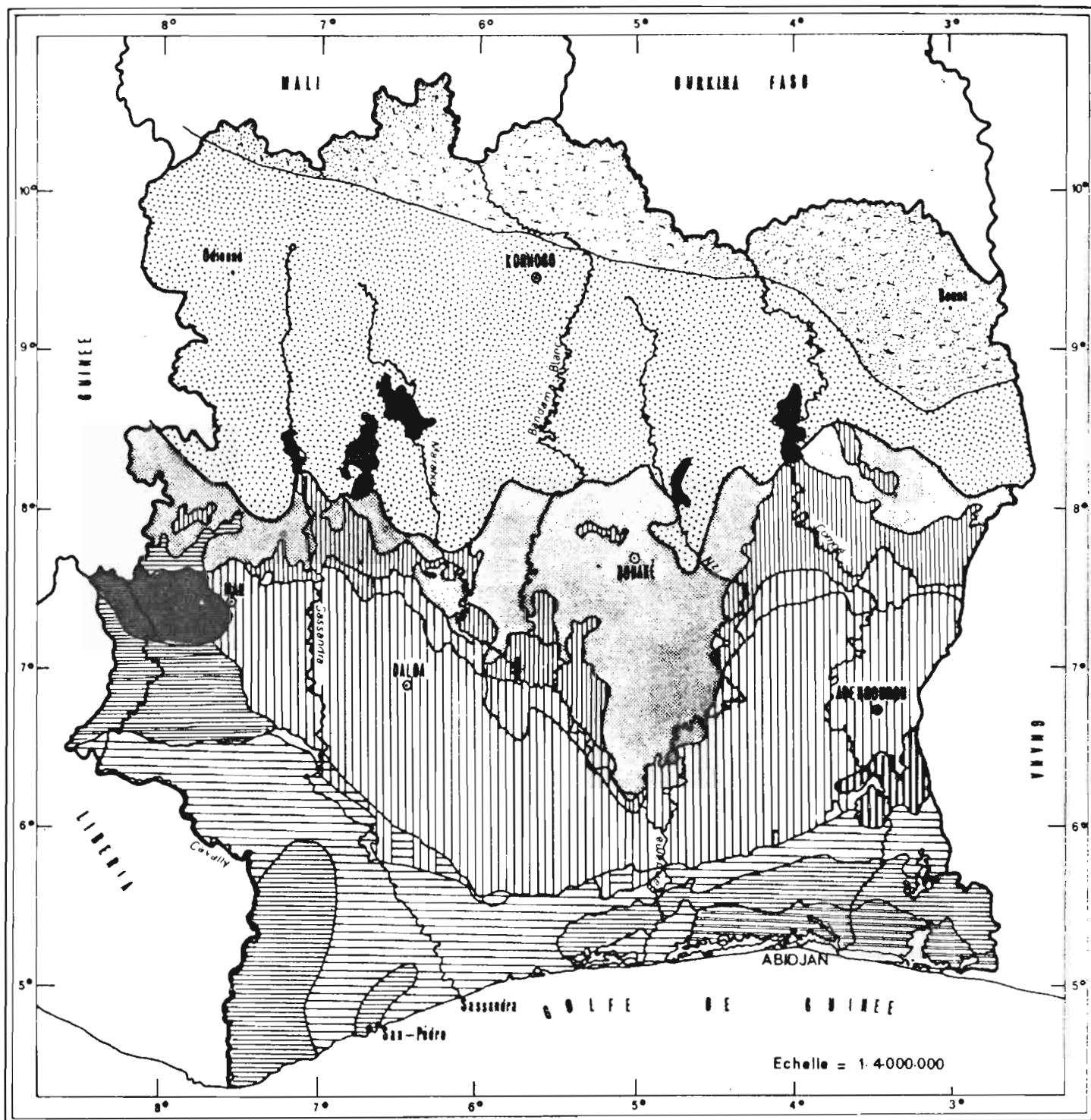
Zones climatiques



MAP 4 : Major climatic zones in central and northern Côte d'Ivoire. (after MOYAL, 1988a).



MAP 5 : Geological map of the geographical square degree of Korhogo. (after ARNOULD, 1963).



