

ATLANTIC ZONE PROGRAMME

Field reports No. 8

“ DETAILED SOIL SURVEY OF HACIENDA BREMEN

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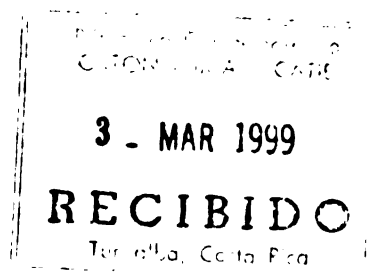
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## PREFACE

The multidisciplinary research carried out in the context of the Atlantic Zone Programme in Costa Rica started with a diagnostic study of the Zone so as to enable the selection of relevant development oriented research themes. A study of the soils and their potential is part of it.

The present detailed soil survey was carried out towards the end of 1986 in the canton Pococí in the northeastern part of the Atlantic Zone. The report is not final. Additional soil studies in the area are required to be able to correlate soil units and to establish definite names so that the nomenclature used in this report is likely to change. Furthermore, the chemical analyses of the soil samples taken from the profile pits had not been completed when the report was prepared. The results presented are therefore of a preliminary nature. The data will eventually be incorporated in a comprehensive report on the soils of the Zone and their potential that is to be prepared in due course.

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## Introduction

This report describes the results of a detailed soil survey (scale 1:17500) of hacienda Bremen, carried out in the period October and November 1986.

The soil survey forms part of joint CATIE-WAU program of research in the Atlantic zone of Costa Rica, and has, in the first instance, to characterize the soil and its properties. The soil survey area of this investigation was restricted to the central part of hacienda Bremen, near Pocora (fig. 1). The area covers about 2000 ha and is bordered by the main road Guapiles-Siquirres and the rivers Parismina and Dos Novillos. Important is the relation between geomorphology and soil formation. Namely, in the soil survey area different stages in age can be made on account of soil formation and geomorphological position.

In this report a general physical description of the soil survey area is given (chapter 1), mentioning subjects like location, geology, parent material, physiography, hydrology and climate. Then the soil survey methods are given (chapter 2), with information about the used aerial photographs and maps and about the way the soil was examined. In the following chapters the soils are discussed, with information on the soil legend (chapter 3) and the soil mapping units (chapter 4). Finally a soil capability judgement for agricultural use is given.

The survey has resulted in the following maps;

- soil map of the central part of hacienda Bremen, based on soil characteristics, scale 1:17500
- soil map of the central part of hacienda Bremen, based on physiography, scale 1:17500
- land capability map of the central part of hacienda Bremen, scale 1:17500
- map of the drilling locations, scale 1:17500

Chapter 1 General physical character of the soil survey area

Hacienda Bremen, near Pocora, is situated in the Atlantic zone of Costa Rica. This is in the lowland at the Atlantic site of Costa Rica that is influenced by the Caribbean sea.

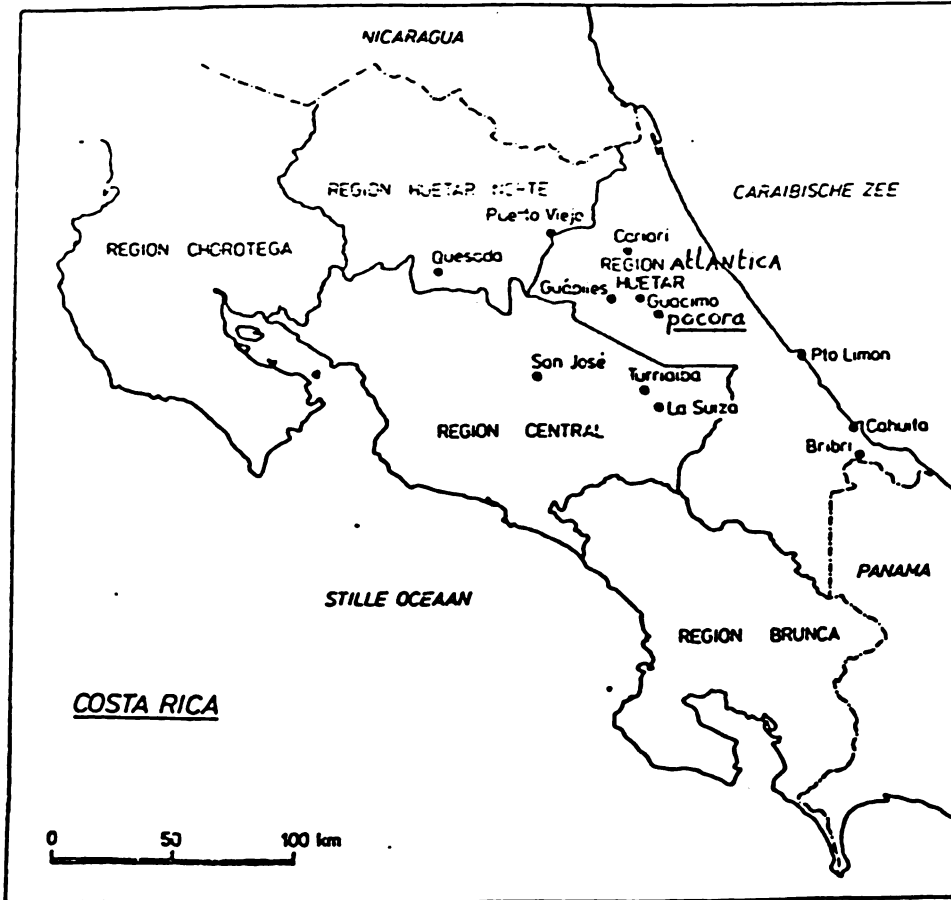


fig. 1 Location map

Hacienda Bremen lies about 114 meter above mean sea level, at the foot of the mountain country of the Cordillera Central. The nearest volcano is the Turrialba with an altitude of 3339 meter. This volcano is build up of andasitic lavas, lahars, tuff and pyroclastic material (Geological map, sheet Limon, scale 1:200000, 1982). The lowland is filled up with quaternary alluvial sediments of volcanic origin. The principle landform is a piedmont alluvial plain. The main part of the soil survey area of hacienda Bremen is a flat plain, slightly

dipping to the north. Only in the northern and western parts appear small hills, which rise to a maximum of about 10 meters above the plain.

Most of the mapped area of hacienda Bremen is drained by the Rio Parismina, Rio dos Novillos, Rio Atarjea, Rio Iroquois and Rio Calzada. The drainage of these rivers is rapid. It is more sluggish in the central part of the area, which is drained by small gullies, so that swampy conditions prevail in those places.

Stream flow in the rivers varies considerably, and maximum discharge is reached in July and August and in October and November. Intense rainstorms in these months cause local flooding along the riversides.

The average annual rainfall at hacienda Bremen is almost always more than 2500 mm. The number of dry months per year is less than one. As shown by the climatic data (table 1), the period January-April is dryer than the other months of the year. During storms the rain-intensity can be very high. Most of the rain falls during the so-called "temporales", when a cold-front or an exhausted hurricane reaches Costa Rica.

	J	F	M	a	M	J	J	a	S	O	N	D
average monthly precipitation	233.1	206.8	110.1	177.5	299.2	265.6	413.9	365.1	252.1	307.3	348.6	281.6

Table 1: Precipitation data from the meteorological station Mercedes (altitude 114 m), during the period 1971-1985

Prec. in mm.

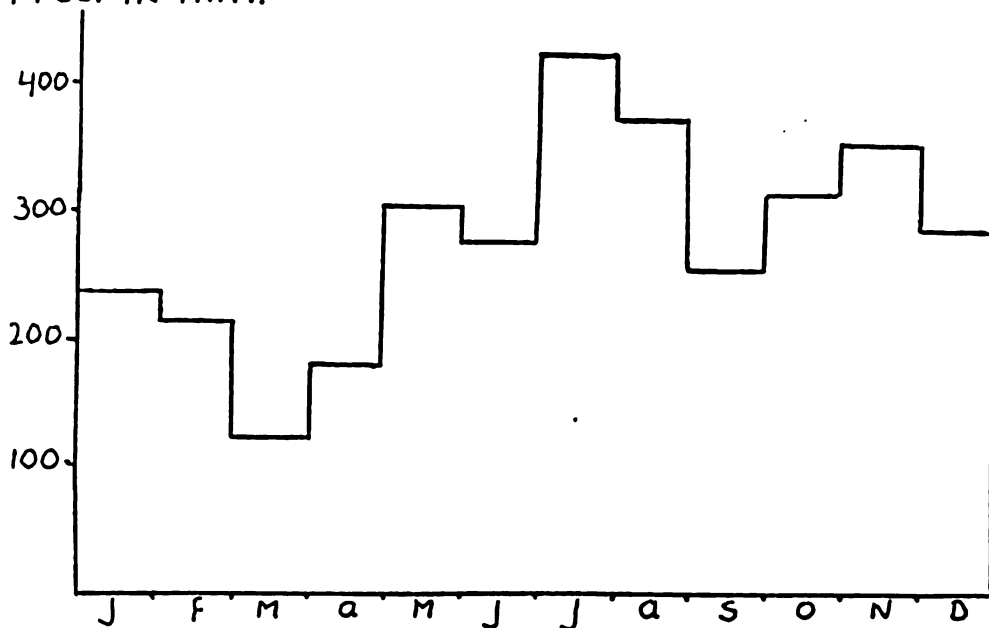


fig. 2 Monthly precipitation at Mercedes/hacienda Bremen

Unfortunately there are no temperature data of hacienda Bremen (altitude 114 m) available. Therefore the temperature data of Carmen (altitude 14 m) and of Guapiles (altitude 249 m) are given. We expect that the annual temperature curve of hacienda Bremen is the average between those of the two mentioned stations.

