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PHYSICAL RESOURCE INVENTORY OF THE COMMUNAL LANDS OF ZIMBABWE

AN OVERVIEW

Overseas Development Administration

PHYSICAL RESOURCE INVENTORY OF THE COMMUNAL LANDS OF ZIMBABWE – AN OVERVIEW

I. P. Anderson, P. J. Brinn, M. Moyo and B. Nyamwanza

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The scientific arm of the
Overseas Development Administration

N.B. The following maps are included with this digital document as attachments:

Map 1 - Land Units

Map 2 - Land Units

Map 3 - Land Units

Map 4 - Land Units

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Summary

This overview of the physical resources of the Communal Lands of Zimbabwe is based on a compilation and condensation of the results of reconnaissance soil surveys undertaken between 1985 and 1991. The area surveyed and mapped at 1:500 000 scale comprises some 163 500 km^2 or 42% of Zimbabwe. Fifty land units, identified by interpretation of aerial photography and defined on a broad geological and landform basis, are used as the framework for describing and mapping the Communal Lands, hereafter referred to as CLs. Following an introduction to the physical environment encompassed by the CLs, each unit is described according to land characteristics and resources relevant to an assessment of potential for agricultural improvement.

Abbreviations and Glossary

ABBREVIATIONS

ADA	Agricultural Development Authority
AGRITEX	Department of Agricultural, Technical and Extension Services
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
CL	Communal Land
CSO	Central Statistical Office
FAO	Food and Agriculture Organization of the United Nations
IBRD	International Bank for Reconstruction and Development
IFAD	International Fund for Agricultural Development
IRDA	Intensive Rural Development Area
ISRIC	International Soil Reference and Information Centre
MAR	Mean Annual Rainfall
MAST	Mean Annual Soil Temperature
MLRRD	Ministry of Lands, Resettlement and Rural Development
NLHA	Native Land Husbandry Act
SARCCUS	Southern Africa Regional Committee on the Conservation and Utilization of the Soil
TILCOR	Tribal Trust Land Development Corporation
UNESCO	United Nations Educational, Scientific and Cultural Organization

GLOSSARY OF VERNACULAR WORDS

bajada:	piedmont alluvial plain
bornhardt:	residual granitic hill having the form of a steep-sided dome
dwala:	bornhardt, usually of the whaleback type
gilgai:	a micro-relief of low mounds and shallow depressions typical of vertisols
gusu:	general term for Kalahari Sand woodland where *Baikiaea plurijuga* is a common constituent
guti:	drizzle or light rain
isidhaka:	Ndebele term for soils with a high clay content, often vertisols
jesse bush:	thicket consisting of mixed woody species, generally *Combretum* spp. interspersed with tall trees
klippe:	a tectonic outlier resulting in older rocks resting upon younger ones
kloof:	a deep, narrow valley in hilly terrain

koppie:	residual granitic hill where weathering along joints has resulted in a castellated structure
mhunga:	pearl millet
miombo:	woodland dominated by *Brachystegia* spp. and *Julbernardia globiflora*
mopane:	*Colophospermum mopane*
rapoko:	finger millet
sidaga:	corruption of *isidhaka*, see above
vlei:	shallow, seasonally or perennially wet depressions forming part of a drainage network usually without a thalweg. Synonymous with dambo

Part 1

Introduction

PROJECT BACKGROUND

This report is a compilation of the results of natural resource surveys undertaken in the Communal Lands of Zimbabwe during the period 1985-1991. These surveys, known as communal land physical resource inventories, were initiated as a component of the IBRD/IFAD funded National Agricultural Extension and Research Project and were intended to provide basic land resource data to support farming systems research and land use planning in the 42% of Zimbabwe under communal land tenure. Staff from the British Overseas Development Administration's Natural Resources Institute, or a predecessor the Land Resources Development Centre, have been involved since inception and the Overseas Development Administration has financially supported the completion of the soil survey component and the preparation of this report since 1989.

The various surveys were undertaken by staff of the Zimbabwe Chemistry and Soil Research Institute and the Ecology Unit, National Herbarium and Botanic Gardens, both under the Department of Research and Specialist Services, Ministry of Lands, Agriculture and Rural Resettlement. In addition to its primary objectives, the project has served to revitalize the Institute's program of regional soil survey required for revision of the provisional soil map of Zimbabwe. The Ecology Unit has undertaken a complementary survey of natural vegetation in the Communal Lands.

METHODS OF INVESTIGATION AND PRESENTATION

The surveys were designed to obtain a maximum of basic land resource data in the shortest time, commensurate with a mapping scale of 1:250 000. This type of rapid reconnaissance has been described by Bennett, (1984).

Initially, a review of the existing literature was made. This indicated that, for some areas of Communal Land, considerable data on the physical resources already existed and this was taken into account when planning the survey. A preliminary stratification of the landscape was prepared by interpretation of aerial photography. This is a well established procedure which relies on the generally strong correlations between geology, landform, soil and natural vegetation particularly in many of the drier tropical environments such as Zimbabwe. Boundaries defining land units were identified on 1:65 000 or 1:80 000 scale air photographs taken in 1982. A land unit based on a particular landform commonly has a distinctive textural and tonal photo-pattern caused by the associated soil and vegetation types and by the presence or absence of erosion features, bare rock and areas liable to waterlogging or seasonal flooding. It is often difficult to detect this pattern on the ground, but is readily recognizable on air photographs.

The field survey involved a sampling of the land units identified during the preliminary photo-interpretation. The observation points are not distributed randomly but based on preselected sites according to the distribution of roads and motorable tracks. These sites were chosen to represent a range of catenary

positions and indications of differences in geology and vegetation within the units. Features of special interest such as gullying, springlines, quarries and unusual vegetation or land use patterns are also noted for field examination. Additional information of significance for land evaluation, such as changes in indicator vegetation species, was recorded during the road traverse between soil inspection sites.

Soils were augered to a depth of 125 cm except where gravel, bedrock or an indurated layer made this impossible. In areas where the soils were particularly deep, the Kalahari sands for example, augering continued to 200 cm. About 75% of the described soils were sampled by horizon for chemical and particle size analyses using methods as described in Appendix 5. In a few cases, soil profile pits were dug to 180 cm depth, fully described and sampled. From some of these pits undisturbed cores were extracted by horizon for the laboratory determination of moisture release characteristics. At the augered sites, the characteristics described included soil depth, horizon differentiation according to texture, colour and mottling, moisture content and free lime using dilute hydrochloric acid. Site description included landform type and slope, natural vegetation by physiognomy, degree of disturbance and the main woody species within a radius of about 50 metres of the soil observation. Surface features relating to stones, rocks, crusting or sealing and erosion status, and land use relating to cropping, grazing and soil conservation structures were noted.

Of the 3 342 soils described during the surveys, 2 473 profiles were sampled and 7 544 samples subsequently analysed. The overall density of observations is 1/49 km^2 with a range from 1/14 km^2 in Wedza District to 1/104 km^2 in Gokwe District.

On the basis of the fieldwork and the soil analytical results, the preliminary land units were reviewed, finalized and then described and mapped at 1:250 000 scale in a series of Communal Land physical resource inventories. This overview is a compilation of the results of these inventories. The mapping scale has been reduced to 1: 500 000 and, in consequence, some small or similar land units have been combined, resulting in a total of 50 units. These are described in Part 3.

HISTORY OF THE COMMUNAL LANDS

The precursors of Communal Land, the Native Reserves renamed Tribal Trust Land in 1962, were created following the advent of the white settler in the late nineteenth century. The first to be demarcated were Gwai and Shangani Reserves in the Matabeleland Kalahari Sandveld region, roughly corresponding to the Tjolotjo-Nata and Lupane-Nkayi CLs of today. By 1911 there were some 104 Reserves occupying about 23% of the country with much of the unassigned land at that time lying in the Zambezi Valley and Southeast Lowveld, regions affected by the tsetse fly and often deficient in water. Subsequent additions, mainly in these unassigned areas, had by 1962 brought the total area under communal tenure to its present size of about 163 500 km^2, or 42% of the country, divided into 170 Communal Lands in 52 administrative Districts. Tribal Trust Land was renamed Communal Land in 1982.

There was very little planned agricultural development in the Reserves until E D Alvord, Director of African Agriculture, initiated a programme of rural development implemented during the 1930s and 1940s. He introduced the concept of centralization, a simple approach to land classification whereby arable land is consolidated and demarcated from surrounding grazing land on precondition of a request by and the active commitment of the local people, a participatory approach well ahead of its time. The implementation package included planned land use, grazing area management, village consolidation, improved water supplies, woodlots and orchards, improved housing, schools, roads, soil conservation works and agricultural extension leading to the creation of a cadre of Master Farmers. During the programme about 45 000 km^2 were centralized (Reid, 1980).

These same features are to be found in the objectives of the 1951 Native Land Husbandry Act (NLHA) with the important difference that this programme of agrarian reform was backed by compulsory legislation and provided for a legal tenure system based on individual rights. There was much emphasis during the period of the NLHA on mechanical soil conservation measures and a considerable area of arable land was protected by contour ridges and associated works at a cost of some $3,4 million or about 10% of the Act's budget (Whitlow, 1988b). The cost of implementation was, however, covered by a state levy on agricultural produce from the Reserves. The removal of the right of free access to land contributed to the growing popular and political opposition to the government and from 1961 to 1964, with individual tenure implemented on less than 10% of Reserve land, the NLHA was gradually abandoned (Bratton, 1978).

A period of relatively successful communal agricultural improvement ensued during the lull before the escalation of civil war from 1973 until independence in 1980. Cotton production was initiated in Gokwe District in 1962 (Reid, 1971) and is now a major cash crop in parts of the Sanyati-Sengwa Basin and Mid Zambezi Valley regions. In 1960 burley tobacco was introduced in some communal areas of Mashonaland Central Province and is currently important in Chiweshe CL. In the Eastern Highlands, tea growing was introduced on a small scale in Holdenby CL in 1962 and Arabica coffee, produced in small quantities for many years in Ngorima CL, was also being planted at about this time by a few growers in Manga and Holdenby CLs (Rhodesia, 1962). Of considerable impact on food production was the increasing availability and use of hybrid maize seed during this period.

