II. Survey of Rice Soils of Hapitigam Korale

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INTRODUCTION

THE rice soils of Hapitigam Korale were surveyed during the first half of 1959 in an attempt to determine the factors that limit productivity. This report embodies observations of the principal soil series encountered in the Korale together with a soil map.

Hapitigam Korale is a revenue division of the Colombo District and covers an area of 52,000 acres of which approximately 5,000 acres are under rice. It is bound in the North by the Maha Oya, in the west by the Alutkuru Korale, and in the south by the Siyane Korale. On its eastern boundary is the Beligal Korale of the Kegalle District.

Climatological data

The average annual rainfall of the Korale is 75-125 inches (5). The monthly precipitaton at three stations in the Korale is presented in Table 1.

The mean annual temperature in the shade remains at approximately 80°F in most parts of the Korale, while the mean relative humidity is approximately 75 per cent.

Geology, physiography and drainage

Except for recent deposits of alluvium and laterite, the bed-rock of the entire Korale is composed of metamorphic rocks of Pre-cambrian age and include charnockites, cordierite gneisses, undifferentiated metasediments, pink gneisses and thin bands of quartzites and calc-silicate rocks. Intrusive into these rocks are a suite of zircon-granites, which give rise to the tors of Looluwa and neighbouring hills. The strike of the foliation is invariably at N20 ° 30 ° W

* Adapted from a paper presented at the twenty-second anuual sessions of the Ceylon Association for the Advancement of Science, 1966.

The direction of the dip is variable with the rocks folded into a series of complementary north-plunging synforms and antiforms tending roughly NW-SE.

The area can be divided into two regions on physiographic grounds, a western lowland region east of the Welihinda Oya and an eastern highland region which sometimes rises to over 800 ft. The area is drained by the tributaries of the Maha Oya and Attanagalla Oya. The northern boundary of the Korale is bounded by the Maha Oya, which meanders below Kotedeniyawa, above which the course of the river runs in an approximate NE-SW direction, at times over a rocky floor. Generally the drainage is characteristic of a landsurface approaching base-level, especially the western half.

Field studies

The rice soils of the Korale were classified into three series on the basis of difference in horizon sequence reflecting various degrees of hydromorphism. The drainage sequence and approximate acreages of these three series are given below.

Each of these three series was sub-divided into soil types on the basis of the texture of the surface soil. Thus each soil type has the same succession of master horizons and same texture in the surface soil. Thirteen soil types were identified and mapped and are shown in figure 2. Field mapping was done on enlargements of contact prints of aerial photographs on the scale 1 : 15,000.

Typical profiles of the three series are diagramatically shown in figure 1 (a-c).

The profile characteristics of typical members of each series are described below. All colour descriptions are Munsell notations on moist soils.

1. *Arukgoda series—poorly drained*

Soils of this series are found in positions of slightly concave relief or in small narrow tongues of large *yayas*. They are dark grey, fine textured and high in organic matter. The water-table is approximately 1½ feet below the surface. They have the horizon sequence A_1pg/G. Faint brown mottles are noticeable in the A horizon. The horizons Bg and BG are usually absent. The lower horizon is completely gleyed and is characterized by its light grey colour. This horizon is completely devoid of mottles indicating the reducing conditions that prevail.

A typical profile is described as follows :—

Horizon	*Depth (inches)*	*Description*
A_1pg	0—6	Very dark gray (5Y 3/1) ; silty clay ; common, faint, reddish brown mottles in diffuse films ; clear change to
G_1	6—30	Dark gray (5Y 4/1) ; clay ; no mottles abrupt change to
G_2	30—40	Gray (2.5Y 5/0) ; sandy clay ; no mottles

Two soil types of this series were identified and mapped.

2. *Danowita series—imperfectly drained*

Soils of this series are medium textured, strongly acid and lateritic. They are found in places of subnormal relief. The A horizon has distinct reddish-brown mottles showing its oxidised nature and the partially oxidised state of the B horizon is indicated by the yellow-brown mottles. The water-table is approximately 2½ feet from the surface and a gleyed horizon is present below this. The development of a plow-sole is observed. Profiles of this series have the horizon sequence $A_1pg/A_{12}\,g/B_2\,G/G$. The content of organic matter is low to medium. A typical profile of this series is is follows :—

Horizon	*Depth (inches)*	*Description*
A_1pg	0—4	Dark yellow-brown (10YR 4/4) ; sany loam ; few faint reddish-brown mottles in thin streaks and films. clear change to
($A_{12}g$ (plow sole)	4—6	Very dark gray (5Y 3/1) ; sandy clay loam ; common distinct reddish-brown mottles in medium sized films ; clear change to
$B_{21}G$	6—9	Gray (2.5Y 6/0) ; loamy sand ; many prominent yellowish brown mottles in diffuse films diffuse change to
$B_{22}G$	9—16	Gray (2.5Y 6/0) ; loamy sand ; common distinct yellowish brown mottles in thin streaks along root channels ; diffuse change to
$B_{23}G$	16—21	Gray (2.5Y 6/0) ; sandy clay loam ; few faint brown mottles along root channels ; diffuse change to
G	21—30	Gray (2.5Y 6/0) ; sandy clay ; no mottles.