month	J	F	M	a	M	J	J	a	S	O	N	D
T. max	29.1	28.9	30.0	30.2	31.1	30.3	29.9	30.5	30.8	30.9	30.3	29.7
T. MIN	19.1	19.6	20.2	20.7	21.8	21.8	21.6	21.6	21.4	21.2	20.8	19.6
T. average	23.5	23.6	24.6	25.1	25.9	25.4	25.1	25.2	25.3	25.1	24.6	23.7
average rel. hum.	86.8	86.9	84.8	85.9	87.7	88.3	90.4	89.8	88.2	87.9	89.8	89.2

Table 2: Temperature and humidity data from the meteorological station at Carmen, during the period 1972-1980

month	J	F	M	a	M	J	J	a	S	O	N	D
T. max	29.2	29.0	29.8	30.2	30.9	30.7	29.7	30.2	30.7	30.2	29.5	28.9
T. MIN	19.5	18.5	18.8	19.5	20.4	20.7	20.8	20.6	20.4	20.3	20.4	19.9
T. average	24.5	25.0	26.1	26.7	26.1	25.0	25.6	25.0	24.5	24.5	23.9	23.9
average rel. hum.	85.0	86.0	85.0	84.0	86.0	86.0	87.0	87.0	86.0	86.0	86.0	88.0

Table 3: Temperature and humidity data from the meteorological station at Guapiles, over a period of 24 years (Louette, 1985).

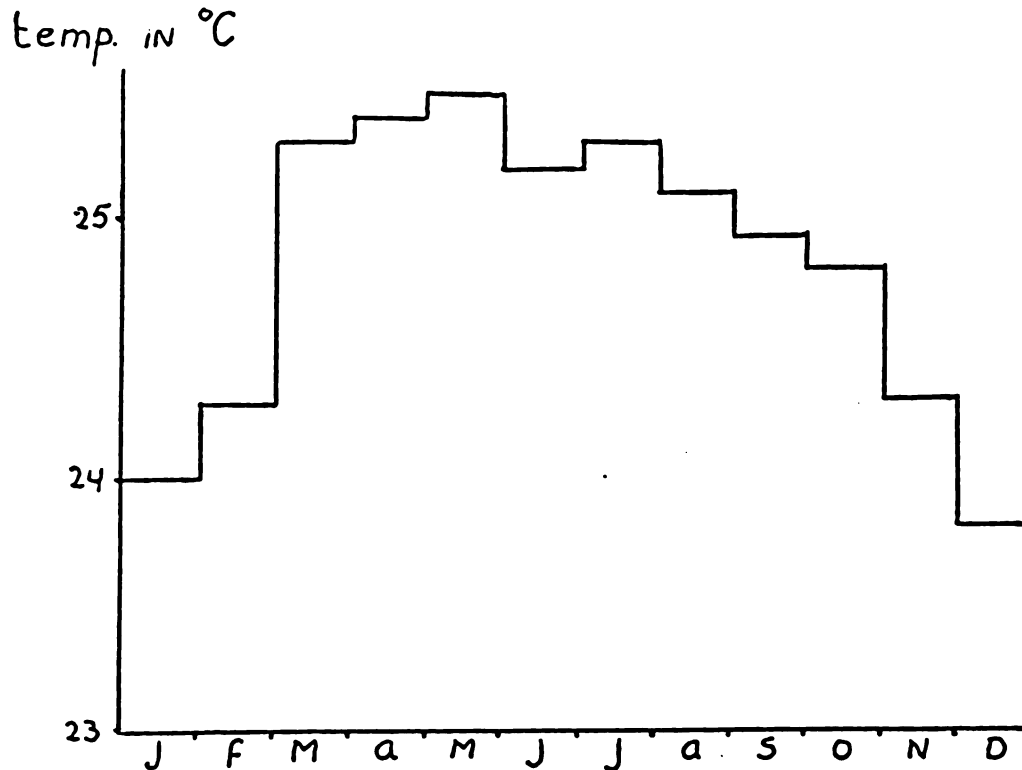


fig. 3 Estimated monthly temperature of hacienda Bremen

During the whole year the average relative humidity is above 85%. The average annual temperature is about 24,9 °C. The difference in temperature between the coldest and hottest month is about 2 °C. The difference in temperature between day and night is about 8 to 10 °C. The average annual sunshine per day is 4,2 hours. The average daily sunshine in the sunniest month is 4,9 hours, and in the cloudiest month 3,1 hours. In general the wind velocity is very low, except just before or during storms (Boerboom et al, 1986).

The greater part of the mapped area of hacienda Bremen is used as pasture. Big plantations with bananas, and increasingly macadamia, are situated along the riversides and in the south-east. Some small plots are used as fields, on which for instance maize is grown. Other small plots are still under forest, but these parts disappear rapidly (fig. 4)



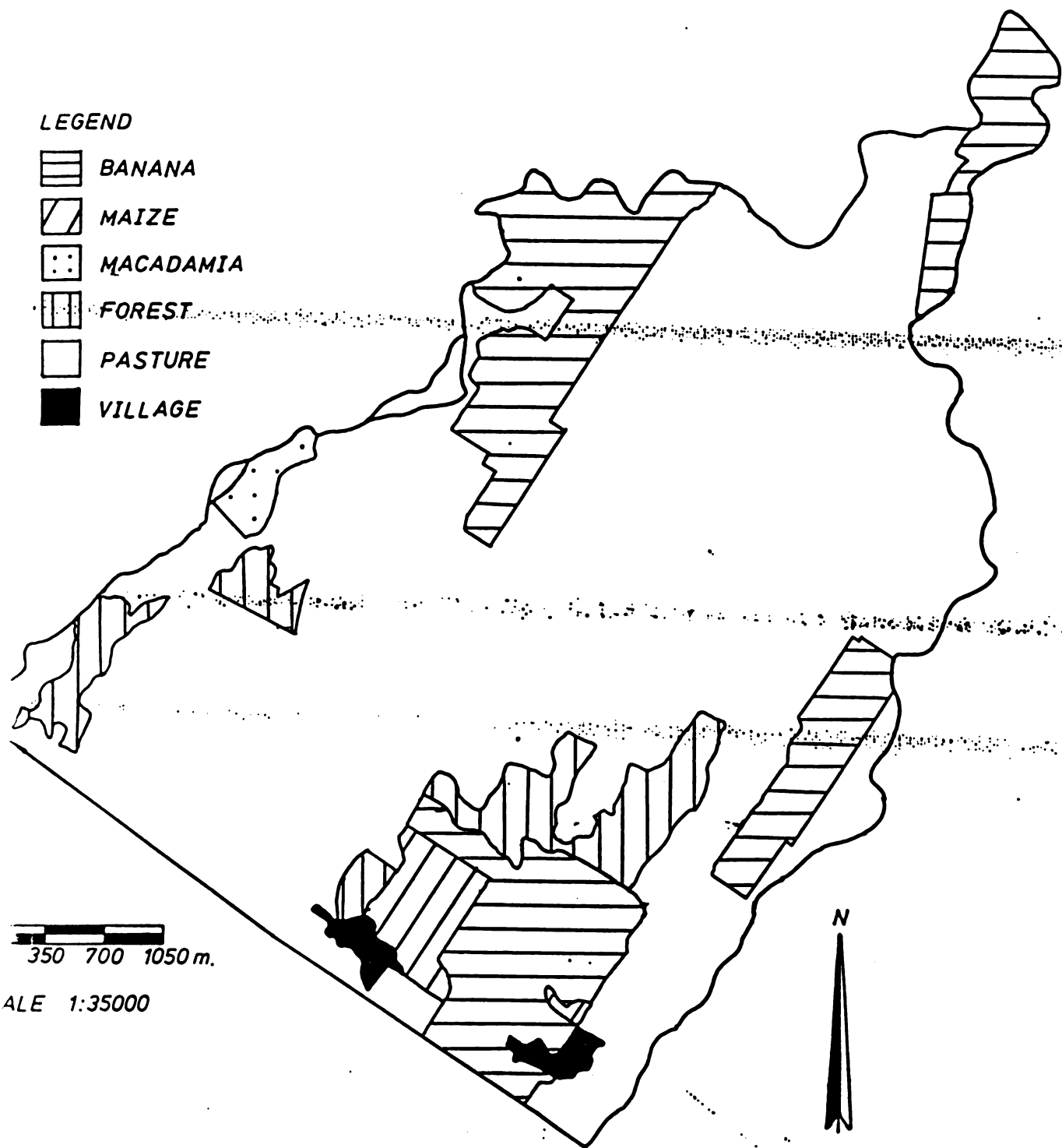


fig. 4 Actual landuse at the central part of hacienda Bremen

Before starting the field work office work was done to gather preliminary information of the territory examined. This included a photo interpretation of the available air photos (1973, R-59 L-238 nr. 051 - 052, scale 1 : 35000; 1981, R-177 L- 242 nr. 24853 - 24857, scale 1 : 35000; 1985, R-231 L-243,7 nr. 38757 - 38758, scale 1 : 35000). Areas were traced with differences in drainage pattern and topography. As an introduction in the surrounding area an excursion was held to get an insight in the geomorphology, sedimentology and pedology.

The available maps were: a topographic map, sheet Guacimo, Hoja 3446 I, scale 1:50000 (I.G.N., 1973); a topographic map of hacienda Bremen, Scale 1:10000 (non-published map, property of hacienda Bremen, 1984); mapa geologico de Costa Rica, sheet Limon, CR2CM-6, scale 1:200000 (I.G.N., 1982); precipitation promedio anual en Costa Rica, periodo 1961 - 1980, scale 1:1000000 (A.G.I.M.N., 1982).

