# Soil Mapping and Advisory Services Botswana

# SOILS AND LAND SUITABILITY OF THE BORO—SHOROBE AREA







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Gaborone, April 1989

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# SOILS AND LAND SUITABILITY OF THE BORO-SHOROBE AREA

by

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The conclusions given in this report are those considered appropriate at the time of its preparation.

They may be modified in the light of further knowledge gained at subsequent

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The definitions employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal or constitutional status of any country, territory or sea area or concerning the delimitation of frontiers.

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#### INTRODUCTION

The Soil Mapping Project is currently mapping the soils of the Shorobe melapo area at scale 1:50 000. Detailed studies are being carried out in the Mazanga and Xhwaa sample are (also pilot areas for the Molapo Development Project). In the sample areas about 50 soil pits have been described and sampled; more than 100 soil pits were dug in the remaining part of the mapping area. The most characteristic ones were sampled.

At present topographic data, flood regime data and soil physical dta are not available. A reinterpretation of the soils data will be necessary, when studies concerning the above mentioned subjects have been completed.

This report is a contribution to the present discussion on land use alternatives for the area.

FAO/UNDP/Government of Botswana. Soil Mapping and Advisory Services Project. Soil and Land Suitability of the Boro-Shorobe area. Prepared by G. J. Rhebergen, Maun June 1985. Updated and completed by K. Verbeek and F. Nachtergaele, Gaborone April 1989.

66 pages, 4 tables, 6 figures, 1 map.

AG: BOT/85/011, Field Document 1

#### ABSTRACT

This report presents the results from the semi detailed soil survey of the Boro-Shorobe area at a scale 1:50 000. Chapter 1 describes the general characteristics of the area. Chapter 2 discusses the soils that occur in the area in more detail, while in Chapter 3 the land is evaluated for Molapo and large scale irrigation farming.

Typifying soil pedons with analyses, and a detailed land suitability classification are given in the appendices. A soil map is attached.

#### SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The <u>current</u> land suitability for molapo farming (both improved traditional and commercial) ranges from moderately suitable (S2) to very marginally suitable (S4) for maize, and from highly suitable (S1) to marginally suitable (S3) for sorghum.

After major improvements the land suitability of most areas can be improved by one class.

- The suitability for irrigated farming is marginal to very marginal for most areas. Only the more sandy area offer better possibilities. The most limiting land quality is 'land drainability' which is determined mainly by the permeability of the subsoil.
- The islands are not suitable for arable farming for the larger part; only the deep sandy edges could be used, but the suitability is marginal to very marginal for most crops.
- The fertility of the regularly flooded alluvial plains is medium to high; available phosphorous remains however low to very low.
- The calcic horizon which was found in the subsoil of some alluvial plains, indicates the low percolation rate of floodwater (if any) to deeper groundwater.
- A yearly increase of the sodium content, measured as the Exchangeable Sodium Percentage (ESP) has been observed in the alluvial plains, which can be attributed to the yearly floods. Successive years of high floods, resulting in a high groundwater table may attribute considerable to the sodification problem.

# It is recommended that:

- a hydrological study is carried out which should cover among others the following subjects:
  - salt balance
  - soil physical studies in particular
  - the permeability of different soil types
  - effect of the proposed water resevoir on the groundwater level
  - groundwater movement
- remote sensing techniques be used to study the extent and the duration of the floods.
- the technical and economic feasibility be studied of a land use types based on flood recession (to control salinity and sodicity) but with supplementary sprinkler irrigation.
- the impact of flooding out of a permanent water resevoir of alluvial plains without a surface drainage component on the salinity and sodicity of the soils be studied.

#### 1 GENERAL DESCRIPTION OF THE AREA

#### 1.1 LOCATION, COMMUNICATIONS

The survey area is situated northeast of Maun between the Boro river and Shorobe village. The Buffalo fence forms the western boundary and the edge of the sandveldt the eastern boundary. (Figure 1)

The mapped area covers approximately 500km<sup>2</sup>, consisting of alluvial plains (melapo) and islands.

The area is accessible by means of the Maun-Shorobe road, running along the eastern boundary of the survey area. Accessibility is very limited during the flood period (June-November)

#### 1.2 CLIMATE

Basic climatic data are given in Table 1. Rainfall data of thirty nine consecutive years were combined with other climatic parameters (22 years record) and processed in FAO headquaters in Rome, Italy. Evapotranspiration (Penman method) was calculated and growing period analysis carried out (see Table 2).

Table 1
CLIMATIC DATA OF MAUN STATION

Station 68032: Maun

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
P (mm)	120.7	115.0	74.1	25.4	4.6	1.2	0.1	1.0	3.1	17.0	55.1	80.1
T-Mean(C)	25.6	25.2	24.6	22.5	18.6	16.0	16.0	19.1	23.5	26.4	26.2	25.8
T-Max (C)	31.6	31.4	31.3	29.9	27.5	25.0	25.1	28.3	32.2	34.1	33.0	32.1
T-Min (C)	19.5	18.9	17.8	15.0	9.6	6.9	6.9	9.8	14.8	18.6	19.4	19.4
T-day (C)	27.8	27.4	27.0	25.1	21.7	19.1	19.2	22.3	26.6	29.2	28.7	28.1
T-night(C)	23.7	23.1	22.1	19.5	14.8	12.1	12.1	15.3	20.2	23.7	24.0	23.8
Ed (mbar)	20.4	20.2	18.3	14.4	9.9	8.4	8.0	8.0	8.7	11.7	15.3	18.6
RH-mean(%)	62	63	59	53	46	46	44	36	30	34	45	56
U (m/sec)	1.8	1.7	1.6	1.3	1.3	1.4	1.6	1.7	2.0	2.2	2.2	2.0
n/N (%)	61	63	69	78	89	87	88	90	84	75	66	62
Rg(cal/cm <sup>2</sup> /	349.1	401.8	477.3	553.5	624.3	618.9	619.7	613.8	549.3	463.0	377.0	336.
day)												

ET-PENMAN 105.2 105.1 135.7 137.8 145.6 134.0 143.7 159.4 171.7 171.6 130.0 108. (mm)

Total moisture period equals the length of the growing period, when one growing period occurs, or equals the total lengths when two or more growing periods occur in one hydrological year.

<u>Growing period:</u> the period of the year in days when available water temperature regime permits crop growth.

Normal growing period: the start of a normal growing period is assumed when precipitation exceeds half the potential evapotranspiration. The end of the period is assumed when precipitation falls below full evapotranspiration,

The following definitions apply:

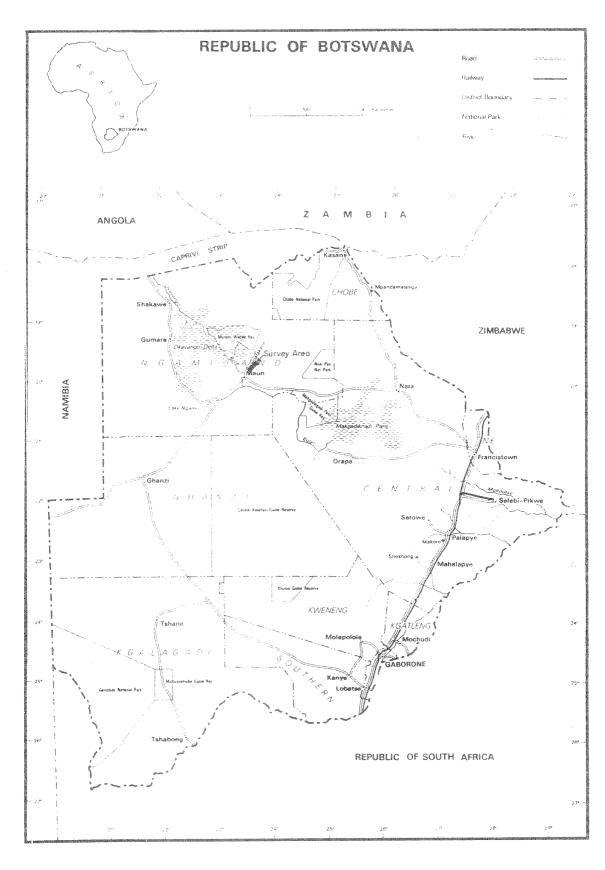


Figure 1 : Location of the survey area

plus a number of days required to evaporate an assumed 100mm moisture reserve when available.

Intermediate growing period: the start of an intermediate growing period is assumed when precipitation exceeds half the potential evapotranspiration. Precipitation does  $\underline{not}$  exceed full potential evapotranspiration and there is no moisture reserve. The end is assumed when precipitation falls below half potential evapotranspiration.

<u>Humid period:</u> period in days during a normal growing period when precipitation exceeds full evapotranspiration.

Table 2

AGRO-CLIMATIC ZONES OF BOTSWANA

Zone	Station	MOI	Total STURE RIOD	HUI	Total MID RIOD			Y LENGTH URE PERI		MEAN PRECIPI (mm)	TATION
			1936		1936	. 244 - 45 - 474					1936
		1982	1982	1982	1982	<70D	/0-99	100-130	>130d	1982	1982
T.	KASANE	139	135	74	74	3	7	2.5	65	680.6	660.9
	SHAKAWE	116	111	46	38				alimanumpyy gogi Pillick i lillak krimanin o ynynny gogirik i Arkii arkin arkiin	535.4	504.9
II	MAUN	106	100	49	49	15	15	35	35	496.2	512.7
III	GABORONE	101	105	26	31	25	30	20	25	535.4	504.9
terrous and the terrous and	MAHALAPYE	106	98	30	23	hinderson eynysynyydd reddioredd mwys.				473.9	463.6
IV	SEROWE	***	89	-	36	30	30	15	25	459	463.0
V	F'TOWN	75	81	22	26	45	20	29	15	463.4	496.2
VI	GHANZI	64	64	14	1.6	4.5	30	15	19	432.4	439.1
VII	BOBONONG	ана и объем темперия и положения учественного с 4406	Antalian marajungungan Mahini Antaka makumpunga kebula 1999		inima anagusu pili ahiri bas u menasoo u uuunta Baar	encontrol de la company de La company de la company de	mananyo ne 1905 fili ili ki Sakida midmuu ng gayay 1904 dhi muda 1904	aka marajan api, apigagi bi kara marayan mpaga magagayan paga pagasa Angka	and discrement year on 1990 to re-industrial and an experience of 1998 in 1990	aldering over niceal by ground from a diversion annual popularity variation and	307.1
gr gr wan objet tops	RAKOPS	ense and method mesons as a supplier of the second	56	eehde en	13			ORA KITARI MANAYAN YA KATARI MANAYAN MANAYAN MANAYAN KATARI MANAYAN MANAYAN MANAYAN MANAYAN MANAYAN MANAYAN MA	nahananya opo a lähtää tienäkännus uuusuguugtiliitinai	nad and community you and all of the commence and an any angle of a benefit	366.3
VIII	TSHANE	words	57	war	14	60	30	5	5	MANA	375.8
IX	TSHABONG	39	40	6	5	80	10	5	5	294.2	309.1

A general map of the agro-climatic zones in Botswana is presented in Figure 2.

In the more recent agro-climatic classification of Botswana, the study area is located in zone 2C2, corresponding with a growing season length of 81 to 100 days with 21 to 30 days being dry within the season. The length of the humid period has been calculated as being between 21 and 40 days with a probability of occurrence of 50 - 74%.

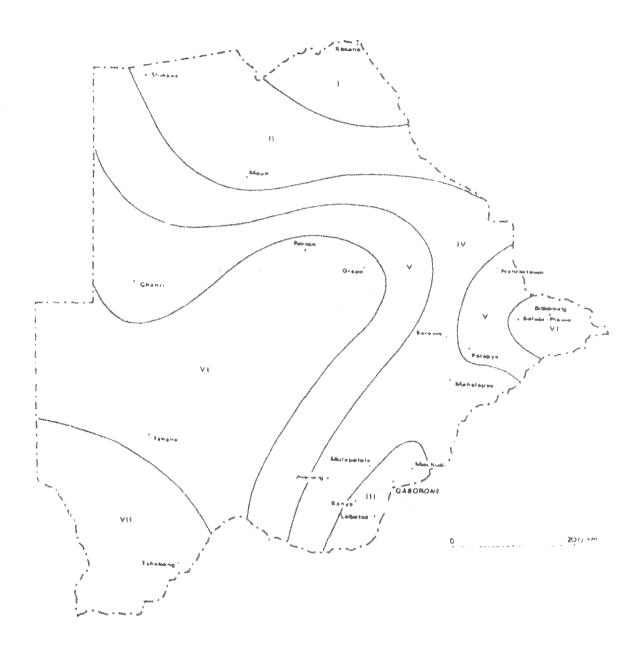


Table 2

		precipitation	probability length
	Climatic zone	(approx.mean)	moist.period 290d.
ì	Kasama	600-700mm	90%
II	Maun-Shakawe	500-600	75
111	Gaborone	500-550	* y * ) - ( y ( )
IV	Mahalapye-Serowe	450-500	1,()
٧	Francistown-Ghanzi	400-450	5° ) A()
VI	Bobonong-Rakops-Tshane	300-400	20
VII	Tshabong	200-300	10-15

Figure 2 : Agro-climatic zones of Botswana

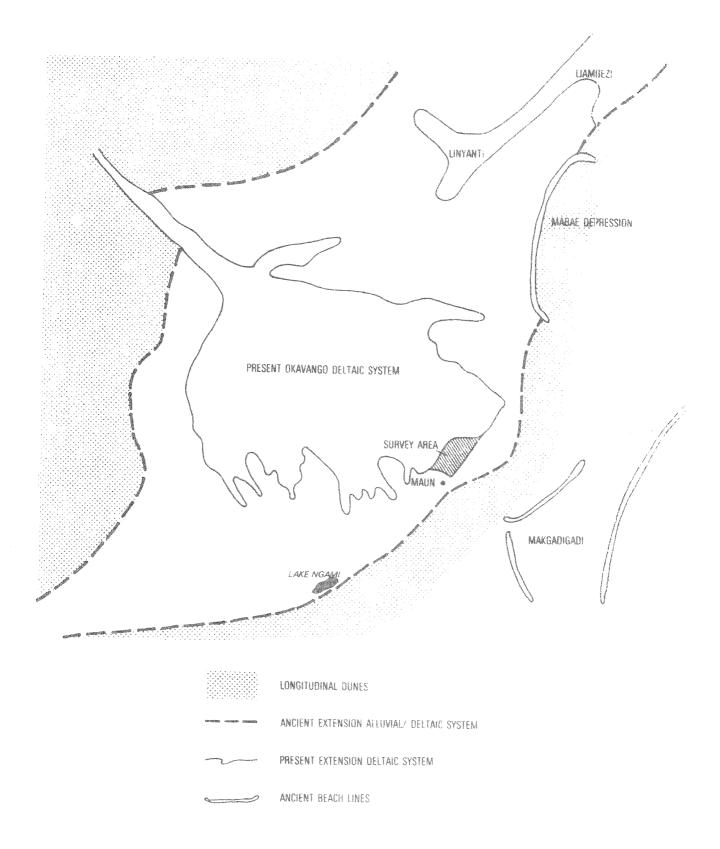


Fig 3: EXTENSION OF PRESENT AND ANCIENT ALLUVIAL SYSTEMS

#### 1.3 PHYSTOGRAPHY

#### 1.3.1 Geology

The survey area is situated between two fault lines: the Kunyere and the Thamalakane fault.

Superficial deposits of considerable thickness consisting of windblown sands (Kalahari beds) and alluvial sediments are overlying the rocks of the Kgwebe Formation.

The Kalahari beds have been reworked by fluvial and deltaic processes and sandy clay and clay has been deposited in the alluvial plains of the survey area.

#### 1.3.2 Geomorphology

The mapping area is situated at the eastern fringe of the Okavango deltaic system. The present deltaic system and at least part of the older alluvial system were deposited in an eolian landscape (see Figure 3). Remnants of the longitudinal dune system can be found in the survey area. The alluvial plains occupy the former interdune depressions and the present islands are remnants of the dunes. The shapes of these features were modified by fluvial and deltaic processes.

Deposition took place in a subsiding basin, confined by faults. There are indications that the fluvial and deltaic deposits reach considerable thickness in some places. As recent and subrecent sediments were deposited in an eolian landscape, the thickness of these deposits does probably not exceed 10m. Deposits found at greater depth (more than 20-30m) must be part of a much older alluvial system.

A schematice cross-section through an island and an alluvial plain is shown in Figure 4.