DOMAINE GUINEEN

SECTEUR OMBROPHILE (dense humide sempervirente)

- type à *Eremospatha africana* et *Diospyros mannii*
- type à *Turraeanthus africanus* et *Heisteria parvifolia*
- type à *Diospyros* Spp et *Mapania* Spp.
- type à *Uapaca esculenta*, *U. guineensis* et *Chidiowia sanguinea*
- type à *Tarrietia utilis* et *Chrysophyllum perpulchrum*

SECTEUR MESOPHILE (dense humide semi decidue)

- type à *Celtis* Spp et *Triplachiton Scleroxylon*
- variante à *Nesogordonia papaverifera* et *Khaya ivorensis*
- type à *Aubrevillea kerstingii* et *Khaya ivorensis*
- Savane Guinéenne

SECTEUR SUB SOUDANAIS

- Forêt dense sèche
- Savane boisée, arborée ou arbustive et/ou forêt claire

DOMAINE SOUDANAIS

SECTEUR SOUDANAIS

- Savane boisée, arborée ou arbustive et/ou forêt claire

Echelle = 1:4000000

MAP 7 : Vegetation map of Côte d'Ivoire.

Losses observed on stored maize and yams are presented in Table 4.

Table 4 : Percentage of weight loss due to insects during storage of maize in the savanna area of Côte d'Ivoire.

Location	Percentage of loss	Duration of storage (months)
North	0.6	7
South-Centre	5.9	7

These results indicate that yield losses due to insects are often very important, reaching about 60% for cotton and maize in the southern part of the savanna area.

Neither were found topographical map more detailed than 1/50.000, nor earlier soil studies of the station's premises. The low-quality 1/50.000 aerial photographs, from the 50's, were not very helpful.

2. Methods

Ten soil profiles, 1,7 m deep - without iron pan- were described along a transect which cuts perpendicularly through the above mentioned land units. In addition, 13 routine augerings were made at 100 m intervals in the plateau to form a cross with the transect.

The landscape-soils correlations were subsequently used for extrapolation of the data to the whole station. Obviously, the observation density is not sufficient to draw an acceptable soil map. In this respect, detailed survey is absolutely necessary. The sketch which is presented was drawn only to provide some insight on the estimated extension of each unit. The reader must keep in mind that the exact location of boundaries is somehow arbitrary and should be ascertained after a detailed soil survey.

The French classification was used (C.P.C.S., 1967).

3. Main soil units

Eight soil types and seven mapping units were distinguished (Table 5)

Table 5 : Classification of the mapping units (Map 8).

Class	Subclass	Group	Subgroup	Facies	Mapping unit
Sols peu évolués	D'origine non climatique	D'érosion	Lithiques	Sur cuirasse	3
Sols fer-rallitiques	Moyennement à fortement désaturés	Indurés			3
		Remaniés	Modaux		2
			Rajeunis		1
			Hydromorphes		5
		Typiques	Jaunes	Indurés	4
Sols hydro-morphes	Minéraux	A pseudogley			6
		A gley			7

Only the most relevant criteria in terms of maize production are listed hereafter. Soil moisture availability which is largely a function of soil texture and depth, and soil nutrient status are the key factors.

a) Unit 1 : Gravelly red ferrallitic soils on shallow weathered schists

Top soil : dark reddish brown (5 YR 3/2) moist, sandy clay loam, fairly stony - small iron concretions, fine subangular blocky structure, soft, many fine roots.

Deep soil : B gravelly layers, between 40 cm and 120 cm, red (2.5 YR 5/6) moist, clayey, very stony - concretions, soft overlay C weathering layers of schist, dusky red (10 R 3/3) and yellow (10 YR 6/8), clayey, soft, moist.

Undoubtedly, the roots can reach the weathering zone which is likely to be rather rich in minerals. Drainage is not hampered. The significant siltiness causes structural collapses and therefore capping of the surface soil especially where cultivation over a long period of time has induced a decrease in organic matter content.

Consequently these almost flat soils offer favourable conditions to crop maize and trials have been mainly located in this soil unit. When they have been cultivated for a long period of time, these soils are most probably the best of the station, but they cannot be really considered as fully representative of northern Côte d'Ivoire. This well endowed soils are responsible of the surprisingly high yields recorded by CYMMIT.