In the semi-detailed soil survey, transverses were made at 100 to 300 meters intervals throughout the area using the 1:35000 aerial photographs to help determine the transverse lines and the points at which to examine the soil. These photographs were used as base maps. The geographical extent of each soil was drawn on the base maps by means of lines intended to separate one soil fase from another.

Soils were examined in augur holes to a depth of 2,20 meter providing parent material was not found above that depth. The holes were spaced in a regular pattern, adapted to variation in topography and vegetation. The outline of each soil fase mapped is based on augur holes, the drainage pattern, on the local vegetation, on the topography and on the pattern of shadowing in the aerial photographs.

Deep pits were dug on carefully selected sites representing the model or central concept of each soil found. If possible pits were dug into underlying parent material. The depth of the pits varied from 60 cm to 150 cm. These pits had distinct horizontal layers called horizons which collectively make up the soil profile. The individual horizons revealed in the pits and the profiles as a whole were examined in detail and observations were made on the number, arrangement and thickness of the horizons; colour of each horizon; texture, or the relative proportions of the various size groups of individual soil grains (sand,

silt, clay) present; structure or the arrangement or natural grouping of soil particles; consistence, or the tendency for the soil to crumble or to stick together; the tixotropy, or the characteristic of material to liquefy under light pressure as a consequence of the expulsion of enclosed water; and other characteristics.

For standardization purposes colour is compared with the Munsell soil colour charts (1975). Colour is usually related to the kind and amount of organic matter and the kinds of minerals present. Texture was estimated in the field by rubbing the moist soil between the fingers. The principle texture classes are: sand, loamy sand, sandy loam, loam, silt, silt loam, clay loam, sandy clay, silt clay and clay. Texture affects moisture retention and the difficulty or ease with which the soil may be cultivated. Structure refers to the shape and arrangement of the natural groups of individual soil particles, and gives clues as to how readily the soil is penetrated by moisture and plant roots and how it will respond physically to cultivation (see also chapter 5). Consistence of each horizon is determined by the way the soil feels under different moisture conditions. This is a valuable aid not only in helping to assess soil texture but it also furnishes a clue as to the nature of the clay minerals.

Other important characteristics observed in the field include the following: the presence of stones that will interfere with cultivation; the steepness and pattern of slopes; the amount and size of mottles; the amount, size and morphology of pores; and the amount and size of roots.

After observing and recording the foregoing physical characteristics in the field, each horizon in the soil pit was sampled for chemical and physical analyses.

## Chapter 3 The soil legend

### Suelo Neguev

The Neguev soil is a deep, well drained, brown, medium to fine structured, porous, very friable soil. It is developed in quaternary river deposits of volcanic origin.

The soil is situated on the high parts in a rolling to hilly landscape in the north and south of the mapped area, or on remnant hills in a gently sloping landscape.

Mostly the Neguev soil has a thin A-horizon (6 - 20 cm) with a dark brown color. It is slightly red or brown mottled, has a strong to moderate structure and has a texture which varies from silt loam to clay loam and silty clay loam.

The thick B-horizon (140 - 190 cm) with a massive porous structure contains much crumb and is dark yellowish brown. Only the top might have a very weak to moderate structure. It has none or very few strongly weathered stones and texture coarsens downward from clay loam to loam and from silt clay loam to silt loam. The horizon is very porous and has pores of various dimensions.

The soil is used for pasture and a small part for bananas.

Closely related to the Neguev soil are the Blanco soil, Iroquois soil, Gley soil and the Mezcla soil. In general the Blanco soil has the same characteristics but is developed in a nearly always watersaturated environment, while the Iroquois soil and the Gley soil contain more and fresh or weathered stones and have a less developed structure of the B-horizon. The Mezcla soil is a mixture of the Neguev soil and Iroquois soil with the Dos Novillos soil.

### Suelo Blanco

The Blanco soil is a deep, fine to medium textured, imperfectly to moderately well drained, porous, very friable soil with a dark topsoil and a bright colored subsoil. It is developed in quaternary river deposits of volcanic origin.

The soil is situated in lower parts and on some terraces in the rolling to hilly landscape in the north and west. Because of differences in altitude some parts of the area covered by this soil are only saturated

with water for a short period a year, while other parts are nearly always saturated with water.

The soil has a black to dark brown, 10 - 55 cm deep, moderate to strong structured topsoil with a texture which varies between clay loam and silty clay loam. The A-horizon has always red and/or brown mottles in the top and nearly always in the whole horizon.

Just below this horizon a gray to brownish yellow, very weak to massive porous structured B-horizon is present which contains much crumb. Few to many soft concretions, and very few strong weathered gravel are sometimes present in the lower part of the horizon. The texture varies between loam and silty clay loam. The horizon is nearly always red and/or brown mottled.

Only the one on the high terraces situated Blanco soils, which are not saturated with water all year, are used as pasture. The soils in the lower positions are swamps. Without artificial drainage nothing, except a swamp vegetation, will grow there. If it is drained it is possible to grow bananas.

The Blanco soil is closely related to the Heguev soil, which is also deep and has a well developed structure, but has a darker B-horizon. Other soils like Iroquois soil and Gley soil have similarities like texture, but contain much more fresh or weathered stones.

### Suelo Iroquois

The Iroquois soil is a deep, moderately well drained, fine to medium textured, very friable brown soil which has few or more fresh or weathered stones within the first 120 cm. It is developed in quaternary river deposits of volcanic origin.

Generally, this soil is situated on gentle slopes, but in some parts the soil is also observed in areas with steeper slopes. Large areas are occupied in the central and north of the mapped area.

An A-horizon is always present and its thickness varies between 10 and 53 cm. The horizon is moderate to weak fine structured, contains none to few fresh to weathered stones of various dimensions and is dark brown to dark yellowish brown. The texture varies between clay loam, silty clay loam, loam and silt loam. Only the top of this horizon shows some compaction and can have some red or brown mottles. The amount of pores increases downward.

The dark yellowish brown to yellowish brown and brown E-horizon has

sometimes brown and/or grey mottles in the lower part. The horizon has few to very frequent weathered to fresh stones in various dimensions. The structure is very weak and mostly the texture shows a coarsening downward and varies from silty clay loam and loam to silt loam and loam.

Nearly everywhere on hacienda Bremen the area occupied by the Iroquois soil is used as pasture. On some small parts bananas are grown, but many of these plantations are abandoned and changed into pastures. The few remnants of the tropical rainforest are also situated on this soil.

The Iroquois soil is closely related to the Gley soil, which is developed in a water saturated environment and shows grey or greyish colors just below or within the A-horizon. Other soils, like the Neguev soil, the Blanco soil and the Mezcla soil show some similarities with the Iroquois soil. The Neguev soil and the Blanco soil are also deep and brown, but have a better developed structure and contain none or very few strongly weathered stones. The Mezcla soil is a mixture of the Neguev or Iroquois soil with the Dos Novillos soil.

#### Suelo Gley

The Gley soil is a deep, imperfectly drained, medium to fine structured and textured, stony soil with a dark topsoil and a bright subsoil. It is developed in quaternary river deposits of volcanic origin. The soil is situated in the lower parts on gentle slopes, mostly close to creeks or rivers. It is nearly always saturated with water.

The very dark gray to dark brown, 10 - 55 cm deep, very weak fine structured A-horizon has a texture which varies between clay loam, silty clay loam and silt loam. Very few or more, fresh to strongly weathered stones can be present in this horizon, which is always red or brown and/or gray mottled.

The B-horizon is very weak structured, gray to brownish yellow and contains always few or more fresh or weathered stones within 120 cm from the surface. Red and/or brown mottles are present in at least a part of the horizon. The texture varies between loam, silt loam, silty clay loam and clay loam and the horizon is very weak structured.

The Gley soil can not be used for any agricultural activity. Even grass will not grow on this wet soil. Only a swamp vegetation is able to flourish in this environment.

Closely related to the Gley soil is the Iroquois soil, which also contains many stones. The Gley soil is always situated in the lower parts between or just beside the Iroquois soil. Another related soil is the Elanco soil which has also a dark topsoil and a bright subsoil and is developed under wet conditions, but contains nearly no stones.

### Suelo Morena

The Morena soil is a deep, dark, porous, well drained soil with a course to medium texture and with thixotropy. The soil is developed on sandy, gravelly and stony quaternary river deposits of volcanic origin.

It is situated on gentle slopes. In the higher part of these slopes, more near the volcano Turrialba, the soil occupies nearly the whole surface except the hills which are covered by the Iroquois soil and the Neguev soil. Downslope, towards the Rio Parismina only tongues of it occur.

The soil has a very dark brown to black, 50 - 12- cm deep, loamy topsoil over a dark yellowish brown to yellowish brown, sandy, weathered B-horizon. Both contain few to very few slightly weathered to fresh stones of various dimensions. Stoniness varies at small distances so that almost no subdivision can be made. Variation in surface stoniness is only due to management. In most pastures belonging to hacienda Bremen nearly all stones are removed or concentrated on spots, in contrast to pastures not belonging to the hacienda, which contain more stones or in which stones have not been concentrated in heaps. The A-horizon as well as the B-horizon have a massive porous structure, with exception of the upper 15 to 20 cm of the A-horizon, which has a weak to moderate fine structure.

Because of the relatively high position, good drainage and massive porous structure the soil is not susceptible to inundation but is very susceptible to erosion. The river cut deep gullies in the soil, except on pastureland and soils with a mulch of leaves. The compact topsoil is due to grazing of cows and can be observed in all pastures. It might be the reason for waterstagnation in the topsoil.

