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COUNTRY REPORT - FRENCH GUIANA

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INTRODUCTION

This report presents the main types of acid soils at present surveyed, where most crops are cultivated in French Guiana. These soils are mainly found along the coast, as the interior, sparsely populated, is not at present included in the development plan.

Although knowledge of the morphology and organization of the soils of this coastal strip is quite advanced, little is still known of their agronomic potential and use. The morphology and variability of the different soil mantles in this area will be given, followed by a brief account of the climate. The agricultural exploits will then be discussed along with the main agronomic problems which already handicap development.

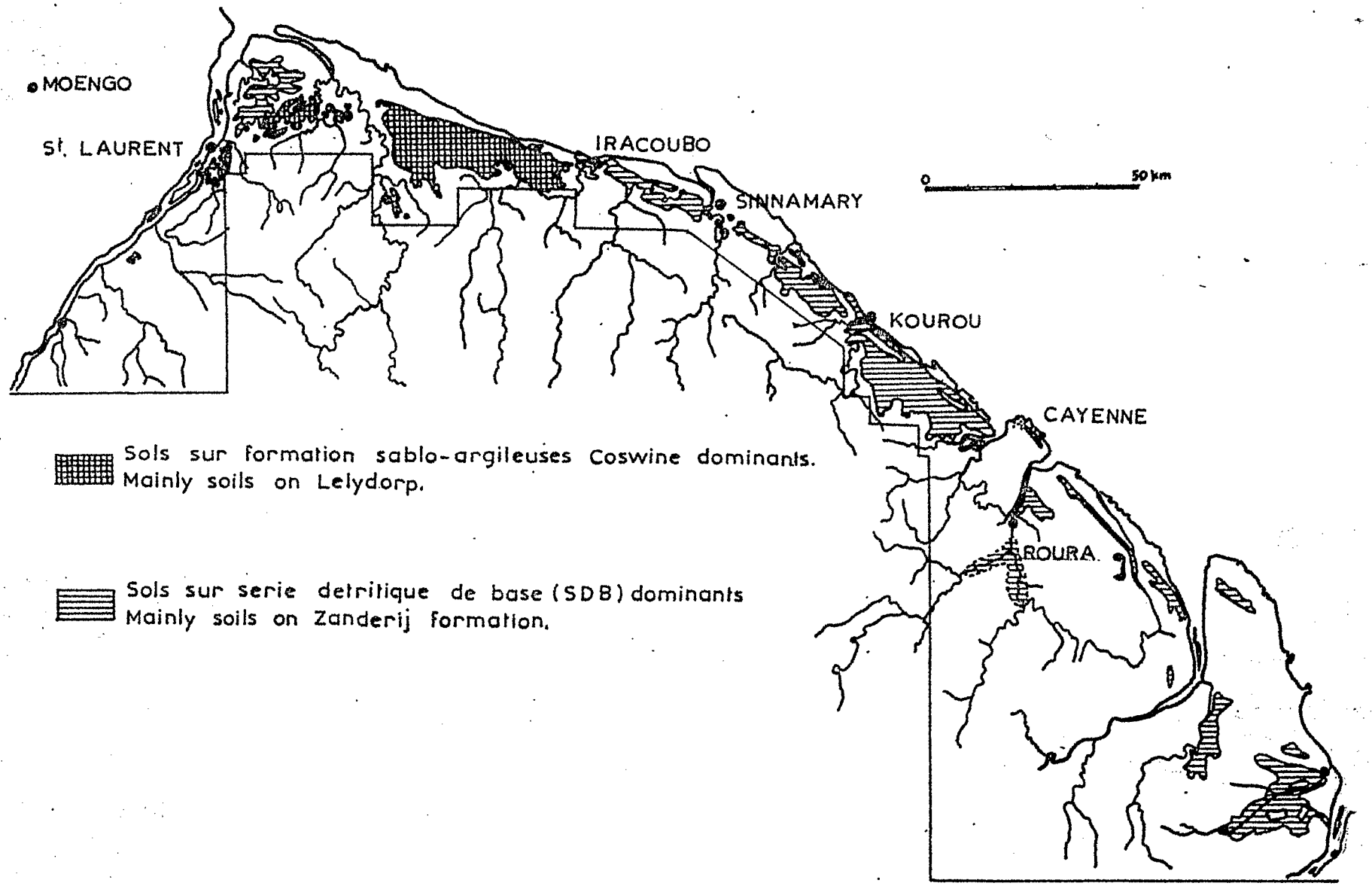


FIG: 1. Extent of Lelydorp and Zanderij formations in French Guina.