Five soil types of this series were identified and mapped.

Madabawita series—moderately well drained

These soils are found in positions of normal relief, where slope and drainage are medium. These are grey, medium textured and strongly acid lateritic soils. The water-table is approximately 3½ feet from the surface. They have the horizon sequence $A_1pg/A_{12}g/B_{21}g$ $B_{22}G$. ×. The A and B horizons have prominent reddish-brown mottles in films and along the root channels. A plow sole is present. A gleyed

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horizon is not usually found in profiles of this series within the first 24 inches. Organic matter is present mostly in the surface horizon. The description of a typical profile is as follows :—

Horizon	*Depth (inches)*	*Description*
A_1pg ..	0—6 ..	Dark brown (10YR 4/4) ; silty clay loam ; common distinct reddish-brown mottles along root chanels spreading into films. clear change to
$A_{12}g$ .. (plow sole)	6—9 ..	Gray (10YR 5/1) ; sandy loam ; many distinct reddish-brown mottles along root chanels ; abrupt change to
$B_{21}g$ ..	9—23 ..	Gray (2.5Y 6/0) ; sandy clay loam ; many prominent reddish-brown mottles along root channels ; diffuse change to
$_{22}G$ ..	23—33 ..	Gray (2.5Y 6/0) ; sandy clay loam ; common, prominent large, reddish-brown mottles, probably the decomposing lateritic parent material

Six soil types of this series were identified and mapped.

LABORATORY STUDIES

Analytical procedure

Soil samples under field moisture conditions were brought to the laboratory in polythene bags, air dried, crushed and the portion passing through a 2 mm sieve was used for particle size and chemical analysis.

Particle size analysis was done by the pipette method (4). Measurement of pH was made with a glass electrode potentiometer system using a soil water ratio 1 : 1. Exchangeable cations and cation exchange capacity were determined after extraction with 1N ammonium acetate at pH 7 (3). Organic matter was estimated by the method of Walkley and Black (7), and total nitrogen by the Kjeldahl method. Available phosphorus was determined by the method of Olsen *et al.* (2).

DISCUSSION

A. *Field studies*

Drainage conditions have a profound influence on the nature and properties of rice soils. Hence these rice soils have been classified according to the degree of hydromorphism into series and drainage classes following the work of Kanno (1). The drainage classes used in this description are totally different from those used in the description of highland soils in the normal systems of soil classification.

The degree of drainage of a rice soil is determined by differences in colour, number, size, and contrast of mottles in the various horizons of the soil profile. These are pronounced, vertical, reddish-yellow and brownish-black patches of oxidised iron and manganese formed as a result of the oxidising action of the rice roots under well drained conditions as when the water-table is considerably below the surface. The subscript 'g' is used to indicate the presence of mottles both ferric iron and manganese. When the water-table is at the surface, as for example in the very poorly drained soils (encountered in Hewagam Korale) (6), mottlings are completely absent. The few mottles in the surface horizons of the poorly drained soils indicate their relatively better drained conditions. The intensity of mottling in the imperfectly drained soils is greater, and that of the moderately well drained soils still greater.

B. *Laboratory studies*

Analytical data of representative soil profiles is presented in table III.

Particle size distribution

The surface soils of all three series are loams with the higher sand fraction in the better drained soils. In the moderately well drained soils the clay fraction increases with depth below 23 inches, while the same phenomenon is observed in the imperfectly drained soils below a depth of 16 inches.

Soil reaction

It is observed that soils generally tend to be less acidic as drainage conditions become poorer. Thus soil of the poorly drained Arukgoda series have the higher pH values as compared with those of the moderately well drained Madabawita series. The soils of the imperfectly drained Danowita series have intermediate values. Such a relationship where pH increases as drainage conditions in rice soils become poorer was also observed with the rice soils of Hewagam Korale (6). Comparision of the data in Table III shows that the poorly drained soils contain considarably more exchangeable bases as compared with the moderately well drained soils, which may contribute to the higher pH values of the former. Generally it is observed that the pH values, tend to increase with depth under all conditions of drainage.