In the mapped area maize and bananas are the main crops on this soil. Despite the good physical characteristics for plantgrowth, none of the crops give good harvests and for this reason many plantations and fields were transformed into pastures.

Closely related to the Morena soil are the Mezcla soil and the Dos

Novillos soil. All of them are young alluvial soils, but the last two are younger. Dos Novillos is more sandy, has a less developed structure and is closer to the present rivers. The Mezcla soil was influenced by recent river alluvium and has characteristics of the Dos Novillos soil, the Iroquois soil and the Neguev soil, but the subsoil contains much more clay.

### Suelo Mezcla

The Mezcla soil is a deep, moderately well drained, brown, very friable, soil with a medium textured, slightly thixotropic topsoil and a fine textured, none thixotropic subsoil. It is developed in loamy river deposits in the upper part and clayey river deposits in the lower part. Both are of volcanic and quaternary origin.

The soil is situated on gentle slopes and terraces, in areas where the Dos Novillos soil is close to the Iroquois soil and the Neguev soil. It is not always present on the boundary of these soil types but only in a small part in the north-west.

The A-horizon with a variation in texture between loamy sand and loam is dark brown to dark yellowish brown colored and has a moderate to very weak fine structure. Sometimes it has a dark brown, strong structured top. High animal activity results in a horizon with much crumb, many fine to very fine pores and a mixing in the lower part between the A-horizon and B-horizon. Only this lower part contains few weathered to strong weathered gravels.

The pale brown to grayish brown and dark yellowish brown, very weak fine structured, mottled B-horizon contains few to very few weathered to strongly weathered gravels. The texture varies between clay loam and silty clay loam.

Nearly the whole area covered by this soil is used for bananas. Only a small area is pasture and shows no compaction because of grazing cows. Severe erosion is prevented by a cover of grass and leave mulch. The soil has strong relations with various soils of the legend. The topsoil has many characteristics for the Dos Novillos soil while the material and development of the subsoil shows many similarities with the clayey Neguev soil and the Iroquois soil. The precise determination of the subsoil was very difficult because of its depth, mixing with the topsoil and influences of the groundwater.



### Suelo Dos Novillos

The moderately deep to shallow, well drained, brown, medium to coarse textured porous Dos Novillos soil has a thixotropic A-horizon direct over a non thixotropic, layered C-horizon. The soil is developed on a sandy, gravelly and stony quaternary river deposit of volcanic origin. It is situated in flat areas or on terraces near or between the Rio Parismina and Rio Dos Novillos.

The very dark grayish brown to dark yellowish brown, very weak fine to very fine structured, slightly to very thixotropic A-horizon has a texture which varies between silty loam and sandy loam. The top of this horizon is mostly one hue and/or one value less. The whole horizon is very friable.

Just below the A-horizon a very dark grayish brown to dark yellowish brown, very weak to porous massive structured, loose to very friable C-horizon is present. The texture varies between sandy loam and sand. In very few soils a slightly thixotropic layer was observed in the C-horizon.

Because of its coarse texture and bad developed structure this soil is very susceptible to erosion, but the presence of a cover with leavemulch or grass slows down this process in a large measure. Even the regular occurrence of inundation in the lower parts don't cause severe erosion. The topsoil shows no compact layer because of grazing cows.

In the mapped area nearly all macadamia and banana plantations are situated on this soil. Only a part of the area between the Rio Parismina and the Rio Dos Novillos is used as pasture.

The Dos Novillos soil is very close related to the Mezcla soil and Morena soil. The latter has a finer texture and a well developed B-horizon and the first is a mixture of the Dos Novillos soil with a brown clayey Iroquois or Neguev soil.

## Chapter 4 Soil mapping units

### A) Based on soil characteristics

The broadest category of this legend of the soil map is based on drainage. Well drained, moderately well drained, imperfectly to moderately well drained and imperfectly drained are the four main units. On the second level the subdivision of these main units is based on texture and on the third level other soil characteristics like stoniness, colour and thixotropy become important.

Each soil description is followed by the name of the Suelo, which has a range in characteristics equivalent to the taxonomical unit Serie. This unit is uniform concerning horizon sequence, horizon characteristics and has developed on one type of parent material (Soil Survey Manual, 1962). The Suelo is preferable because beside the just mentioned characteristics of the Serie it also has to be physiographic mappable. The only disadvantage is the fact that the suelo is not a part of an established taxonomic system like the Soil Taxonomy or the F.A.O. system. The mapping unit is identified (see app. I & II) by a symbol consisting of

- a soil symbol
- a depth class symbol
- a slope class symbol
- a surface stoniness class symbol

The terms used in the legend of the soil map and in the following description of individual soil mapping units are based on the F.A.O. Guidelines for Soil Profile Description (1977). All colours mentioned are for moist soil conditions and are described by the Munsell Soil Colour Charts (1975).

### Soil mapping units

#### 1) Well drained

##### 1.1 Coarse to medium textured

- 1.1.1 Deep, porous, moderate to very thixotropic, few or more fresh to weathered stones containing soil with a very dark brown to black, 50 - 120 cm, loam over dark yellowish brown to yellowish brown loamy sand and sandy loam.

Suelo Morena

1.1.2 Medium to shallow, porous, few or more fresh to weathered stones containing soil with slightly to very thixotropic, very dark grayish brown to dark yellowish brown silty loam to sandy loam over very dark grayish brown to dark yellowish brown layered sandy loam, loamy sand and sand.

Suelo Dos Novillos

1.2 Fine to medium textured

Deep, porous, very few strong weathered stones, dark yellowish brown, clay loam to silt loam.

Suelo Neguev

2) Moderately well drained

2.1 Fine to medium textured

2.1.1 Deep soil with slightly thixotropic dark brown to yellowish brown, 50 - 150 cm, loamy sand and loam over pale brown to grayish brown and dark yellowish brown, mottled clay loam and silty clay loam

Suelo Mezcla

2.1.2 Deep, few or more fresh to weathered stones containing soil with dark brown to dark yellowish brown clay loam, silty clay loam, loam or silt loam over dark yellowish brown to yellowish brown, sometimes brown and/or gray mottled silty clay loam, silt loam or loam

Suelo Iroquois

3) Imperfectly to moderately well drained

3.1 Fine to medium textured

Deep, porous, nearly always red and/or brown mottled soil with black to dark brown, 10 - 55 cm, clay loam and silty clay loam over gray to brownish Yellow loam to silty clay loam with very few or none strongly weathered gravel in the lower part.

Suelo Blanco

4) Imperfectly drained

4.1 Fine to medium textured

Deep soil with dark gray to dark brown, 10 - 55 cm, red and/or brown and/or gray mottled, clay loam, silty clay loam or silt loam with stones over gray to brownish yellow partly red and/or brown mottled loam, silt loam, silty clay loam and clay loam.

Suelo Gley

B) Based on physiography

The broadest category of this legend of the soil map is based on physiography. Only hills and gently sloping areas can be distinguished. On the second level the subdivision is based on the relative age of the parent material and on the third level soil characteristics like drainage, depth and color become important.

For further and more general information see soil mapping units based on soil characteristics.

Soil mapping units

1) Hills

1.1 Old river deposits of volcanic origin

1.1.1 Well drained, deep, porous, very few strong weathered stones, dark yellowish brown, clay loam to silt loam.

Suelo Neguev

1.1.2 Moderately well drained to imperfectly drained, deep, porous, nearly always red and/or brown mottled soil with black to dark brown, 10 - 55 cm, clay loam and silty clay loam over gray to brownish yellow loam to silty clay loam with very few or none strongly weathered gravel in the lower part

Suelo Blanco

## 2) Gently sloping areas

### 2.1 Old river deposits of volcanic origin

2.1.1 Moderately well drained, deep, few or more fresh to weathered stones containing soil with dark brown to dark yellowish brown clay loam, silty clay loam, loam or silt loam over dark yellowish brown to yellowish brown, sometimes brown and/or gray mottled silty clay loam, silt loam or loam

Suelo Iroquois

2.1.2 Imperfectly drained, deep soil with dark gray to dark brown, 10 - 55 cm, red and/or brown and/or gray mottled, clay loam, silty clay loam or silt loam with stones over gray to brownish yellow partly red and/or brown mottled loam, silt loam, silty clay loam and clay loam.

Suelo Gley

### 2.2 Young over old river deposits of volcanic origin

Moderately well drained, deep soil with slightly thixotropic dark brown to yellowish brown, 50 - 150 cm, loamy sand and loam over pale brown to grayish brown and dark yellowish brown, mottled clay loam and silty clay loam.

Suelo Mezcla

### 2.3 Young river deposits of volcanic origin

2.3.1 Well drained, deep, porous, moderate to very thixotropic, few or more fresh to weathered stones containing soil with a very dark brown to black, 50 - 120 cm, loam over dark yellowish brown to yellowish brown loamy sand and sandy loam.

Suelo Morena

2.3.2 Well drained, medium to shallow, porous, few or more fresh to weathered stones containing soil with slightly to very thixotropic, very dark grayish brown to dark yellowish brown silty loam to sandy loam over very dark grayish brown to dark yellowish brown layered sandy loam and sand.

Suelo Dos Novillos

## Chapter 5 Land capability

The in this report used land capability system is the "Manual para la determinacion de la capacidad de uso de las tierras de Costa Rica" (C.C.T., 1985). This modified land classification is based on the Agricultural Handbook no. 210 (1966) of the United States Department of Agriculture.