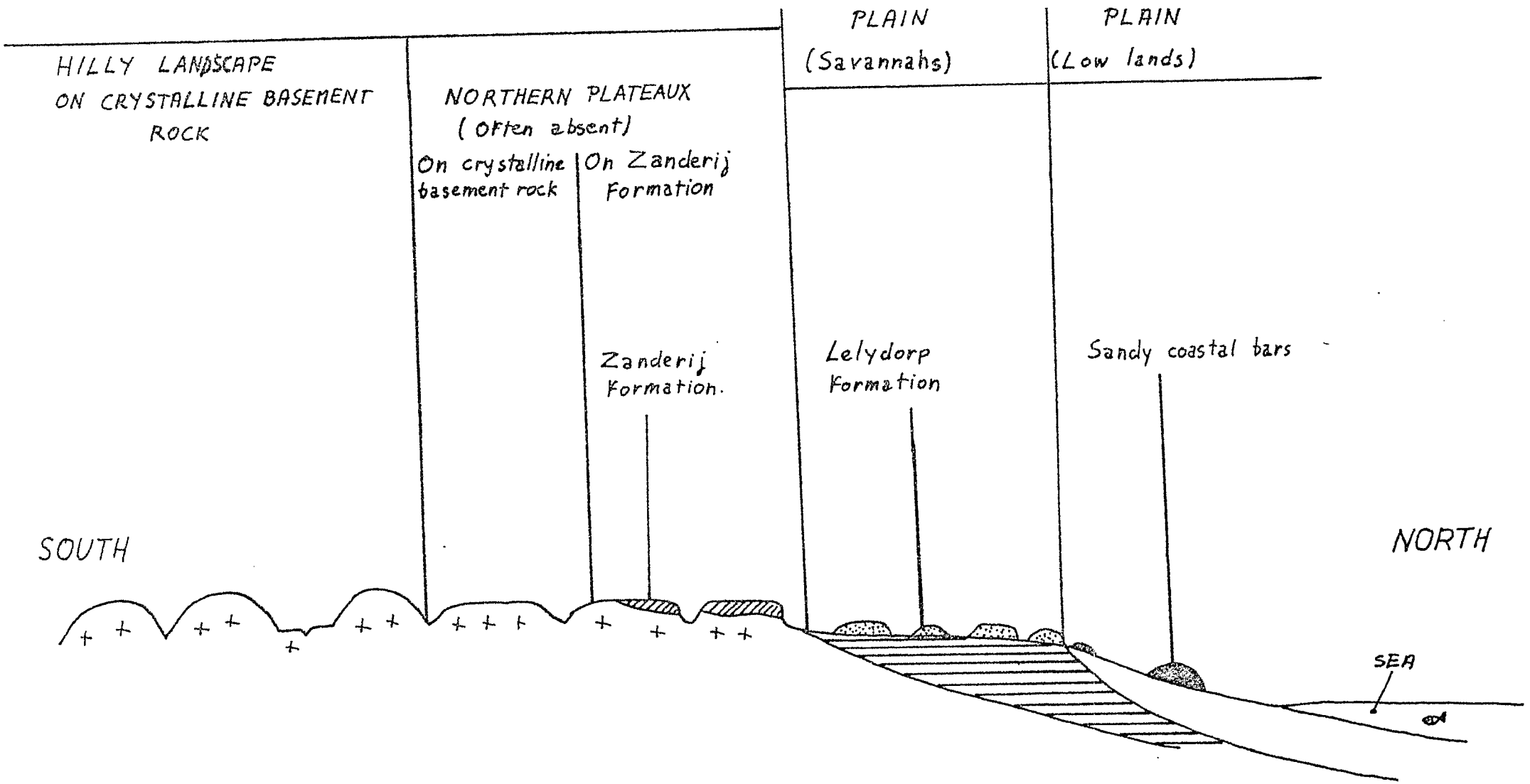


FIG. 2. RELATIVE POSITION OF CRYSTALLINE BASEMENT ROCK AND SANDY TO SANDY CLAY SEDIMENTARY DEPOSITS.

SOIL TYPES, THEIR EXTENT AND PROPERTIES

The acid soils on sandy to sandy-clay, sedimentary formations which have so far been surveyed in French Guiana, are found on Zanderij formations, Lelydorp formations and sandy formations on recent coastal bars.

Soils on Zanderij formation

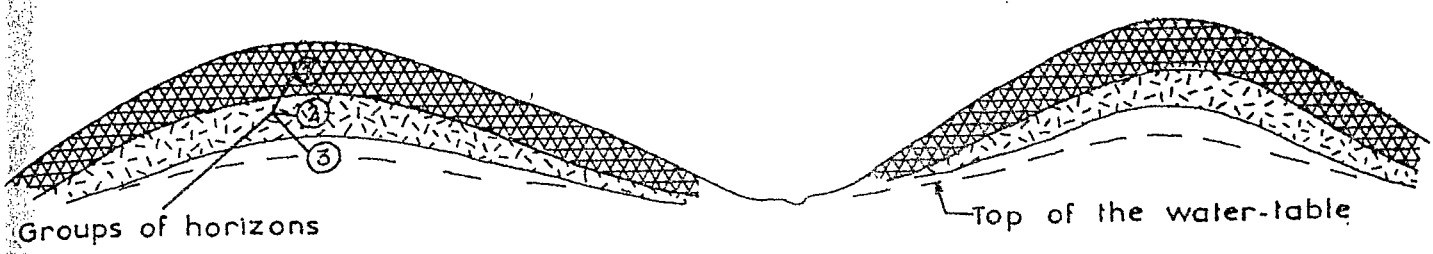
The Zanderij formation, called in French Guiana, the Detrital Basement Series (SDB), is found in the north west of the country. Its present known extent is shown in Figure 1 and covers more than 53000 ha. Figure 2 shows the position of the Zanderij formation relative to the surrounding formations : the formation is unconformable with the basement crystalline rock on which it lies, and is at the limit between this rock and the ancient coastal plain formations. It covers surface areas varying between strips of a few hectares to plateaux of over 5000 ha.