Improvements in livestock production were achieved through grazing management and over 1 000 schemes were established before the war interfered (Geza and Reid, 1983). The communal areas of Masvingo Province were the focus for much of these developments and, by 1973, as much as 32% of Bikita and Matsai CLs in Bikita District were covered by veld management schemes (Froude, 1974).

In 1968 a statutory body, the Tribal Trust Land Development Corporation (TILCOR) now called the Agricultural Development Authority (ADA), was created and charged with the responsibility of developing communal areas mainly through estate-scale irrigation projects such as those established at Muzarabani, Tjotjolo and Sanyati. TILCOR was also responsible for devising the policy of growth point development which is now part of the present government's strategy in the CLs.

The last of the grand schemes for developing the communal sector is found in the Intensive Rural Development Area (IRDA) concept current at about the time of independence. Using an integrated rural development approach, the plan aimed at increasing productivity mainly through the Master Farmer group. Growth points provided with electricity, water and improved transport systems were intended as nuclei for rural industrialization and the absorption of a proletariat made landless by the removal of "part- time" farmers from the land and the introduction of private tenure (Ellsworth, 1981). The development plan for the CLs of the Masvingo Middleveld region, IRDA No.1, is described by Jordan (1980).

The post-independence period has seen a change in emphasis with a major programme of resettlement of communal farming families and others on to land mainly acquired from the commercial sector. By 1989 about 52 000 families had been resettled. In the Communal Lands themselves there has been considerable improvement and extension of the basic socio-economic infrastructure particularly in the main sectors of agriculture, health, education, water, roads and housing (Auret, 1990). Resettlement has also been planned for several CLs, mainly in the sparsely populated Zambezi Valley where one of the results of tsetse control has been to attract numbers of pioneer farmers and create concern for possible damage to the environment. Recent land use planning studies in this region include ARDA (1986) and Brunt *et al.* (1986).

Small-scale irrigation schemes have, for many years, been seen as an appropriate way of increasing the human and livestock carrying capacity of the CLs, improving agricultural output and relieving pressure on the dryland farming areas, especially in the lower rainfall sections of Manicaland, Masvingo, Midlands and Matabeleland South Provinces. Also in some of the drier, agriculturally more marginal CLs of the Zambezi Valley and Southeast Lowveld, generally adjacent to a National Park or Safari Area, a conservation strategy known as Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) has been initiated. This allows the local community some control over the management of their wildlife, water, wood and range resources, with the emphasis on wildlife hunting, viewing and cropping for meat (Murindagomo, 1989).

However, current official directives and general strategy for Communal Land agricultural development are in a state of flux evidenced by a plethora of government commissioned but ultimately ineffectual CL studies, surveys and assessments. Land use planning in the CLs has recently been based on the concept of villagization (MLRRD, 1985 and AGRITEX, 1989) but very few, if any, CLs have been reorganised in this way since independence. The World Bank (1991) recommends that the formal process of villagization be dropped and replaced by a "magnet" strategy whereby social services are provided at a central site and households allowed to judge the balance of costs and benefits involved in a move to that site.

Part 2

The Environment

PHYSICAL ASPECTS

Location and physical regions

There are 170 Communal Lands, totalling 163 500 km^2 or 42% of Zimbabwe, distributed through 52 administrative Districts. Their locations are shown in Text Map 1. The country can be divided into six broad physical regions as shown in Text Map 2. These are:

1. the Eastern Highlands, a series of mountain ranges extending some 250 km along the Mozambique border;

2. the Highveld region, comprising a more or less gently undulating plateau above 1 200 m elevation. A northern subregion extends from Chinhoyi to Rusape and south to Gweru. Karoi is centred on an outlier of this subregion to the northwest. A southern, more arid, subregion extends and narrows southwest from Gweru to Plumtree;

3. the Middleveld region, bordering the Highveld and declining to a lower elevation limit of 600 m to 900 m. Undulating to rolling, with common rock outcrops and locally dissected, it comprises a subregion 80 to 160 km wide southeast of the Highveld and two more complex subregions to the northeast and northwest of the Highveld;

4. the Kalahari Sandveld, an extensive area in western Zimbabwe influenced by a mantle of Kalahari Sand. Flat to gently undulating, it forms plateaux in the east transitional to a sand plain, with pans and fossil dunes, in the west;

5. the Zambezi Valley which can be divided into two subregions separated by the Kariba Gorge. The Upper Zambezi Valley and Sanyati-Sengwa Basin subregion, mainly at elevations between 500 m and 900 m, shows strong structural control, resulting in the Matuzviadonha and Chizarira plateaux. Differential erosion of Karoo-age sediments has produced a generally broken terrain of many low ridges, hills and distinctive mesas. The Mid Zambezi Valley subregion, downstream of the Kariba Gorge and demarcated by the precipitous Zambezi Escarpment, declines northwards from about 600 m elevation at the escarpment foot to about 350 m at the Mozambique border. It is generally less broken than the Upper Zambezi Valley, particularly east of the Manyame River where the landform shape is almost flat to undulating but with a finely dissected microrelief in places;

6. the Southeast Lowveld and Middle Save Valley, a broad pediplain at elevations less than 600 m to 900 m. East of the middle reaches of the Save River, there is a marked rise through the foothills of the Eastern Highlands. Elsewhere, the transition to Middleveld is gradational. Landform is very subdued, generally almost flat to gently undulating.

Climate

There are Communal Lands in all climatic zones in Zimbabwe, although there is a preponderance in the drier and hotter parts. The country falls entirely within

the tropics although much of the Highveld and Eastern Highlands has a subtropical to temperate climate owing to the modifying effect of altitude. North of approximately 20° S the single wet season of about four months is mainly associated with the summer movement of the Inter-Tropical Convergence Zone into the northern parts of Zimbabwe. South of this latitude, which approximates to the position of Bulawayo and Masvingo, the wet season is likely to be a more fitful event marked by brief convectional thunderstorms and drizzle or light rain (known locally as guti), especially towards the end of the season, when periodic invasions of cool, moist maritime air from the southeast pass through the Limpopo Valley gap into the Lowveld (Seccombe, 1970).

Local variation in the regional rainfall pattern caused by orographic effects occurs in several areas where Communal Lands predominate. Archipelagos of granitic bornhardts, and other high ground with a southeast aspect, attract reliably high precipitation in the Middleveld from Bikita through Mberengwa, and with diminishing effect, as far west as Matobo. A similar local enhancement of rainfall occurs in the north around the Zambezi Escarpment as a result of exposure to the prevailing northeasterly airflow. Several of the Eastern Highlands' Communal Lands have a particularly humid climate owing to their elevation and to the predominant easterly winds resulting in this area having no truly dry season. However, at low elevations in the Save Valley on the leeward side of the Eastern Highlands there is a rain shadow causing a rapid decline in annual rainfall to 400-500 mm.

A classification of the country according to agro-ecological criteria, with particular emphasis on climate, was prepared by Vincent and Thomas (1960) using an approach pioneered by Trapnell and Clothier (1957) in Northern Rhodesia. For agricultural planning purposes, the Department of Agricultural Technical and Extension Services (AGRITEX) has adapted the classification by defining and mapping five Natural Regions based on rainfall amount, distribution and altitude (Department of the Surveyor-General, 1984a). A revision of the Natural Region boundaries and classification criteria, particularly those relating to the drier parts, is overdue. Hussein (1987) in an analysis of growing season data for 39 stations in Natural Regions III, IV and V recognises several anomalies and recommends a reassessment. Hawkins Associates (1982) in a development study of the Mid Zambezi Valley give evidence for reclassifying the main part of the region as Natural Region III rather than IV.

Bernardi and Madzudzo (1990a) provide a more consistent alternative to the established Natural Region classification. Agroclimatic Zones, reflecting differences in moisture availability, have been defined and mapped for the country. These zones are based on the ratio of the mean annual rainfall at the 80% probability level and the calculated or extrapolated average annual potential evapotranspiration. Six zones have been mapped and these are compared with the Natural Regions in Text Map 3. There is little difference in boundary location compared with the AGRITEX Natural Regions in the moister areas of the Highveld and Eastern Highlands. However, in the Southeast Lowveld and the Zambezi Valley, in areas where Communal Lands predominate, there are important changes which tally with the ecological assessments made during the resource inventory. In the Lowveld, Natural Region V has been split to create Zone VI in the extreme south, representing the most arid climate in Zimbabwe. In the Upper and Mid Zambezi Valley, Natural Region V has been promoted to Zone IV. Table 1 below compares the results of classification according to the two systems for a range of rainfall stations in the Communal Lands. The zonal method appears to give a better climatic classification of land and has therefore been used as a descriptor of the land units in Part 3. Further refinements, involving the incorporation of site specific factors, are required to develop an agro-ecological land classification suitable for applications in regional agricultural planning.