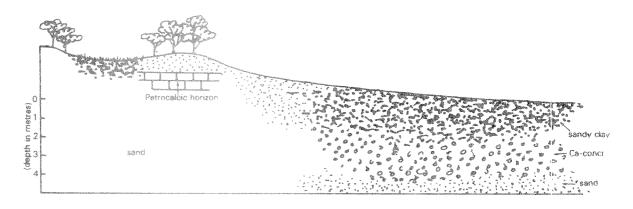


Fig 4: CROSS SECTION THROUGH AN ISLAND AND AN ALLUVIAL PLAIN IN BORO-SHOROBE

Calcic horizons were found in the alluvial plains at a depth of 1.5-2m. It occurs as soft powdery lime, but also as concretions. A petrocalcic horizon has not been found in the alluvial plains.

#### 1.3.2 Hydrology

Understanding of the hydrology of the survey area is most essential before sound recommendations can be given on land use alternatives. As hydrological studies are being carried out by the Molapo Development Project, only some preliminary conclusions are given here (pers. comm. R. Roostee, Molapo Dev. Proj.):

- an average flood recession in Xhwaa molapo of  $10\,\mathrm{mm/day}$  can be assumed, out of which 6mm through evaporation and approximately 4mm infiltration.
- the sandy clay loam to sandy clay soil material in the alluvial plains can store about 150 mm/m of water.
- studies are being carried out to find out if any percolation to deeper groundwater occurs. If not then the salts remain in the upper 3 meters. If percolation does occur salt transport to deeper groundwater takes place. The amount of water percolating, if it occurs, will probably not exceed 1mm/day. A salt balance of the area can only be made when results of the hydrological study are available.

#### 1.4 VEGETATION

The different vegetation types clearly reflect variations in environmental conditions such as : soil pH, drainage, flood regime, etc.

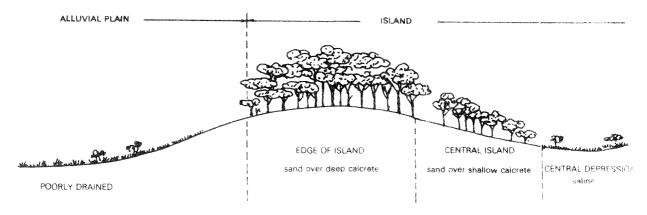


Fig 5: VEGETATION ON DIFFERENT TERRAIN TYPES

# The most common species are listed below:

### 1. along edges of islands

trees: Lonchocarpus

Ficus sycomorus
Combretum imberbe
Combretum hereoense
Kigelia africana
Albizia harveyi
Acacia sieberana
Acacia hebeclada
Ziziphus mucronata

 ${\it Croton megalobotrys}$ 

shrubs Diospy

shrubs

Diospyros lyciodes Diospyros mespiliformis

Grewia flava Grewia bicolor

Dichrostachys cinerea

Maytenus heterophylla Ximenia americana

2. centre of islands (not depressions):

trees: Colosphermum mopane

Maytenus heterophylla
Hyphaene ventricosa
Acacia tortillis
Combretum imberbe
Combretum hereoense

Pluchia leubnitzii Blumea gariepina

3. central depressions:

shrubs:

Acacia tortillis halopithic grasses

4. alluvial plains:

grasses:

Asclepias fruticosa Vernonia glabra

Ziziphus mucronata (on anthills)

pioneer species after periods without floods

Acacia tortillis Acacia erioloba Combretum imberbe

#### 2 SOILS

#### 2.1 Soil Classification

The soils are classified following the FAO/Unesco system with amendments made by the Soil Mapping Project. Classification is also made according to Soil Taxonomy (USDA, 1975), and FAO/Unesco (1988).

Soil profile description sheets together with the soil analyses results are presented Appendix 1.

For definitions of diagnostic horizons and properties reference is made to previous project reports and to the legend of the soil map of the world (FAO, 1974).

The FAO definition of hydromorphic properties was changed and brought into line with the definitions of Soil Taxonomy. This implies that some soils, which would be classified as Calcic Gleyic Luvisol according to the present FAO/Unesco system, are now classified as Calcic Luvisol. A soil with chromas between 1 and 2 without mottling does not classify as hydromorphic. The revised definition should read as follows:

In soils having an argillic B horizon immediately below the plough layer or an A horizon that has moist colour values of less than 3.5 when rubbed, <u>one or more</u> of the following.

- (a) moist chromas of two or less;
- (b) mottles due to segregation of iron;
- (c) iron-manganese concretions larger than 2mm;

# combined with one or more of the following:

- (i) dominant moist chromas of 2 or less in coatings on the surface of peds accompanied by mottles within the peds, or dominant moist chromas of 2 or less in the matrix of the argillic B horizon accompanied by mottles of higher chromas (if hues are redder than 10YR because of parent material that remain red citrate-dethionite extraction, the requirement for low chromas is waived).
  - (ii) moist chromas of 1 or less on surface of peds or in the matrix of the argillic B horizon
  - (iii) dominant hues of 2.5Y or 5Y in the matrix of the argillic B horizon accompanied by distinct or prominent mottles.

The most important differentiating criterion applicable in the **alluvial plains** is the development of the B-horizon. <u>Fluvisols</u> do not show any B-horizon development, neither of a cambic-B nor of an argillic B. <u>Gleysols</u> have a weakly developed cambic B (structure) horizon. <u>Luvisols</u> generally have a weakly to moderately developed argillic B horizon often in combination with a calcic horizon.

The **islands** are underlain by calcrete (both soft and hard). At the edges they are covered with sand (Calcic or Petrocalcic Arenosol or Eutric Arenosol where the calcrete is too deep). In the central depressions sodic and saline conditions occur. The soils are more clayey and are both calcic and sodic/saline: Calcic Luvisol, sodic phase.

#### 2.2 The Soil Units

In the alluvial plains soil types mostly occur as complexes. Boundaries are very gradual and can probably shift in time depending on changes in the floodregime. Some dry years may be followed by a succession of high floods; Eutric Gleysols may then change into Eutric Fluvisols.

Islands in the alluvial plains are indicated separately on the soil map when the area exceeds two ha. Islands smaller than two ha are generally omitted and they can be considered as minor inclusions in the alluvial plains. An association of soils occurs on the islands as the relation between the soil type is known, but can not be mapped at the scale used. The association is indicated with the capital X. It should be noted that not necessarily all the soil types of the association occur on evey island. The central depression may be absent or the deep sandy edge, characterized by high trees.

Soil units recognized in the survey area are listed below. Details are given on occurrence, soil characteristics and typifying pedons. Particular attraction is paid to the flood risk.

Selected profiles are given in Appendix 1, with standard analytical results. Information on all other soil profiles described during this survey are available from the Botswana Soil Database.

#### SOIL ON ALLUVIAL DEPOSITS

A7 FAO: Gleyic Luvisol, partly sodic (1974)

Gleyic Luvisol/Stagnic Luvisol (1988)

ST : Mollic Ochraqualf

**Description:** Deep to very deep, poorly to imperfectly drained, dark gray to grayish brown, sandy clayloam to clay.

Topography: Flat

Profiles: MA108, 122

Occurrence: In saucer shaped depressions, at some distance from the water source and the slightly sloping areas on the plains. Frequent flooding occurs, but is probably of short duration. These soils occur often in complex with Eutric Gleysols (A31a and b)

Characteristics: Their structure is weak to moderate subangular and angular blocky in the argillic horizon and a prismatic structure occurs in places. ESP values noted are moderate and in the range of 2 to 8%.

A7a As A7, but sandy loam texture

Profile: MA 201

**Occurrence:** The occurrence of these soils increases towards the Junyere fault line, as generally the soil texture becomes more sandy deeper into the delta. They occur also on somewhat higher positions in the floodplain.

Characteristics: The structure of the argillic horizon is massive to very weak subangular blocky. Between the A and the B horizons a white sandy layer (or pockets) may be found, with a thickness ranging from twenty to fifty centimeters. This layer is considered as windblown deposits on alluvial materials. ESP levels are more than 6 in places (sodic phase).

A7b FAO: Calcic Gleyic Luvisol, partly sodic (1974)
Calci-Gleyic Luvisol, Calci-Stagnic Luvisol (1988)

ST : Mollic Ochraqualf

**Description:** Deep to very deep, poorly to imperfectly drained, dark gray to grayish brown, sandy loams to clay.

Topography: Flat.

Profiles: MA 114, 115, 247

Occurrence: On the slightly higher parts of the alluvial plains, Floods occur only sporadically.

Characteristics: The structure of the argillic horizon is massive to moderately subangular blocky, in some places weakly prismatic. ESP values often exceed 6% (sodic phase), whilst an increased salinity level, compared to other A7-soils, is observed. The electrical conductivity remains below 4 m5/m.

A9 FAO: Calcic Luvisol, partly sodic (1974)
Calcic Luvisol/Luvic Calcisol (1988)

ST: Typic Haplustalf

**Description:** Deep to very deep, imperfectly to moderately well drained, dark brown to dark grayish brown, sandy clayloam to clay.

Topography: Flat to gently undulating

Profile: MA 143, 15, 174

Occurrence: This soil occurs on the higher parts of the alluvial plains and on the edges of islands. It also occurs on the alluvial plains without flood risk. These soils are very rarely flooded. They occur in complex with Gleyic Solonetz (A5)

Characteristics: These soils have an argillic horizon with a weak subangular blocky to massive structure. ESP can be high to very high (sodic phase). Chromas of the Bt horizon range from one to two.

A9a As A9, but sand to loamy sand over sandy loam to sandy clay loam. (Arenic Haplustalfs in Soil Taxonomy, Arenic Calcic Luvisol in FAO (1974).

Profile: MA 25

A24 FAO: Eutric Fluvisol (1974)

Eutric Gleysol/Eutric Fluvisol (1988)

ST : Mollic Aeric Haplaquent and/or Mollic Fluvaquent.

Description: Very deep, poorly to imperfectly drained, dark grayish brown to black, sandy clayloam to clay.

Topography: Flat

**Profiles:** MA 16, 19, 31, 32, 39, 102, 103, 110, 123

Occurrence: These soils occur in the lowest parts of the alluvial plains, often in saucer-shaped depressions. They are flooded for very long periods. They occur in complex with A31a (Eutric Gleysols). When the soils dry out for a considerable period, cracks develop.

Characteristics: The structure is massive, the consistency is very hard to extremely hard when dry. Mottling occurs from a depth of 80cm onwards. A calcic horizon is present at a depth of 150cm or more. ESP remains generally below 4%.

A24b FAO: Arenic Eutric Fluvisol (1974)

Gleyic Arensols/Areni-eutric Fluvisol (1988)

ST: Aquic Quartzipsamment, Mollic Psammaquent, Mollic Haplaquent.

Description: As A24, but sand to loamy sands.

Topography: Flat

Profiles: MA 7, 23, 38, 118

Occurrence: As A24

Characteristics: Massive to structureless

A31a FAO: Eutric Gleysol (1974)

Eutric Gleysol (1988)

ST: Mollic Aeric Haplaquept

Description: Very deep, poorly to imperfectly drained, dark grayish brown to black sandy clayloam to clay.

Topography: Flat

**Profiles:** MA 2, 3, 4, 5, 22,  $\underline{135}$ ,  $\underline{104}$  **Occurrence:** The soils occur in the same or slightly higher positions as the Fluvisols. They flood regularly and for long periods.

Characteristics: Their structure is weak to moderately prismatic, breaking into a very weak subangular blocky structure. Hydromorphic properties are present within 50cm from the surface. A calcic horizon is present at a depth of 150 cm or more. These soils are non sodic.

A31b FA0: Eutric Gleysol (1974)

Eutric Gleysol (1988)

ST : Mollic Haplaquept

As A31a, but with a sandy loam texture.

A40 FAO: Eutric Arenosol, partly sodic (1974)

Eutri-Haplic Arenosols (1988)

ST: Ustoxic Quartzipsamment, Typic Ustipsamment

Description: Deep to very deep, moderately well to well drained, gray to white, sand to loamy sand.

Topography: Flat to gently undulating

Profile: MA 237

Occurence: These soils occur on the intermediate levels of the alluvial plains, they are rarely flooded. They also occur as a transition to the Sandveld.

Characteristics: Structureless; ESP levels may be high.

#### SOILS ON LACUSTRINE DEPOSITS

FAO: Calcic Arenosol, sodic phase (1974) Calcic Arenosol (1988) L11

ST : Aridic Ustochrept

Description: Deep to very deep, well to somewhat excessively drained, brown to pale brown, fine sand to loamy fine sand, having a calcic horizon, and calcareous between 0-15cm.

Topography: Almost flat to gently undulating.

Profile: MA 117

Occurrence: These soils occur in the central depressions (pans) of the islands.

Characteristics: The soil structure is very weak subangular blocky to structureless; the calcic horizon is massive, transitions to a petrocalcic horizon occur. Some characteristics of a Bt horizon may be present (some clay increase and/or pressure of clay cutans). ESP is generally high. (>8%).

L24a FAO: Calcic Luvisol, sodic phase, partly saline (1974)
Calcic Luvisol (1988)

ST : Typic Haplustalf

Description: Very deep, imperfectly drained, very dark grayish brown to brown, sandy clay loam to clay.

Topography: Flat to gently undulating.

Profile: MA 106 Occurrence: As L11

Characteristics: These soils have a weak subangular blocky structure which is never prismatic nor columnar. An extremely high ESP ( %) is common, while relatively high EC values are also observed, ( ms/m). A calcic horizon is always present with both soft powdery lime and nodular concretions. A transition to a petrocalcic horizon is noted in places.

#### SOILS ON COARSE GRAINED SEDIMENTARY ROCKS

S13 FAO: Calcic Arenosol (1974)

Calcic Arenosol (1988)

ST : Aridic Ustochrept

Description: Moderately deep to very deep, well to somewhat excessively drained, yellowish red to grayish brown, sands and loamy sands, having a calcic horizon.

Topography: Flat to undulating.

Profile: MA 13.

Occurrence: Between the central depression and the edge of the islands.

Characteristics: As Lll

\$13a As \$13 but with a petrocalcic horizon.

S17 FAO: Eutric Arenosol (1974)

Eutri-Haplic Arenosol (1988)

ST: Ust(ox)ic Quartzipsamment or Typic Ustipsamment

**Description:** Deep to very deep, well to somewhat excessively drained, light yellowish brown to dark grayish brown, fine sands to loamy fine sands. Non calcareous between 50 and 100cm.

Topography: Flat to undulating.

Profile: MA 44.

Occurrence: Mainly occurs along the edges of the islands.

**Charactertistics:** The structure of the top soil is very weak subangular blocky and becomes structurless in the subsoil. A calcic horizon may be present at a depth of more than 125 cm.

#### 2.3 Profile development and floodregime

There is no clear relation between floodregime and soil development. Important aspects are the duration and the frequency of the floods. These depend on:

- the distance from watersource (Thamalakane, Boro or Santantadibe river)
- 2. the shape of the alluvial plain (saucer shaped basins retain floodwater for a very long period).
- elevation.

Areas which receive floodwater almost every year and for a long period are characterized by soils without profile development (<u>Fluvisols</u>) or by soils with a weak cambic B horizon (Gleysols). The basins are often saucer shaped.

Gleyic Luvisols (A7) can be found in areas which are frequently flooded for a short period. An argillic B horizon develops under conditions of repeated alternated wetting and drying to near-desiccation (Wilding et al, 1983). These conditions occur in:

- 1. the slighlty higher areas (lower floodlevel and shorter duration)
- flat, not saucer shaped alluvial plains, which fall dry very quickly.
- areas at greater distance from the watersource, so that the floodlevel is lower and duration shorter.

Calcic Luvisols (A9) are found in the higher areas of the alluvial plains. The floods are very infrequent and the floodlevel is low. These conditions occur on the terrace-like areas bordering some islands, and on higher areas at greater distance from the watersources. As the wetting and drying cycle is infrequent (most years being dry) the argillic B horizon is not well developed. The calcic horizon is evidence of the yearly net upward movement of capillary water. Whether salts are also deposited and to what extent is not yet established.

The calcic horizon which is found in the lowest part of Xhwaa molapo at a depth of approximately 1.50m is most probably related to the floodregime, specifically to the amount of water infiltrating.

It has been shown by Yaalon (in Wilding, et al, 1983) that the top of a calcic horizon is an exponential function of the mean annual precipitation. (see Figure 6)

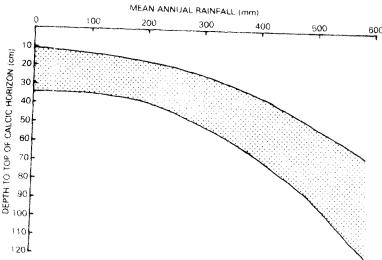


Figure 6. Depth to the calcic horizon as a function of mean annual precipitation (after Yaaloon, in: Wilding, et al, 1983)

In the molapo environment the floodwater has to be added to the precipitation. It can be concluded that floodwater infiltration plus precipitation is not adequate to leach the carbonates from the subsoil.