Morphological observations made in the field during soil surveys have enabled us to broadly retrace the history of the region's soil formations with the appearance of the Zanderij formation. This history will be briefly given as it explains the distribution, organization and dynamics of the soils encountered. It may be divided up into four stages, schematized in Figure 3 :

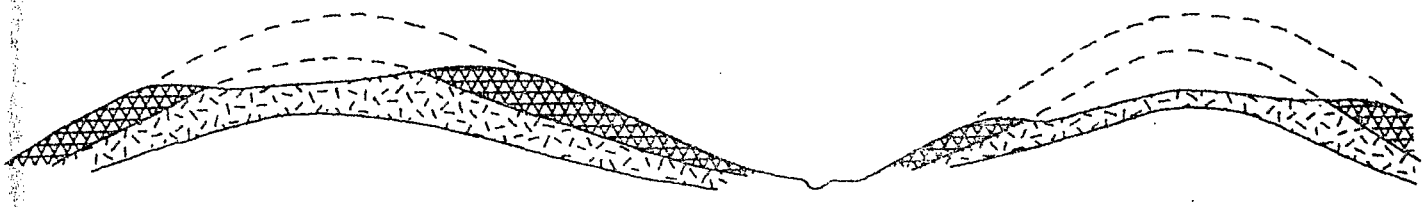
a) Initial formation, on the basement crystalline rock, of a soil mantle with the same horizon types as presently found in soils on this rock.

b) At an undetermined period, most probably antequaternary, truncation of this soil mantle during an active erosion period.

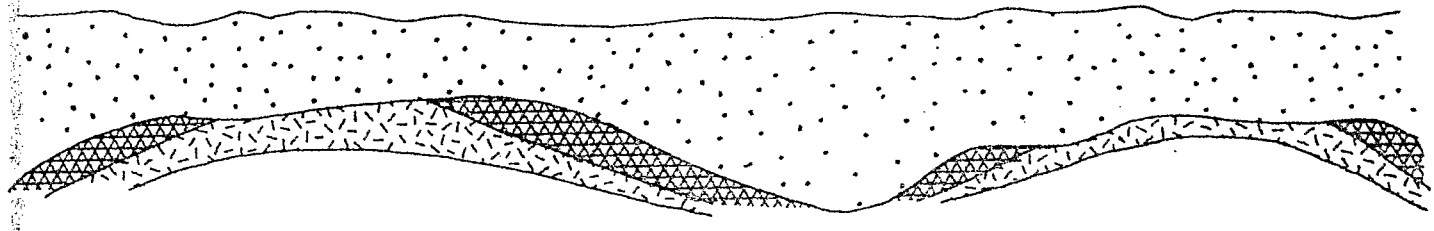
c) Simultaneously, or a little later, appearance of the Zanderij formation. From what we know of present-day sedimentations, it is most probably a question of continental spreading in relation to shifting rivers. The base of this sedimentation is systematically marked by a thin bed (5cm) of smooth quartz pebbles. Thicker beds no doubt mark the position of bigger water flow axes.



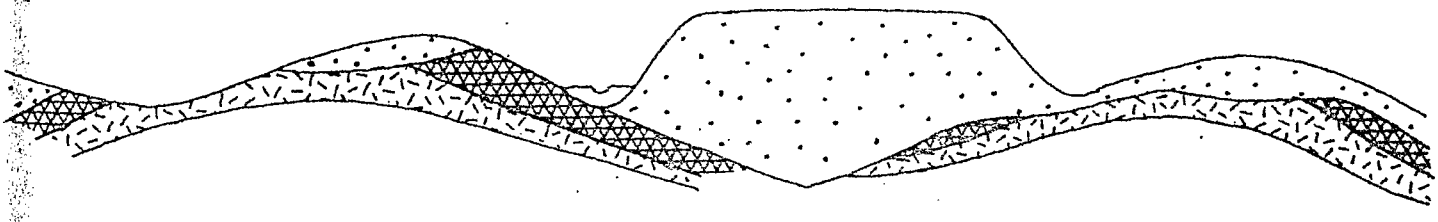
A- First topographical surface, with initial soil mantle.



B- Truncation of this soil mantle: second topographical surface.



C- Deposit of the zanderij formation: third topographical surface.



D- Actual stage: Fourth topographical surface, cutting through previous formations.

FIG: 3. The different stages of the formation of soils and landscape in the aera where the zanderij formation is present, French Guiana.

d) During the quaternary, the topographical surface then sank into this sedimentary formation, sometimes reaching the base.

It is therefore the intersection of three seemingly independent, topographical surfaces which determines the complex distribution of the various soil materials. This complexity (Figure 3 gives one an idea) has important consequences : it is impossible to foresee the distribution of materials from a limited number of observations made in particular sites. Therefore, a systematic survey has to be made in these regions, the size of the squaring depending on the precision required for the use in view.