Cation exchange capacity

The better drained soils have a lower capacity for cation exchange and conversely cation exchange capacity tends to increase as drainage becomes poorer. This may be attributed to differences in particle size distribution between the poorly drained and the better drained soils as the fraction of clay in the former is generally greater. Another contributory factor to the higher cation exchange capacity in the poorly drained soils may well be their higher content of organic matter.

Exchangeable bases

Exchangeable bases are generally low in the surface soils of all series, the poorly drained and the moderately well drained soils having the highest and the lowest values respectively and the imperfectly drained soils having intermediate values. The accumulation of bases in the profile appears to be governed by the drainage conditions that prevail. For example in the moderately well drained series it appears that bases are leached away from the upper horizon and accumulate at lower depths in the profile. In the imperfectly drained series the bases leached away accumulate relatively closer to the surface due to the imperfect drainage conditions. The poorly drained conditions of the Arukgoda series are reflected in the relatively higher concentration of bases immediately below the surface horizon.

Organic matter

As expected the organic matter content of the surface soils is highest in the poorly drained series with a value of almost twice that in the better drained members. In the poorly drained Arukgoda series there is appreciable organic matter up to 30 inches of depth. The high water-table during the greater part of the year is a contributory factor to the slow decomposition of plant and animal residues. These conditions are conducive to the accumulation of aliphatic organic acids like butyric, acetic and lactic, and other aliphatic and aromatic compounds that may cause physiological diseases in rice plants. In direct contrast to this is the situation in the moderately well drained Madabawita series where the concentration of organic matter decreases rapidly below the surface horizon. The distribution of organic matter in the imperfectly drained Danowita series is in accordance with the intermediate condition of drainage that prevails.

Total nitrogen

The content of nitrogen in the surface soils of all series ranges between 0.13-0.27 per cent and appears to be related to organic matter content. Those of the poorly drained series having the highest values while the lowest value of 0.13 per cent in the Madabawita series is probably associated with better drainage in addition to the lower organic matter content. At lower depths the nitrogen content is generally low in all soils.

Available phosphorus

The available phosphorus in the surface soils appears to increase as drainage improves. It is interesting to note what appears to be an inverse relationship between organic matter and available phosphorus in the surface soils. The distribution of phosphorus in the profiles does not fall into any pattern.

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TABLE 1.—Normal Monthly Precipitation at Some Stations in Hapitigam Korale

Station	*Height above mean sea level in feet*	*Monthly Rainfall in Inches*												*Total for the year in inches*
		Jan.	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	
1. Ambepussa	180	8·31	1·63	11·76	5·53	6·28	11·61	0·66	2·44	2·99	12·53	16·34	2·17	82·25
2. Kandalama	500	4·98	2·40	2·65	3·52	0·44	1·85	0·00	0·13	0·00	4·23	16·94	10·76	47·90
3. Walpita	40	7·04	0·08	8·24	5·77	6·20	9·56	0·38	2·69	5·22	11·69	16·48	4·47	77·77

TABLE 2.—Predominant rice soil series of Hapitigam Korale and their approximate extent

Series	*Approximate Extent (Acres)*
1. Arukgoda (Poorly drained)	300
2. Danowita (Imperfectly drained)	1,900
3. Madabawita (Moderately well drained)	2,100

Table III.—Particle size Distribution and Chemical Properties of Representative soil Profiles in Hapitigam Korale