The used classification system divides the land in 10 classes. It is a hierarchical system and is based on the limiting factors for land capability (appendix VI). The first class has the highest demands for crops and further down in the system the limiting factors decrease. A land unit can be used in its most suited class with the highest yield, but the system allows that the same land unit also can be used in a class further down in the system.

A class is defined as a group of soils which present similar conditions in the relative degree of limitations for potential land use. The system recognises also subclasses, which are the limiting factors for a certain kind of land use. The in this report used limiting factors are not the same as used in the "Manual para la determinacion de la capacidad de uso de las tierras de Costa Rica", but are the estimated physical limiting factors for mechanical agriculture.

The capability classes are:

### I Annual crops (very high yield)

The soils in this class don't have any limitations and their agro-ecological conditions permit sowing, tillage and harvestin, for all kinds of annual crops, that are ecological suited, without decreasing the productive capability of the soil.

### II Annual crops (high yield)

Soils that have agro-ecological conditions that permit sawing, tillage and harvesting of a majority of annual crops that are ecologically suited, without decreasing the productive capability of the soil.

### III Annual crops (moderate yield)

Have agro-ecological conditions similar to the forgoing class, but have more severe limitations. In spite of this limitations the production of selected annual crops is economically managcable, without decreasing the productive capability of the soil.

IV Perennial crops or semi-perennial crops

Soils with agro-ecological conditions that do not allow use of annual crops as defined before, but do allow the sowing, tillage and harvesting of crops with a period of growth of more than two years, or grasses and shrubs that don't need frequent tillage and that protect the soil against erosion, except for a few and short periods, without decreasing the productive capability of the soil.

V Intensive grazing

Soils that don't meet minimal conditions for classification suited for crops as defined before, but are adequate for the continuous grazing at a high level, without decreasing the productive capability of the soil.

VI Extensive grazing

Soils that don't meet the required conditions to cultivate annual or perennial crops, but do allow continuous grazing at moderate or low level, without decreasing the productive capability of the soil.

VII Trec crops

Soils that don't meet the minimal conditions for classifying them as suitable for annual or perennial crops or pasture as defined before, but do present favourable conditions for the establishment of species of trees that keep a protective plant cover, without decreasing the productive capability of the soil.

VIII Intensive forestry

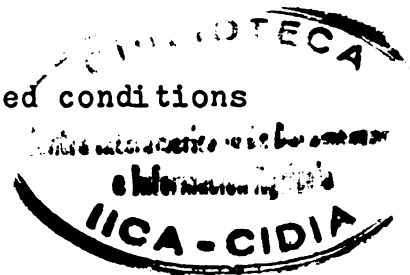
Soils that don't meet the minimal required conditions for crops or pasture, but do allow an intensive and permanent production of wood and other forestry products of natural forest that can be technically managed, without decreasing the productive capability of the soil.

IX Extensive forestry

Soils that do not allow permanent use for crops or pasture, but are suitable for extensive and permanent production of wood and other forestry products of natural forest that can be technically managed, without decreasing the productive capability of the soil.

X Protection

Soils that do not meet the minimal required conditions for crops, pasture or forestry.



The subclasses are:

e erosion

This subclass presents the risk for erosion and contains the slope and the actual erosion.

i inundation

This subclass presents the risk for inundation.

d bad drainage

This subclass presents limitations caused by imperfectly drainage conditions.

o compaction

This subclass presents the risk for compaction of the top-soil.

r poor rooting conditions

This subclass presents the penetrability for roots and contains the soil effective depth and the porosity and the surface stoniness.

m impediment for mechanization

This subclass presents the limitations for mechanization and contains the slope and the surface stoniness.

a deficiency of water

This subclass presents the risk for shortage of water and contains the texture and the soil stoniness.

f low fertility

This limiting factor is shown by the condition of crop growth, thixotropy and the presence of nutrients.

The limiting factor climate is not included in the subclasses because of its similar influence on all soils in this climatic zone.

The foregoing land capability system only represents the most suited land use type. For the landsuitability per land utilization type an



other system, based on the F.A.O. system (1978), is used (App. VII). In this system, with actual and potential use, 4 suitability classes are distinguished. Additionally subclasses are used, which are the same as those used in the land capability classification.

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## ACKNOWLEDGEMENTS

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Appendix V. Descripciones de perfiles

Suelo Neguev

Numero del perfil: ERE 121

Clasificación: F.A.O. :

U.S.D.A.:

Ubicación: Hacienda Bremen; 3/46I Guacimo; 581,1E, 245,6N; entre 10 y 20 m.;  
28/10/1986.

Formación geológica: Cuaternario sedimentario; Qal; Depósitos fluviales,  
coluviales y costeros recientes.

Material de partida: Aluvial derivado de rocas vulcánicas.

Unidad geomorfológica: Cumbre.

Forma del terreno circundante: Colinado

Pendiente donde el perfil está situado: Llano o casi llano.

Vegetación: No vegetación naturales.

Uso de tierra: Pasto.

Erosión: Nil.

Pedregosidad superficial: No hay.

Fauna del suelo: Tartugas, hormigas y c. Mucho actividad de la fauna del  
suelo.

Inclinación: 0%.

Clase de drenado: Bien drenado.

## Descripción del Perfil

### BRE 121

- A1 0-7cm Pardo oscuro (10 YR 3/3) húmedo; pocas, finas, distintas, neto manchas; franco arcillo limoso; fuerte fino, sub-angular bloques; ligeramente adhesivo, ligeramente plástico, muy friable húmedo; frecuentes muy finos poros y abundantes muy finos interstaciales muy pocos grandes, muy pocas medianas, abundantes finas y abundantes muy finas raíces; no tixotropico; brusco plano límite; pH.  
(muestra BRE 121 0-7).
- Bw1 7-22cm Pardo oscuro amarillento (10 YR 4/4) húmedo; no manchas; franco arcillo limoso; moderado; fino sub-angular bloques; no adhesivo, ligeramente plástico, muy friable húmedo; frecuentes muy finos y pocos muy finos poros; abundantes muy finas y muy pocas medianas raíces; no tixotropico; brusco plano límite; pH.  
(muestra BRE 121 7-22).
- Bw2 22-70cm Pardo oscuro amarillento (10 YR 4/4) húmedo; no manchas; franco arcillo limoso; (maciso poroso) sin estructura; ligeramente adhesivo, ligeramente plástico, muy friable húmedo; abundantes muy finos y finos, pocos medianos y pocos grandes poros; frecuentes muy finas raíces; no tixotropico; difuso plano límite; pH.  
(muestra BRE 121 22-70).
- Bw3 70-132+ Pardo oscuro amarillento (10 YR 4/4) húmedo; no manchas; franco limoso; sin estructura (maciso poroso); ligeramente adhesivo, ligeramente plástico, muy friable húmedo; abundantes muy finos y finos, pocos medianos poros; muy pocas, muy finas raíces; no tixotropico. (muestra BRE 121 70-132+).

Suelo Blanco

Numero del perfil: BRE 123.

Clasificacion: F.A.O. :

U.S.D.A.:

Ubicacion: Hacienda Bremen, 3446I Guacimo; 581,2E, 245,6N; entre 10 y 20m.;  
8/10/86.

Formacion geologica: Cuaternario sedimentario; Qal; Depositas fluviales,  
coluviales y costeros recientes.

Material de partida: Aluvial derivado de rocas vulkanicos.

Unidad geomorfologica: Terrace en position alto.

Forma del terreno circundante: Fuertemente ondulado.

Pendiente donde el perfil esta situado: Llano o casi llano.

Vegetacion: No vegetacion naturales.

Uso de tierra: Pasto.

Erosion: Nil.

Pedregosidad superficial: No hay.

Fauna del suelo: No se observan.

Inclinacion: 1%.

Clase de drenado: Moderadamente bien drenado.

## Descripción del Perfil

### BRE 123

- Ap 0-8 Pardo oscuro (10 YR 3/3) húmedo; franco arcillo limoso pocas, finas, distintas, neto, óxido manchas; fuertemente, muy fino sub-angular bloques; ligeramente adhesivo; ligeramente plástico, suelto húmedo; frecuentes muy finos poros y abundantes finos interstaciales; frecuentes muy finas y finas raíces; no tixotropico, neto, plano límite; pH.  
(muestra BRE 123 0-8).
- Au1 8-30 Pardo oscuro (10 YR 3/3) húmedo; franco arcillo limoso moderado, fino y mediano, sub-angular bloques; ligeramente adhesivo, ligeramente plástico, muy friable, húmedo; muchos muy finos poros y pocas muy finos interstaciales; frecuentes muy finas y frecuentes finas y pocas medianas raíces; no tixotropico, neto, ondulado límite; pH. (muestra Bre 123 8-30).
- Au2 30-55 Pardo oscuro (10 YR 3/3) húmedo; franco arcillo limoso; maciso poroso; ligeramente adhesivo, ligeramente plástico, muy friable húmedo; muchos muy finos y frecuentes finos poros; pocas muy finas raíces; no tixotropico; bruceo ondulado límite; pH.  
(muestra BRE 123 - 30-55).
- Bw1 55-94 Amarillo, olivioso (2,5 YR 6/6) húmedo; franco arcillo limoso; maciso poroso; franco arcillo limoso; ligeramente adhesivo, ligeramente plástico, muy friable húmedo; muchos muy finos y muchos finos poros; pocas muy finas raíces; no tixotropico ; neto ondulado límite; pH. (muestra BRE 123 55-94).
- Bw2 94-122 Moreno, brillar, amarillento (2,5 YR 6/4) húmedo; franco arcillo limoso; maciso poroso; ligeramente adhesivo, ligeramente plástico, muy friable húmedo; muy pocas fuertemente meteorizadas, redondeadas gravas; muchos muy finos poros; pocas muy finas raíces; no tixotropico ; gradual ondulado límite; pH.  
(muestra BRE 123 . 94-122 ).