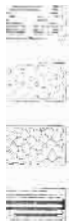
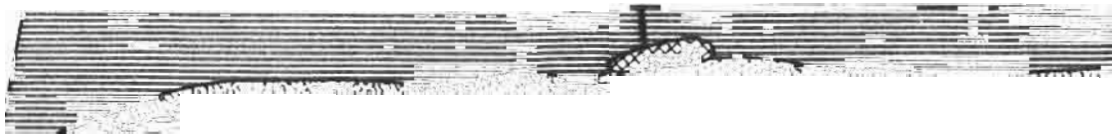
These soils covered an estimated area of 23 ha of which at least 8 ha are already occupied by the existing trials, the ancien track, the road and the weather station. The unit is not uniform. The depth of the gravelly layers, and their thickness vary, as well as the depth the weathering layer. But this type of variation occurs all over the station. Despite its heterogeneity, this tophill unit appears as the most suitable to identify small differences among genetic materials, provided a very detailed soil mapping is carried out prior to the laying out of the trials.

b) Unit 2 : Deep gravelly ferrallitic soil

The main difference with the previous unit consists in the occurrence below the gravelly layers of a few decimeters thick ferrallitic horizon (what was called "hypostructichron" by BEAUDOU and SAYOL, 1980). As result, the weathering zone is deeper (Fig.1) and minerals are likely to be less abundant. These soils are freely drained. Good aeration and a low mechanical resistance to root penetration in moderate well-structured soils enables deep-rooting woody plants.

Besides the stoniness, slope inclination may be a limiting factor. However, in northern Côte d'Ivoire conditions, these soils are most suitable for cultivation.

Among the 100 ha of this largest unit, more than 60 are occupied by new sugarcane trials, wood, station offices and compound. As for the previous unit, large variations may occur in the depth and the thickness of



gravelly layers. Note that extremely gravelly layers may outcrop associated to quartz vein. In addition, the topsoil texture becomes locally more sandy.

These deep red gravelly soils may be used for trials since they are representative of the upperslope soils in northern Côte d'Ivoire, but the part they cover in the station is exaggerated compared with their usual occurrence in a more typical catena.

c) Unit 3 : Shallow soils and outcropping of ironstone

Where the profiles contain laterite there is often a noticeable break of slope occurring midslope or downslope.

Since this unit comprises several limited tracks of land scattered over the station, it is likely that some of them were not identified during the survey. As a result, the evaluation of 4 ha is probably underestimated. This unit is generally covered with low grass. Obviously, site selection will have to delineate this unit carefully in order to exclude it.

d) Unit 4 : Yellow ferrallitic soils

Top soil : light brown (7.5 YR 6/6) to brownish yellow (10 YR 6/6), moist, sand to sandy loam, coarse subangular blocky structure, many fine roots.

Deep soil : below a brownish yellow (10 YR 6/6), sandy clay, massive, ferrallitic horizon which may be mottled, indurated layers occurs at 75 cm.

These soils are located lower in the catena than the red ferrallitic soils. They are underlain by an indurated ironpan layer. The internal drainage of these soils is poor and, because of the reduce effective depth of the profile, they also have a low water storage capacity. Usually these soils are chemically poor. Due to these constraints, no trial has been so far implemented in this unit. However, maize breeding trials should not neglect these soils which may interact with genotype. Furthermore, these soils which approximately cover 23 ha, extensively cultivated, even in the station, are representative of northern Côte d'Ivoire and, to some extent, of southern Burkina Faso and Mali.

e) Units 5 and 6 : Lower slope hydromorphic soils

Topographically, these soils lie just a little higher in the catena than the valley bottom soils, and in the small thalweg located SSE of the station. Subjected to the variations of the groundwater level, their profiles contain significant mottling. They are alternately waterlogged and dry. Since maize is cropped even under these conditions, some plots, if necessary, may be used to test these specific conditions.

f) Units 7 : Seasonally flooded soils

Primarily, one the main objective of the Ferké station was to study the improvement of paddy cultivation in northern Côte d'Ivoire. As a result, the waterlogged "paddy soils" cover a large part of the station, approximately 42 ha, which does not seem to be very suitable for maize cultivation since surface water to a depth of 20 cm may lie on the surface for several months in the year.