Table 1 Mean monthly and annual rainfall totals for a selection of Communal Land stations

Station and Communal Land	Elevation (masl)	No.of years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	CV%	NR*	ACZ**
Rusitu, Ngorima	1 070	30	318	309	240	87	44	51	39	57	58	90	159	284	1 735	24	I	I
Bikita, Bikita	970	45	211	202	166	52	20	32	15	14	17	35	112	197	1 074	28	III	III
Nyamaropa Sereko, Nyamaropa	1 040	20	267	239	98	41	12	11	4	8	10	26	94	228	1 037	NC	IIa	II
Jichedza, Ndanga	1 050	50	205	176	137	37	14	17	11	10	13	35	94	164	912	32	III	III
Domboshawa, Chinamora	1 550	50	215	175	122	35	12	4	1	2	3	26	97	188	880	28	IIa	II
Magunje, Hurungwe	1 180	30	208	172	109	36	9	3	0	2	5	17	103	173	838	17	IIa	II
St. Barbara, Manyika	1 520	30	184	147	105	40	11	9	5	5	9	32	106	179	832	25	IIb	II
Guruve, Guruve	1 180	55	211	172	118	31	7	2	1	1	3	14	78	181	820	23	IIa	II
Sanyati Junction, Umfuli	780	15	213	170	95	19	8	1	0	0	3	16	103	193	820	NC	IV	III
Wedza, Wedza	1 380	45	176	139	93	38	10	6	3	4	5	29	119	190	815	28	IIb	II
Gokwe, Gokwe	1 280	55	198	167	103	30	6	2	0	0	4	20	88	174	791	28	III	III
Lusulu, Manjolo	990	20	196	195	85	24	4	1	0	0	2	19	78	165	769	NC	IV	III
Holy Cross, Chirumanzu	1 350	20	162	136	61	35	9	7	1	3	7	35	115	183	754	NC	III	III
Mavuradonha, Masoso	760	40	198	168	79	16	3	2	0	1	1	4	65	188	725	26	IV	IV
St. Michael, Ngezi	1 340	30	170	137	71	25	5	3	0	2	3	30	102	174	723	29	III	III
All Souls, Mutoko	1 065	30	186	143	84	25	7	5	1	0	4	8	74	154	691	28	III	III
Siabuwa, Siabuwa	655	20	183	152	76	17	7	1	0	2	0	21	68	161	688	NC	V	IV
Marymount, Chimanda	620	20	212	148	64	15	4	4	1	0	2	10	68	158	687	NC	IV	IV
Chikafa, Dande	350	20	179	168	61	10	4	1	0	0	1	7	53	171	656	NC	IV	IV
Matopo Mission, by Gulati	1 490	65	146	130	85	25	8	3	1	1	5	26	86	138	655	39	IV	IV
Nyamapanda, Ngarwe	630	20	194	143	61	12	5	6	1	1	1	4	71	152	651	25	IV	IV
Binga, by Manjolo	620	30	178	142	82	18	4	0	0	0	1	14	53	160	651	30	V	IV
Nkayi, Nkayi	1 130	40	150	129	64	29	7	4	0	1	5	19	79	153	639	28	IV	IV
Inyathi, Inyathi	1 330	65	148	113	71	20	6	2	0	1	5	28	89	141	625	35	IV	IV
Lupane, Lupane	1 010	30	152	127	71	21	7	2	0	1	3	24	68	144	619	30	IV	IV
Alheit, Gutu	1 020	55	143	108	78	17	7	6	1	2	5	23	86	140	616	39	IV	IV
Tjolotjo, Tjolotjo	1 100	45	123	106	66	27	4	2	0	1	4	21	66	145	564	32	IV	IV
Chivi, Chivi	940	20	127	106	39	25	6	5	1	2	7	21	80	143	562	NC	V	V
Dadaya, Runde	1 050	30	117	107	63	24	6	8	1	1	5	20	75	108	534	31	IV	V
Embakwe, Mpande	1 130	30	113	97	63	25	5	3	0	0	6	26	67	126	530	40	IV	V
Kezi, Tshatshani	1 015	55	113	110	67	26	10	4	1	1	4	18	69	104	528	37	V	V
Nyanyadzi, Muwushu	530	30	98	98	44	24	5	3	0	3	7	28	57	119	489	35	V	V
Mphoengs, Mphoengs	950	30	94	97	63	28	8	3	1	1	3	20	64	90	472	41	V	VI
Manama, Dibilishaba	720	30	82	75	44	22	3	5	1	1	5	20	57	82	398	43	V	VI
St. Joseph, Semukwe	960	30	87	71	50	21	4	3	0	1	3	20	48	86	395	39	V	VI
Tuli, Machuchuta	580	40	81	68	40	15	8	1	3	1	4	18	62	71	372	NC	V	VI

* Natural Region (Department of the Surveyor-General, 1984a)
** Agro-climatic Zone (Bernardi and Madzudzo, 1990a)
NC Not calculated
Main source: Department of Meteorological Services (1977)

Average rainfall

The mean monthly and annual rainfall totals for 36 stations in Communal Lands are given in Table 1. These illustrate the wide range in total rainfall as well as differences in distribution throughout the year.

Rainfall variability

The reliability of rainfall increases with elevation and from south to north. Coefficients of variability range from more than 40% in the Communal Lands south of Bulawayo, where they border Botswana, to less than 20% in the Highveld portion of Hurungwe Communal Land and parts of the Eastern Highlands.

Rainfall reliability is generally of greater importance in dryland cropping than the annual average. In the driest areas of Matabeleland South however, the mean annual rainfall of less than 400 mm, even if well distributed, is insufficient to support crops other than the most drought tolerant such as some millet varieties. At Messina, 16 km south of Beitbridge, between 1913 and 1988, only 67% of the seasons received more than 80% of the average rainfall, 356 mm (Snyman, 1991).

Table 2 shows the percentage probability of monthly wet-season rainfall exceeding 50 mm at five stations representing sites in Agroclimatological Zones III through VI. Rainfall totalling less than 50 mm in a month is likely to evaporate and contribute nothing to soil moisture availability. Since very few soils are likely to have a moisture reserve sufficient to meet crop requirements over this period, there is a high risk of yield reduction or crop failure.

Maximum and minimum monthly rainfall totals also show considerable variation from year to year as indicated in Table 3, using the same stations as Table 2 and a 60 year period to 1991. Exceptionally high monthly rainfall is likely to result in reduced crop yields through lack of sunshine, waterlogging and soil erosion.

Table 2 The percentage probability of rainfall exceeding 50 mm in a wet season month at four stations in Agroclimatological Zones III, IV, V and VI (1961-91)

		Percentage probability of receiving more than 50 mm rainfall											
Station	ACZ	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Gokwe	III	<1	<1	<1	17	77	89	97	92	64	35	3	<1
Nkayi	IV	<1	<1	2	18	77	85	90	84	61	29	<1	<1
Kezi	V	<1	<1	1	20	69	76	75	73	49	24	3	3
Thuli Estate	VI	<1	<1	2	24	63	67	63	74	43	29	1	1

Table 3 The maximum and minimum monthly wet season rainfall at four stations in Agro-climatological Zones III, IV, V and VI (1931-91)

	Oct		Nov		Dec		Jan		Feb		Mar		Apr	
Station	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Gokwe	121	0	233	0	385	29	650	17	405	4	335	0	171	0
Nkayi	100	0	201	7	443	11	429	33	341	7	265	0	142	0
Kezi	94	0	236	1	289	3	434	0	315	0	249	0	131	0
Thuli Estate	131	0	200	1	292	0	477	0	233	0	221	0	143	0

A further implication of the generally marked variability of rainfall is its effect on the start and length of the crop growing season. This feature has been analysed by Lineham (1978) by defining the start and end of the season according to the first and last rainy pentads; a rainy pentad (five day period) is taken as the middle one of any three which together have at least 40 mm of rain, provided that not more than one of the three has less than 8 mm. The number of rainy pentads in a season provides a guide to the quality of the season. For the drier parts of the country, Agroclimatological Zones V and VI with less than about 600 mm mean annual rainfall, the definition of a rainy pentad was considered too stringent a criterion to define the season. In these areas the start of the season may be better described as the date by which 25 mm of rain is recorded within a five day period, ignoring isolated heavy falls. This would allow the surface 50 mm or so of soil to reach field capacity.

According to rainy pentad analyses, the mean start of the season is early November for the Communal Lands of the Eastern Highlands and mid November for those on the Highveld, becoming progressively later through the Middleveld and Lowveld where mid December is the average towards the Limpopo valley. The length of season ranges from about 160 days in the Eastern Highlands to less than 50 days in the extreme south. The nature of the rainy season is however notoriously fickle and predictions for a particular area should be based on probabilities derived from long term historical rainfall data.

A refinement to this procedure, using an agro-ecological approach, was developed by Donovan (1960) and recently by Bernardi and Madzudzo (1990b), using the growing period concept applied by FAO (1978). An important adjunct to this methodology is the ability to obtain crop yield or yield reduction estimates based on crop specific soil water balance models (Frere and Popov, 1979; Gommes, 1983). An application of this type of model for estimating yield levels for maize, sorghum and millet is shown in Appendix 1 and is taken from Anderson (1986).

Rainfall intensity

About 90% of the total rainfall in Zimbabwe is associated with thunderstorm activity producing falls of short duration and high intensity. Periods of drizzle and light rain (guti) are only significant southeast of the central watershed although total amounts contributed by this type of rainfall are small. Table 4 is adapted from Department of Meteorological Services (1981) and shows the range of rainfall intensities during the wet season for the area experiencing guti, the southeast Middleveld and Lowveld, and the non-guti area, essentially the rest of the country.

Table 4 Comparison of rainfall intensity in guti and non-guti areas

Area	Intensity in mm/hr						Seasonal rainfall
	<3	3-6	6-13	13-25	25-51	>51	
Non-guti	14%	15%	14%	16%	19%	22%	779 mm
Guti	18%	17%	15%	15%	17%	18%	695 mm

Rainfall intensities greater than 13 mm/hr are likely to lead to runoff in all but the sandiest soils with high infiltration rates. With 50% or more of the rainfall having intensities above this level, a high proportion of rain is therefore likely to be lost as runoff, particularly at sites where the natural vegetation has been excessively disturbed or where cultivation practices exacerbate this process. Maximum rainfall intensities do not appear to show significant geographical variations.

Temperature

Values for air temperature are closely related to altitude with mean annual temperature ranging from about 25°C in parts of the Zambezi Valley, through 18°C in the Highveld to less than 15°C above 1 800 m in the Eastern Highlands. Maximum temperatures are lowest in June or July and highest in October, except in the Southeast Lowveld where the frequent absence of cloud cover results in high insolation and the hottest month occurs closer to the summer solstice during December. Minimum temperatures are lowest in June or July and highest in December or January, apart from the Upper Zambezi Valley adjacent to Lake Kariba where October may have the highest minimum.

The mean of maximum and minimum monthly temperatures for 21 stations in or close to Communal Lands is shown in Table 5.