Descripción del Perfil

BRE 123

Bw3 122-145+

Amarillento pardoso (10 YR 6/6) húmedo; franco arcillo limoso; muy débil, muy fino sub-angular bloques; ligeramente adhesivo, ligeramente plástico, muy friable húmedo; muy pocas fuertemente meteorizadas, redondeadas gr vas; muchos muy finos poros; no raíces; no tixotropico ; pH. (muestra BRE 123 122-145+).

Suelo Iroquois

Numero del perfil:ERE 5

Clasificación: F.A.C. :  
U.S.D.A.:

Ubicación:Hacienda Bremen;3446I Guacimo;579,6E244,7N;entre 10 y 20 m.;  
7/10/1986.

Formación geológica: Cuaternario sedimentario;Qal;Depositas fluviales,  
coluviales y costeros recientes.

Material de partida:Aluvial derivado de rocas vulkanicos.

Unidad geomorfologica:Planicie.

Forma del terreno circundante:Ondulado.

Pendiente donde el perfil esta situado:Llano o casi llano.

Vegetacion:No vegetacion naturales.

Uso de tierra:Pasto.

Erosion:Nil.

Pedregosidad superficial:K2 (2-4%).

Fauna del suelo:No se observan.

Inclinacion:0%.

Clase de drenado:Moderamente bien drenado.

## Descripción del Perfil

### TRE 5

- A1 0-7cm Pardo oscuro amarillento (10 YR 3/4) húmedo; frecuentes, pequeñas, definidas, brusco, rojo oscuro manchas, franco arcilloso; moderado, fino sub-angular bloques; ligeramente adhesivo, ligeramente plástico, muy friable húmedo; pocos muy finos poros muy abundantes, muy finas raíces; no tixotropico neto, plano límite; pH.
- A Bw<sub>2</sub> 7-26cm Pardo oscuro amarillento (10 YR 3/4) húmedo; no manchas; franco arcilloso; moderadamente débil, fino, sub-angular bloques; ligeramente adhesivo; muy finos poros; no raíces; no tixotropico ; neto, plano límite; pH.
- Bw 26-54/59 Pardo oscuro amarillento (10 YR 3/6), húmedo; no manchas; franco arcilloso; moderadamente adhesivo ligeramente plástico, muy friable húmedo; muy pocas, meteorizadas y fuertemente meteorizadas, redondeadas gravas y piedras; frecuentes muy finos poros; no raíces; no tixotropico ; brusco irregular límite; pH.
- Br 54/59-94+ Pardo oscuro amarillento (10 YR 4/4), húmedo; no manchas; franco arcilloso; muy débil, fino sub-angular bloques; ligeramente adhesivo; ligeramente plástico; muy friable húmedo; abundantes, meteorizadas y fuertemente meteorizadas, redondeadas gravas y piedras; frecuentes muy finos poros; no raíces; ligeramente tixotropico ; solo muy cerca piedras fuertemente meteorizadas; pH.

Suelo Iroquois

Numero del perfil:BR7 16.

Clasificacion: F.A.C. :

U.S.D.A.:

Ubicacion:Hacienda Bremen;3446I Guacimo;580,0E,242,4N;50 m.;9/10/1986.

Formacion geologica:Cuaternario sedimentario;Qal;Depositas fluviales,  
coluviales y costeros recientes.

Material de partido:Aluvial derivado de rocas vulkanicos.

Unidad geomorfologica:Planicie.

Forma del terreno circundante:plano o casi plano.

Pendiente donde el perfil esta situado:Llano o casi llano.

Vegetacion:No vegetacion naturales.

Uso de tierra:Pasto.

Erosion:Nil.

Pedregosidad superficial:1%.

Fauna del suelo:No se observan.

Clase de drenado:Moderadamente bien drenado.

## Descripción del Perfil

### BRE 16

- Au1 0-11cm Pardo oscuro (10 YR 3/3) en húmedo, franco arcillo limoso, con poco grava redondeado no alterados; estructura moderada en bloques subangulares, finos; no adherente ligeramente plástico, muy friable en húmedo; no se observan cutánes; frecuentes poros intersticiales y tubulares muy fino; muy abundantes raíces finas; límite neto, ondulado; pH no tixotropico.
- Au2 11-31/53cm Pardo amarillento oscuro (7,5 YR 3/4) en húmedo, franco arcillo limoso, con poco grava redondeado y meteorizados; estructura moderada en bloques sub-angulares, finos y medianos; ligeramente adherente, ligeramente plástico, muy friable en húmedo; no se observan cutánes; muchos poros tubulares muy finos; comunes raíces finas; límite brusco, irregular; pH ; no tixotropico.
- Br 31/53-67cm Pardo amarillento oscuro (10 YR 4/6) en húmedo; franco arcillo limoso, con abundante grava a pedregón redondeado y no alterados; estructura débil en bloques sub-angulares; finos; ligeramente adherente, ligeramente plástico, muy friable en húmedo; no se observan cutánes; muchos poros tubulares muy finos; muy pocas raíces muy finas; límite difuso, ondulado; pH ; ligeramente tixotropico.
- Br/c 67-77 Pardo amarillento (10 YR 5/8) en húmedo, franco limoso, con abundante grava a pedregón redondeado y fuertemente meteorizados; frecuentes manchas de color, medianas definidas, neto, pardo fuerte; estructura muy débil en bloques sub-angulares, finos; ligeramente adherente, ligeramente plástico, muy friable en húmedo; no se observan cutánes; frecuentes poros tubulares, muy fino; no raíces; pH ; muy tixotropico.

Suelo Dos Movillos

Numero del perfil: BRE 7.

Clasificacion: F.A.C. :

U.S.D.A.:

Ubicacion: Hacienda Bremen; 3446I Guacimo; 580,6E, 244,6N; entre 20 y 30 m.;  
8/10/1986.

Formacion geologica: Cuaternario sedimentario; Qal; Depositas fluviales,  
coluviales y costeros recientes.

Material de partida: Aluvial derivado de rocas vulcanicos.

Unidad geomorfologica: Terrace.

Forma del terreno circundante: Plano o casi plano.

Pendiente donde el perfil esta situado: Llano o casi llano.

Vegetacion: No vegetacion naturales.

Uso de tierra: Plantacio de bananas.

Erosion: Nil.

Pedregosidad superficial: 1%.

Fauna del suelo: No se observan.

Inclinacion: 0%.

Clase de drenado: Bien drenado.

## Descripción del Perfil

### BPE 8

- A1 0-51cm Pardo grisáceo muy oscuro (10 YR 3/2) húmedo; no manchas; franco arenoso; muy fébil; muy finos; sub-angular bloques; no adhesivo, no plástico, muy friable; húmedo; no grava; muchos muy finos y finos poros; pocas finas raíces; ligeramente tixotropico; brusco plano límite; pH.
- Cu1 51-75/82cm Pardo grisáceo muy oscuro (10 YR 3/2) húmedo; no manchas; arena; sin estructura; adhesivo; no plástico, suelto húmedo; pocas; no alteradas; redondeadas gravas; muchos muy finos y finos poros; pocas finas raíces; no tixotropico; gradual ondulado límite; pH.
- Cu2 75/82-106/113 Negro (10 YR 2/1) húmedo; no manchas; arena; sin estructura; no adhesivo, no plástico, suelto húmedo; pocas, no alteradas, redondeadas gravas; muchos muy finos y finos poros; no raíces; no tixotropico; gradual ondulado límite; pH.
- Cu3 106/113-125+ Pardo grisáceo muy oscuro (10 YR 3/2) húmedo; frecuentes, medianas, definidas, neto, pardo fuerte manchas; arena; sin estructura; ligeramente adhesivo, no plástico, suelto húmedo; no grava; muchos muy finos y finos poros; no raíces; no tixotropico, pH.

APPENDIX VII. LAND SUITABILITY

THE SURLOS (5 PHASES)	INTENSIVE ANNUAL CROPS		EXTENSIVE ANNUAL CROPS		INTENSIVE PERENNIAL CROPS		EXTENSIVE PERENNIAL CROPS		PASTURE		TREES
	IMO	IM	IMO	IM	IMO	IM	IMO	IM	IMO	IM	
MEQUEY	IMO	IM	IMO	IM	IMO	IM	IMO	IM	IMO	O	IMO
BLANCO	IMO	IM	IMO	IM	IMO	IM	IMO	IM	IMO	dr	IMO
IROQUOIS	IMO	IM	IMO	IM	IMO	IM	IMO	IM	IMO	M	IMO
OLEY	IV		IV		IV		IV		IV		IV
MOREXA	IMO	IM	IMO	IM	IMO	IM	IMO	IM	IMO	M	IMO
MEZCLA	IMO	IM	IMO	IM	IMO	IM	IMO	IM	IMO	md	IMO
DOS MEVILLOS	IMO	IM	IMO	IM	IMO	IM	IMO	IM	IMO	Iia	Iia

LIMITING FACTOR

- e erosion
- i inundation
- d drainage
- o compaction
- r rooting conditions
- m mechanization
- a deficiency of water
- f low fertility