In fact, it is essential that one should be able to differenciate between soils on sufficiently thick Zanderij formation, soils on a shallow Zanderij formation, lying on horizons weathered from basement crystalline rock, and soils directly formed from this weathering rock. When certain horizon types, formed on the basement rock, (horizon groups 2 and 3 in Figure 3 for example), are present near the surface (about 1 meter deep), the water flow in the soil is essentially superficial and lateral compared to soils with a vertical and deep water flow. This difference in water circulation is of great agronomic importance, and must therefore be identified by surveying.

When the Zanderij formation is sufficiently thick, the soils are either brightly coloured, of white sand, or are a combination of both in transformation system.

The brightly coloured soils represent the least transformed part of the Zanderij formation. These soils have a strong brown colour (7,5YR 5/6,5/8) whose texture is sandy-loamy to sandy-clay loamy from 20cm deep. This clay content increases reaching a maximum around 30 to 40%, 110cm deep. This content remains at about 30% in a thick, strong brown horizon with a massive, microaggregated structure (ϕ about 0,2mm). These soils may present morphological variations in the eluviation and dulling of the surface horizons: under the humiferous horizon is a brown, yellow-brown, sandy horizon (10YR5/4-5/3), with a distinct passage, at 30 to 80cm, to strong coloured, clayier horizons. In this case, between 40 and 60cm, one may observe a more compact horizon of greater bulk density, associated with the transient presence of a perched water table during the rains.

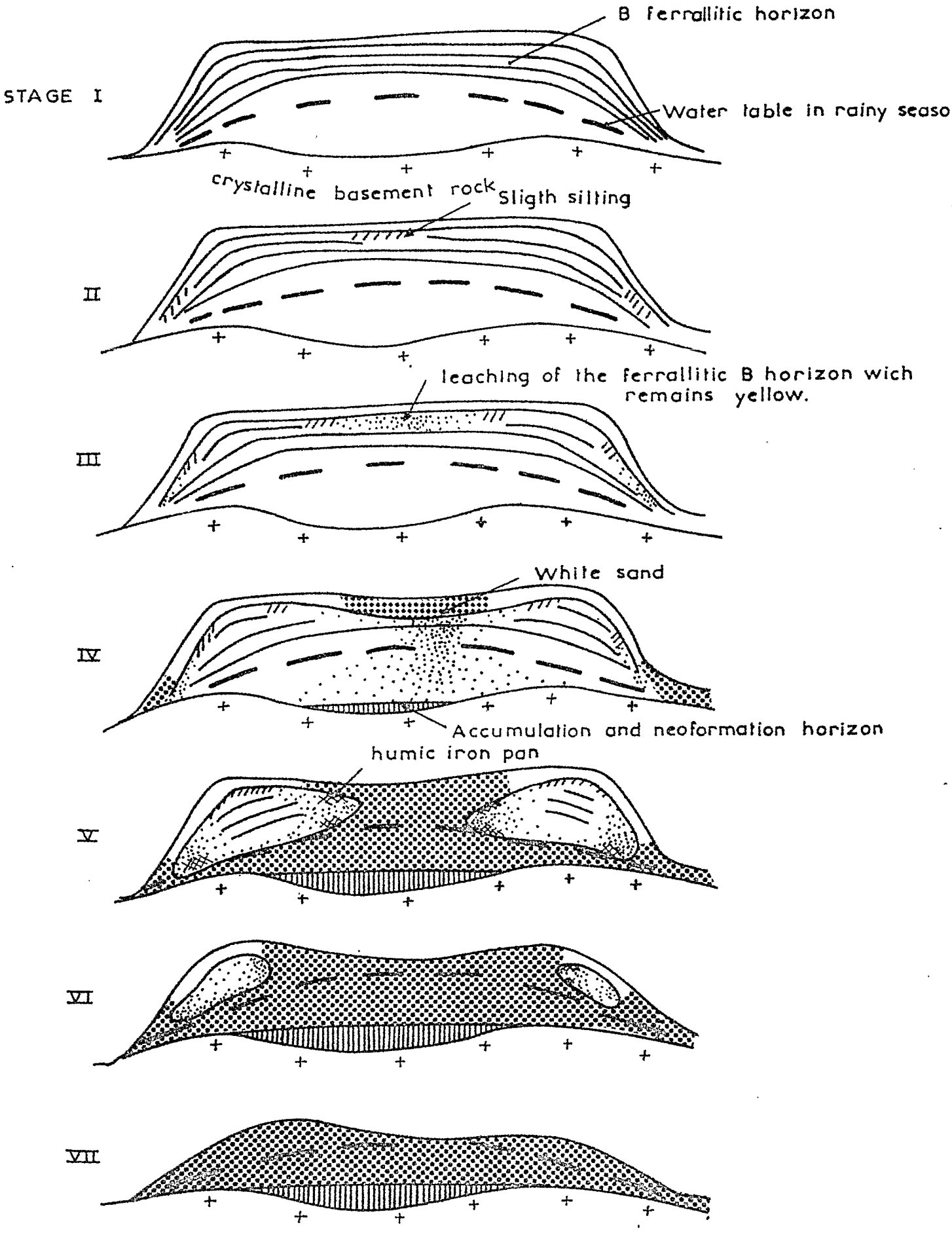


FIG: 4. Schematized transformation stages from a sandy-clay mantle on zanderij formation to a sandy white mantle.