The following <u>hypothesis</u> can be made to explain the widespread presence of a calcic horizon in the subsoil of the alluvial plains of the survey area:

It can be observed in several places in the delta, especially along the Boro channel, that at least some areas are flooded by rising groundwater rather than by surface flow. It seems that the flood is partly spreading through groundwater. Groundwater levels in the eastern fringe of the delta seem to fluctuate with the floodlevel in the upper delta. Groundwater levels being low in years with low floods and high in years with high floods. During years with a high groundwater table, evapotranspiration takes place throughout the year on the islands resulting in high salinity and a petrocalcic horizon; in the alluvial plains of the survey area evapotranspiration takes place from a high groundwater table in addition to the infiltrated flood- and rainwater, resulting in the formation of a calcic horizon in the subsoil. During years with low floods percolation in the alluvial plains is extremely slow; as a result, carbonates, deposited by evapotranspired groundwater, are not washed out beyond a certain depth (1.5-2m).

#### 2.4 Salinization/Sodification

At present the edges of the alluvial plains show clear signs of sodification and salinization. The Exchangeable Sodium Percentage (ESP) exceeds 6, but remains mostly below 15. Sodification often goes together with the formation of a calcic horizon.

In the centre of the depressions (Fluvisol-Gleysol complex) a yearly increase in ESP in the topsoil is noticeable after flood recession caused by evaporation of floodwater and susbsequent evapotranspiration of the infiltrated water. When a new flood spreads over the area most of the accumulated sodium and salts are dissolved; some are transported through deep percolation. After flood recession the ESP increases to roughly the pre-flood level. In this natural system an equilibrium exists between sodification/salinization and floodregime and ESP and salinity remain at acceptable levels.

It is obvious that side effects will occur when the natural conditions are changed.

At present four land use types are under consideration:

- traditional molapo farming
- improved traditional molapo farming
- commercial molapo farming
- medium to large scale irrigated farming

The first three land use types make use of a modified flood regime. The amount of floodwater in a basin and the length of flooding is controlled by a system of sluices and bunds. Side effects, if any, will be limited and correction can be made, as the floodlevel can be controlled and the natural equilibrium can be restored at any time.

Irrigated farming does not make use of floods. Fertilizer inputs will be necessary to maintain high production levels. Residual salts will accumulate in the (top)soil. Leaching into the subsoil is impossible due to the very low infiltration rate. Flushing of the area by means of a high flood results in a reduction of the cropping time and an increase in production cost (2 crops per year will not be possible). It is also doubtful whether a high flood level is available when needed.

In conjunction with the formation of the calcic horizon, as described in section 2.3, sodification/salinization can take place. Due to low (ground)water levels these processes can not be studied adequately at present. However a definite answer has to be found before any development plans can be made.

#### 3 LAND EVALUATION

#### 3.1 Introduction

The proposed system is based on the FAO publication: "A Framework for land evaluation" (1976). The framework gives the principles and concepts on which land suitability evaluation is based, and indicates overall strategies for their application.

The Botswana system evaluates different land units for relevant existing, arable farming land use types, as defined by agronomists. Emphasis has been put on sorghum growing under different management levels. Sorghum represents more than 50% of the planted area, and is traditionally the first nutritional source in the rural areas. Several alternative crops, which are actually cultivated at a smaller scale than sorghum, have been proposed and can be evaluated: maize, millet, dolichos, cowpeas and sunflower. In the light of further rural development, other crops under different management levels have to be identified and potential new uses have to be described.

For the location of arable land, a qualitative land evaluation system has been recommended. The suitability is expressed in qualitative terms only, based on physical elements, without specific estimates of outputs (crop yields), inputs, costs and returns.

The systems is worked out according to the limitations approach. The limiting effect of each land quality is evaluated using an ordinal scale.

The system refers to current suitability. Minor land requirements which use common practice for the defined land uses are outlined.

# 3.2 Land use types

Four land use types can be distinguished in the survey area. Descriptions of the types read as follows:

LAND USE TYPE: Traditional Molapo Farming

Molapo farming is the cultivation of channels and floodplains ("melapo") immediately after the floods have receded (flood recession cultivation). Molapo farming is often practised in combination with dryland farming and communal grazing.

<u>Produce</u>: Maize, sorghum, water melon, pumpkin, groundnuts

Yields: 600 kg/ha grain

Market orientation: Subsistence, occasional sale of surplus

Size of holding: 2-10 ha; area cultivated depends on availablity of

draughtpower, extent and time of flooding/flood reces-

sion and rainfall

<u>Capital intensity</u>: Very low

Credit facilities: None

<u>Labour intensity</u>: Low to moderate

Farm power: Oxen, donkeys, mules; occasionally a tractor may be

hired for ploughing

Technical Knowledge: Knowledge of traditional farming only

Management practices: Location of fields may vary from year to year, depend-

ing on time and extent of flood; no fencing; very limited bunding to protect fields against flooding after planting; broadcasting; multi-cropping; no fer-

tilizer.

Infrastructure

<u>requirements</u>:

None

Land tenure system: Communal

LAND USE TYPE: Improved Traditional Molapo Farming

Produce: sorghum, maize, cucurbits and other

<u>Yields</u>: 1500 to 2500 kg/ha grain

Market orientation: subsistence and partly commercial

Size of holding: 4 - 10 ha

<u>Capital intensity</u>: Low

<u>Credit facilities</u>: Government institutions

<u>Labour intensity</u>: Moderate to high

Farm power: Mainly animal (oxen, donkeys, mules); occasionally a

tractor may be hired for ploughing

Technical Knowledge: Good knowledge of modern farming practices

Management practices: Permanent cultivation of land protected by (fenced)

bunds with inlet structure; improved seeds, monocropping, modest application of fertilizer or manure;

proper weeding; row planting

Land tenure: Communal

<u>Infrastructure</u>: Adequate extension service; depots for supplies

(seeds, fertilizer); adequate market/storage; bridges

crossing channels

# LAND USE TYPE: Large scale commercial molapo farming

<u>Produce</u>: maize, sorghum, sunflower and others

<u>Yields</u>: 2500-4500 kg/ha grain

Market orientation: commercial

Size of holding: more than 50 ha

Capital intensity: moderate

<u>Credit facilities</u>: commercial banks and government

<u>Labour intensity</u>: moderate

<u>Farm power</u>: engine

Technical knowledge: good knowledge of molapo farming and machinery essen-

tial

Management practices: permanent cultivation of land protected by bunds with

inlet structures. Farming operations mechanized.

<u>Land tenure</u>: communal; communal with long term lease

<u>Infrastructure</u> enough flood water available every year; good access to markets and/or storage facilities; good access to

to markets and/or storage facilities; good access to supplies and mechanical skills/workshops if not

present on the farm.

Adequate technical advise.

LAND USE TYPE: Medium to Large Scale Irrigated Farming

<u>Produce</u>: Food crops (including rice) and industrial crops

Yields: 4 - 10 ton/ha grain

Market orientation: Commercial

Size of holding: 20 - 200 ha

Capital facilities: Government and commercial banks

<u>Labour intensity</u>: Moderate to high

<u>Farm power:</u> Engine

Technical Knowledge: High

Management practices: Advanced irrigation techniques, unlimited inputs as

long as net return is expected

Source of water: Large weirs, dams, high-yielding boreholes, perennial

swamps

<u>Infrastructure</u> Easy access to markets or adequate storage facilities; requirements: easy access to agricultural expertise or on-the-farm

easy access to agricultural expertise or on-the-farm skilled manager. Easy access to mechanical expertise/

workshop or on-the-farm facilities

Land tenure system: communal; communal with long term lease

#### 3.3 Land Suitability Classification

Four categories of decreasing generalization are recognized: Orders, Classes, Subclasses and Units.

Orders: There are two orders: <u>Suitable(s)</u> and <u>Non-suitable(N)</u>

Classes: Within order (S) are four classes:

<u>S1 highly suitable</u>: Land which is expected to be highly productive for the defined use. High returns amply justify required inputs. No significant limitations.

<u>S2 moderately suitable</u>: Land which is expected to be moderately productive for the defined use. Moderate returns justify required inputs. Limitations reduce crop yield 10 - 25% and/or increase recurrent costs for production and conservation.

S3 marginally suitable: Land which is expected to have a low productivity for the defined use. Yield benefits are just high enough to justify required inputs. Limitations reduce crop yield 25 -50% and/or considerably increase costs for production and conservations.

<u>S4 very marginally suitable</u>: Land which is expected to have a very low productivity for the defined use. It is doubtfull whether yield benefits alone justify required inputs. Severe limitations reduce crop yields with more than 50% and/or considerably increase costs for production and conservation.

Seasonal cultivation of land classed as S4 will, over a long period, not be profitable in terms of money. However, part of this land is used and will be used, if only periodically, for the following reasons:

- economic considerations do not play a role, or only a minor one, in traditional dryland farming. Very low yields are justified in this concept;
- b. due to the highly erratic rainfall, yields in some years are relatively high and (dryland) farming is justified;
- c. considerations other than economic, such as employment and selfsufficiency, justify strongly reduced crop yields.

Within order (N) are two classes:

N1 currently unsuitable land: Land with very severe limitations which at present cannot be corrected economically.

N2 permanently unsuitable land:

<u>Subclasses</u>: Land suitability subclasses reflect kinds of limitations. They are indicated by lower-case letter, symbolizing the kind of limitation (e.g. subclass S2e: limitation caused by erosion).

Only the limitations(s) determining the suitability class are shown, with a maximum of three.

Classes S1 and N2 have no subclasses.

#### Units:

Land suitability units are subdivisions of subclasses, indicated by arabic numbers, following a hyphen (e.g. S2e-1). The units differ from each other in their production characteristics or in minor aspects of their management requirements.

Land suitability units are used in detailed studies only.

#### Current and Potential Suitability:

The current suitability refers to the suitability for a defined use of land in its present condition, without major improvements. Minor improvements which are common practice for the defined land use are included.

Potential suitability refers to the suitability for a defined use of land <u>after</u> specified major improvements have been completed.

#### 3.4 Preliminary suitability assessment

A final land suitability evaluation can only be made when all the analitical data and the results of the hydrological studies are available. A preliminary qualitative assessment involving a few land qualities will be presented here.

# 3.4.1 Molapo farming (improved traditional and commercial)

Only the regularly flooded areas and the areas with a potential for regular flooding will be considered.

The following soils can be found in the alluvial plains: Eutric Fluvisol, Eutric Gleysol, (Calcic) Gleyic Luvisol, Calcic Luvisol ( see description of soil types, section 2.2).

The land qualities which can limit the suitability of the land for molapo farming are:

- (m) moisture availability
- (n) nutrient availability
- (f) absence of damaging floods
- (o) oxygen availability
- (p) absence of pests and diseases
- (t) absence of toxic substances
- (w) workability
- (x) adequacy of topography
- (y) adequacy of flooding

The land qulaity which caused the most severe limitation determines the final suitability class.

#### (m) moisture availability

Moisture availability in the alluvial plains is determined by the amount of floodwater, the duration of the flood, climate and soil characteristics. The amount of floodwater and the duration of the flood largely depend on the topographic position (distance from the water source) and the shape of the basin (plain or saucer shaped).

It has been shown by data from the Molapo Development Project (unpublished) that a flood duration of two months is necessary to bring the moisture content of sandy clay profile to field capacity over a depth of lm.

On plain, but slightly sloping areas the duration of the flood is often limited (estimated at 1 to 3 months), because of rapid recession. In saucer shaped depressions the duration of the flood and the amount of floodwater increased towards the centre of the depression (estimated duration of the flood is 3 to 6 months).

It should be noted that in sandy soils (soil type A24b, A31b and A7a) percolation to deeper groundwater will occur; to what extent is not (yet) known. Therefore a larger portion of the infiltrated water (as compared to the more clayey soils) is not available for evapotranspiration during the croppping season. Also the available water holding capacity (AWHC) is lower (estimated at 70 - 110 mm/m) as compared to the sandy clay soils (A24, A31a and A7) with AWHC of 150-220mm/m.

Although the average infiltration is 4mm/day, it has been observed that the total amount of infiltrated water does not exceed 450mm (unpublished data R. Roostee, M. D. P.). In some Fluvisols the total amount of infiltrated water (after a long flood of at least 3 months) did not exceed 200mm.

In soil type A7 ((Calcic) Gleyic Luvisol) the average depth of the seasonally wetted profile is considered to coincide with the depth of the Bt-horizon. This depth generally varies between 60cm and 100cm. The average total amount of infiltrated water is therefore estimated at 90-220mm.

The effective rainfall for the Maun agro-climatic zone is estimated at an average of 400mm per cropping season (80% of the mean annual rain).

The total amount of water available for evapotranspiration during a cropping season is estimated in table 3 using the above mentioned approximations and following the methodology described in the System of Land Evaluation (Venema and Rhebergen, 1985).

Table 3
SUITABILITY CLASSIFICATION IN RELATION TO MOISTURE AVAILABILITY

MOISTURE AVAILABILITY

#### DILLOWITON IN WHALLOW TO MOIDIONE WANTHWHILLI.

SUITABILITY CLASS

topography	soil type	flood duration (month)	AWHC Main/M	inf.water avail. for evapotr (mm)	eff rain (mm)	_		rad o farm sorgh.	commer molapo maize	
	A24, A31a	3 - 6	150-220	200-450	400	600-800	\$2	\$1	S2-S3	S1-S2
saucer shaped depression	A7, A9,A31a	1-3	150-220	90-220	400	490-620	\$2-\$3	\$1-\$2	\$3	\$2
	A24b, A31b	3-6	70-150	70-250	400	470-650	S <b>3</b>	\$2	\$3-\$4	\$2-\$3
plain, slightly sloping	A31a, A7 A9	1-3	150-220	90-220	400	490-620	\$2-\$3	\$1-\$2	\$3	\$2
channe 1 s	A24b	1-6	70-150	high gwter table	400	>500	S2-S3	\$1-\$2	\$3	S 2

AWHC = Available Water Holding Capacity; AW = Available Water

The suitability classification has been downgraded to account for the probability of a total moisture period below average  $(^+-30\%)$  and for the probability of a very low or absent flood (not enough data available, but estimated at 10%).

#### (n) nutrient availability

The nutrient availability is assessed, considering the amount of exchangeable calcium, magnesium, potassium, phosphorous and the CEC. The availability of nitrogen is estimated, using the organic carbon percentage as an indicator. A correction for pH is made (if necessary) depending on the type of crop.

It can be concluded that the nutrient availability ranges from medium to high (see System of Land Evaluation for calculation procedure; Venema, Rhebergen, third draft 1985). In the lower parts of the frequently flooded areas (soil type A24, A31a,b, part of A7) the nutrient availability is highest; however the availability of phosphorus generally remains low. In the slightly higher areas nutrient availability is medium (A7, A31a,b, A7b, A9); phosphorus availibility is low to very low and the Ca/Mg ratio is often unfavourable (>10).

# (f) absence of damaging floods

Damging floods can occur in the channels during years of excessive rainfall. The frequency is considered to be low (once every 5-10 years).

#### (o) oxygen availability

oxygen availability is mainly a function of drainage. When only the drainage during the cropping season is considered, soil types A24 and A31a are imperfectly drained and the ponding hazard is estimated at 1-7 days every 6-10 years. The centre of some depressions will be more poorly drained. Other soil types will have a better drainage and present less or no limitations to most crops.

The suitability of crops sensitive to waterlogging (maize) will be limited most.

#### (p) absence of pests and diseases

Quantification of this land quality is difficult, because of the great variety of pests and quick (spatial and seasonal/yearly) changes in distribution and intensity. Therefore no suitability rating will be given.

On average however there seems to be considerable damage and the input to improve the situation will be moderate to high (in terms of labour and/or capital).

#### (t) absence of toxic substances

The following characteristics are considered in the suitability evaluation:

- salinity (chlorides, sulphates, carbonates)
- 2. sodicity
- 3. calcium carbonate percentage

<u>Salinity</u> ratings in the alluvial plains are very low and will, under natural conditions, not limit crop production. Electrical conductivity of the saturated soil paste remains below 2mmhos/cm at  $25^{\circ}C$ .

<u>Sodicity</u>; the exchangeable sodium percentage (ESP) is used as the indicator of sodicity. When the ESP of the topsoil exceeds 6 adverse effects on crop production can be expected.

Along the edges of the alluvial plains, irrespective of the soil type, ESP values of 4-8 have been found after flood recession. Under natural conditions the ESP is not expected to increase to much higher levels.