SUITABILITY CLASSES

- I very suitable
- II moderate suitable
- III slightly suitable
- IV non suitable

current suitability subclass

required improvement potential suitability subclass





APPENDIX VIII DIAGNOSTIC CHARACTERISTICS

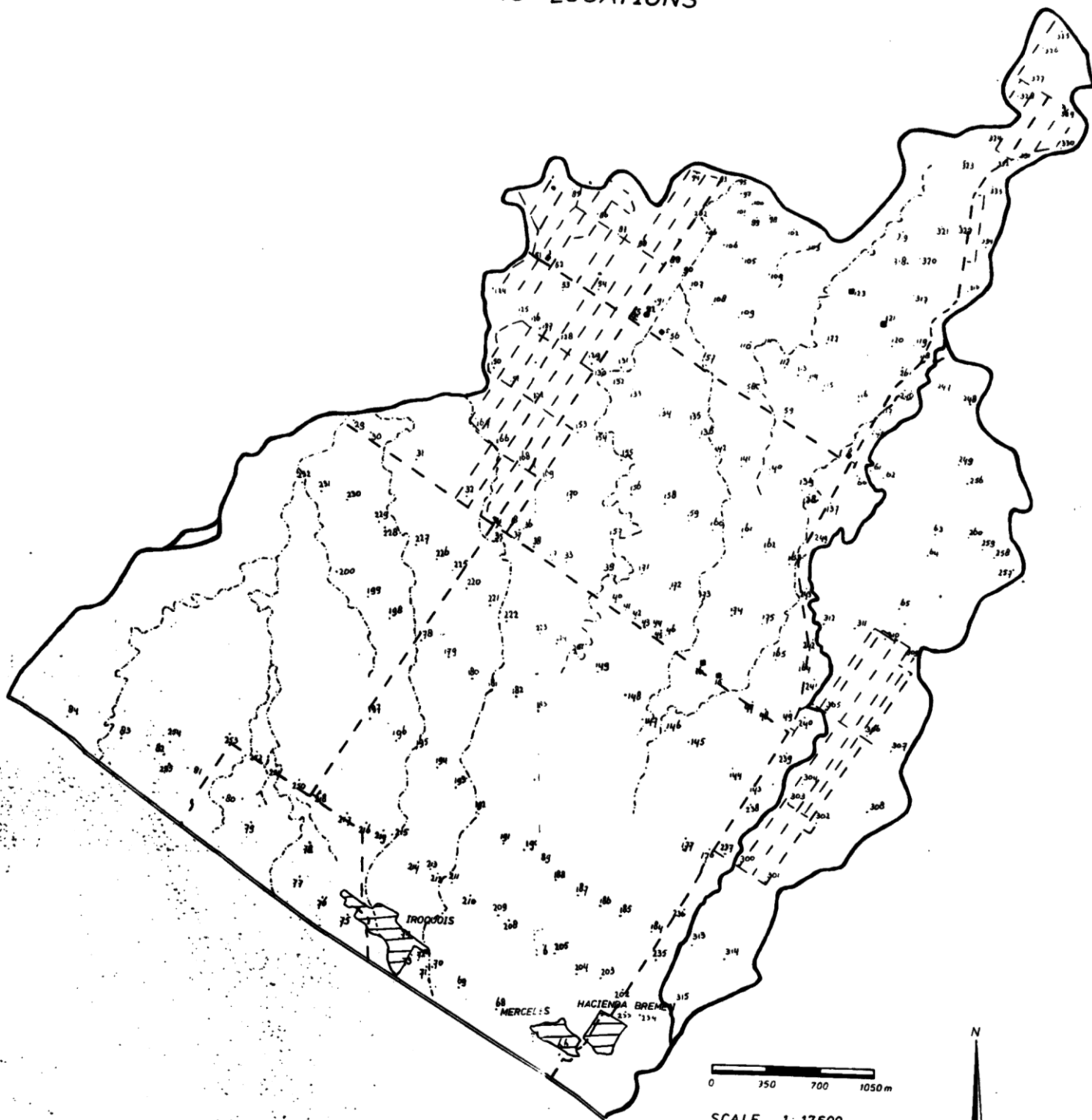
Legend  
 L loam  
 SL silty loam  
 SCL silty clay loam  
 CL clay loam  
 LSa loose sandy loam  
 SAL sandy loam  
 Sa sand

Soils	Topography	Genetic soil horizon	Colour A-hor.	Texture			Thixotropy	Gley	Stoniness in profile	Other
				A-hor.	B-hor.	C-hor.				
Mequeo	hills in a rolling to hilly area	ADC	dark brown	SL, CL, SCL or L	SL, CL, SCL or L	?	non	none	non or very few, strongly weathered	much crumb to depth over 100 cm
Blanco	flat valley bottoms and terraces in a rolling to hilly area	ABGcG or AGBgG	black to dark brown	CL or SCL	L, SL or SCL	?	non	always present at a depth less than 60 cm	non or very few, strongly weathered	-
Irrequiza	flat to undulating	ABC	dark brown to dark yellowish brown	CL, SCL, L or SL	CL, SCL, L or SL	?	non	none	few or more fresh to weathered within 120 cm	-
Gley	flat to undulating	AGBgG	very dark gray to dark brown	CL, SCL or SL	CL, SCL, L or SL	?	non	always present at a depth less than 60 cm	few or more fresh to weathered within 120 cm	-
Morena	flat to undulating	ABC	very dark brown to black	L	LSa or SAL	?	moderate to very	none	fresh to weathered	A-horizon over 50 cm
Mezcla	flat to undulating	ABBcb	dark brown to yellowish brown	LSa or L	L or SCL	?	slightly thixotropic topsoil	non or present at a depth of more than 60 cm	non or few to very few fresh to strongly weathered	-
Don Novillo	flat to undulating	AC	very dark grayish brown to dark yellowish brown	SL, L or SAL	no B-hor.	LSa, or LSa or Sa	slightly to very thixotropic topsoil	none	few or more fresh to weathered	very dark grayish brown to dark yellowish brown layered parent material