The white sand soils represent the most transformed part of the Zanderij formation. They comprise a dark grey horizon which gradually becomes white sand 30cm down. The texture is very sandy, clay content being less than 1%. Water infiltrates rapidly, without being retained by a soil whose retention capacity is very low. It feeds a water table which fluctuates rapidly and, in places, reaches the surface, either at the bottom of a slope or at the centre of a plateau.

These two extremes, strongly coloured soils and white sand soils, are two poles of a transformation system. This system was discovered and then studied with much field work, first by J.F. Turenne and then by R. Boulet and F.-X. Humbel. The various stages of this transformation are schematized in Figure 4. In short, the clay fraction gradually disappears from the centre and from the limits of the landscape units, which cover a few kilometers, without decolorating the soil. When the clay content falls below a threshold of about 3%, one notes a whitening of the sandy material associated with the frequent presence of horizons with an accumulation of organic matter and iron (Bh, fe). These horizons are situated at the contact between the upper and lower transformation fronts. This transformation, which is thus a podzolization, eventually sweeps away the complete soil mantle and so only white sand remains.

The strong coloured, untransformed soils on Zanderij formation are among the least limiting soils of the French Guiana highlands. They are therefore the first to be surveyed. The Iracoubo-Saut Sabbat region is at present under study.

Soils on Lelydorp formation

The Lelydorp formation also has varied soils which constitute a transformation system. It forms precoastal bars which roughly run parallel with the coast, 1 to 10m high, 200m long, 5 to 800m wide. They are found on the coastal strip, running about 20 kilometres inland. Their present known extent is shown in Figure 1, and covers about 100,000 ha, associated with Para formation.

On these bars, the least transformed stage has soils, sandy and brown on the surface, becoming, 40cm down, strong brown, sandy loamy

to sandy clay loamy, fine sand (ø 0,1mm, 20% clay) with a possible presence of violet-red spots or nodules. Their thickness depends at what depth the Para clay appears. The most transformed stage has a white sand profile lying directly on Para clay. Between these two extremes are intermediate stages with eluviation of surface horizons, until a decoloration threshold of 3-5% clay is reached and a textural floor is formed with the appearance of a discontinuous and transient Bh Fe horizon. This transformation is both centripetal, beginning at the centre of the bars, and centrifugal, beginning at their limits.

Soils of recent coastal bars

The recent coastal bars, with medium to coarse sand, also differenciate between yellow, sandy, well-drained soils and white sand soils where the water table is near the surface during the rainy season. These formations are limited to narrow strips parallel with the coast.

Acid soils on material from the basement crystalline rock.

Certain soils on the basement crystalline rock have features and a morphology which closely ressemble the least transformed soils on Zanderij formation. They are found on topographical surfaces which follow on from the Zanderij formation. Their profile is conformable with the topography. Underneath brown to yellow-brown surface horizons, one observes a thick, yellow-red, clay to sandy clay horizon (over 1m), porous, with numerous microaggregates which passes onto a redder horizon of compact aspect. Rainwater drains vertically through the whole profile. These soils are called "free vertical drainage" soils. They are also an initial stage of a transformation sequence, which differs considerably from the Zanderij formation sequence. In brief, various studies have shown that this transformation is initiated by a relative subsiding of the base level which causes the topographical surface to sink into the horizon sequence just described. This is due to a tectonic lifting of French Guiana between two subsident, sedimentary basins, Guyana-Surinam in the north and the Amazon basin in the south. When the red horizon of compact aspect or the deeper horizons appear near the surface (less than about 1m),