Horizon	Depth in inches	Particle Size Distribution				Chemical Properties					
		Coarse sand% 2.000-0.200 mm.	Fine sand% 0.200-0.020 mm.	Silt% 0.020-0.002 mm.	Clay% < 0.002 mm.	pH	C. E. E. NH_4OAc. me/100gm.	Exch. Bases NH_4OAc me/100gm.	Organic Matter %	Total Nitrogen %	P_2/O_5 lbs./ac.
Arukgoda Series (Poorly drained).:											
A1pg ..	0—6	18.8	22.9	15.1	28.2	4.8	16.48	5.91	6.10	0.27	29.8
G_1 ..	6—30	31.5	24.5	3.7	36.8	6.8	11.56	8.64	5.20	0.03	19.2
G_2 ..	30+	45.4	24.2	1.5	30.1	7.9	8.69	8.43	0.50	0.13	29.8
Danowita Series (Imperfectly drained) :											
A1pg ..	0—4	33.7	33.9	5.6	23.1	4.3	5.80	2.02	3.00	0.14	36.7
A12g ..	4—6	42.9	27.7	0.4	25.2	4.3	6.32	0.90	2.40	0.11	29.8
B21G ..	6—9	63.1	24.4	0.7	11.9	4.7	1.15	0.36	0.80	0.02	33.0
B22G ..	9—16	61.2	23.5	6.7	13.7	4.8	1.40	0.49	0.40	0.18	27.5
B23G ..	16—21	44.3	14.6	11.5	34.1	5.1	5.46	2.60	0.60	0.03	27.5
G ..	21+	38.8	13.0	0.7	43.2	5.3	7.41	3.26	2.20	0.03	25.2
Madabawita Series(Moderately well drained)											
A1pg ..	0—6	24.9	39.6	16.3	20.3	4.2	8.44	0.58	2.70	0.13	39.8
A12g ..	6—9	50.5	36.1	6.0	4.5	4.6	6.87	0.40	1.72	0.16	28 3
B21g ..	9—23	32.7	49.9	9.9	8.1	4.8	4.95	4.04	0.64	0.07	28.3
B22G ..	23—33	36 9	37.9	2.8	21.0	4.8	8.86	1.06	0.44	0.03	38.9

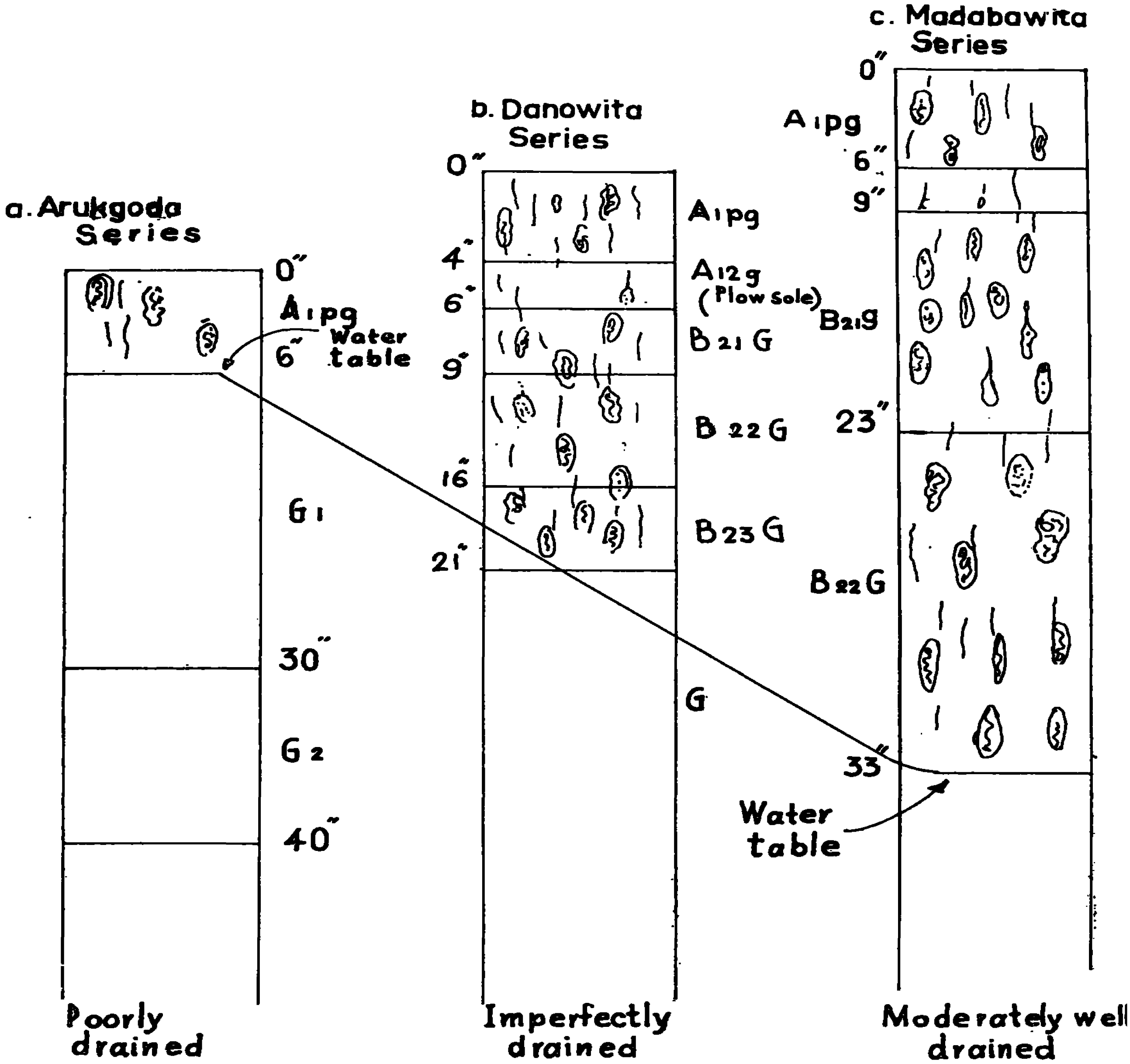

Fig. 1. Schematic diagrams of representative soil types.