Frost may occur in most areas between May and September, with the highest incidence in June and July. It occurs more frequently and more severely at mid and high altitudes. Severe frosts are associated with an influx of cold dry southwesterly air which most affects the Kalahari Sandveld and southern Highveld regions. Soil type can effect ground temperatures with sand soils such as the Matopos granite sands and the Kalahari sands cooling more rapidly than clay soils owing to a lower specific heat and conductivity in the sands. Local topography however is the main determinant of frost risk with valleys, vleis and other sites which receive and retain cooled night air being especially susceptible. The Mid Zambezi Valley is probably the only frost-free region.

Soil Climate

Soil Temperature Soil temperatures at 5 cm, 10 cm and 20 cm soil depths are recorded for a 10 year period at 14 stations in the Department of Meteorological Services (1968). None of the stations are in Communal Land but extrapolation is possible as there is a good inverse correlation between temperature and altitude. The soil temperature regime, as used by Soil Survey Staff (1990) for classification according to Soil Taxonomy, has been calculated for 75 stations

Table 5 Mean of maximum and minimum monthly air temperatures for a selection of Communal Land stations (Department of Meteorological Services, 1978)

Station and Communal Land	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Year	Altitude (metres)	No. years
Hope Patrol, by Mutasa N.	11	13	14	17	17	17	18	18	17	15	13	11	15	1 651	5
Gutu, Gutu	14	16	18	21	21	21	20	21	20	19	16	13	18	1 393	10
Wedza, Wedza	14	16	19	21	21	21	21	21	20	19	16	14	18	1 384	25
Martin Forest, by Chikukwa	13	15	17	20	20	20	20	20	19	18	16	14	18	1 323	12
Gokwe, Gokwe	16	18	22	24	23	22	22	22	22	21	18	16	20	1 282	25
Mubayira, Mhondoro	14	16	20	22	22	22	22	22	21	20	17	14	19	1 260	22
Mutoko, Mutoko	15	17	20	22	22	22	22	22	21	20	18	15	20	1 245	25
Buhera, Save	14	16	19	22	22	22	22	22	21	19	17	14	19	1 192	25
Guruve, Guruve	15	18	21	24	23	22	22	22	21	20	18	15	20	1 177	25
Nkayi, Nkayi	15	17	21	24	23	23	23	23	22	21	17	15	20	1 131	25
Tjolotjo, Tjolotjo	15	18	22	25	24	24	24	23	23	21	18	15	21	1 100	15
Ncema Dam, by Umzingwane	13	16	19	23	23	23	23	22	21	19	16	13	19	1 070	25
Kezi, Tshatshani	14	17	21	24	24	24	24	23	22	21	17	14	20	1 015	25
Lupane, Lupane	15	17	22	25	25	25	24	24	23	22	18	15	21	1 012	25
Zaka, Ndanga	16	18	21	23	24	24	24	24	23	21	19	16	21	774	25
Thuli Estate, Gwaranyemba	14	17	21	24	25	25	25	24	23	21	17	15	21	765	22
Binga, by Manjolo	21	23	26	29	28	27	26	26	26	25	23	21	25	617	18
Hot Springs, Mutambara	17	19	22	26	26	26	26	26	25	23	20	16	23	558	10
Birchenough Bridge, Save	17	19	22	26	26	26	26	26	25	23	20	17	23	498	12
Beitbridge, by Mtetengwe	17	19	23	25	26	27	27	27	26	24	20	17	23	457	25
Chisumbanje, Ndowoyo	17	19	22	24	25	26	26	25	24	22	19	17	22	421	16

in Zimbabwe and tentatively mapped in Van Wambeke (1982). This broadly places the Southeast Lowveld and Middle Save Valley region in the Hyperthermic regime with mean annual soil temperature (MAST) of 22°C or higher at 50 cm depth; the Highveld and Eastern Highlands regions are placed in the Isothermic regime with a MAST between 15°C and 22°C at 50 cm depth with an annual difference of less than 5°C, and the rest of the country in the Isohyperthermic regime which is similar to Hyperthermic but with an annual difference in temperature of less than 5°C.

Soil moisture The soil moisture regime, as applied in Soil Taxonomy, has also been calculated and mapped by Van Wambeke (1982). The Southeast Lowveld and Save Valley region has been placed in the Aridic regime indicating that soils have inadequate moisture, derived from rainfall, for most crops throughout the year; the Eastern Highlands region in the Udic regime indicating adequate soil moisture during a normal cropping season for annual crops; and the remainder of the country in the Ustic regime indicating limited availability of moisture, intermediate between the aridic and udic regimes. The aquic moisture regime occurs locally where drainage is poor, as in the case of vleis, and conditions of excessive soil moisture develop, unsuitable for most crops without artificial drainage.

Geology

The Communal Lands include examples of all the main lithologies and structures in Zimbabwe. The major formations are shown in Text Map 4 and the dominant rock types are listed in Table 6.

The geological backbone of Zimbabwe is an Archaean craton, also called the Basement Complex, consisting of a large area of gneissic rocks into which granitic bodies have subsequently been emplaced. The craton also includes about 32 linear to arcuate greenstone belts which are metamorphosed remnants of ancient lava and sedimentary sequences. Dolerite dykes, sheets and sills have intruded the craton and are particularly common in the northeast quarter of the country where they are estimated to occupy an area of more than 10 000 km^2. The Highveld, Middleveld and central part of the Eastern Highlands are dominated by these cratonic rocks; the granitic-gneissic rocks are particularly well represented in the Communal Lands of the southeast and northeast Middleveld. Granite, *sensu stricto*, in which alkali-feldspar constitutes more than two-thirds of the total feldspar, is extremely rare in Zimbabwe and most of the rocks given this general name are in fact adamellites (Stagman, 1978).

The craton is bordered on the west and north by the Zambezi mobile belt and on the southeast by the Limpopo mobile belt, which approximately conforms to the Southeast Lowveld. These areas are complex in detail, mainly comprising high grade metamorphic gneisses, migmatites and granulites.

The Great Dyke is a conspicuous geological feature extending from the north of the Highveld region near the Zambezi Escarpment southwards through the Basement Complex into the Southeast Lowveld. It is composed of mafic and ultramafic rocks. Small areas in Mhondoro and Mberengwa Communal Lands occur on the Dyke.

These large-scale tectonic features provide the foundation for later igneous events and the development of major sedimentary basins. The earliest of these sedimentary deposits, within the Piriwiri, Deweras and Lomagundi Groups, occur in the area extending from the Karoi Highveld outlier, through the northwest Middleveld into the eastern part of the Sanyati River basin. The main rock types are phyllites, mica schists, arkoses, slates, dolomites, quartzites and minor volcanics, all more or less metamorphosed. On the eastern margin of the craton, sedimentary basin deposits are represented by the Umkondo Group in the Eastern Highlands in Chipinge and Chimanimani Districts and to a lesser

Table 6 Geological succession in Zimbabwe

Age	Classification	Dominant Rock Types
Quaternary and Tertiary	Kalahari System	Alluvium and other superficial deposits Aeolian sands
Cretaceous and Upper Jurassic	Malvernia Beds, Kadzi Beds, Gokwe Formation	Sandstone, siltstone, conglomerate and limestone
Lower Jurassic to Upper Carboniferous	Upper and Lower Karoo including Batoka Basalt, Forest Sandstone, Pebbly Arkose, Escarpment Grit, Madumabisa Mudstone, Upper and Lower Wankie Sandstone and Wankie Main Coal Seam	Basalt, sandstone, arkose, grit, mudstone and coal
Late Precambrian	Sijarira Group	Sandstone, shale, grit, arkose and conglomerate
	Tengwe River Group	Limestone, dolomite and quartzite
	Makuti-Rushinga Groups	Paragneiss, meta-arkose, schist, dolomitic marble
Mid Precambrian	Umkondo Group	Quartzite, arkose, shale, phyllite, schist and andesite
	Lomagundi Group	Slate, dolomite and quartzite
	Deweras Group	Grit, meta-arkose, conglomerate and basic metavolcanics
	Piriwiri Group	Phyllite and quartzite
Early Precambrian	Beitbridge Group	Paragneiss and anorthositic gneiss
	Shamvaian-Bulawayan-Sebakwian Groups (Greenstone Schist or Gold Belts)	Metasediments and felsic to ultramafic metavolcanics
	Zambezi and Limpopo mobile belts	Gneiss, migmatite and granulite
		INTRUSIVE IGNEOUS ROCKS
Late Jurassic		Granophyre, granite, syenite and gabbro
Various ages	Mashonaland-Umkondo Dolerite suites	Dolerite and epidiorite
	Great Dyke	Norite, gabbro, serpentinite and pyroxenite
	Cratonic Basement Complex	Gneiss, granodiorite, adamellite, tonalite and granite

Source: 1:1 million map, Department of Geological Survey, 1985.

extent in Nyanga District. These sediments include quartzites, limestones and shales, intruded by many doleritic sills.

The Tengwe River Group, consisting mainly of calcareous sediments and quartzites, forms part of a large thrust-block or klippe occupying part of Rengwe and Hurungwe Communal Lands in the northwest Middleveld. The klippe overlies the younger Sijarira Group consisting of unmetamorphosed sandstone and shale red beds which extend intermittently southwestwards through the Upper Zambezi Valley as far as Hwange District.

The Karoo succession occupies a period of about 100 million years from the late Carboniferous Period to early Jurassic times ending with vast fissure eruptions of basaltic lava. The main areas of sedimentary deposition were in the Zambezi Valley and Southeast Lowveld regions. Subsequent to the basal glacial beds, there is a succession of sandstone, shale and coal deposits followed by a

thick deposit of mudstone, together comprising the Lower Karoo. The Upper Karoo is mainly arenaceous with grits overlain by red beds and aeolian sandstones which are capped by basaltic lavas. The succession is well represented in the Gokwe and Manjolo Communal Lands.

Post Karoo sediments of late Jurassic to Cretaceous age occur to a limited extent in Gokwe and Nkayi Communal Lands, towards the eastern edge of the Kalahari Sandveld region. More extensive deposits are found in the Mid Zambezi Valley, as sandstones, siltstones and conglomerates, and in the Southeast Lowveld, as sandstones, grits and conglomerates.