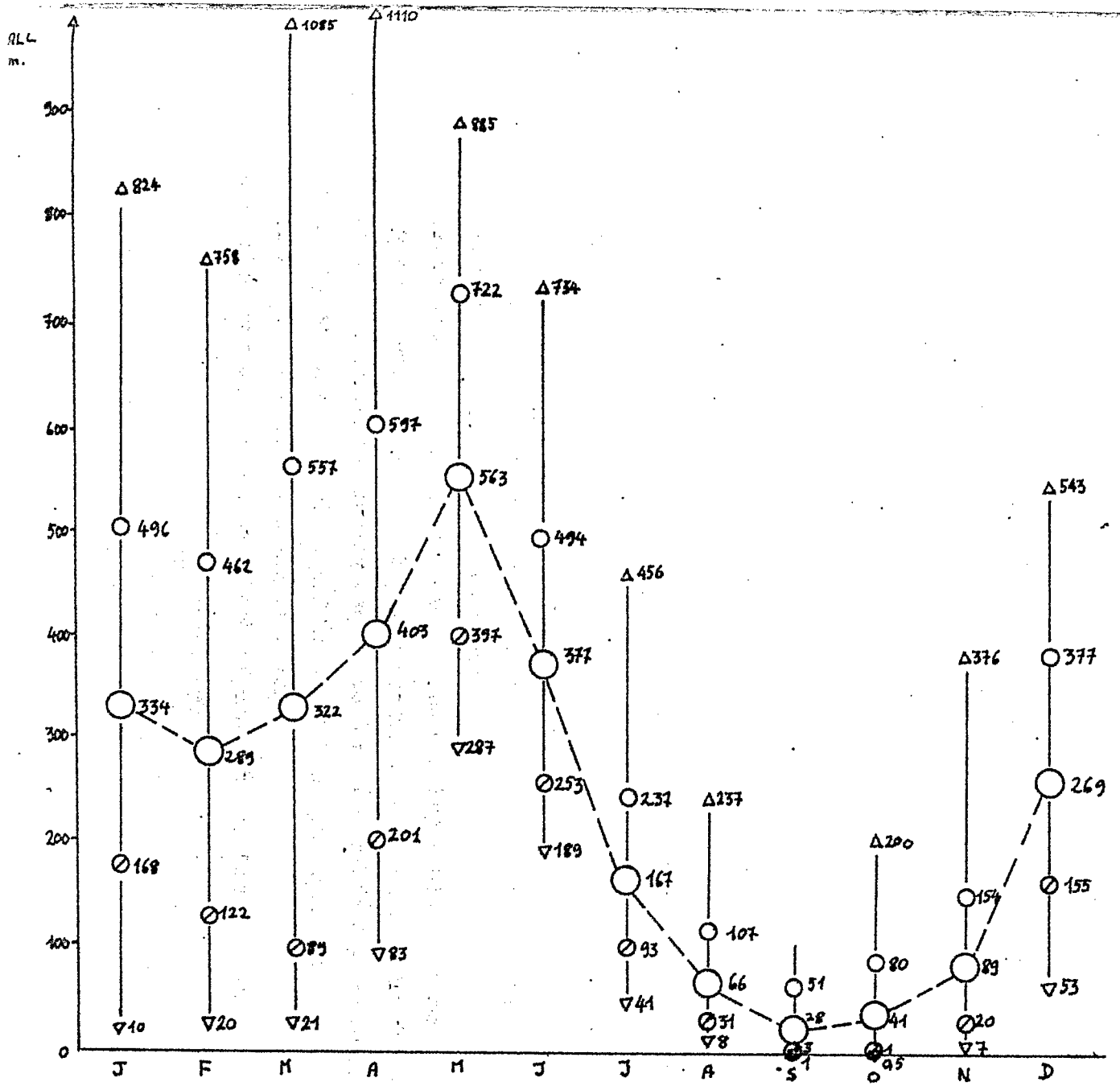


FIG. 5

FREQUENTIAL STUDY OF MONTHLY RAINFALL

(FROM PH. GODON, 1980)

they cause the water flow to become essentially superficial and lateral; these soils are, called "blocked vertical drainage" soils. This differentiation of the water flow is at present an important limitation for agricultural development and usage. Techniques must be developed to eliminate these drawbacks as these soils cover considerable areas of the high lands.

CLIMATIC CONDITIONS (Ph. Godon, 1980)

The Guianese climate, of equatorial type, has two seasons :

- dry season from mid-August to mid-November.