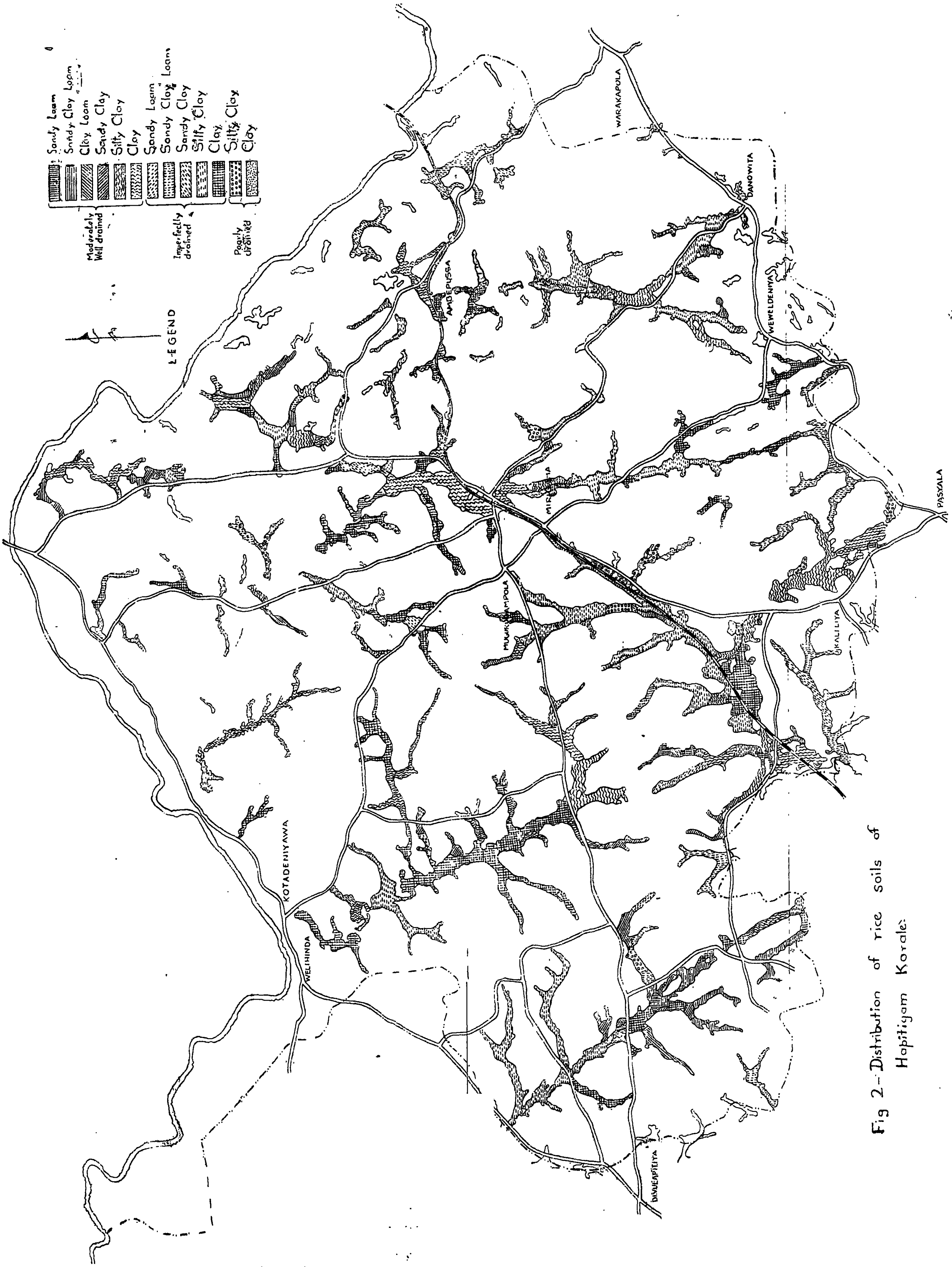

Fig 2 - Distribution of rice soils of Hapitigam Korale

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