During the Miocene and Pliocene, the western half of the country was subject to deposition of aeolian sands of the Kalahari System. The undisturbed sand consists of bimodally sorted, moderately well-rounded frosted quartz grains accompanied by about 5% clay-sized particles. Since the Pleistocene there has been considerable attrition of the sand sheet as rivers such as the Sengwa and Shangani have cut through to older rocks. This has resulted in extensive redistribution and mixing of the sand with Karoo and Cretaceous sediments.

Local deposits of Pleistocene alluvium are associated with many river valleys but there are few extensive deposits. An exception is the large tract of alluvium in the middle section of the Save Valley. Otherwise, important areas of alluvium are restricted to the two sections of the Zambezi Valley, generally as alluvial fans at the base of escarpment slopes. Also of similar age are chemical alterations, such as ferricretes, calcretes and silcretes, which are of minor importance especially in the Kalahari Sandveld region.

Landform

The major landform features of the Communal Lands, in common with the rest of the country, are the result of cycles of tectonic movement, weathering and erosion to base level surfaces over the past 100 million years or so. Lister (1987) has described and mapped the principal erosion surfaces in relation to four geomorphic provinces, the Eastern Highlands, the Limpopo-Save Lowlands, the Zambezi Valley and the Central Axis. The Central Axis corresponds to the Highveld, Middleveld and Kalahari Sandveld regions described in this report.

The Southeast Lowveld, Middle Save Valley and the Zambezi Valley regions are predominantly associated with an erosion surface or pediplain of Pliocene age. In the northeast, this surface is also recognised in Mudzi and Rushinga Districts where headward erosion by the Ruya, Mazowe and Ruenya Rivers is occurring. Most of the larger rivers crossing the pediplains have floodplain and terrace deposits, generally of very limited extent, resulting from an encroaching Quaternary erosion cycle which continues to the present day.

The Middleveld is representative of the Post-African erosion cycle, of Miocene age. This is an area of moderate slopes, steeper on the southeast than the northwest, and has been a focus for dissection since Pliocene times, with widespread stripping of the weathered mantle to produce bornhardt landscapes and other dissected terrain.

Dissection decreases on the Highveld above about 1 200 m elevation, and the Post-African surface usually merges with the African surface which forms a planation of very subdued relief rising eastwards from Plumtree at about 1 400 m elevation to the Marondera area at about 1 700 m elevation.

The Kalahari Sandveld, as a depositional surface, has fossilised the African and younger erosion surfaces over much of western Zimbabwe. Similarly, the Karoo succession fossilised a more ancient landscape, some of which has now been resurrected by erosion as Pre-Karoo surfaces, such as the Mwanesi Range bordering Ngezi Communal Land.

The Eastern Highlands compose the most complex region having the greatest relief and showing the complete range of erosion cycles, owing to periodic uplift since Jurassic times.

Local irregularity in elevation across the various pediplains is usually a result of differences in jointing or resistance to erosion of the underlying rock types. Bornhardt or granite-gneiss inselberg landscapes are characteristic of many of the Communal Lands in the Middleveld as well as the Highveld perimeter north of Harare, in Chinamora and Masembura CLs, and south of Bulawayo, in the CLs comprising part of the Matobo Hills. These conspicuous rock outcrops may be high and domed, exhibiting sheet jointing, or well jointed in a rectangular pattern thus enhancing the weathering process and the development of smaller, residual castle koppies and balancing rocks (Plate I). These type of outcrops are not common in areas of paragneiss or more mafic orthogneiss. In these cases the topography may be almost flat over a wide area, as in parts of the Southeast Lowveld, or undulating to rolling with long slopes and low rock outcrops, as in the Middleveld sections of Kandeya and Hurungwe CLs.

Linear topographic features are common. The various swarms of doleritic dykes have produced low, rocky ridges sometimes of considerable length. Elsewhere, these dykes may have no topographic expression or may weather to form depressions. On a larger scale, the Great Dyke follows a similar topographic pattern. Particularly resistant rocks such as quartzites, banded ironstones, jaspilite and serpentinite often outcrop as isolated ridges or may produce a more extensive landform comprising a series of longitudinal ridges and valleys such as, for example, in much of Magondi CL. In part of Tjolotjo CL, in the western part of the Kalahari Sandveld, stabilised linear dunes trend approximately east to west. Farther east, the dunes are replaced by broader, whale-backed ridges and plateaux in Lupane, Nkayi and Gokwe CLs. These give way to more dissected terrain characterised by Karoo basalt and Escarpment Grit capped plateaux and mesa outliers passing northwards into the Upper Zambezi Valley CLs of Gokwe, Binga and Kariba Districts.

Hydrology

Surface water

The river systems of Zimbabwe are divided into six hydrological zones (Department of the Surveyor-General, 1970) as shown in Text Map 5. They comprise:

Zone A (27% of Zimbabwe). The western drainage basins of which the Gwayi and the Sengwa are the largest – mean annual runoff (MAR) 1 756 million cubic metres and 10% of the potential yield in use;

Zone B (16%). The southern basins draining into the Shashi and Limpopo Rivers – MAR of 1 157 million cubic metres and 40% of the potential yield in use;

Zone C (23%). The northern basins draining into the Zambezi River mainly by way of the Manyame and Sanyati systems – MAR of 5 638 million cubic metres and 22% of the potential yield in use;

Zone D (10%). The Mazowe, the Ruya and the Ruenya basins draining the northeast to the Zambezi through Mozambique – MAR of 4 133 million cubic metres and 9% of the potential yield in use;

Zone E (22%). The Save and Runde basins draining southeast into Mozambique – MAR of 5 954 million cubic metres and 36% of the potential yield in use;

Zone F (2%). A small, discontinuous zone comprising several rivers flowing into Mozambique from the Eastern Highlands – MAR of 1 272 million cubic metres and 5% of the potential yield in use.

The data for water utilisation refer to May 1983, exclude the Zambezi and Limpopo Rivers and are taken from Tabex (1987). Other general hydrological data are found in Southern Rhodesia Ministry of Agriculture and Lands (1952-54).

The proportion of Communal Land within each Hydrological Zone varies from as little as 20% in Zones C and F to about 65% in Zones D and A (excluding Hwange National Park). The relationship between unit area MAR and mean annual rainfall for the six Zones is shown in Table 7.

Table 7 Runoff relative to mean annual rainfall for the Hydrological Zones

Zone	Area km²	Communal Land %	Mean Annual Rainfall mm	Mean Annual Runoff /km² (mcm†)
A	105 500	65*	630	0.017
B	62 520	40	480	0.019
C	89 870	20	753	0.063
D	39 080	65	828	0.106
E	85 970	40	684	0.069
F	7 820	20	1 071	0.163
Zimbabwe	390 760	42	675	0.051

† million cubic metres
* excluding Hwange National Park (14 651 km²)

Although Zone A has a substantially higher mean annual rainfall than Zone B, runoff per unit area is similar in both. This is largely a result of the relatively better vegetation cover, with extensive areas of *Brachystegia* and *Baikiaea* woodland, and the particularly permeable sandveld soils, derived from Kalahari and Karoo sediments, in Zone A.

Zone D, also with a high proportion of Communal Land, has good surface water resources, mainly associated with the Mazowe River system. These are largely untapped although proposals have been made for their development, particularly in the drier CLs of Rushinga and Mudzi Districts (PTA Consulting Services, 1982).

The Mid Zambezi Valley Communal Lands of Zone C receive perennial flow from the Angwa, Manyame and Musengezi Rivers where they debouch from the Zambezi Escarpment, although most of the base flow is subsequently lost to stream bed infiltration.

Several of the Middleveld Communal Lands in Zone E and, to a lesser extent, Zone B are catchment areas and sites for large reservoirs mainly serving the Southeast Lowveld sugar estates.

Groundwater

Groundwater reserves are low throughout most of the Communal Lands on the widespread granite-gneiss complex, although their exploitation, usually by

boreholes fitted with handpumps penetrating localized basins of rock decomposition, is of great importance for primary domestic needs. Somewhat better conditions prevail, however, in areas where these rock types are associated with the African erosion surface. Unlike the younger Post African to Pliocene-Quaternary surfaces, the African frequently has a deep regolith and moderate groundwater reserves associated with extensive aquifers 30-50m deep (Interconsult, 1985b).

Also associated with this surface and, to a lesser degree, the Post African, are dambos, locally termed vleis, seasonally waterlogged depressions which often yield groundwater at shallow depth throughout the year and which are important in many CLs for primary water supply, winter grazing and micro-scale irrigation. In some CLs, such as Seke and Chiota, dambos occupy about one-third of the area (Whitlow, 1984 and Dambo Research Unit, 1987).

Aquifers with adequate potential for piped supply schemes and irrigation are generally restricted to sedimentary rocks. These include the calcareous facies of the Lomagundi and Tengwe River Groups in Magondi and Hurungwe CLs; some of the Karoo sandstones and overlying aeolian deposits in the Kalahari Sandveld region (MacDonald, 1970); the Upper Zambezi Valley and the Sanyati-Sengwa Basin where, in Gokwe CL, artesian conditions occur; the primary Kalahari Sand, where it is sufficiently deep, (in Lupane, Nkayi and Kana CLs for example) and many localized alluvial deposits. The more important of these occur in the Sanyati-Sengwa Basin and the Mid Zambezi Valley as alluvial fans and river terraces (Aquater, 1984; Owen, 1989). Major alluvial deposits occur in the Middle Save Valley although Communal Land is poorly represented apart from Musikavanhu (Hindson and Wurzel, 1963). River-bed sand is locally of importance as a perennial water reservoir, often as a primary source from shallow wells but occasionally sufficient for irrigation (Ball and van Rynveld, 1972). Up to 60 ha are being irrigated from a single well point in sand in parts of the lower Shashi River (Mitchell, 1976).