<u>Calcium carbonate</u>; the  ${\rm CaCo_3}$  percentage is not included in the standard chemical soil analyses. A quantitative assessment can therefore not be given. Soils with a shallow calcic or petrocalcic (A9a, A9) have some limitation for the two land use types.

# (w) workability

In the alluvial plains the ease with which the soil can be cultivated mainly depends on the consistence of the soil. A large portion of the alluvial plains has a sandy topsoil. In the lower parts the sandy topsoil is often absent; the clayey topsoil has a sticky consistence when wet and is hard to very hard when dry, causing a moderate limitation to improved traditional

molapo farming with animal traction. In the case of mechanized farming, either improved traditional or commercial, the limitation wil be less or absent.

Soils with a sandy texture throughout will not cause workability limitations.

#### (x) adequacy of topography

This land quality can not be assessed quantitatively because of absence of topographic data. The main characteristics are the shape of the basin which is to be bunded and the meso-micro within that basin.

#### (y) adequacy of flooding

More data have to be made available to assess the adequacy of flooding (extension of the flood, frequency and duration). Remote sensing techniques could be used to gather part of the information (extension of the flood and duration).

<u>Land suitability Classification</u> for improved traditional and commercial molapo farming.

The <u>current</u> land suitability is indicated on the land suitability classification sheets as well as the <u>potential</u> land suitability. The potential land suitability refers to the suitability after the recommended improvements have been carried out. It should be noted that no economic considerations have been taken into account. For both land use types only mechanized farming is considered. The suitability classes have to be downgraded in the case of animal traction.

Moisture availability and oxygen availability are the most critical limitations under natural conditions. Soil physical studies have to be carried out before final recommendations for improvements can be given; especially in areas where flood frequency and duration is sufficient, but where total infiltration is limited (part of unit A24, A31a).

The creation of a permanent water resevoir would offer the possibility to increase the moisture availability in areas with a short and somewhat irregular flood (part of unit A7, A7b, A9, A3la,b). However, the impact of such a resevoir on the watertable of the area has to be studied. A high groundwater table would be detrimental to the area as salinization is likely to occur.

Oxygen availability problems can be expected in areas with low infiltration rates after heavy rainfall. Shallow drainage systems have to be designed to improve the surface drainage.

Under natural flood conditions excess floodwater is drained out of the area, carrying dissolved salts. When a permanent water resevoir is present no surface drainage is possible, unless pumping is introduced. The impact of flooding without a surface drainage component on the salinity/sodicity of the soils will have to be studied. Depending on the results of such study the frequency of excess flooding followed by surface drainage can be calculated and measures can be taken.

#### 3.4.2 Medium to large scale irrigated farming

It is assumed that enough water of good quality is available throughout the year for irrigated farming and that floods are kept out of the farm area by bunds.

Most land quality ratings as discussed in section 3.4.1 also apply for irrigated farming. Land quality (m) moisture availability and (y) adequacy of flooding are not applicable.

The most important land quality limiting the suitability for irrigated farming is (d), soil drainability.

Soil drainability refers to the internal drainage of the soil which should neither be impeded, resulting in a high groundwater table and accumulation of toxic salts, nor very rapid, resulting in a loss of irrigation water.

Internal drainage is mainly a function of infiltration rate, permeability and depth of groundwater table.

Table 4

INTERNAL DRAINAGE CRITERIA

	minimum depth to	1/	2/
rating	groundwater table (cm)	infiltration rate (cm/h)	permeability cm/h
1	>200	>2	0.5-6
2	120-200	0.8-2	0.2-0.5 6-12
3	75-200	0.3-0.8	0.05-0.2
4	<75	<0.3	<0.05

<sup>1/</sup> infiltration defined as entrance of water into saturated topsoil (0-25 cm)

2/ permeability defined as percolation rate of least permeable horizon within 150cm from the surface

The soil characteristic with the lowest rating determines the final soil drainability rating.

The  $\underline{\text{minimum depth to the groundwater table}}$  varies following topographic position and distance to the water source. Not enough data are available for adequate quantification.

The <u>infiltration rate</u> is generally considered high as most areas are covered with a sandy topsoil.

The <u>permeability</u> of soils with a sandy clay texture is generally severly limiting the drainability (soil type A24, A31a). The available data indicate a permeability of less than 0.02cm/h. It is recommended that permeability tests are carried out for soil types A31b, A7, A7b, and A9, as permeability rates are probably higher in well structured Luvisols (A7, A7b) and in more

# sandy soils (A31b).

It is evident that the soils with a very low permeability are at best marginally suitable for irrigated farming, while the soils with sandy loam or coarser textures offer better possibilities.

It is recommended that special attention is given to the area east of Boro-Xasanare river junction (soil type A31b and A7a). Soil drainability is expected to be more favourable; care has to be taken as high ESP levels have been found.

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# APPENDIX 1.

#### SOIL PROFILE DESCRIPTIONS

Profile Symbol	Soil Unit	Soil Classification
MA108	A7	Gleyic Luvisol
MA122	A7	Gleyic Luvisol
MA201	A7a	Gleyic Luvisol
MA114	A7b	Calcic Gleyic Luvisol
MA115	A7b	Calcic Gleyic Luvisol
MA174	A9	Calcic Luvisol
MA25	A9a	Arenic Calcic Luvisol
MA123	A24	Eutric Fluvisol
MA35	A31a	Eutric Gleysol
MA104	A31a	Eutric Gleysol
MA237	A40	Eutric Arenosols, sodic phase
MA117	Lll	Calcic Arenosols, sodic phase
MA106	L24a	Calcic Luvisol, sodic phase
MA13	S13	Calcic Arenosol
MA44	S17	Eutric Arenosol

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ě	9
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ŀ	CQ5
	rci
E	
8	5.1
8	<b>S</b>
	marel
1	14
8	$ \rho_{i}$

SOLL	SOIL PROFILE DESCRIPTION	医毛皮黄色 医乳虫素 计分词 化苯甲基苯甲基苯甲基苯甲基苯甲基苯甲基苯甲基苯甲基苯甲基苯甲基苯甲基苯甲基苯甲基苯	多年 医骨骨 化二甲基甲基 化二甲基甲基 化二甲基甲基苯甲基甲基苯甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲	Profile: MA 0108 Unit: A7 Status: 2
SHEET	SHEET : 1923D3 LXCATION : Xxwaa molapo area. AUTHOR(S): G.Baert K.Verbeek		GRID: COORD: 19-45-21-S 23-37-10-E DATE: 14/02/85	AGRO CLIM.ZONE: 2C2 ELEVATION :
CLASS	CLASSIFICATION FAO: Abrupti-Cleyic Luvisol(1988) ST : Aeric Ochradualf	uvisol(1988) Gleyic Luvisol (1974)		SWR: aquic
TOPOG	IANDFORM : alluvial plain TOPGGRAPHY: almost flat	ā pr	IAND ELEMENT : flood plain MICRO TOPOGRAPHY: even	POSITION: higher part SLOPE : 0 - 1 %
LAND	John Charles, M. Lacens, M. evidence of LAND USE: traditional grazing SPECIES : Trees -	٠ المام ا	VEGETATION: open shrub savanna	GRASSCOVER:
	: Shrubs - Acacia sp. (dom.) : Grasses/forbs-			
PAREN	PARENT MATERIAL: alluvium MOIST. COND: dry 0 - 120 cm		ROCK TYPE:	GEOL.UNIT: DRAINAGE : immerfactiv drained
SURF.ST EROSION	SURF.STONES: none EROSION : nil		ROCK CUTCROP: none	HUMAN INF: nil
REMARI	S: From 60cm on:oxidation along	REMARKS: From 60cm on:oxidation along rootchannels. Slightly calcareous along rootchannels	rootchannels from 15cm on.	
	SAMPLES: A: 0 - 15 B: 30 -	50 C <sub>2</sub> 90 - 110		
. 100 also also also				
<b>4</b> ∠	0 - 15 cm 10TR 2/1.5 (moist	0 - 15 cm 10TR 2/1.5 (moist) and 10TR 3/1.5 (dry), fine sandy losm, moderate me very fine and fine pores, non calcareous, abrupt irregular boundary.	moderate medium and coarse subangular blocky structure, slightly hard to hard, common	lightly hard to hard, common
B# 00	15 - 60 cm 10TR 3/1 (moist) broken moderately	10TR 3/1 (moist) and 10TR 4.5/1 (dry), sandy clay, moderate very coarse prismatic falling apart into moderate angular blocky structure, extremely hard, broken moderately thick clay cutans on pedfaces, common very fine and fine pores, non calcareous, few very fine and fine roots, clear wavy boundary.	se prismatic falling apart into moderate angul fine pores, non calcareous, few very fine and	ar blocky structure, extremely hard, fine roots, clear wavy boundary.
8	60 - 120 cm 10TR 3,5/2 (moist) and 10 very fine and fine roots,	107R 3.5/2 (moist) and 107R 4.5/2 (dry), very weak angular and subangular blocky structure, extremely hard, few very fine and fine pores, non calcareous, very fine and fine roots,	gular blocky structure, extremely hard, few ver	y fine and fine pores, non calcareous, very few

STANDARD SOIL ANALYSIS RESULTS

PROFILE: MA 0108	MA 0108																		90 90 90 90 90 90 90 90 90 90 90 90 90 9	of the case of the	00- 00- 000 100- 000- 000 000 000 000 00
SAMPLE	DEPTH	SAMPLE DEPTH pH EC P C CEC Ca Mg K Na PBS Particle size (weight %) CECclay METH PRETR	23	p.		CEC	13	90	1 1 1 1 1 1 1 1	Na Sa	PBS	Particle size (weight %)	Le si	Ze (w	nght	64			CECclay	MEIM	PRETR
		H20 CaCL2	ns/cm	add	weight % ù meg/l	T	/bau	100gr s	- Ijo	00gr soilû %	分电	ocs c	e s	44 S2	A L	ScSi	fSf	vcs cs ms fs vfs csi fsi Clay	meq/100gr	* 100 pt (0) tt	at, qui app atp ann een een efte obb êen tep i
70 max day 100 tays day 400 dd0 000			after the figure and take the city that	Mar on 150 Mar on 150 Mar		No. 100 dec dec dec dec 100 dec	20 de se se se		1												
A	0 15	0.6 6.0	0.4	9	6.0	13.7	80	2.	1.5 0.8 0.3	6.3	š	0	~~	1 10 54	জ ব	77	٧٦	P	19	四	₩
m	30	7.6 6.9	5,0	~	0.1	21.7	14.2	e,	3.3 1.4 0.5	0.5	80	0	e-d	9 41	<b>₩</b>	2	ኖን	38	56	ш	A
Ü	90 110	7.6 6.7	0	md	0.1	19.0	19.0 13.3	3.0	3.0 1.4 0.3	0.3	95	0	اسم	0 4.	1 10 42 6	C)	S	33	56	pi pi	₩.
Soil Surv	rey of Botswam	Soll Survey of Botswana FAO/BOT/85/011		AT 400 AN 400 AN	60 60 60 00 00 00 00 00 00 00 00 00 00 0				1	ade vice date who man can man man		ACT - STAR - STA	10 cm 10 cm	400 MIN AND AND AND AND AND AND AND AND AND AN	3 # # # # # # # # # # # # # # # # # # #	t t t	9 AND		Print date: 23/03/89	Print da	Print date: 23/03/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, \* = Not Known pRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

SOIL PI	SOIL PROFILE DESCRIPTION		Profile: MA 0122 Unit: A07 Status:
SHEET LOCATIC AUTHOR	SHEET : 1923D3 LOCATION : Xhwaa molapo area, 2.5km NW from MDP camp AJTHOR(S): G.J.Rhebergen G.Baert K.Verbeek B.Kopelo G.ASTFICATION EAO: Orthi-Glevic Luvisol (1988) Glevic Luvisol (1974)	GRID : COORD: 19-45-39-S 23-36-20-EDATE : 27/08/85	AGRO CLIM.ZONE: 2C2 ELEVATION : SMR: aquic
LANDFO! TOPOGRA	ST : Mollic Ochraqualf LANDRORM : alluvial plain TOPOGRAPHY: almost flat	LAND ELPENT : flood plain MICRO TOPOGRAPHY: even	POSITION: higher part SLOPE : 0 - 0.5%
SURF. ( LAND US SPECIES	SURK. CHAR: strong sealing, no cracks, nil evidence of salt, LAND USE: traditional Molapo farming SPECIES : Trees -	VECETATION: open shrub savanna	GRASSCOVER:
	: Shrubs - Acacia sp. (dom.) : Grasses/forbs-		
PARENT	PARENT MATERIAL: alluvium	ROCK TYPE:	GEOL.UNIT: DRAINAGE : immosfertly drained
SURF.ST EROSION	NALSI: WAND: MOAST 0 - 100 cm SURF.STONES: none EROSION : nil	ROCK OUTCROP: none	HUMAN INF: nil
REMARK	REMARKS: Bleached sand grains on ped surfaces in Bt2 horizon. Bt1 and Bt2 slightly calcareous along rootchannels. Not regularly flooded molapo.	reous along rootchannels. Not regularly floo	ded molapo.
SAMPLES: A:	S: A: 0 - 20 B: 30 - 50 C: 80 - 100		
A	0 - 15 cm 10YR 3/1 (moist) and 10YR 4/1 (dry), sandy clay loam, weak medium to very coarse subangular blocky structure, firm, non calcareous, common very fine and fine roots,	o very coarse subangular blocky structure, f	irm, non calcareous, common very fine and fine ro
Btgl	15 - 65 cm 10TR 2.5/1- (moist) and 10TR 3.5/1- (dry), sandy clay, moderate coarse and very coarse angular and subangular blocky structure, very firm, broken moderately thick clay cutans on pedfaces, non calcareous, few very fine and fine roots, clear smooth boundary.	rse and very coarse angular and subangular bits, clear smooth boundary.	clocky structure, very firm, broken moderately thic
Btg2	65 - 110 cm 10TR 4/1- (moist) and 10TR 5/1- (dry), sandy clay loam, weak very coarse subangular blocky structure, very firm, broken thin clay cutans on pedfaces, non calcareous, very few very fine and fine roots,	oarse subangular blocky structure, very firm	1, broken thin clay cutans

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Soil Survey of Botswana RAO/BOT/85/011

STANDARD SOIL ANALYSIS RESULTS

PROFILE: MA 0122	MA 0122											1	1	*******		8 8 8	1	age see dath cap cap cap and dop det off	PROFILE: MA 0122		
SAMPLE	DEPTH	Hd.	EC		O	283	යි	Mg	M	Na	PBS	Parti	Particle size (weight %)	ze (w	eight	3			CECclay	METH	PRETR
		H20 CaCL2	mS/cm	mdd	mS/cm ppm weight % u meq/100gr soilù	, u	/bem ·	100gr	soil	p	н	vcS	vcS cS mS fS vfS cSi fSi Clay	S.	S	S	£Sł	Clay	1/100gr soilù % vcS cS mS fS vfS cSi fSi Clay meq/100gr	G co 80 St (5) St (5) An en 180 At	
A 2011 days one one was one case one	en ere en vo so de en en en en en en en en en	泰恩 医电光电影 电电子系统 化化丁基苯酚 医阿拉斯氏 医电子 医电子 医电子性 医电子性 医电子性 医电子性 医电子性 医克里氏性 医二甲基氏试验检检验检验检验检验检验检验检验检验检验检验检验检验检验检验检验检验检验检验				****		1		*******	AS 500 000 000 000 000 000 000 000 000 00	5 6 5 5 6									
A	0 20	6.8 6.0	0.0	0.0 4 0.8	0.8	18.6	18.6 10.3	2.5	1.3	2.5 1.3 0.2	11	0	0 5 8 46	8	9	8 4 6 24	9	24	99	m	¥
æ	30 50	7.6 7.0	0.7	0.7	0.1	20.8	20.8 12.2	3.0	3.0 1.3 0.5	0.5	82	0	-	6 45	5 7	7 1	1 4	37	55	ш	¥
ပ	80 100	7.7 6.9	0.0	0.0 1 0.1	0.1	17.9		2.5	1.1	2.5 1.1 0.4	78	0	0 1 8 44 6 4 4	24	9 4	7	4	33	2.5 1.1 0.4 78 0 1 8 44 6 4 4 33 53 H A	ш	A
Soil Sur	vey of Botswan	Soil Survey of Botswana RAO/BOT/85/011	011			# # # # # # # # # # # # # # # # # # #			***	! !										Print da	Print date: 23/03/89
PART.SIZ	PART.SIZE DETERMINATION	NN METHOD: H = Bydrometer Method, P = Pipette   PRETREATMENT: O = Organic Matter, F = Free Iron O	): H = Hy	dromete	er Mathod, Matter, F	P = Pi	pette M [ron Ox	fethod, ides,	. J	Method, * = Not Known Oxides, C = Carbonates, S = Soluble Salts N = None	ma is, S⊪	Solubl	e Salt	ai M	- None						