- rainy season from mid-November to mid-August.
  This last season can be divided into three periods :
  - two intensive rainy periods (1st and 2nd crop cycles)
  - a statistical slackening of the rains ("little March summer" between these two cycles).

The rainfall regime is dependent on the intertropical convergent zone.

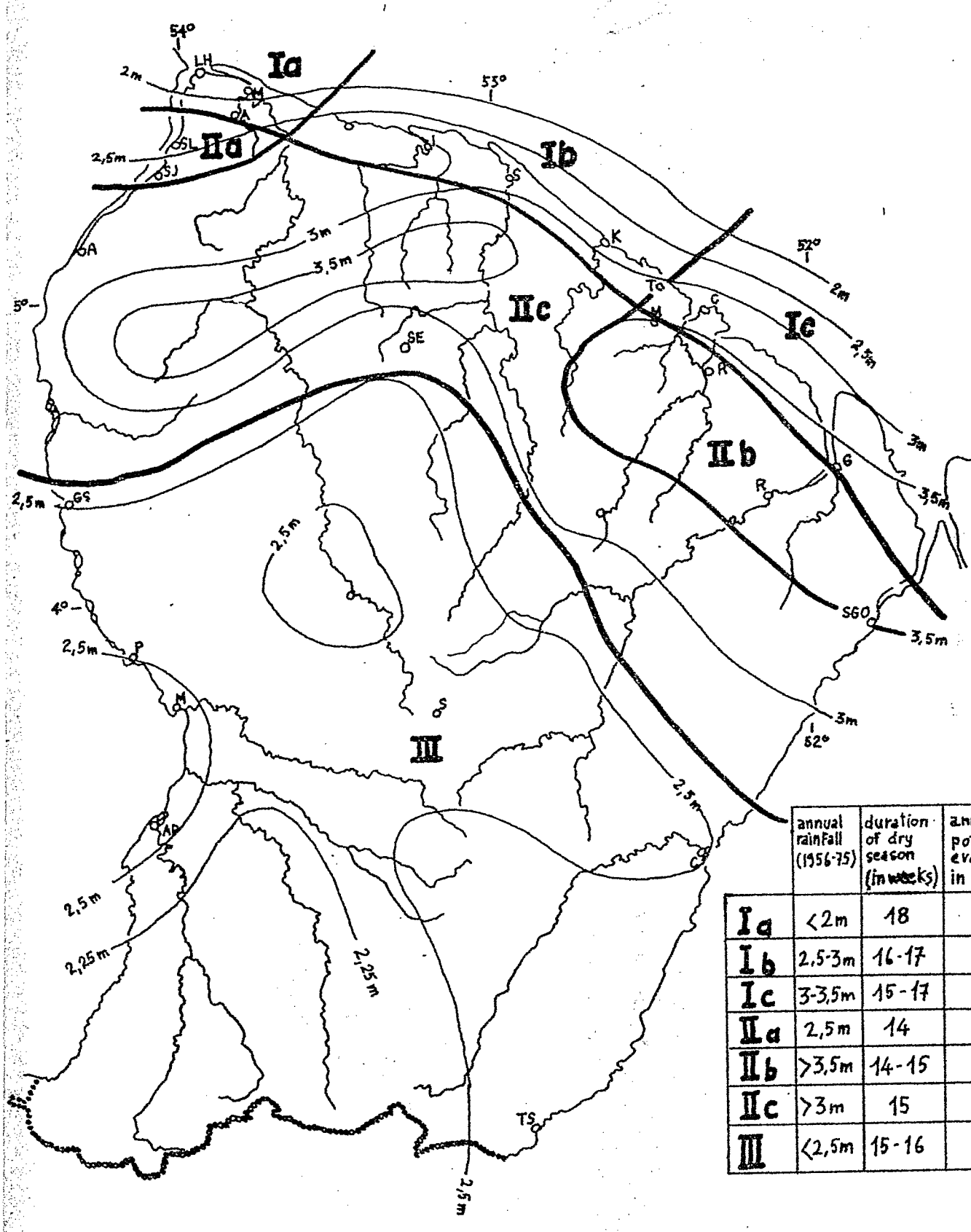
Rainfall varies considerably from one year to the next and there is considerable dispersion of monthly averages, as shown in Figure 5. Average annual rainfall can double (ex. 1,5m to 4,2m in Cayenne). Rains are sometimes heavy and of long duration. They slacken inland and in the north.