Soils

The soils of the Communal Lands are described in some detail in Part 3. The framework used there and in the map legend subdivides the physiographic land units according to parent rock. The lithological subdivisions are:

Group G – Felsic igneous and metamorphic rocks (e.g. adamellite)
Group E – Mafic igneous and metamorphic rocks (e.g. dolerite)
Group M – Arenaceous sedimentary rocks (e.g. Escarpment Grit)
Group K – Kalahari Sand
Group D – Argillaceous sedimentary rocks (e.g. Madumabisa Mudstone)
Group U – Alluvium
Group R – a miscellaneous land type, is used for mappable areas of non-soil or land considered to be non-arable owing to severe soil or slope limitations.

The soils of the land units occur as associations of taxonomic units used in the sense defined in the soil survey manual of the United States Department of Agriculture (Soil Survey Staff, 1951). Soil classification is at the level of group or family in the Zimbabwe system; soil unit at level 2, occasionally level 1, according to FAO (1988); and subgroup, occasionally great group, according to Soil Survey Staff (1990).

The soil association of a land unit may comprise:

(a) two or more soils derived from different parent materials, as commonly occurs in banded gneiss or granite-dolerite terrain;

(b) a toposequence of a number of different soils on similar parent material, irregularly distributed down the length of a slope, with the properties of each soil attributable to its relative position in the landscape;

(c) a catena, a specific type of toposequence, with a regular and predictable sequence of soils derived from similar parent material and occurring

under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage (Department of Agricultural Development, 1991). The catenary association is well developed in some land units of the Kalahari Sandveld, Middleveld and Highveld regions, especially on granite-gneiss terrain, but is only weakly expressed or not evident in the Eastern Highlands and the Lowveld regions.

The Zimbabwe soil classification system is essentially based on the legend for the Inter African Pedological Service soil map of Africa (D'Hoore, 1964) and is described in Thompson and Purves (1978). The classified soils have been mapped nationally to family level at 1:1 million scale by the Department of Research and Specialist Services (1979). In summary, the system accommodates four taxonomic levels which are:

The soil order – differentiated on the basis of the degree of development of the soil and the degree of weathering of the soil minerals. A natric order is also included at this high level, comprising soils that are dominated by the presence of appreciable amounts of sodium on the exchange complex.

The soil group – comprising a subdivision of the soil order based on soil development as influenced largely by age and climate, and to a lesser extent by the rock type and soil-site characteristics.

The soil family – grouping soils which are broadly similar in profile morphology and soil texture. These characteristics are usually correlated with the nature of the parent material thus the family level is designated by reference to broad categories of parent material or rock. The exceptions are the three families differentiated within the sodic group where weakly, strongly and saline sodic soils are identified independently of the parent material.

The soil series – the lowest taxonomic level recognised in Zimbabwe. Thompson and Purves (1978) state that the principles used in recognising soils at this level are those described in the Soil Survey Manual (Soil Survey Staff, 1951). The Manual describes the soil series as a group of soils having soil horizons similar in differentiating characteristics and arrangement in the soil profile, except for the texture of the surface soil, and developed from a particular type of parent material. The soils within a series are essentially homogeneous in all soil profile characteristics except texture, principally of the A or surface horizon, and in such features as slope, stoniness, degree of erosion, topographic position, and depth to bedrock where these features do not modify greatly the kind and arrangement of soil horizons.

The number of named soil series in Zimbabwe has increased from the 46 referred to by Loxton and de Villiers (1963) to about 100 at the time of writing, including recently proposed new series by Nyamapfene (1991). However, the mapping of Zimbabwean soils at series level has been in abeyance for many years, with the last surveys of any consequence described by Purves *et al.* (1981) in the Banket area, where the mapping units are mainly catenary associations of soil series and by Godwin (1981) in the Seke-Chiota area, where toposequential associations of soil series are mapped.

The specific criteria used to differentiate soils at the group and family levels of the Zimbabwean soil classification system are shown in Appendix 2.

Vegetation

Complementary to the soil survey, a study of the natural vegetation of the Communal Lands north of the central watershed has been made by Timberlake *et al.* (1992). The vegetation is mapped as species associations appropriate to a mapping scale of 1:500 000, and described according to species composition, physiognomy, topographic position and other ecological factors. However, in many Communal Lands, particularly those of the Highveld and Middleveld regions of relatively high population density, disturbance of the vegetation by cultivation has greatly depleted the extent of climax woody cover. Miombo

woodland, dominated by *Brachystegia* species and *Julbernardia globiflora* in the 700 to 1 000 mm rainfall zone, has been the most affected by this population pressure (Whitlow, 1988a). In these areas, the vegetation survey has focused on relict communities usually associated with non-arable land. The vegetation status of cultivated and fallow land was assessed less formally during the soil survey, in terms of degree of disturbance and preserved species, but goes some way towards establishing a synthesis of the current stage in succession, the probable climax vegetation and the edaphic relationships relevant to land evaluation (Makin and Rose Innes, 1987).

By contrast, many of the CLs of the Southeast Lowveld, Zambezi Valley and Kalahari Sandveld retain considerable areas of climax vegetation, although this is generally far from pristine. Cultivation in these regions tends to be localized, with land selection being strongly controlled by access, water supply and soil type. Alluvial sites are traditionally preferred in lowveld areas, and water-receiving sites with medium textured soils in the sandveld area. Although the rate at which land is being brought into the cultivation cycle appears to be increasing, particularly in the Zambezi Valley regions, factors such as grazing in the Southeast Lowveld, fire in the Zambezi Valley and fire and logging in the Kalahari Sandveld have had a considerable impact on the vegetation status.

The principal vegetation types, according to physical region and with particular reference to the Communal Lands, are outlined below. General information has been drawn mainly from Rattray (1961) and Wild and Barbosa (1968). A more detailed description of natural vegetation is given in Part 3 as part of each land unit description.

Eastern Highlands

Although Communal Land is not well represented in this region, the full range of principal vegetation types is found in the larger CLs such as Ngorima and Holdenby. A short open submontane *Themeda-Loudetia* grassland occurs at the highest levels in high rainfall areas and may grade downslope into a bracken scrub comprising dominant woody shrubs of the Leguminosae and Compositae families, and minor, scattered trees (often pioneer forest species) such as *Faurea saligna* and *Harungana madagascariensis* as well as *Pterocarpus rotundifolius, Catha edulis* and species of *Protea* (Bromley *et al.*, 1968). Although Goodier and Phipps (1962) consider that both these vegetation types would revert to a climax forest if protected from fire, current opinion is that forest distribution, in the Eastern Highlands, is generally edaphically and aspect/altitude controlled (Müller, 1991).

Closed evergreen forest occurs in moist valleys or on slopes with east or south aspects. Two variants are recognised: a subtropical montane forest of varied composition, including the distinctive *Albizia gummifera*, and the similar *A. adianthifolia*, and a tropical evergreen high forest which is found at lower elevations and is now very rare in Communal Land.

In drier situations with a west or north aspect or on steep, rocky slopes, the climax vegetation is a deciduous miombo woodland dominated by *Brachystegia spiciformis* locally replaced by *B. utilis*. Other species which may be locally dominant include *Uapaca kirkiana* and *Parinari curatellifolia* and, as rainfall decreases, *Julbernardia globiflora* and *Brachystegia boehmii*. Where the effect of rain shadow is marked, *Combretum* spp. become common.

Northern Highveld

A *Brachystegia* savanna woodland extends westwards from the Eastern Highlands on to the Northern Highveld along the Rusape – Marondera watershed, and forms the most important vegetation type throughout this region. Communal Land is well represented only on the southern and northern periphery, from Shurugwi through Gutu, Wedza to Manyika and Weya through Chinamora to Guruve. In these areas the climax vegetation of well drained upland sites on

granitic terrain is a *Brachystegia spiciformis-Julbernardia globiflora* savanna woodland. Vlei grassland forms an important component of the landscape, part of a well developed soil-vegetation catena which typically takes the form, from crest to vlei, *Brachystegia glaucescens* (granite outcrops) – *Brachystegia spiciformis* – *Burkea africana* – *Parinari curatellifolia* – *Terminalia sericea* – grasses and sedges.

Closer to the central watershed, large parts of Seke, Mhondoro and Zvimba CLs are characterised by subdued relief and poor drainage. Here open grassland with scattered mature *Parinari curatellifolia* trees are found. In some of these wet situations, large termitaria provide the base for clumps of shrub and tree thicket surrounded by moist grassland. The occurrence of *Colophospermum mopane* is localised and a reliable indicator, in this region, of sodium influenced soils of low permeability.

Southern Highveld

The Southern Highveld region is also poorly represented with respect to Communal Land and areas of significance are restricted to the peri-Bulawayo CLs and Bulilimamangwe District. Most of the vegetation types show strong edaphic influences connected mainly with soil moisture availability in this region of relatively low rainfall. The CLs north and south of Plumtree mainly have a low open woodland of *Combretum – Acacia – Terminalia sericea* associated with granitic or gneissic derived sandy soils under an annual rainfall of 500 mm to rather more than 600 mm. Where drainage is restricted, or on heavier textured soils, *Colophospermum mopane* becomes important. Under a similar rainfall regime, but on the well drained clay soils derived from basement schists as found in parts of Mzinyathini and Ntabazinduna, the woodland is dominated by *Acacia* spp.

The Communal Lands of Kumalo, Gulati and Matopo, surrounding Matopos National Park, are at the western limit of a discontinuous extension from the Eastern Highlands of a forest element of phytogeographic interest (Wild, 1968). Forest species are located in kloofs and valleys receiving runoff from the numerous rock outcrops in this area. Species include *Erythrina lysistemon, Calodendrum capense, Ilex mitis, Tarenna zimbabwensis* and *Homalium dentatum* (Lightfoot, 1981). This area also marks the southwesterly limit of *Julbernardia globiflora*, which covers a large area as savanna woodland although the other common constituents of miombo woodland, *Brachystegia spiciformis* and *B. boehmii* are missing.