23/03/89
date:
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Soil Survey of Botswana FAO/BOT/85/011

SOIL PROFILE DESCRIPTION		Profile: MA 0201 Unit: A07a Status: 2
SHEET : 1923D3 LOCATION : Boro molapo area. AUTHOR(S): K.Verbeek CLASSIFICATION PRO: Gleyic Luvisol(1988) Gleyic Luvisol (1974) ST : Mollic Othramalf	GRID ; CORD; 19-52-59-S 23-31-24-E DATE ; 20/03/85	AGRO CLIM.ZONE: 2C2 ELEVATION ; SMR: aquic
LANDRORM : alluvial plain TOPOGRAPHY: almost flat SURF. CHAR: moderate sealing, no cracks, nil evidence of salt, LAND USE: traditional grazing	IAND ELEMENT : channel MICRO TOPOGRAPHY: even VEGETATION: open shrub savanna	POSITION: intermediate part SLOPE : 1 - 2 % GRASSCOVER:
SPECIES: Trees - : Shrubs - Acacia sp. (dom.) : Grasses/forbs- : Grasses/forbs- PARENT MATRIAL: alluvium 'MOIST. COND: moist 0 - 100 cm SURF.STONES: none EROSION : nil	ROCK TYPE: ROCK GUTCROP: none	GEOL.UNIT: DRAINAGE : imperfectly drained HUMAN INF: nil
REMARKS; Bt2 slightly calcareous along rootchannels. Cracks starting under A, few millimet: SAMPLES; A: 0 - 20 B: 30 - 50 C: 70 - 90	few millimetres wide. Oxidation along rootchannels in Btl and Bt2.	id Bt2.
R 4.5/1 (dry), fine sand to loamy y boundary.  ORR 5.5/1 (dry), fine sandy loam,	fine sand, very weak medium and coarse subangular blocky structure, very fine weak very coarse prismatic structure, very firm, non calcareous, few	ructure, very friable, non calcareous,
gradual smooth boundary.  Bt.2 70 - 100 cm 10YR 4/1- (moist) and 10YR 5/1- (dry), fine sandy loam, very weak very	very weak very coarse prismatic structure, very firm, non calcareous, no roots,	careous, no roots,
	计分类 化对射 医外侧外外 医外侧外外外外外外外外外外外外外外外外外外外外外外外外外外外外外	医胃炎 医唇骨 医多合体 医阿耳氏素 医马克氏氏征 医皮肤 医阿尔氏氏征 医阿尔氏氏征 医克氏氏管 医皮肤管 医皮肤炎 医医皮肤

STANDARD SOIL ANALYSIS RESULTS

PROFILE: MA 0201	MA 020.	11																				
SAMPLE	DEPTH	* * * * * * * * * * * * * * * * * * *	SAMPLE DEPTH PH EC P C CBC Ca	22	p.	0	CEC Ca	త	₩ B	×	Na	PBS	Particle size (weight 7)	le siz	se (we	ight 1	100			Mg K Na PBS Particle size (weight %) CECclay METH PRETR	METH	PRETR
			HZO CaCL.2	mS/cm	mdd	mS/cm ppm weight % ù meq/	ù	/bem	100gr 4	soil -	100gr soilù %	м	vcS cS mS fS vfS cSi fSi Clay	S	. fs	; v£s	, cSt	fSi	Clay	meq/100gr		
40 May 400 May			电电流电路 医电阻检验 医电阻性 医电阻性 医电阻性 医电阻性 医电阻性 医电阻性 医电阻性 医电阻性		1 1 1 1			1 1 1 1		1 1 1 1				1		1					*********	*****
₩.	0	0 20	7.4 6.3	0.0	0.0 2 0.5	0.5	5.9	5.9 6.4	0.8	0.4	0.8 0.4 0.1	100	0	1 10	. 58	0 1 10 58 13	9	9	7	57	m	Ą
щ	30	જ	7.5 6.5	0.4	7	2 0.1	7.7	7.7 7.2	1.1	0.4	1.1 0.4 0.2	100	0	1 10	54	1 10 54 13	S	Ŋ	13	54	ш	Ą
ပ	70 90	06	7.6 6.4	0.3	0.3 1 0.1	0.1	12.7 10.6	10.6		9.0	2.0 0.6 0.2	100	0		, 47	1 9 47 10 10 6	10	9	18	69	ш	¥
Soil Sur	vey of 1	Botswana	Soil Survey of Botswana FAO/BOT/85/011	1	i !	* * * * * * * * * * * * * * * * * * *	1 1 1 1	! ! ! !		1	: 1 1 1 1	1 1 4 1 1	1 1 1 1	***					AND ON USE ON ON ON ON ON	Print date: 23/03/89	Print da	Print date: 23/03/89

METHOD: H = Hydrometer Method, P = Pipette Method, \* = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None PART.SIZE DETERMINATION

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וארידואים חדיואיו דוגה		FIGURE: MA ULI4 ULLU: AU/D	Status: 2
SHRET : 1923D3	GRID :	AGRO CLIM.ZONE: 2C2	
LOCATION : Xhwaa molapo area.	COORD: 19-45-59-S 23-38-09-E	ELEVATION :	
AUTHOR(S): B.Kopelo G.Baert CLASSIFICATION FAO: Calci-Gleyic Luvisol(1988) Calcic Gleyic Luvisol (1974)	DATE: 20/02/85	SMR: aquic	
LANDFORM : alluvial plain	LAND ELEMENT : flood plain	POSITION: intermediate part	
TOPOGRAPHY: almost flat	MICRO TOPOGRAPHY: even	SLOPE : 0 - 1 %	
SURF. CHAR: no cracks, nil evidence of salt,			
LAND USE: traditional grazing	VEGETATION: grassland	GRASSCOVER:	
SPECIES: Trees -			
: Shrubs -			
: Grasses/forbs-			
PARENT MATERIAL: alluvium	ROCK TYPE:	GEOL, UNIT:	
MOIST. COND: dry 0 - 100 cm		DRAINAGE : imperfectly drained	
SURF.STONES: none	ROCK OUTCROP: none		
EROSION : mil		HUMAN INF: nil	

REMARKS: From 18cm on: oxidation is along rootchannels. Bleached sand grains along structure elements.

80 - 100 ပံ 45 22 ä 0 - 15 A: SAMPLES:

10TR 3/1 (moist) and 10TR 3.5/1 (dry), sandy clay to clay, weak prismatic structure, very hard, patchy thin clay cutans on pedfaces, very few fine spherical soft calcareous white nodules, slightly calcareous, few very fine and fine roots, gradual wavy boundary. 18 cm 10TR 2/1 (moist) and 10TR 3/1 (dry), sandy clay loam, hard, non calcareous, common very fine and fine roots, clear wavy boundary. 18 - 50 cm 0

50 - 100 cm 10TR 4.5/1 (moist) and 10TR 5.5/1 (dry), clay, moderate medium and coarse subangular and angular blocky structure, extremely hard, patchy thin clay cutans on pedfaces, frequent fine spherical hard calcareous white soft segregations, strongly calcareous, very few very fine and fine roots, Btgk

Soil Survey of Botswana FAO/BOT/85/011

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STANDARD SOIL ANALYSIS RESULTS

PROFILE: MA 0114	MA 0114											200			20,000,000,000	1	8 8 8	100, 140 004 500 500 400 400 ATO ATO ATO	PROFILE: MA 0114		C) and and with win with the Co. (iii) and co.
SAMPLE	DEPTH	78.	EC	p.		280	3	Š	×	Na	PBS	Parti	cle s	ize (	Particle size (weight 7)	7)			CECclay	METH	PRETR
		H20 CaCL2	mS/cm	audd	mS/cm ppm weight % uu	-p	ned.	100gr	soil	ÚÚ	84	veS	S	Sa	ES AT	So	Ŧ.	veS cS mS fS vfS cSi fSi Clay	meq/100gr	\$ 00 00 00 00 00 00 00 00 00 00 00 00 00	000 day and map may may may and may may
1 100 Etc. del con cit. con 100 Con 10	- THE REP LESS COST AND		AN ANY COL SEC THE USE OF THE THE THE SEC	1		0 00 mm co on me mo	M 400 000 110 000 400 1			10 co co mis co co co co co	0 100 40 40 40 40 40 40 40 40 40 40 40 40 4	9 90 90 90 90 90 90 90 90 90 90 90 90 90									
4	0 15	6.7 6.1	0.0	4	4 1.2	17.0	17.0 13.2	2.3	0.2	2.3 0.2 0.2	76	0	0	φ.	6 39 10 10 9	07	9	26	94	ш	A
m	25 45	8.0 7.3	0.3	,i	0.2	21.1	21.1 13.6	5.2	0.0	5.2 0.9 0.2	76	0	0	'n	30	u;	7	45	45	щ	Ą
ပ	80 100	8.9 8.0	0.3		0.3 1 0.1	25.1	25.1 37.1	9.0	0.4	9.0 0.4 0.2	100	-	1 1 2 11	2		2	16	2 16 62	40	pc	A
Soil Sur	Soil Survey of Botswana RAO/BOT/85/011	EAO/BOT/85	/011								on on the part of								Soil Survey of Botswana RAO/BOT/85/011	Print da	Print date: 23/03/89

METROD: H = Hydrometer Method, P = Pipette Method, \* = Not Known PRETREATMENT: 0 = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None PART.SIZE DETERMINATION

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	Soil Survey o

SOIL 1	SOIL PROFILE DESCRIPTION	"百百 克 重 医 克 草 医 香 号 医 医 香 医 医 医 医 医 医 医 医 医 医 医 医 医 医		Profile: MA 0115 Unit: A7b	Status: 1
SHEET LOCATI AUTHOR	sol(1988)	Calcic Gleyic Luwisol (1974)	GRID : COORD: 19-45-58-S 23-38-12-E DATE : 20/02/85	AGRO CLIM.ZONE: 2C2 ELEVATION : SMR: aquic	
LANDE	ST : Mollic Ochraqualf LANDFORM : alluvial plain TOPOGRAPHY: almost flat		LAND ELEMENT : flood plain MICRO TOPOGRAPHY: even	POSITION: intermediate part SLOPE : 0 - 1 %	
SURF. LAND 1 SPECII	SURF. CHAR: no cracks, nil evidence of salt, LAND USE: traditional grazing SPECIES : Trees -		VECETATION: grassland	GRASS COVER:	
	: Shrubs - : Grasses/forbs-				
PAREN	PARENT MATERIAL ALL TO THE MATERIAL AND A 110 cm		ROCK TYPE:	GEOL.UNIT: DRAINAGE : imperfectly drained	
SURF. ST EROSION	SURF.STONES: none EROSION : nil		ROCK OUTCROP: none	HUMAN INF: nil	
REMARK	REMARKS: Thin layer of white sand between A and Btg. Oxidation along rootchannels in Btgl.	on along rootchannels in Btgl.			
SAMPLE	SAMPLES: A: 0 - 15 B: 25 - 45 C: 60 - 80	D: 100 - 120			
39					
⋖	0 - 15 cm 10TR 2/1 (moist) and 10TR 3/1 (dry), fine sandy loam, ver non calcareous, common fine roots, clear smooth boundary.	ne sandy loam, very weak mediu r smooth boundary.	15 cm 10TR 2/1 (moist) and 10YR 3/1 (dry), fine sandy loam, very weak medium subangular blocky structure, slightly hard, common very fine and fine pores, non calcareous, common fine roots, clear smooth boundary.	mon very fine and fine pores,	-
Btg1	15 - 55 cm 10TR 3/1 (moist) and 10TR 4/1 (dry), few fine distinct st patchy thin clay cutans on pedfaces, few fine pores, non	w fine distinct sharp yellow m # fine pores, non calcareous, ?	10TR 3/1 (moist) and 10TR 4/1 (dry), few fine distinct sharp yellow mottles, sandy clay to clay, weak medium subangular blocky structure, very hard, patchy thin clay cutans on pedfaces, few fine pores, non calcareous, few very fine and fine roots, gradual smooth boundary.	r blocky structure, very hard, dary,	
Btg2	55- 100 cm 10TR 4/1 (moist) and 10TR 5/1 (dry), few fine distinct clear yel fine pores, non calcareous, few fine roots, clear wavy boundary.	w fine distinct clear yellow m ots, clear wavy boundary.	10TR 4/1 (moist) and 10TR 5/1 (dry), few fine distinct clear yellow mottles, sandy clay to clay, weak medium subangular blocky structure, very hard, few fine pores, non calcareous, few fine roots, clear wavy boundary.	r blocky structure, very hard, few	
Cgk	100 - 110 cm 10YR 5/1.5 (moist) and 10YR 6/1.5 (dry) fine pores, few fine spherical soft cal	, few fine distinct clear yell, careous white nodules, strongl)	10YR 5/1.5 (moist) and 10YR 6/1.5 (dry), few fine distinct clear yellow mottles, clay, strongly coherent massive structure, extremely hard, few fine pores, few fine spherical soft calcareous white nodules, strongly calcareous, very few very fine and fine roots,	cture, extremely hard, few	

STANDARD SOIL ANALYSIS RESULTS

PROFILE: MA 0115	MA 011.	5																					
SAMPLE	DEPTH	50 TO 10 TO	鬼		22	D.	0	CEC	ঞ	¥3	M	Na	PBS	Parti	cle si	ze (r	Particle size (weight %)	7)		A 644 505 505 505 505 506 506 506 506 506 506	SAMPLE DEPTH pH EC P C CEC Ca Mg K Na PBS Particle size (weight %) CECclay METH PRETR	METH	PRETR
			H20 CaCL2	aCI.2	mS/cm	mdd	mS/cm ppm weight % ù meq/100gr soilù %	ů	/bem	1000gr	soil -	p	<b>F4</b>	vcS	cS 1	δ. ±	SS.	So Si	5 5	vcS cS mS fS vfS cSi fSi Clay	meq/100gr		
Ą	0 15	15	6.6 5.8	5.8	0.0	m	3 1.3	15.9 8.2	8.2	1.4	1.0	1.4 1.0 0.1	29	0	-	97 6	9	9 6 10	10	20	A 0 15 6.6 5.8 0.0 3 1.3 15.9 8.2 1.4 1.0 0.1 67 0 1 9 46 9 6 10 20 54 H A	H	A
ρα	25	45	7.7	7.0	0.3		0.1	20.0	20.0 12.3	2.9	2.9 1.0 0.3	0.3	83	0	0	9	29 6	6 2	2	5 52	38	m	Ą
ပ	09	80	8.0	7.2	0.3	<b></b> 4	0.1	19.1	19.1 15.8	2.9	0.2	0.5	100	0	0	9	27 6	9	ζ.	55	34	Ħ	Ą
Ω	100 120	120	8.5 7.7	7.7	0.2		0.1	22.4	22.4 22.6	3.4	0.2	3.4 0.2 0.6	100	0	0	4 2	0 0 4 20 5 6 4		4	61	36	Ħ	Ą
Soil Sur	vey of 1	Soil Survey of Botswana FAO/BOT/85/011	EAO/BO	rr/85/011					2 8 8 8	1	!		1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			* * *	3		m) and the cap was the last cap the far the	Soil Survey of Botswana RAO/BOT/85/011	Print da	Print date: 23/03/89

METHOD: H = Hydrometer Method, P = Pipette Method, \* = Not Known PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None PART.SIZE DETERMINATION