## DRILLING LOCATIONS



0 350 700 1050 m

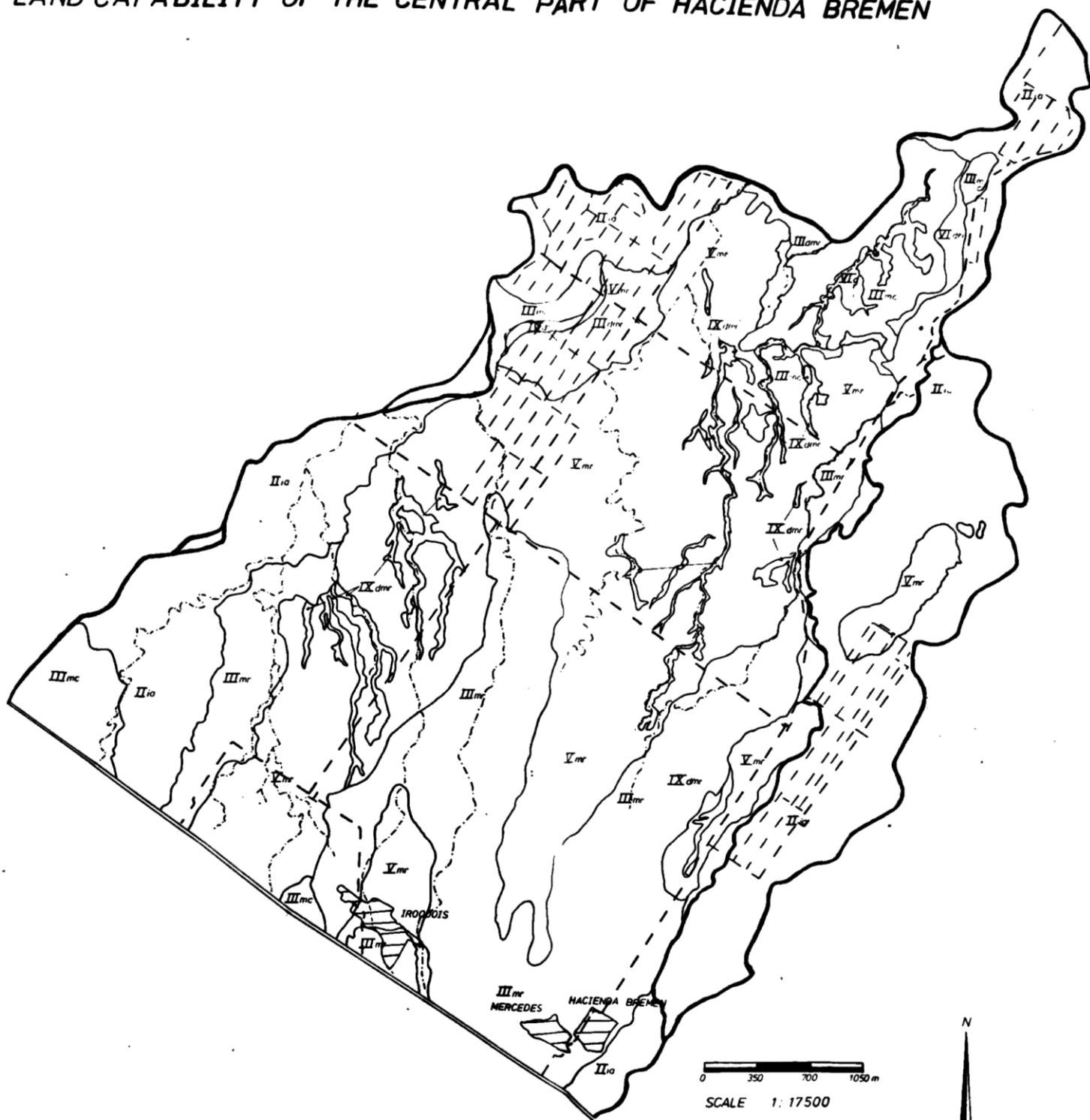
SCALE 1:17500

MIM MEUFFELS

JWH JANSSEN

GUAPILES, COSTA RICA 1986

# LAND CAPABILITY OF THE CENTRAL PART OF HACIENDA BREMEN



III<sub>mr</sub>  
MERCEDES  
HACIENDA BREMEN  
II<sub>io</sub>

0 350 700 1050 m

SCALE 1:17500

H. J. M. MEIFFELS  
J. W. H. ANSSEN

GUAPILES, COSTA RICA, 1986

ANNEX VI LAND CAPABILITY AND LIMITING FACTORS

MAPPING UNITS	EROSION			INUNDATION	BAD DRAINAGE	COMPACTION	POOR ROOTING CONDITIONS			IMPEDIMENT FOR MECHANIZATION			DEFICIENCY OF WATER			LOW FERTILITY				
	slope	actual erosion	total				soil effective depth	porosity and structure	total	slope	surface stoniness	total	texture	soil stoniness	total	condition of crop	thixotropy	presence of nutrients	total	
Neguev	Ne-5 C	+++	+	**	0	0	+++	0	C	0	++	0	++	0	0	0	+++	0	+	**
	Ne-6 D	+++	+	**	0	0	+++	0	0	0	+++	0	+++	0	0	0	+++	0	+	**
	Ne-5/5 D	+++	+	**	0	0	+++	0	C	0	+++	0	+++	0	0	0	+++	C	+	**
	Ne-6 E	+++	+	**	0	0	+++	0	0	0	+++	0	+++	0	0	0	+++	0	+	**
Blanco	B1-5 A	0	0	0	++	+++	+++	+++	+	+++	0	0	0	0	0	0	++	0	+	**
	B1-6 E	+	+	+	++/+++	+++	+++	+++	+	+++	+++	0	+++	0	0	0	++	0	+	**
Iro- quois	Ir-3 A	C	C	0	0	+	**	0	+	+	0	0	0	0	+	+	++	0	+	**
	Ir-3/5 A	0	0	0	0	+	**	0	+	+	0	0	0	0	+	+	++	0	+	**
	Ir-3/4 A K1/2	0	0	0	0	+	**	0	+	+	0	++	++	C	+	+	++	0	+	**
	Ir-4/5 A	0	0	0	0	+	**	0	+	+	0	0	0	0	0	0	++	0	+	**
	Ir-4/5 K1	0	0	0	0	+	**	0	+	+	0	+	+	0	C	0	++	0	+	**
	Ir-4/5 K1	0	0	0	0	+	**	0	+	+	0	+	+	0	0	0	++	0	+	**
Gley	Ir-2/3 B K1	+	+	+	0	+	**	0	+	+	0	++	++	0	+	+	++	0	+	**
	G1-2/5 A K1	0	0	0	+++	+++	**	+++	++	+++	0	+	+++	0	0	0	+++	0	+	**
Morano	Mo-3 K1	0	+	+	0	0	+	C	C	0	0	+	+	0	+	0	+	+++	0	**
	Mo-4 K1	0	+	+	0	0	+	C	0	0	0	+	+	0	+	0	+	+++	0	**
	Mo-3/5 A	0	+	+	0	0	+	0	0	0	0	0	0	0	0	0	+	+++	0	**
	Mo-2/4 A/B K1/2	0	+	+	0	0	+	0	0	0	0	+	+	0	+	0	+	+++	0	**
Mezcla	Me-3/5 A	0	+	+	0	+	+	0	0	0	0	0	0	0	0	0	+	+	+	+
	Me-4/5 A	0	+	+	0	+	+	0	0	0	0	0	0	0	0	0	+	+	+	+
	Me-6 A K1	0	+	+	0	+	+	0	0	0	0	+	+	0	+	0	+	+	+	+
Dos Novil- los	Do-2/3 A	0	+	+	++	0	0	0	0	0	0	0	0	++	0	++	0	++	0	**
	Do-2/3 A K1/2	0	+	+	++	0	0	0	0	0	0	+	+	++	0	++	0	++	0	**
	Do-2/4 A K1	0	+	+	++	0	0	0	0	0	0	+	+	++	0	++	0	++	0	**
	Do-3/4 A	0	+	+	++	0	0	0	0	0	0	0	0	++	0	++	0	++	0	**
	Do-3/4 A K1	0	+	+	++	0	0	0	0	0	0	+	+	++	0	++	0	++	0	**

LAND CAPABILITY
III so
VI dri
V mr
IX dar
III mr
III dar
II la

0 non limiting  
 + slightly limiting  
 ++ moderate limiting  
 +++ severely limiting

H.J.M. MEUFFELS  
 J.W.H. JANSSEN  
 Guapiles, Costa Rica, 1986.

## Soil legend based on physiography

## 1) Hills

## 1.1 Old river deposits of volcanic origin

1.1.1 Well drained, deep, porous, very few strong weathered stones, dark yellowish brown, clay loam to silt loam.



Suelo Heguev

1.1.2 Moderately well drained to imperfectly drained, deep, porous, nearly always red and/or brown mottled soil with black to dark brown, 10 - 55 cm, clay loam and silty clay loam over gray to brownish yellow loam to silty clay loam with very few or none strongly weathered gravel in the lower part.



Suelo Blanco

## 2) Gently sloping areas

## 2.1 Old river deposits of volcanic origin

2.1.1 Moderately well drained, deep, few or more fresh to weathered stones containing soil with dark brown to dark yellowish brown clay loam, silty clay loam, loam or silt loam over dark yellowish brown to yellowish brown, sometimes brown and/or gray mottled silty clay loam, silt loam or loam.



Suelo Iroquois

2.1.2 Imperfectly drained, deep soil with dark gray to dark brown, 10 - 55 cm, red and/or brown and/or gray mottled, clay loam, silty clay loam or silt loam with stones over gray to brownish yellow partly red and/or brown mottled loam, silt loam, silty clay loam and clay loam.



Suelo Gley

## 2.2 Young over old river deposits of volcanic origin

Moderately well drained, deep soil with slightly thixotropic dark brown to yellowish brown, 50 - 150 cm, loamy sand and loam over pale brown to grayish brown and dark yellowish brown, mottled clay loam and silty clay loam.



Suelo Mezcla

## 2.3 Young river deposits of volcanic origin

2.3.1 Well drained, deep, porous, moderate to very thixotropic, few or more fresh to weathered stones containing soil with a very dark brown to black, 50 - 120 cm, loam over dark yellowish brown to yellowish brown, loamy sand and sandy loam.



Suelo Morena

2.3.2 Well drained, medium to shallow, porous, few or more fresh to weathered stones containing soil with slightly to very thixotropic, very dark grayish brown to dark yellowish brown silty loam to sandy loam over very dark grayish brown to dark yellowish brown layered sandy loam and sand.



Suelo Dos Novillos

## Soil legend based on soil characteristics

## 1) Well drained

## 1.1 Coarse to medium textured

1.1.1 Deep, porous, moderate to very thixotropic, few or more fresh to weathered stones containing soil with a very dark brown to black, 50 - 120 cm, loam over dark yellowish brown to yellowish brown loamy sand and sandy loam.



Suelo Morena

1.1.2 Medium to shallow, porous, few or more fresh to weathered stones containing soil with slightly to very thixotropic, very dark grayish brown to dark yellowish brown silty loam to sandy loam over very dark grayish brown to dark yellowish brown layered sandy loam, loamy sand and sand.



Suelo Dos Novillos

## 1.2 Fine to medium textured

Deep, porous, very few strong weathered stones, dark yellowish brown, clay loam to silt loam.



Suelo Heguev

## 2) Moderately well drained

## 2.1 Fine to medium textured

2.1.1 Deep soil with slightly thixotropic dark brown to yellowish brown, 50 - 150 cm, loamy sand and loam over pale brown to grayish brown and dark yellowish brown, mottled clay loam and silty clay loam.



Suelo Mezcla

2.1.2 Deep, few or more fresh to weathered stones containing soil with dark brown to dark yellowish brown clay loam, silty clay loam, loam or silt loam over dark yellowish brown to yellowish brown, sometimes brown and/or gray mottled silty clay loam, silt loam or loam



Suelo Iroquois

## 3) Imperfectly to moderately well drained

## 3.1 Fine to medium textured

Deep, porous, nearly always red and/or brown mottled soil with black to dark brown, 10 - 55 cm, clay loam and silty clay loam over gray to brownish yellow loam to silty clay loam with very few or none strongly weathered gravel in the lower part.



Suelo Blanco

## 4) Imperfectly drained

## 4.1 Fine to medium textured

Deep soil with dark gray to dark brown, 10 - 55 cm, red and/or brown and/or gray mottled, clay loam, silty clay loam or silt loam with stones over gray to brownish yellow partly red and/or brown mottled loam, silt loam, silty clay loam and clay loam.



Suelo Gley

Soil depth*	
1.	0- 25 cm
2.	25- 50 cm
3.	50- 80 cm
4.	80-120 cm
5.	120-180 cm
6.	more than 180 cm
1/2.combination of classes	
Abbreviation suelo name	
Mo-3	K1
Surface stoniness	
K1.	0- 2%
K2.	2- 5%
K3.	5-15%
K4.	15-30%
K5.	30-60%
K6.	more than 60%
1/2.combination of classes	
Topography of surrounding country	
A.	0- 2%
B.	2- 5%
C.	5- 8%
D.	8- 15%
E.	16- 30%
F.	more than 30%
H.	mountainous
A/B.combination of classes	

\*Note: This soil depth means the depth of the top of the C-horizon. For the suelos Dos Novillos, Iroquois, Morena and Gley it can also mean the depth on which stones are found within the A or B-horizon.

- Unit boundary
- Estimated fase boundary
- Highway
- Local road
- Main river
- Tributary
- Village
- Drilling location & number
- Pit & number

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