The yearly mean temperature is high (25,5°C at Rochambeau); relative humidity is high all year round, winds are light. Variations in daily sunlight are considerable. Potential evapotranspiration is high.

From an agro-climatic standpoint, one notes :

- The long rainy season favours perennial crops or ones with a long growth period (over ten months).
- Crops with a usual growth period (few months) could be grown twice a year. There are however restrictions : during the first period, difficult maturing and harvesting (possible dry February); during the second period, difficult tillage and sowing with risks of water excess in May and June.

All crops may be subject to a lack of sunlight during certain periods or to water excess at other times.



	annual rainfall (1956-75)	duration of dry season (in weeks)	annual rainfall / potential evapotranspiration in march.
Ia	<2m	18	<1,5
Ib	2,5-3m	16-17	1,5-2
Ic	3-3,5m	15-17	2,5-3
IIa	2,5m	14	1,5
IIb	>3,5m	14-15	>2,5
IIc	>3m	15	1,5-2
III	<2,5m	15-16	1,5-2

FIG. 6._ AGROCLIMATIC AREAS IN FRENCH GUIANA.

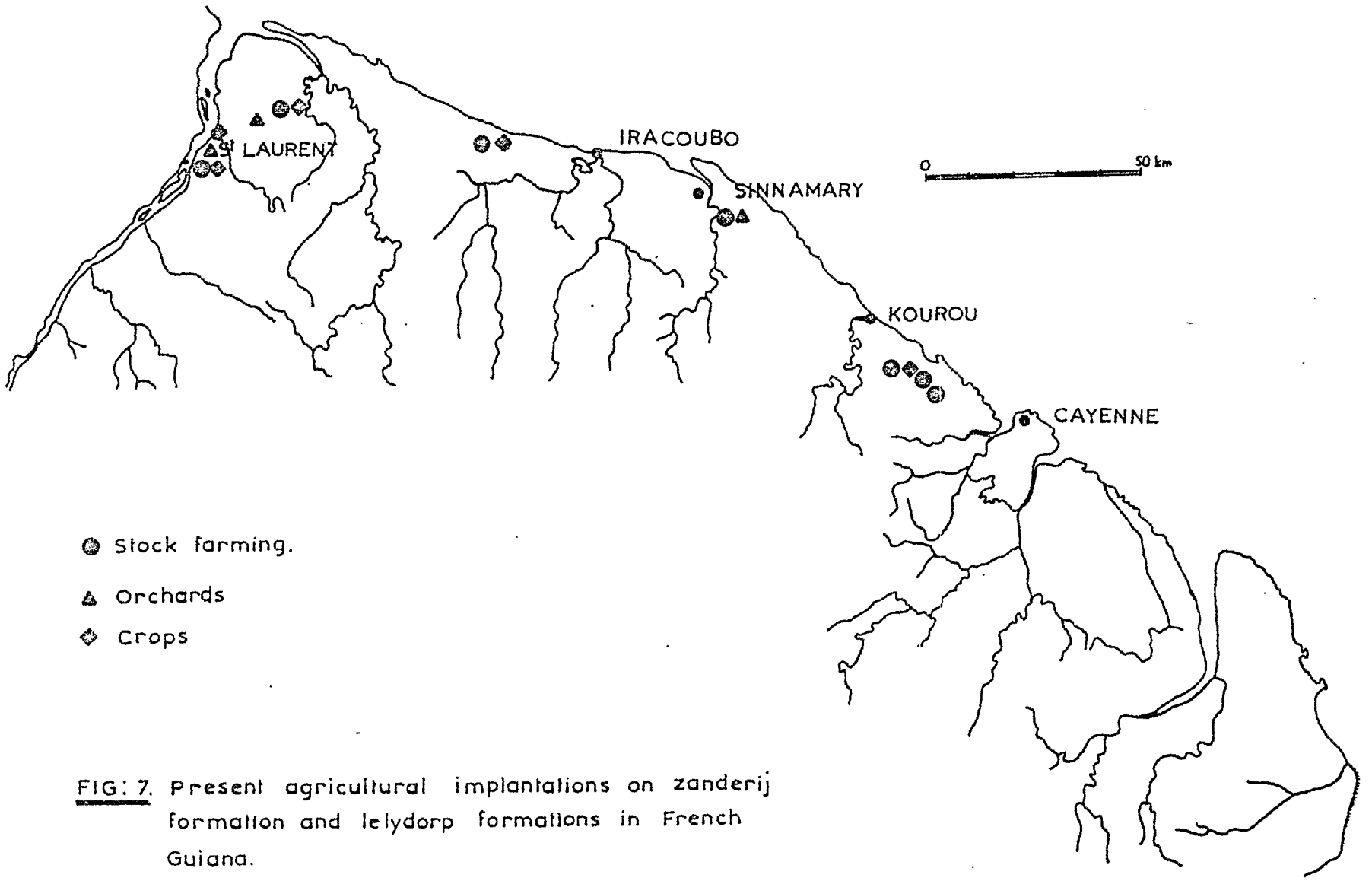


FIG: 7. Present agricultural implantations on zanderij formation and lelydorp formations in French Guiana.

Figure 6 gives an agro-climatic zoning of the region which interests us here. Critoria considered are total, annual rainfall, length of dry season and the rapport rainfall : potential evapotranspiration in March.

PRESENT USE OF THESE FORMATIONS

Figure 7 schematizes the various agricultural implantations at present established or being established. One notes how small the total cultivated area is, about 4500 ha, concentrated along the coastal zone.

On Zanderij formation, mainly stock farms (about 900ha) and crops (about 450ha) have been set up in the Saint Jean and Acarouany regions, and a little arboriculture around St Laurent. The rest of the formation is covered by forest.

On Lelydorp formation, always associated with Para formation, stock farms (about 1100ha), crops and orchards are being created. The rest of the formation is covered by forest or savannas.

The agronomic potential of soils of these various formations, Zanderij, Lelydorp, basement crystalline rock, is far from being precisely known. In fact, without sufficient agronomic trials, one cannot, for the time being, relate advanced knowledge of the soils' morphology and features to agronomic techniques for intensive agriculture.

However, quite a few problems may be noted :

- In areas on a little transformed Zanderij formation, the water's superficial infiltration is extremely heterogeneous; this leads to boggy patches. IRAT"s observations at Acarouany show that these boggy patches have an important, negative effect on the growth of sugar cane. Also, these areas, where water stagnates on the surface, have low pressure resistance and tillability.
- Water infiltration and textural floor pose problems at medium depth (perched water tables) in transformation systems on Lelydorp formation.
- For pastures on Lelydorp formation or on vertical blocked drainage soils on basement crystalline rock, there is a serious invasion of adventitious weeds (Carex especially) after a few months or years.

- Citrus fruit orchards on Lelydorp formation or on soils on basement crystalline rock show a growth variation in the trees which is in direct correlation with the soil's differentiation.

Several agronomic trials are presently being made by IRAT, ORSTOM and INRA. These trials, however, are quite insufficient for us to be able to define the agronomic potential of the various soil types and to designate techniques adapted to their development and use.

However, the following figures give an idea. They come from trials by IRAT whose results are at present being drafted.

Sugar cane cultivation : results in tons / ha

	Cayenne	St Laurent
	Soils with vertical free drainage on crystalline basement rock.	Soils on little transformed Lelydorp formation.
1976 2nd cut	65 t/ha	56 t/ha
1977 1st 2nd 3rd cuts	80 t/ha	73 t/ha
	Acarouany	
	Soils with blocked vertical drainage on crystalline basement rock	Soils on little transformed Zanderij formation.
1977-78 2nd cut	74 t/ha	114 t/ha
1978 1st cut	80 t/ha	102 t/ha

The relatively high figures of the Acarouany Zanderij formation soils are due to recent reclaiming (1st year of cultivation); surface water infiltration problems are still little apparent.

Sugar cane's response (leaf analysis) to the chemical potential in soils on Zanderij formation show deficiencies, primarily in potassium and, secondly, in phosphate. No nitrogen deficiency has been observed. Oligo-elements appear to cause some problems.

CONCLUSION

In conclusion, acid soils in French Guiana, situated on highlands or on the ancient, coastal plain, have considerable pedological variations. In fact, they belong to systems transforming soil mantles with favourable, physical properties into ones with unfavourable, physical properties - an excessively, sandy texture or deficient internal drainage. These variations in the soils have important agronomic consequences. Although, in French Guiana, the morphology, physico-chemical features, and dynamics of soils on Zanderij formation, Lelydorp formation or on basement crystalline rock, are now well understood, agronomic trials still remain insufficient for any sound forecast to be made for their cultivation.

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