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SOIL PROFILE DESCRIPTION		Profile: MA 0174 Unit: A09 Status: 2
1(1988) Calcic Luvisol (1974)	GRID : COORD: 0-E DATE : 26/03/85	AGRO CLIM.ZONE: 2C2 ELEVATION ; SMR: ustic
ST : Typic Haplustalf LANDFORM : alluvial plain TOPOGRAPHY: almost flat	IAND ELEMENT : flood plain MICRO TOFOGRAPHY: even	POSITION: intermediate part SLOPE : 0 - 0.5%
SURF. CHAR: no cracks, nil evidence of salt, LAND USE: medium scale irrigated farming SPECIES : Trees - : Shrubs -	VEGETATION:	GRASSCOVER:
: Grasses/forbs- PARENT MATERIAL: alluvium MOIST. COND: slightly moist 0 - 100 cm SURF.STONES: none EROSION : nil	ROCK OUTCROP: none	GEOL.UNIT: DRAINAGE : imperfectly drained HUMAN INF: ploughing
REMARKS: Rice field, poor crop perfomance.		
SAMPLES: A: 0 - 20 B: 30 - 50 C: 80 - 100		
A 0 - 20 cm 10YR 3/2 (moist) and 10YR 4/2 (dry), loamy fine sand, weak medium and coarse subangular blocky structure, slightly hard, slightly calcareous, common roots, abrupt smooth boundary.	oarse subangular blocky structure, slightly hard	d, slightly calcareous, common
Bt 20 - 50 cm 10TR 4/2 (moist) and 10TR 5/2.5 (dry), fine sandy loam, very weak coarse and very coarse subangular blocky structure, hard, moderately calcareous, few roots, gradual smooth boundary.	e and very coarse subangular blocky structure, i	hard, moderately calcareous, few
Etk 50 - 100 cm 10YR 4/2 (moist) and 10YR 5/2.5 (dry), sandy clay loam, very weak coarse and very coarse subangular blocky structure, very hard, patchy thin clay cutans on pedfaces, frequent fine spherical soft calcareous white soft segregations, strongly calcareous, very few roots,	e and very coarse subangular blocky structure, 'soft segregations, strongly calcareous, very fer	very hard, patchy thin W roots,
Soil Survey of Botswana RAO/BOT/85/011		print date: 27/04/89

STANDARD SOIL ANALYSIS RESULTS

SAMPLE	DEPTH	띺	22		υ	CBC	હ	₩ ₩	×	Na	PBS	Parti	cle s	ize (	Particle size (weight %)	(2)			83	ECclay	METH	PRETR
	H2O CaCL2 mS/cm ppm weight % ù meq/l	HZO CaCL2	mS/cm	udd	mS/cm ppm weight % u meq/l	ή. 	/beat	1000gr	soil -	100gr soilù %	**	vcS	cs	Sil	vcS cS mS fS vfS cSi fSi Clay	rfs c	St	St C	lay me	.00gr soilù % vcS cS mS fS vfS cSi fSi Clay meq/100gr	# # # # # # # # # # # # # # # # # # #	 
	0 20	7.3 5.2	0.2	4	0.2	6.9	6.9 6.1		0.3	0.9 0.3 0.3	100	0		18	1 18 61 6 2	9		1 10		59	ш	¥
	30 50	7.5 6.3	0.1	7	0.1	11.0 8.1	8.1	1.4	0.3	1.4 0.3 0.4	93	0		17 55	55	9	en	4	15 7.	73	m	Ą
	80 100	8.6 7.7	0.7		1 0.0	13.3 18.5	18.5	2.4	0.5	0.5	2.4 0.5 0.5 100	0	, <b>-</b> 1	16	1 16 51 6		2	3 20		99	ш	<b>₩</b>

METROD: H = Hydrometer Method, P = Pipette Method, \* = Not Known PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None PART.SIZE DETERMINATION

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SOIL PROFILE DESCRIPTION		Profile: MA 0025 Unit: A09a Status: 2
SHEET : 1923D3 LOCATION : Xhwaa molapo area. AUTHOR(S): G.J.Rhebergen CLASSIFICATION FAO: Areni-Luvic Calcisol(1988) Arenic Calcic Luvisol (1974)	GRID: COORD: 19-46-30-S 29-38-06-EDATE: 15/05/84 sodic phase	AGRO CLIM.ZONE: 2C2 ELEVATION : SWR: ustic
ST : Arenic Haplustalf LANDFORM : alluvial plain TOPOCRAPHY: almost flat	IAND ELEMENT : flood plain MICRO TOPOGRAPHY: even	POSITION: higher part SLOPE : 0 - 1 %
SUKF. CHAK: no sealing, no cracks, nil evidence of salt, LAND USE: traditional Molapo farming SPECIES : Trees -	VEGETATION: grassland	GRASSCOVER:
: Shrubs - : Grasses/forbs- PARENT MATERIAL: alluvium MAIST CONN: drv 0 - 100 cm	ROCK TYPE:	GEOL, UNIT: DRATMAGE : moderately wall to immorfantly desired
SURF. STONES: none EROSION : nil	ROCK OUTCROP: none	HUMAN INF: ploughing
REMARKS: Position: edge of alluvial plain		
SAMPLES: A: 0 - 20 B: 30 - 50 C: 80 - 100		
A 0 - 20 cm 10YR 3/1 (moist) and 10YR 4/1 (dry), fine sand to loamy fine common roots, clear smooth boundary.	oamy fine sand, very weak medium subangular blocky structure, slightly hard to hard, moderately calcareous,	slightly hard to hard, moderately calcareous,
Btk 20 - 60 cm 10YR 3/2 (moist) and 10YR 4/2 (dry), loamy fine sand, strongly coherent massive Ck 60 - 100 cm 10YR 4/3 (moist) and 10YR 6/2 (dry), fine sand, massive structure, hard, frequence very few roots,	rongly coherent massive structure, hard, frequer	structure, very hard, strongly calcareous, few roots, gradual smooth boundary. It fine irregular soft calcareous white soft segregations, slightly calcareous,
Soil Survey of Botswana FAO/BOT/85/011		print date: 23/03/89

STANDARD SOIL ANALYSIS RESULTS

PROFILE: MA 0025	MA 0025					i					8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	\$ 50 E	1	8 8 8	1	1	1	1			
SAMPLE	DEPTH	SAMPLE DEPTH pH EC P C CEC Ca	EC	p.	0	CBC	ප්	<b>№</b>	M	Na	PBS	Parti	cle s	ize (	Particle size (weight %)	2			CECclay	METH	PRETR
		HZO CaCL.2	2 mS/cm	udd	ppm weight % ù meq/100gr soilù %	-tj	/bear	100gr	soil -	ņ	н	vcS	S	Sil	£S 4	fs c	St	veS es ms fs vfs esi fSi Clay	meq/100gr	- 00 de	45 40 50 50 50 50 50 50 50 50 50 50 50 50 50
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щ	30 50	9.6 8.4	E. I		1 0.2	4.1	4.1 12.1		,d	0.9 1.1 2.1	100	0	ന	28	20	Ŋ	prod	3 10	34	щ	¥
O	80 100	8.9 7.5	0.1	****	1 0.1	2.5	2.5 2.9	9.0	0.5	0.6 0.5 0.4	100	0	7	26 55	55	vs	-	3 7	31	ш	A
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METROD: H = Hydrometer Method, P = Pipette Method, \* = Not Known PRETREATMENT: 0 = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None PART.SIZE DETERMINATION

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SHECT : 1923D3  LOCATION : Xhwaa molapo.  AUTHOR(S): G.J.Rhebergen G.Baert K.Verbeek B.Kopelo  CLASSIFICATION FAO: Orthi-Eutric Gleysol(1988) Eutric Eluvisol (1974)  ST : Mollic Haplaquent  LANDFORM : alluvial plain  TOPOGRAPHY: rolling  SURR. CHAR: no cracks, nil evidence of salt,  VEGETATION: stored Molaco farmine, crobs: sorehum, maize	-50-S 23-35-09-E 85 : flood plain NPHY: even grassland : none	AGRO CLIM.ZONE: 2C2 ELEVATION SMR: aquic POSITION: lower part SLOPE : 0 - 0.5% GRASSCOVER:
	HIMAN IN	GEOL.UNIT: DRAINACE : imperfectly to poorly drained EUMAN INF: ploughing
REWARKS: 3.80m depth groundwater reached by augering. SAMPLES: A: 0 - 20 B: 40 - 60 C: 90 - 110 D: 140 - 160 E: 190 - 210	F: 240 - 260	
0 - 20 cm 10TR 2/1 (moist) and 10TR 3.5/1 (dry), sandy clay loam, weak medium and coarse non calcareous, common very fine and fine roots, clear smooth boundary.	weak medium and coarse subangular blocky structure, very hard friable, common very fine and fine pores,	common very fine and fine pores,
20 - 70 cm 10YR 3/1 (moist) and 10YR 4/1 (dry), few fine faint clear reddish-brown mottles, sandy clay loam, strongly coherent massive very fine and fine pores, non calcarecus, few fine roots, gradual smooth boundary.		structure, firm to very firm, few
Cg2 70 - 170 cm 2.5% 3/2 (moist), many fine distinct clear reddish-brown mottles, sandy clay l non calcareous, no roots, gradual smooth boundary.	mottles, sandy clay loam, strongly coherent massive structure, firm, f	structure, firm, few very fine and fine pores,
Cgk 170 - 270 cm 2.5Y 5.5/2 (moist), many fine faint clear reddish-brown mortles, sandy clay loam to sandy clay, strongly coherent massive very fine and fine pores, frequent fine irregular hard and soft calcareous white modules, strongly calcareous, no roots,		structure, friable, few

STANDARD SOIL ANALYSIS RESULTS

PROFILE:	PROFILE: MA 0123									8	6 A	outs age age was more age.	20 00 00 00 00 00 00 00 00 00 00 00 00 0	utto man con esso son e	es ap es an	1	1 1	1 1	1 1 1	PROFILE: MA 0123	20 00 00 00 00 00 00 00 00 00 00 00 00 0		8 8
SAMPLE	DEPTH	H	1 1 1 1 1 1 1 1 1 1 1 1 1	EC	А	0	SEC	ප්	₩ We	M	Ma	PBS	Parti	tcle s	ize (	Particle size (weight %)	(% ::			CECclay	y METH	PRETR	-4
		田	H20 CaCL2	mS/cm	mdd a	weight % u meq/	7	ped .	/100gr	so <u>i</u> 1	100gr soil	કન્શ	76S CS	တ	Sm	mS fs vfs cSi fSi Clay	rfS c	Sif	Si C	ay meq/100gr	)gr	n par the spe spe spe spe spe and spe	ally state and wice
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O	90 110		6.6 5.8	0.0	geneg	0.1	15.0	6.2	 &	p    	0.5	99	v-4	****	13	69	9	7	3 23	63	ш	Ą	
۵	140 160		7.2 6.7	0.0	2	ő	19,3	10.3	2.1	1.4	0.4	74	0	send		44	9	rU.	4 29	65	m	₹	
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Ş24	240 260		8.5 7.7	0,3	0	0.0	18.3	18.3 48.4	3.2	0.8	0.2	100	<b>~</b>	end	10	75	_	7	6 29		ш	A	
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METROD: H = Hydrometer Method, P = Pipette Method, \* = Not Known PRETREATMENT: O = Organic Matter, F = Free Iron Orides, C = Carbonates, S = Soluble Salts N = None PART. SIZE DETERMINATION

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SOIL	SOIL PROFILE DESCRIPTION		Profile: MA 0035 Unit; A31a Status: 2
SHEET LOCATI AUTHOI CLASS:	: 1923D3 ION: Mazanga molapo. R(S): G.J.Rhebergen IFICATION FAO: Eutric Gleysol(1988) Eutric Gleysol (1974)	GRID: COORD: 19-48-30-S 23-33-44-E DATE: 26/06/84	AGRO CLIM.ZONE: 2C2 ELEVATION : SMR: aquic
TOPO		LAND ELEMENT : not applicable MICRO TOPOGRAPHY: even	POSITION: lower part SLOPE : 0 - 0.5% concave
SURF	SURF. CHAR: no cracks, nil evidence of salt, LAND USE: improved Molapo farming SPECIES : Trees -	VECETATION: grassland	GRASSCOVER:
PARE		ROCK TYPE:	GBOL UNIT:
MOIST. ( SURF.ST	COND: dry 0 - 120 cm ONES: none : moderate accumulation by water	ROCK OUTCROP: none	DRAINANE : poorty drained HUMAN INF: nil
REMA	REMARKS: Ah contains less humus than MA0032.Bg and Cg oxidation along rootchamels.		
ZAWE	SAMFLES: A: 0 - 200 B: 0 - 0 C: 0 - 0		
Ah i	0 - 20 cm 10YR 3/2 (moist) and 10YR 4/2 (dry), loamy fine sand to fine sandy loam, very weak medium subangular blocky structure, hard, common very fine and fine pores, non calcareous, common roots, abrupt wavy boundary.	ry weak medium subangular blocky structure,	hard, common very fine and fine pores,
88 E	20 - 80 cm 10YR 3/1- (moist) and 10YR 4/1- (dry), sandy clay, very weak very coarse angular blocky structure, very hard, common very fine and fine pores, non calcareous, few roots, gradual smooth boundary.	gular blocky structure, very hard, common ve	ery fine and fine pores,
్రో	89 - 120 cm 10YR 4/1- (moist) and 10YR 3/1- (dry), sandy clay to clay, strongly coherent massive	it massive structure, very hard, non calcareous, very few roots,	eous, very few roots,
Soil	Soil Survey of Botswana RAO/BOT/85/011		print date: 27/04/89

STANDARD SOIL ANALYSIS RESULTS

SAMPLE	DEPTH	SAMPLE DEPTH PH EC P C CEC Ca	22	щ	ပ	CEC	ద్ద	¥8	M	Na	PBS	Parti	cle s	ize (	Particle size (weight %)	73			CECclay	METH	PRETR
		H20 CaCL2	mS/cm	ndd	mS/cm ppm weight % ù meq/100gr soilù %	4	/bea	100gr	30il -	# 1	<b>8</b> 4	vcS	so	Sa	ES &	£S C	Si fi	vcS cS mS fS vfS cSi fSi Clay	100gr soilù % vcS cS mS fS vfS cSi fSi Clay meq/100gr	as who wan near near age age see see see see see age ag	se en ne se een eel een de de de lac ee ee ee
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ρū	0	5.9 5.2	0.0	'n	3 0.1	20.0	20.0 14.7		1.4	2.5 1.4 0.4	95	0		o,	39	9	m,	38	51	m	<b>⋖</b>
υ	0	6.6 5.9	0.0 1 0.1	4	0.1	22.8	22.8 16.9	2.8	1.6	2.8 1.6 0.3 95	95	0	0	7	0 7 36 7	1	4 6	41	55	ш	Ą
Soil Sur	vev of Botswana	Soil Surgey of Botswana RAC/BOT/85/011			de des 195 une cos, este cata cos cos cos cos des			an on on an on an	10 de		•		5 8 8 8 8		5 8 8 8	\$ \$ \$			Print date: 23/03/89	Print o	Print date: 23/03/89

METROD: H = Hydrometer Method, P = Pipette Method, \* " Not Known PRETREATMENT: O " Organic Matter, F = Free Iron Oxides, C " Carbonates, S = Soluble Salts N = None PART.SIZE DETERMINATION

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SOIL PROFILE DESCRIPTION		Profile; MA 0104 Unit: A31a Status: 2
: : 19231 TON : Xhwaa R(S): K.Ver	GRID: COORD: 19-45-47-S 23-37-40-EDATE: 14/02/85	AGRO CLIM.ZONE: 2C2 ELEVATION : SMR: aquic
IANDFORM : alluvial plain TOPOGRAPHY: almost flat	IAND ELFMENT : flood plain MICRO TOPOCRAPHY: even	POSITION: higher part SLOPE : 1 - 2 %
SURF. CHAR: no cracks, nil evidence of salt, LAND USE: improved Molapo farming, crops: maize SPECIES : Trees - : Shrubs -	VECETATION: grassland	GRASSCOVER:
: Grasses/forbs- PARENT MATERIAL: alluvium MOIST. COND: moist 0 - 110 cm	ROCK TYPE:	GEOL.UNIT: DRAINAGE : imperfectly drained
SURF.STONES: none EKOSION : slight accumulation by water	ROCK OUTCROP: none	HUMAN INF: ploughing
REMARKS; On contact Ap-Bgl 2cm thick layer of bleached sand. Bgl oxidation along rootchannels	1s	
SAMPLES; A: 0 - 5 B; 0 - 0 C: 0 - 0		
18 cm 10TR 2/1 (moist) and 10TR 3/1 abrupt smooth boundary.	coarse subangular blocky structure, friable, non	calcareous, few very fine and fine roots,
Bg1 18 - 75 cm 10TR 3/1 (moist) and 10TR 3.5/1 (dry), sandy clay loam to sandy clay, very fine roots, clear smooth boundary.	sandy clay, weak coarse and very coarse subangular blocky structure, very firm, non calcareous, few	ructure, very firm, non calcareous, few
Bg2 75 - 110 cm 10TR 3/1 (moist) and 10TR 3.5/1 (dry), common fine distinct clear yellowish-brown mottles, sandy clay, strongly coherent massive structure, very firm, non calcareous, very few roots,	owish-brown mottles, sandy clay, strongly coherer	it massive
0 cm +		