Middleveld

The Southeast Middleveld subregion is an area of transition with vegetation type and species composition changing with elevation, and from southwest to northeast as rainfall increases. In the southwest, CLs such as Brunapeg and Semukwe, with rainfall less than 500 mm, have a sparse low mopane woodland which is gradually replaced northeastwards by a *Terminalia sericea* open woodland in the Wenlock, Matshetshe and Glassblock communal area. *Julbernardia globiflora* may be locally common on high ground and *Brachystegia glaucescens* on granitic or gneissic rock outcrops. An association of *Colophospermum – Combretum – Acacia*, in variable proportion, is common in lower slope positions. *Acacia* spp. are dominant on the few areas of red clay soils derived from schist as, for example, at the Tuli – Makwe irrigation scheme.

Outliers of *Brachystegia spiciformis* woodland appear in the east of Godlwayo CL near the end of the Great Dyke and continue through the Mberengwa highlands, part of the higher rainfall extension, to become the dominant vegetation type by the Masvingo – Ndanga area. The effect of relief can be very pronounced, with high ground, as at Buchwa in Mberengwa and the Nyoni Range partly in Chivi, receiving locally high rainfall with some winter mist or drizzle. As a result of this orographic rainfall on southeast facing slopes, certain

areas fall within an adjacent rain shadow. Areas so affected include Mazvihwawa and Ungova CLs and a south west to north east strip south of Zaka in Ndanga CL. The evidence of a drier climate is indicated by a reduction in the number of miombo species and an increase in *Colophospermum mopane, Adansonia digitata, Lonchocarpus bussei, Sclerocarya birrea* and *Acacia* spp. A small area of edaphic grassland forms the western boundary of Mberengwa CL where it abuts on the serpentine of the Great Dyke.

The changes in vegetation species that occur with decrease in elevation through the Middleveld have been described for Gutu CL by Loxton and Associates (1971). Within the miombo woodland, *Julbernardia globiflora* assumes dominance at lower elevations. *Uapaca kirkiana* disappears below about 1 000 m, where *Kigelia africana, Lonchocarpus capassa* and *Sclerocarya birrea* appear. *Adansonia digitata* and *Berchemia discolor* occur below about 900 m. *Colophospermum mopane* is found below 1 000 m but, where pure stands are found, can be correlated with edaphic rather than climatic conditions.

Save, Marange, Muwushu and Mutema CLs, all on the lee side of the Eastern Highlands, have a drier variant of miombo savanna woodland dominated by *Julbernardia globiflora*. This type grades at lower elevations, approaching the Save River, into a *Colophospermum mopane* woodland.

North of the central watershed, the most common vegetation type of the Middleveld is a savanna woodland dominated by *Brachystegia boehmii* in association with *Julbernardia globiflora* and, at higher elevations, *Brachystegia spiciformis*. Other common associates include *Bauhinia thonningii, Pericopsis angolensis, Diospyros kirkii* and *Uapaca kirkiana* with *Brachystegia allenii* occurring below about 900 m elevation on the Zambezi escarpment. This type of vegetation is characteristic of Kandeya westwards through Guruve, Kachuta to Mukwichi and Hurungwe CLs in the Northwest Middleveld subregion. The CLs of Rushinga and Mudzi Districts, in the Northeast Middleveld subregion, are at a lower elevation with a less humid climate and here there is a transition from a miombo woodland to a drier open woodland, below about 700 m elevation, comprising tall trees of *Adansonia digitata, Sterculia africana, Kirkia acuminata, Cordyla africana* and some patches of low *Colophospermum mopane* (Wild, 1953).

Kalahari Sandveld

The eastern part of the region, in south Gokwe, Kana, Lupane and Nkayi, comprises a series of east – west trending plateaux of deep, primary Kalahari sand supporting a semi-deciduous woodland with frequent *Brachystegia spiciformis* and *Baikiaea plurijuga*. The *B. spiciformis* is generally much larger and straighter than the same species in typical Highveld miombo woodland. Associated species include *Julbernardia globiflora, Pterocarpus angolensis, Erythrophleum africanum, Ochna pulchra, Combretum psidioides, Paropsia brazzeana* and *Baphia massaiensis*. The pale, grey to white sands, which occur towards the interior of the broader plateaux, often associated with incipient drainage lines and pans, carry a shorter woodland principally composed of *B. spiciformis* without *Baikiaea plurijuga*. Additional species common to this landscape are *Swartzia madagascariensis* and *Monotes glaber*.

The redistributed Kalahari Sand is characteristic of parts of the valleys of the Lutope, Kana, Lupane and Gwampa Rivers. On these slightly heavier soils, *Brachystegia boehmii* becomes a conspicuous constituent of the woodland at the expense of *Baikiaea plurijuga*, although *B. spiciformis* remains dominant. Other species, rarely found on primary Kalahari Sand, include *Burkea africana, Diplorhynchus condylocarpon* and *Pericopsis angolensis*. The redistributed sand is also associated with long, linear, perennially moist grassland vleis forming the mid to upper reaches of the above rivers and their tributaries. There is generally a band of low *Terminalia sericea* separating the miombo woodland from the grassland. In the lower reaches of these small rivers, and in the valley of the Shangani River through Nkayi and Lupane CLs, most of the Kalahari sand has

been dissipated and the underlying Karoo basalt and sediments have produced substantially heavier textured but variable soils. A complex mosaic of vegetation types may occur with *Colophospermum mopane* locally dominant on water-shedding sites and *Brachystegia* spp., *Acacia* spp. and *Combretum imberbe*, for example, common at water receiving sites (Plate 2). Discontinuous stands of *Acacia tortilis* woodland occur on alluvial terraces bordering the larger rivers, especially the Shangani.

Tjolotjo CL, west of the miombo ecotone (Calvert, 1984), occupies the driest part of the Kalahari Sandveld. *Colophospermum mopane* low woodland is locally common on heavier-textured soils and in areas of restricted drainage. This species can occasionally be found growing on deep (> 2 metres) sands, a situation which does not appear to occur in the CLs farther east. *Baikiaea plurijuga* woodland is common in the north, especially on slightly elevated linear dunes, but can be found throughout the CL on other more amorphous sandy rises. In areas of subdued ridge and valley topography, a catenary sequence may be present comprising *Baikiaea plurijuga* woodland on the crest passing downslope through *Terminalia sericea* tree savanna to the depressions, generally ill-defined, where *Colophospermum mopane* and *Acacia* spp. are dominant. However, fire and frost are probably as important as edaphic factors in this area in determining vegetation type. Pans are common and support a seasonally moist grassland. *Combretum collinum* open woodland is characteristic of the Karoo sandstone soils in the south of Tjolotjo CL.

Upper Zambezi Valley and Sanyati-Sengwa Basin

The Upper Zambezi Valley and Sanyati-Sengwa Basin are predominantly areas of *Colophospermum mopane* woodland of variable habit, depending on edaphic conditions, with miombo inclusions frequently forming miombo – mopane catenas. On the deeper soils derived from fine grained Karoo sediments or basalt a tall mopane woodland, with few other species, occurs. Good examples occur in Gokwe, Omay and Gatshe Gatshe CLs (Timberlake *et al.*, 1991). The more open, shorter savanna woodland occurs on the extensive areas of shallower soils associated with Karoo mudstone and dissected sandstone terrain. Where vertisols occur, as in parts of Busi and Gokwe CLs, the natural vegetation is a grassland with few low shrubs of mopane and *Dalbergia melanoxylon.*

In moister situations to the south, the Escarpment Grit plateaux with deep sandy soils carry a *Julbernardia globiflora-Brachystegia boehmii* savanna woodland with minor *B. spiciformis.* To the north, with decrease in elevation and a drier climate, this woodland is more open and *Brachystegia spiciformis* is replaced by species such as *Xeroderris stuhlmannii, Diplorhynchus condylocarpon, Afzelia quanzensis* and *Bauhinia petersiana.* A *Tamarindus indica – Faidherbia albida* riverine woodland is characteristic of many alluvial river terraces, particularly in the Sanyati-Sengwa Basin. Of special botanical and pedological interest are the many patches of species- rich thicket communities (jesse) which occupy a variety of landscape positions on a number of different soil parent materials but which have an apparent linkage with Karoo lithology and soil chemical characteristics of strong acidity and low base status. The vegetation of part of Gokwe District has been described and mapped by Farrell (1968a).

Mid Zambezi Valley

The Communal Lands of the Mid Zambezi Valley have much in common with those of the Upper Zambezi Valley although the effect of macrorelief is less significant in the disposition of vegetation types. The main types are described in Timberlake and Mapaure (1992). *Colophospermum mopane* is again the dominant species extending from Dande eastwards to Masoso, generally as a savanna woodland but, in several areas of old alluvium, assuming the status of tall mopane woodland. On residual soils, which are generally shallow, the mopane

is associated with *Combretum apiculatum, Terminalia stuhlmannii* and *Diospyros kirkii. Brachystegia allenii* is an important constituent of the woodland on scarpfoot deposits adjacent to the Zambezi Escarpment. *Xylia torreana* thicket and *Terminalia brachystemma* bushed woodland, both without mopane, occur on deep acid sands in the north of Dande CL. West of the Angwa River on slightly elevated sandy soils, *Julbernardia globiflora* is a conspicuous component of the open woodland. Recent alluvium, adjacent to the major rivers, has a distinctive woodland, frequently dense, where *Acacia tortilis* is often dominant.

Southeast Lowveld and Middle Save Valley

This region includes a large area with an annual rainfall expectancy of less than 500 mm. As with the Zambezi Valley, *Colophospermum mopane* is the predominant species but under these more arid conditions it generally forms a very open tree savanna. The idiosyncrasies of the growth habits of mopane and the significance of the tree as an indicator species is discussed by Thompson (1960). Edaphic factors have an important influence on vegetation type and form, modified by increases in rainfall northeast towards the Mozambique border. The vegetation of the lower Save-Runde basin is described and mapped by Farrell (1968b).