E. Land use

Of particular relevance to the study of the traditional cropping system are the fields which, more or less legally, occupy at least two thirds of the station. Undoubtedly, the 17 staff members find the present situation beneficial and no really effective action has been so far undertaken to combat this occupancy even though *Eucalyptus spp* and *Azadirachta indica* (Neems) are planned to be planted to delineate more clearly the limits of the station. At present only 15 ha out 220 ha are really used for trials. The extension of new plots will be made on the expense of these fields. Political power should be strong enough to make it accepted.

Maize is the dominant crop, mixed with groundnut, yam, upland rice, sorghum and millet. Paddy is cultivated in the valley bottom. Because of the shortage of land nearby Ferkéssédougou, fallow periods between cultivation phases have been greatly reduced. Consequently, fertilizers are required for maize production and even small holders use some quantity. From this viewpoint, the Ferkéssédougou research station provides an interesting field for testing improved management practices to help restore soil fertility.

Trials concern maize, millet and sugarcane. Sugar plots have been implemented in the station for one year. They had to be fenced owing to the hazards of degradation caused by cattle passing along the road.

The steepest slopes are covered with wood (see unit 2).

Note that according to the official agreement of 1968 with IRAT (replaced nowadays by IDESSA), about 20 ha located in unit 2 are still owned by the Ministry of Agriculture. Actually, this piece of land was formerly allocated to an agricultural school that no longer exists.

F. Weeds

Although *Striga* may be found in the sorghum and maize fields of the station, infestation by this parasitic weed remains insignificant at present. *Cyperus spp* is more noxious.

IV. NOTE ON OTHER SITES :

The sugarcane substation

A substation completely devoted to sugarcane research is located at 4 km from the main station, near the Lokpoho river. Soils mainly belong to the units 3, 4, and 5 above mentioned. The soil map of this sub-station is available but no free land remains for new trials.

A. The CIDT observation spots

Compagnie Ivoirienne de Développement Textile (CIDT) has a dense network of observation spots (briefly called by the acronym P.O. "Points d'Observation") all over northern Côte d'Ivoire. Provided a special agreement is made with this important company in charge of the development of the savanna zone, trial plots in these observation spots would be very beneficial to have access to more diverse soil especially on granite.

B. The FORO-FORO substation

Located 20 km north from Bouaké, the Foro-Foro substation is mainly used to study irrigated crops and market gardening. The Director of IDESSA would have liked to regroup all the institutes of Bouaké in one site, at Foro-Foro. Due to the lack of funding to build a completely new research complex, apparently this project has been abandoned.

According to LENEUF (1956), the soils which are gravelly and derived from granito-gneiss are very similar to those of Bouaké. Since no particular climatic variation distinguishes either this site, initiating maize experiments in Foro-Foro would not provide more information than those already collected in Bouaké or Ibadan.

V. CONCLUSION

1. Three main soil units of the Ferkéssédougou station are suitable to meet the objectives of IITA. However, even though these soils are representative at a region scale, especially units 2 and 4, one must keep in mind that the best soils are over-represented. Unit 1 may offer too favourable conditions to extrapolate experiments results to the whole moist savanna ecosystem. Anyhow, detailed soil survey must be undertaken to select an uniform track of land so that small differences among genetic materials may be identified. Soil variation along the catena provide suitable conditions to test soil factor x genotype interactions.

2. At present, only one tenth of the available land is used for experiments. Two-thirds are traditionally cropped by the staff and neighbouring farmers. As a result, the station itself yields an interesting sample of a maize system which has to cope with an increasing pressure on land.

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APPENDIX

MET PERSONS :

- Dr.Ouayogode BAKARY*, Director of Research and Training, Ministry of Scientific Research, Abidjan.
- Dr.KOFFI GOLI*, Director of IDESSA, Bouaké
- Dr.MARNOTTE*, Director of the Department of food production, IDESSA, senior weed scientist, Bouaké
- Dr.MOYAL*, senior entomologist, IDESSA, Bouaké
- Dr.BENINGA*, millet breeder, IDESSA, Ferkéssédougou.

OTHER PERSONS TO BE MET BY THE IITA STAFF :

- MM. KONE DOFFANGUI, SOUMAILA TRAORE, GIGOU and CHOPART*, scientists of IDESSA, Bouaké, dealing more or less with soil science.
- KONE LAKOUN*, Director of the Ferkéssédougou station.