STANDARD SOIL ANALYSIS RESULTS

PROFILE: MA 0104	PROFILE: MA 0104				0.00	0 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		AT distribution of the state of the	* 00-00-00-00	50 CB CR CR CR	5 00 00 mm de de de 90		- 90 00 00 00 00 00 00 00 00	1		- 10 00 00 00 00 0	* ** *** ***	40 ca se es es x				
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		HZ0	H20 CaCL2	mS/cm	mdd	mS/cm ppm weight % ù meq/100gr soilù %	ùù	med/	1000gr &	oil -	7	8-6	ACS	So	Sa	A S3	£S C	Si fi	vcS cS mS fS vfS cSi fSi Clay	00gr soilù % vcS cS mS fS vfS cSi fSi Clay meq/100gr	\$ \$40 \$5 am 15 456 \$7 \$5 \$5 \$10 \$10 \$10 \$10 \$10 \$10 \$10 \$10 \$10 \$10	
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O	0	6.9	6.9 6.1	0.0	2	0.1	17.4 12.8	12.8		2.8	2.8 0.4	86	0		1 10 31	31	S	4 1(	4 10 39	777	æ	¥
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METHOD: H = Hydrometer Method, P = Pipette Method, \* = Not Known PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None PART SIZE DETERMINATION

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SOIL PROFILE DESCRIPTION	罗马里 医毛术 医亚耳耳氏性 医多种性的 医多耳氏病 医原生性 医复数医皮肤 医结膜 医皮肤 医皮肤 医皮肤 医皮肤	Profile: MA 0237 Whit: A40 Status: 2
SHEET : 1923D3  LOCATION : Santantadibe molapo area,  AUTHOR(S): G. Baert K. Verbsek B. Kopelo R. Kelabemang CLASSIFICATION FAO: Habita Areacosol (1988) Eutric Arenosol (1974) sodic phase	GRID:	AGRO CLIM.ZONE: 2C2 ELEVATION :
	IAND ELEMENT : not applicable MICRO TOPOGRAPHY: even	POSITION: higher part SLOPE : 0 - 1 %
cks, nll evidence of salt, ent management system	VECELATION: grassland	GRASS COVER:
: Crases/forbs- PARENT WATERIAL: alluvium MOIST. COND: dry 0 80 cm SUR: STONES: none REOSION :	ROCK TYPE: ROCK CUTCROP: none	GEOL.UNIT: DRAINAGE : imperfectly drained HUMAN INF: mil
REMARKS: SAMPLES: A: 0 - 10 B: 10 - 30 C: 50 - 70		
A 0 - 10 cm 10YR 2.5/1 (moist) and 10YR 4/1 (dry), fine sand, weak medium subangular 1 Ac 10 - 30 cm 10YR 3/1 (moist) and 10YR 4.5/1 (dry), fine sand, weakly coherent massive	medium subangular blocky structure, soft, non calcareous, common roots, coherent massive structure, soft to alightly hard, non calcareous, few	n roots, gradual smooth boundary.  eous, few roots, gradual smooth boundary.
.C 30 - 80 cm 10YR 4/1 (moist) and 10YR 6/1 (dry), fine sand, weakly coherent massive s	structure, alightly hard, non calcareous, very few	few roots,
Soil Survey of Botswana FAD/BOT/85/011		print date: 27/04/89

STANDARD SOIL ANALYSIS RESULTS

PROFILE	PROFILE: MA 0237																					
SAMPLE	DEFE		60- 60 CD -00- 60 NO CD	22	10,		CEC	3	Mo	b4		SE	Particle size (weight %)	le si	Ze (W	ight		10 do 40 ma	were only year the only one of the one only	SAMPLE DEFIH pH EC P C CEC Ca Mg K Na PBS Particle size (weight %) CECclay METH PRETR	MEIN	PRETR
		E20	CaCLL	mS/cm	ELC.	weight % Q meq/100gr soilù	100	T/beat/I	OOgr s	oil	A Section of the sect	8-8	ves es ms	E CO	¥4 53	fS off cSi	63	1531	Clay	meq/100gr		
C 1900 AND AND AND AND AND AND AND	- Mile -	or Education and then edit state with man who the	all have seen thin side who was not and the	THE SEC  SEC  AND  SEC  SEC  SEC  SEC  SEC  SEC  SEC  SE	d did not ray and	and also the time has also the local cuts and and time time time time.	that title also yets alto, east that left	State Alle Alle State State State	Die lag 100 con des des o		o de um co eo eo eo eo eo eo eo	- 100 de cu se so so de 100 de	8 8 8 8 8 8	40 do 40 ma 40 ma		60 mm	1	1	A NAT AND ADD ADD ADD ADD ADD ADD ADD	在 医 医 医 医 医 医 医 医 医 医 医 医 医 医 医 医 E	and the case of th	
N. C.	0 10		6.5 5.6	0.0	2	invi is pool	0.11	02 02	0.1	7.0	7.0 7.0	16	0	2	23 47	e-	r	00	france	96	m	Ą
£C)	90	0	6.7 5.8	0.0	2	50	0.0	4.5	5	0.3	0.4	76	0	2	28 54	50 7	77	5~	୯୯୨	80	田	A
U	50 70	\$	6.8	0.0	pod	0.0	3.6	2,2	0,3	0.2	0.0	83	0	0	28 5.	51	4	<\$r	m	120	四	A
Soil Su	Soil Survey of Botswana RAD/BOT/85/011	wana TAO,	/BOTI/85/01			on sand ordereds acrossocial and since freeze their	MT 450 MM 950 MM 151 MM	20 001 001 001 001 001	PP 020 000 000 000 000 000 000 000 000 0	B 00 00 00 00 00 00 00 00 00 00 00 00 00	alle, orbo ages ever state area odes additi	and the same than the same of	major state and control fines due	\$ \$ \$	- 10 mm				è une còn que plu um seu clar seu	Soil Survey of Botswana RAO/BOT/85/011	Print da	Print date: 23/03/89

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipetre Method, \* = Not Known PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

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20 - 120 cm 10TR 4.5/ 1 (moist) and 10TR 5.5/ 1 (dry), fine sand to loamy fine sand, massive structure, slightly hard to hard, common very fine and fine pores, few fine spherical soft calcareous white nodules, strongly calcareous, very few fine roots,

Soil Survey of Botswana FAO/BOT/85/011

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	GRID : COORD: 19-45-56-S 23-38-22-E	AGRO CLIM.ZONE: 2C2 ELEVATION : SMR: ustic
LANDRORM : alluvial plain TOPOGRAPHY: almost flat.	LAND ELEMENT : island MICRO TOPOGRAPHY:	POSITION: intermadiate part SLOPE : 0 - 2 % convex
JONG. WOAK: NO CIRCER, HIL EVICENCE OI SAIL, DREACGEG SANG ON SWINCE LAND USE: traditional grazing SPECIES: Trees - Hyphaene ventricosa (dom.) Shrubs - Apphaene ventricosa (dom.)	VECETATION: open savanna	GRASSCOVER:
PARENT MATERIAL: lacustrine reworked aeolian MOIST, COND: dry 0 - 120 cm SURF.STUNES: none EROSION : nil	ROCK TYPE: ROCK GUTCROP: none	GEOL.UNIT: DRAINAGE : well drained HUMAN INF: nil
REMARKS: Transition between island and molapo. Repeat analyses to check for saline phase (paste) and soluble salts to calculate SAR. SAMPLES: A: 0 - 20 B: 40 - 60 C: 90 - 110	paste) and soluble salts to calculate SAR.	
A 0 - 23 cm 10TR 3/1 (moist) and 10TR 3.5/1 (dry), fine sand, very weak medium subangular blocky structure, soft to slightly hard, common very fine and fine pores, strongly calcareous, common fine and medium roots, clear wavy boundary.	bangular blocky structure, soft to slightly hard,	common very fine and fine pores,
C 23 - 70 cm 10YR 4.5/1 (moist) and 10YR 5.5/1 (dry), fine sand to locary fine sand, massive structure, slightly hard to hard, common very fine and fine pores, strongly calcareous, very few fine roots, clear wavy boundary.	, massive structure, slightly hard to hard, common	on very fine and fine pores,

Status: 2

Profile: Ma 0117 Unit: L11

SOIL PROFILE DESCRIPTION

STANDARD SOIL ANALYSIS RESULTS

A HZO CACLZ mS/cm ppm weight 7 ill-10.0 ft 11.3 0.6 0.3 1.6 1.0 1.0 1.2 8.6 1.0 1.0 1.0 2.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1	PROFILE: MA 0117	A 0117																					
mS/cm ppm weight % ù meq/100gr soil	SAMPLE	DEPTH	H	AN	EC	a a	0	CEC	S	Me	<b>×</b>	Na	PBS	Parti	le si	w) ez	eight.	(%)	2 2 3 8 8	• 45 × 101 100 • 401 100 100 100 100 100 100 100 100 100	CECclay	METH	PRETR
0.2 6 0.1 4.0 11.3 0.6 0.3 0.2 100 0 1 23 60 6 2 2 6 60 60 0.5 1 0.0 4.5 33.6 1.6 0.7 1.8 100 0 2 23 55 6 6 1 8 54 1.3 1 0.0 3.8 26.4 0.6 0.6 1.9 100 0 1 23 59 6 1 2 7 53			H20 (	CaCL2	пS/сп	mdd	weight %	1	meq/1	S ISOO	- Tio	The see on on an	\$-6	ACS (	S C	Sa A	TA SS	SS	i fS:	. Clay	meq/100gr		
0.2 6 0.1 4.0 11.3 0.6 0.3 0.2 100 0 1 23 60 6 2 2 6 60 60 0 0.5 1 0.0 0.5 1 0.0 0 2 23 55 6 6 1 8 54 1.3 1 0.0 3.8 26.4 0.6 0.6 1.9 100 0 1 23 59 6 1 2 7 53	the size are see see the six the size of		e (the man war outs also also for the the same that	have able that with able and dell in	* 50 00 00 00 00 00 00 00 00 00	An of the same and the co.	or Cov later clos onto what date take well more year or	On the case one one of the few or	4 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	44 - 100 - 1	800 oz 29 ave sal 4	or the Alle distribution to	and and one one one the line of	200 wh size and any star time	* ** ** ** **	00 mm and 000 mm	* ** ** ** ** ** ** ** ** ** ** ** ** *	NO 444 NO 444 NO 114 NO	- 400 Elle 444 Elle 500	IS ON OIL ON MAR SILV BUT THE GO O	Table who are and and the way and the day are one one one of the control of	NO AND THE DAY ON AND THAT WAS AND THE	the date were done from this day who state that days days
0.5 1 0.0 4.5 33.6 1.6 0.7 1.8 100 0 2 23 55 6 6 1 8 54 1.3 1 0.0 3.8 26.4 0.6 0.6 1.9 100 0 1 23 59 6 1 2 7 53	A.		80	7.00	0.2	9		4.0	~ ~ ~	0.6	0.3	0.2	100		****	9 52				Ø	000	m	-di
1.3 1 0.0 3.8 26.4 0.6 0.6 1.9 100 0 1 23 59 6 1 2 7 53	æ	09 05	10.0	& &	0.5	georg	0.0	4.5	33.6	1.6	0.7	00	100	0					hand	∞	32		A
	Ü	90 110	10.2	ري د	~	ent		00	26.4	0.6	9.0	1.9	100	0	h	23		, parting	8	<i>r</i> ~	53	H	⊲1
	Soil Surve	y of Botswa	ma EAO/B	OT/85/011	an a	Q	0 MA - MAY -	ha dish title data data biling tidar da	1		1 10 and	- 00+ 00+ 00+ 00+ 00	ood make will one over AVE one in	to the second day and the	2 2 3 3 3 4 4	do no no no no no no		der met der met inte u	-	v side das was toke safe same von one vide dij		1	te: 23/03/89

METROD: E = Hydrometer Method, P = Pipette Method, \* = Not Known PRETREATMENT: 0 = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None PART.SIZE DETERMINATION

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SOIL PROFILE DESCRIPTION		Profile: MA 0106 Unit: L24a Status: 2
SHEET : 1923D3  LOCATION: Xhwaa molapo.  AUTHOR(5): K.Verbeek G.Baert CLASSIFICATION FAO: Luvic Calcisol(1988) Calcic Luvisol (1974) sodic phase  ST: Typic Haplustalf LANDFORM : alluvial plain TOPOGRAPHY: almost flat SURF. CHAR: no cracks, nil evidence of salt, LAND USE: traditional grazing SPECIES: Trees - : Shrubs - : Grasses/forbs- : Grasses/forbs- PARENT MATERIAL: lacustrine MOIST. COND: dry 0 - 10, moist 10 - 110 cm SURF.STONES: none EROSION : nil	GRID; GOORD; 19-45-38-S 23-37-47-E DATE; 14/02/85 LAND ELEMENT; island MICRO TOPOGRAPHY; even VECETATION; grassland ROCK TYPE;	AGRO CLIM.ZONE: 2C2 ELEVATION : SMR: ustic FOSITION: lower part SLOPE : 0 - 1 % GRASSCOVER: GEOL.UNIT: DRAINAGE : imperfectly drained
REMARKS: Depression on island. Repeat EC, check for saline phase.  SAMPLES: A: 0 - 10 B: 20 - 40 C: 80 - 100		
A 0 - 15 cm 10TR 5.5/1.5 (moist) and 10TR 6.5/1 (dry), fine sand to loamy fine sand, roots, abrupt smooth boundary.	loamy fine sand, weak medium subangular blocky structure, slightly hard, strongly calcareous, few	tly hard, strongly calcareous, few
Btkl 15 - 50 cm 10YR 4/2 (moist), common coarse distinct diffuse black mottles, sandy loam, weak coarse and very coarse subangular blocky structure, firm, broken thin clay cutans on pedfaces, strongly calcareous, few roots, clear smooth boundary.	am, weak coarse and very coarse subangular blockoundary.	ky structure, firm, broken thin
Btk2 50 - 110 cm 10YR 3/2 (moist), many coarse distinct diffuse black mottles, sandy clay loam, weak coarse subangular blocky structure, very firm, broken thin clay cutans on pedfaces, strongly calcareous, very few roots,	loam, weak coarse subangular blocky structure,	very firm, broken thin

Soil Survey of Botswana FAO/BOT/85/011

STANDARD SOIL ANALYSIS RESULTS

PROFILE: MA 0106	MA 0106	, &																					00 000 000 000 000 000 000 000 000 000
SAMPLE	HLAHO	All the same was the same and the		0 3.35.4	1 2		SAMPLE DEPTH PH EC P C CEC Ca	CEC	J	Mg	M	es es	PBS	Parti	Te si	ze (v	Particle size (weight 7)	7			CECclay	METH	PRETR
			H20 CaCL2	12 "	aS/cm	mcid.	mS/cm ppm weight % ù meq/100gr soilù	0	med/1	oogr s	110	7	8-4	VcS	S	Si	S	S	£	vcs cs ms fs vfs csi fsi Clay	meq/100gr		
yes ann with 600 tall 700 the 865 tall	No. 100 day no los 100 and 100 a	No. 500' 500' 600' 600' 500' 500' 500' 500'	and makes dated drafte drafts (1920) (1920) (1920) (1920)	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	AL 100 00 70 06 100 0	all	化二苯基酚 医牙囊试验 化二甲苯酚 化氯化 化苯甲甲基苯酚 医克格氏征 医乳腺性 医乳腺性 医乳腺性 经现代 医乳腺性 医乳腺性 医乳腺性 医乳腺性 医乳腺性 医乳腺性 医乳腺性 医乳腺性	AND AND TOO TOO TOO TOO	40 all all all all all all all all all al	000 Mar often 600 Mar often 600	20 cm en co co	cor-nor after fint was war main	00 eac on on on on on on on					8 8 9 9		10 miles and 100			
Ą	0	10	10.1 8.9	6	0.7	m	0.2	7.4 12.5	12.5	1.0	2.0	1.0 2.0 6.2	100	0	rm)	7 5%	1 24 46 9	4	F==	10	99	m.	4M.
m	20	40	10.4 9.8	00	1.2	9	Ö	10.9 5.5	5,	0.7	1.5 6.9	6.9	100	0		10	53 8	60		10 16	64	m	A
ပ	80 100	99	10.6 9.2	2	3.5 28 0.1	28	ं	14.0 3.1	~	0.4	1.6	0.4 1.6 14.0	100	0	~~ ~~	01	52 7		4	24	57	ш	A
Soil Surv	ey of B	orswana	Soil Survey of Botswana FAO/BUT/85/011	85/011		de one see the chi	200 DOD -0.00 COT COT COT COT -0.00 TOD -0.00	on one one out an co- on-	offer and what year gan	en out out the out	70 en ma -co un en	and wine wife this one can been	M 40 40 10 10 10 10 10 10 10 10 10 10 10 10 10			; 1 1	1 1 1 1	8 8 8 0		0 Od 100 - 1	Soil Survey of Botswana EAO/BOT/85/011	Print d	Print date: 23/03/89
PART.SIZE DETERMINATION	) DETERM	TINATION	PREIRE		= Hydr = Orga	ometer nic Ma	H = Hydrometer Method, P = Pipette Method, * = Not Known O = Organic Matter, F = Free Iron Oxides, C = Carbonates,	Free In	on Ort	thod,	C * Ca	ot Know rbonate		S = Soluble Salts N = None	s Salt	z g	None						

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Soll Survey of Botswana FAD/BOT/85/011

SOIL PROFILE DESCRIPTION	SCRIPTION		Profile: MA 0013 Unit: S13 Status: 2
SHEET ; 1923D3 LOCATION : Xhwaa camp island. AUTHOR(S): G.J.Rhebergen A.R CLASSIFICATION FAO: Areni-Per TYPOCRAPHY: gently undulating SURF. CHAR: no sealing, no cre LAND USE: traditional grazing SPECIES : Trees - Hyphaene vv : Shrubs - : Grasses/forbs- PARENT MATERIAL; aeolian pale MOTST. COMD: Are 0 - 150 cm	SHEET ; 1923D3 LOCATION : Xhwaa camp island. AUTHOR(S): G.J.Rhebergen A.Remmalzwaal CLASSIFICATION EAO: Areni-Petric Calcisol(1988) Calcic Arenosol (1974) ST : Typic Ustochrept LANDFORM : alluvial plain TOPOGRAPHY: gently undulating SURF. CHAR: no sealing, no cracks, nil evidence of salt, bleached sand on surface LAND USE: traditional grazing SPECIES ; Trees - Hyphaene ventricosa (dom.) : Shrubs - : Grasses/forbs- FAKENI MATERIAL: aeolian pale sand MOTST. COMD: Arv 0 - 150 cm	GRID: GRID: DATE: 19-46-18-S 23-37-23-E DATE: 04/05/84 IAND ELEMENT: island MICRO TOPOGRAPHY: VEGETATION: open tree savama ROCK TYPE:	AGRO CLIM.ZONE: 2C2 ELEVATION : SMR: ustic FOSITION: higher part SLOPE : 0 - 2% GRASSCOVER: GEOL.UNIT: DRAINAGE; moderately well drained
SURF.STONES: none EROSION : nil		ROCK CUTCROP: none	HUMAN INF: nil
REMARKS: Edge o.	REMARKS: Edge of island. Transition to Sl3a-Petrocalcic at depth Cmk moderately commented.		
SAMPLES: A:	0 - 0 B; 0 - 0 C; 0 - 0		
A 0 - 36	30 cm 10YR 3/2 (moist) and 10YR 4/2 (dry), fine sand to loamy fine sand, we strongly calcareous, many and many roots, clear smooth boundary.	fine sand, weak fine to coarse subangular blocky structure, soft, common very fine and fine pores, a boundary.	soft, common very fine and fine pores,
Bk 30 - 60	60 cm 10YR 3.5/3 (moist) and 10YR 6/3 (dry), loamy fine sand to fine sandy loam, very weak fine to coarse subangular blocky structure, soft, common very fine and fine pores, few spherical hard calcareous white nodules, strongly calcareous, many roots, gradual smooth boundary.	loam, very weak fine to coarse subangular bloch;, strongly calcareous, many roots, gradual sm	ky structure, soft, common both boundary.
Ck 60 - 140 cm	10YR 5/4 (moist) and 10YR 8/3 (dry), loamy fine sand to calcareous white nodules, extremely calcareous, common	fine sandy loam, weakly coherent massive structure, soft, roots, clear wavy boundary.	structure, soft, few very fine and fine pores, few hard
Cnk 140 - 150	140 - 150 cm 10YR $5/4$ (moist) and 10YR $7/2$ (dry), massive structure, hard, cemen	hard, cemented, extremely calcareous, few roots,	

STANDARD SOIL ANALYSIS RESULTS

SAMPLE	DEPTH	思		EC	а	0	CEC	eg W	Me K	Na		PBS	Parti	Particle size (weight %)	as (w	eight	2			CECclay	METH	PRETR
1	50 St. 501 Apr. 500 Can sept and sept state Apr. 504 Apr. 504 Apr. 505 Apr.	H20	HZO CaCL2	mS/cm	udd	H2O CaCL2 mS/cm ppm weight % û meq/		meq/10	Ogr so	100gr soilù	D.	W	vcS	SS	જુ !	S VÍ	S cS:	ESI 1	vcS cS mS fS vfS cSi fSi Clay	100gr soilù 7 vcS cS mS fS vfS cSi fSi Clay meq/100gr	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
	0	∞ 	8.2 7.5	0.1	grand	0,5	7.5 23.5		1.5	1.5 1.1 0.1		100	0	***	9	6 79	2	2	0	56	Ħ	₩
	0	80	8.3 7.7	0.1	7	0.1	4.3 26.3		2.0	2.0 1.1 0.1		100	0	1 10 62	9	2 8	. 2	5	12	32	m	Ą
	0	9.2	9.2 8.1	0.2	group	0.0	5.1 31.5		1,9	1.9 3.2 0.7		100	0	-	14 61	1 88	m	m	-	87	m	Ą

PART.SIZE DETERMINATION METHOD: H = Hydrometer Method, P = Pipette Method, \* = Not Known
PRETREATMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None

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- 8	3
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# 40 OV	int d
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	Profile: MA 0044 Unit: S17 Status: 2	Profile: MA 0044 Unit: S17 Status: 2
SHEET : 1923D3 LOCATION : Matsaoudi research plot. AUTHOR(S): G.J.Rhebergen G.Baert G.ASSIFICATION FAO: Eurri-Haplic Arenosol(1988) Eutric Arenosol (1974)	GRID : 0-E COORD: 0-S 0-E DATE : 20/09/84	AGRO CLIM.ZONE: 263 ELEVATION : SWR: ustic
ST : Ustic Quartzipsamment LANDFORM : sand plain TOPOGRAPHY: almost flat	IAND ELEMENT : not applicable MICRO TOFOGRAPHY: even	POSITION: higher part SLOPE : 0 - 1 %
SURF. CHAR: no sealing, no cracks, nil evidence of salt, LAND USE: improved trad. dryland farming SPECIES ; Trees - Colophospermum mopane (dom.) Acacia sp.	VEGETATION: open tree savanna	GRASSCOVER:
: Shrubs - : Grasses/forbs- : Grasses/forbs- PARENT MATERIAL: aeolian sand MOIST. COND: dry 0 - 110 cm SURF.STONES: none EROSION :	ROCK TYPE: ROCK GUTCROP: none	GEOL.UNIT: DRAINAGE : somewhat excessively drained HUMAN INF: clearing
REMARKS: SAMPLES: A: 0 - 0 B: 0 - 0		

0 - 15 cm 10TR 3/2 (moist) and 10TR 4/2 (dry), fine sand, very weak medium subangular blocky structure, loose, non calcareous, common roots, clear smooth boundary.

STANDARD SOIL ANALYSIS RESULTS

SAMPLE	DEPTH	SAMPLE DEPTH pH EC P C CBC Ca	EC	А	ပ	CEC	cs es	Mg R		Na	PBS	Parti	cle s	ize (	Particle size (weight %)	23			CECclay	METH	PRETR
		H20 CaCL2	mS/cm	ndd t	mS/cm ppm weight % ù meq	ņņ	meq/1	/100gr soilà	Tr	Ď	M	ves	S	Sa	ves es ms fs vfs esi fsi	32 S3	FS FS	i Clay	meq/100gr		
2 02 00 m		the test total diffe total diffe the electric total total delectric		-	Ass (are 10) 100 100 100 100 100 100 100 100 100	- sep see see see see see .	No. 400 de 400 de 400 de					1	1 1	- 000 000 000 000		400 Me 100 Me 10	-		在 医 医 医 医 医 医 医 医 医 医 医 医 医 医 医 医 医 医 E		
	0	7.1 6.6	0.1	শ্ব	0.2	4.6	3.2	0.2	0.3 0.2	0.2	85	0	s—1	19 64	54 1	10 1	0	9	89	m	¥
	0	8.0 7.5	0.2		0	ы 00	3.0	0.8	0.4	0.8 0.4 0.1 100	100	0	Н	18 (	1 18 62 10		0	7	48	ш	A

METROD: H = Hydrometer Method, P = Pipette Method, \* = Not Known PRETREAIMENT: O = Organic Matter, F = Free Iron Oxides, C = Carbonates, S = Soluble Salts N = None PART.SIZE DETERMINATION

## APPENDIX 2

LAND SUITABILITY CLASSIFICATION SHEETS FOR SPECIFIC SOIL MAPPING UNITS

location: Boro-Shorobe area

sheet: 1923 C4,D1,D3 date: June 1985

agro-climatic zone: Maun (II)

mapping unit: A24, A31a

author: G.J.Rhebergen

site characteristics:

remarks:

flood duration: 3-6 months

saucer shaped depressions

\*egularly flooded alluvial plain; only mechanized farming is considered

				LAND I	USE TYPE:		1	LAND I	USE TYPE	*
			improv	ved trad	. molap	o farm.	comme	rcial mo	olapo f	arming
				CRO		**************************************		CRO		
LAND QUALITY	CODE	RATING	maize	sorghum			maize	sorghum		
accessibility	а	1	S1	Sl			S1	S1	manager manager	araphoo delemanoon
correct temp. regime	С	1	S1	S1			S1	S1	ements of	
soil drainability	d	N.A.		****			****	-		
resistance to erosion	е	1	S1	S1	n e de la completa de CESA de CESA de CESA de La CESA de CESA		S1	S1		
absence of damaging floods	f	1	Sl	S1	province in the second	angang (dan ang gagap aggar manggap pamain ilinin) kan man	S1	S1		
conditions for germin.	g	1	S1	S1			S1	S1		
moisture availability	m	1	S2	S1			S2-S3	S1-S2		
nutrient availability	n	1-2	S1-S2	S1			S2	S1-S2		
oxygen availability	0	2	S2-S3	Sl			S2-S3	S1		
absence of pests and diseases	р	2–3	no sui	tabilit	y class	is giv	en	secondary engryphys. day		Additional Control of the Control of
availability of water of good quality	q	N.A.	· makein	areo	-			- de la constante de la consta		
foothold for roots	r	1	S1	SI	- Table 1		S1	S1		
absence of toxic substances	t	1	S1	S1	and the second s		S1	S1		To the state of th
workability	W	2-3	S1	81	and the state of t	and the same of th	S1	s1		and the state of t
adequacy of topography	x <sub>1</sub>	no da	a		water automotive	nanomining agriculture	and a special section of the section	900		- Applications
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#### RECOMMENDED IMPROVEMENTS:

- soil physical condition (structure, permeability) to improve infiltration of floodwater.
- fertilizer application
- improve surface drainage to avoid ponding

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	1			·			
POTENTIAL LAND SUITABILITY	S1-S20	S1			S1- S2mo	S1	

location: Boro-Shorobe area sheet: 1923 C4,D1,D3 date: June 1985

agro-climatic zone: Maun (II) mapping unit: A24b, A31b

author: G.J.Rhebergen site characteristics: relatively low remarks: areas with higher stream velocities

often occuring in narrow alluvial

· plains between islands; flood duration 3-6 months

· plains between is	TOIL	us, ii	1		USE TYPE:	15	1	LAND !	JSE TYPE	¢ 9
			improv	ed trad	. molapo	o farm.	comme	rcial mo	lapo fa	arming
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LAND QUALITY	CODE	RATING	maize	borghum			<u>maize</u>	sorghum		_
accessibility	а	1	S1	S1	demonstrative demonstrative	union statements	S1	S1		oo.
correct temp. regime	С	1	S1	S1			S1	S1	and the same and the same of t	
soil drainability	đ	N.A.	L. Company	-			ame	0000		
resistance to erosion	е	1	S1	S1	Commence of the commence of th		S1	S1		
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conditions for germin.	g	1	S1	S1			S1	S1		
moisture availability	m	1-2	S2-S3	S1-S2			53	S2		
nutrient availability	n	2	52	Sl			52	52		
oxygen availability	0	2	S2	S1			52	S1		
absence of pests and diseases	р	2-3	no sui	tabilit	y class	is give	en	Transition (Management of the Control of the Contro		dinnerale. Charliedes din
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#### RECOMMENDED IMPROVEMENTS:

land suitability

POTENTIAL LAND SUITABILITY	S2mno- S3m	S1-S2m		S3m	S2mn	

<sup>-</sup> low available water holding capacity causing moisture availability limitation can not be corrected; therefore potential land suitability equal to current

location: Boro-Shorobe area

sheet: 1923 C4,D1,D3 date: June1985

agro-climatic zone: Maun (II)

ice c. 1020 04, b1, b0 dave. Dancioo

mapping unit: A24b

author: G,J,Rhebergen

site characteristics:

remarks:

stream channels

flood duration varying: 1-6 months

			-	LAND	USE TYPE:		**************************************	LAND	USE TYPE:	
			improv		. molapo	farm.	commer		lapo fa:	rming
LAND QUALITY	CODE	RATING	maize	CR  sorghu		adiave	maize	sorhgu	KOP ml	*
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correct temp. regime	С	1 1	S1	S1			S1	S1		
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resistance to erosion	е	1	S1	S1	1		S1	l sı	T	
absence of damaging floods	f	2	\$2 ;	S2		om mageld 65 M in Control of Angula promiserant in color on all PPS AND 16 december 2015	\$2	S2		
conditions for germin.	g	1	S1	S1			S1	Sı		
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oxygen availability	0	3	S4	S2-S3			S4	S2-S3		
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absence of toxic substances	t	1.	S1	S1			S1	S1		auminin augus augus de politico de la citatina de qualita de partir de la citatina de la citatina de la citati
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# RECOMMENDED IMPROVEMENTS:

- oxygen availability can hardly be improved as channels are lowest spots in the area; potential suitability is equal to the current suitability.

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POTENTIAL LAND SUITABILITY	S4o	530		S4o	S30		
		Season Company	mm-d-mile (1900)				

location: Boro-Shorobe area sheet: 1923 C4,D1,D3 date: June 1985

agro-climatic zone: Maun (II) mapping unit: A7,A7b,A9,A3la (partly sodic)

author: G.J.Rhebergen site characteristics: saucer shaped depressions and plain, slightly sloping

flood duration: 1-3 months areas

regularly flooded alluvial plain; only mechanized farming is considered

regularly 1100ded	hraru;		USE TYPE:	ng is considered  LAND USE TYPE:						
			improve	ed trad.	. molapo	farm.	commer	cial mo	lapo farmit	ng
LAND QUALITY	CODE	RATTNG	maize	CR  sorghum	OP -1	elecono	maize	CR  sorghu		
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conditions for germin.	g	1	S1	l Sl		egyggggggggggggggggggggggggggggggggggg	Sl	S1		North County Strategies
moisture availability	m	1-2	S2-S3	   S1-S2	topological appropriate topolo		S3	S2		
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oxygen availability	0	2	S2-S3	S1	***************************************	n na anggananggalel a Circum Pilipumanana na Winawana manang	S2-S3	S1		m.manager/mmega-r
absence of pests and diseases	р	2-3	no su	tabilit	y class	is giv	en	PPRINCE BOTH BUTCH AND		
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URRENT LAND SUITABILI	lY.	at 1 miles and a m	S3mot	S2mt			S3mot	S2mnt		

- increased flood duration might improve limitation (t)
- fertilizer application
- improve surface drainage to avoid ponding

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POTENTIAL LAND SUITABILITY	S2mot	S1			S2mot	Sl	

Appendix 3

Area calculation of combinations of associations

Associations	Proposed colour		Area (ha)
A24b	dark blue		470
A24, A24-24B A24-31a, A24-31a-24b	light blue		3300
A31a, A31a-24 A31a-7, A31-7a-40 A31a-40-31b A31a-24-31b A31b, A31b-24 A31b-7, A31b-24 A31b-7, A31b-7a A31b-31a-7 A40-24b, A40-31a	light green		8150
A7, A7a A7-31a, A7-7b A7a-7b, A7a-31b A7-31a-7a A7a-7b-9a A7b-7, A7b-7-9 A40-, A40-7a	dark green		4200
A7a-9-40, A7b A7b-A9, A7b-7-9 A7b-9-9a, A9-7b A9-9a-7b, A9a-7b A40, A40-7b A40-9a, A40-9a-7b	yellow		2750
islands	brown	TOTAL	<u>20750</u> 39620 na

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