The extensive area of soils derived from gneiss is typically under mopane open woodland but with an increase in the occurrence of *Combretum apiculatum* and *Acacia nigrescens* to the northeast. On the very poor, shallow soils of the basalt area, centred on Machuchuta CL in Beitbridge District, there is a *Commiphora* spp. tree savanna which includes *Combretum apiculatum, Boscia albitrunca, Adansonia digitata* and *Colophospermum mopane*. Farther east, the somewhat deeper, vertic soils on basalt in Matibi No. 2 CL carry a *Colophospermum mopane* shrub savanna. On the basalt soils east of the Save River in Ndowoyo CL, a more diverse tree or shrub savanna occurs with mopane infrequent and replaced by *Combretum fragrans* and *Lonchocarpus capassa* merging with *Terminalia stenostachya, Acacia nigrescens* and *Pterocarpus brenanii* in more dissected areas. On the granophyric Chihunju Hills, extending into the south of Ndowoyo, a *Brachystegia glaucescens* savanna woodland is associated with minor areas of *Julbernardia globiflora*. The Cretaceous sandstone areas, forming parts of Matibi No. 2 and Sengwe CLs, include some species more typical of the Kalahari sand. *Guibourtia conjugata* is frequent and may form a tree savanna or, locally, a *Guibourtia conjugata – Baphia massaiensis* woodland thicket, both being very similar to vegetation types recorded in the Communal Lands of Hwange and Binga Districts. *Androstachys johnsonii* thickets also occur but this species is specific to the southeast. Other thicket-forming species common to the Zambezi Valley occur near the confluence of the Runde and Save Rivers on deep sandy soil and were first recorded by Wild (1955). Species include *Xylia torreana, Pterocarpus lucens, Cleistochlamys kirkii, Hippocratea parvifolia, Millettia usaramensis* and *Combretum celastroides*. The thicket community in the Nwambiya sandveld, forming part of the Kruger National Park immediately south of Sengwe CL, is unique in South Africa and appears to have affinities with the Zimbabwean thicket types (van Wyk, 1972).

The soils of the Middle Save Valley, particularly the alluvia, show a close association with vegetation type, the relationship usually based on soil age, texture and drainage status, and this correlation has been used in assessing irrigation suitability (Ellis *et al.*, 1953). Well developed *Colophospermum mopane* savanna woodland, typical of the Zambezi Valley, is restricted in the southeast to deep, well drained alluvium. Similar soils, but generally lighter textured, more friable, less calcareous and probably younger, are under an *Acacia tortilis* tree savanna containing tall specimens of *Lonchocarpus capassa, Combretum imberbe, Lannea schweinfurthii* and *Xanthocercis zambesiaca*. Savanna woodland dominated by *Hyphaene coriacea* occurs on young alluvium with a high seasonal watertable close to the Save River. In wetter situations *Acacia xanthophloea* occurs and in seasonally wet saline sodic pan areas,

Salvadora persica. All these vegetation types are represented in Musikavanhu CL.

POPULATION AND LAND USE

Population

The population of Zimbabwe at 30 June 1991 was estimated to be 9.6 million with a rate of natural increase of 2.9% (Central Statistical Office, 1991). The 1982 census (Central Statistical Office, 1984) showed the population of the District Council areas, which closely approximate to the Communal Lands, to be about 4.3 million, or 57% of Zimbabwe's population at that time, distributed as shown in Text Map 6. Assuming this proportion still holds today, then the 1991 population of the CLs is of the order of 5.5 million, an average of 34 persons per square kilometre. In 1982, only 15% of CL had densities of less than 10 persons per square kilometre. Table 8 shows the population and growth rates for the District Councils within each Province in 1982. The second post-independence population census will be undertaken in 1992.

Table 8 Population, growth rate and density of District Councils by Province

Province	Population 1982	Annual growth rate % (1969-82)	Area* (km^2)	Population density (persons/km^2)
Manicaland	799 089	2.6	20 540	39
Mashonaland Central	333 233	3.8	15 536	21
Mashonaland East	488 671	2.2	13 871	35
Mashonaland West	281 576	2.6	13 179	21
Matabeleland North	348 930	2.3	29 986	12
Matabeleland South	413 653	2.7	25 420	16
Midlands	770 746	3.2	27 712	28
Masvingo	841 002	2.6	23 312	36
Total for District Councils	4 276 900	2.7	169 556	25

* Area of District Councils includes Communal Lands and a few Forest Lands and small scale commercial farming areas.

Relatively high population densities occur in most of the CLs in the Highveld, Middleveld and Eastern Highland regions. In particular, densities over 40 persons per square kilometre, high by Zimbabwean standards, are found along a discontinuous arc of Southeast Middleveld CLs stretching from Matopo north-eastwards through Mberengwa, Ndanga, Marange and into the Northeast Middleveld extending from Mutoko through Madziva to Guruve. This arc appears to encompass most of the pre-colonial settlement sites, including core areas near Matopo and at Great Zimbabwe (TABEX, 1987).

Migration from this well-populated zone to the Sanyati-Sengwa Basin and Zambezi Valley in the north and northwest has occurred over many years, with a large influx during the 1960s and shortly after independence. From observations made during the surveys of Gokwe, Dande and Muzarabani CLs, these pioneer farming families tend to be large with a propensity for cotton cultivation. In Kanyati CL, ARDA (1986) note that the average household size was 9.8, nearly twice the rural average (Central Statistical Office, 1989b) with working adults accounting for 42% of the population and a high proportion (77%) of resident, male family heads. This resurgent spirit is the response of the enterprising farmer to the long-standing unfavourable economic conditions in what may be called the high density CLs of the Middleveld, generally the archetypal granitic terrain which can no longer contain its burgeoning population. In these areas, the farmer is usually a woman while the male family head is often absent in urban employment (Callear, 1984).

Table 9 Communal Land crop area estimates by Natural Region – average for 1985/86 to 1988/89 seasons (area in hectares)

N.R.	Maize	Mhunga	Sorghum	Rapoko	Cotton	G.Nuts	Sunfl.	Veget.	Beans	Fruit	Mixed/ Other	Fallow	Crops+ Fallow	Total Crops
I	14 450	1 356	70	895	664	108	27	46	92	180	3 729	3 637	25 254	21 617
IIa	211 176	2 613	3 382	4 079	29 002	10 602	7 413	3 510	1 751	2 897	19 654	129 458	425 537	296 079
IIb	109 810	11 244	2 821	5 868	2 570	11 280	10 000	4 374	1 741	925	13 661	74 604	248 898	174 294
IIb/III	54 647	451	3 676	1 248	39 436	4 059	6 602	50	50	12	6 980	24 083	141 294	117 211
III	226 436	32 036	16 157	11 267	49 046	17 548	17 256	2 048	979	2 054	37 271	138 410	550 508	412 098
III/IV	35 391	9 081	6 207	46	4 421	2 940	2 270	0	47	0	6 832	18 597	85 832	67 235
IV	674 435	318 630	142 176	55 820	87 420	90 542	60 721	12 031	4 203	8 831	177 745	499 022	2 131 576	1 632 554
IV/V	9 277	27 108	15 768	2 963	2 090	1 986	1 088	0	78	0	6 709	16 453	83 520	67 067
V	94 758	72 194	135 666	7 316	12 537	9 431	11 229	352	243	848	20 124	147 128	511 826	364 698
TOTAL	1 430 380	474 713	325 923	89 502	227 186	148 496	116 606	22 411	9 184	15 747	292 705	1 051 392	4 204 245	3 152 853

Table 10 Percentage of the total area occupied by each crop type or fallow in each Natural Region – average for 1985/86 to 1988/89 seasons

N.R.	Maize	Mhunga	Sorghum	Rapoko	Cotton	G.Nuts	Sunfl.	Veget.	Beans	Fruit	Mixed/ Other	Fallow	Crops+ Fallow	Total Crops
I	1%	<1%	<1%	1%	<1%	<1%	<1%	<1%	1%	1%	1%	<1%	<1%	<1%
IIa	15%	<1%	1%	5%	13%	7%	6%	16%	19%	18%	7%	12%	10%	9%
IIb	8%	2%	<1%	7%	1%	8%	9%	20%	19%	6%	5%	7%	6%	6%
IIb/III	4%	<1%	1%	1%	17%	3%	6%	<1%	<1%	<1%	2%	2%	3%	4%
III	16%	7%	5%	13%	22%	12%	15%	9%	11%	13%	13%	13%	13%	13%
III/IV	2%	2%	2%	<1%	2%	2%	2%	0%	<1%	0%	2%	2%	2%	2%
IV	47%	67%	44%	62%	38%	61%	52%	54%	46%	56%	61%	47%	51%	52%
IV/V	<1%	6%	5%	3%	1%	1%	1%	0%	1%	0%	2%	2%	2%	2%
V	7%	15%	42%	8%	6%	6%	10%	2%	3%	5%	7%	14%	12%	12%

Table 11 Percentage of the total cropped area in each Natural Region occupied by each crop type – average for 1985/86 to 1988/89 seasons

N.R.	Maize	Mhunga	Sorghum	Rapoko	Cotton	G.Nuts	Sunfl.	Veget.	Beans	Fruit	Mixed/ Other
I	67%	6%	<1%	4%	3%	<1%	<1%	<1%	<1%	1%	17%
IIa	71%	1%	1%	1%	10%	4%	3%	1%	<1%	1%	7%
IIb	63%	6%	2%	3%	1%	6%	6%	3%	1%	<1%	8%
IIb/III	47%	<1%	3%	1%	34%	3%	6%	<1%	<1%	<1%	6%
III	55%	8%	4%	3%	12%	4%	4%	<1%	<1%	<1%	9%
III/IV	53%	14%	9%	<1%	7%	4%	3%	0%	<1%	0%	10%
IV	41%	20%	9%	3%	5%	6%	4%	<1%	<1%	<1%	11%
IV/V	14%	40%	24%	4%	3%	3%	2%	0%	<1%	0%	10%
V	26%	20%	37%	2%	3%	3%	3%	<1%	<1%	<1%	6%
ALL NRs	**45%**	**15%**	**10%**	**3%**	**7%**	**5%**	**4%**	**<1%**	**<1%**	**<1%**	**9%**

Table 12 Proportion of fallow to total area cropped in each Natural Region for seasons 1985/86 to 1988/89

Natural Region	Fallow/Area Cropped %
I	17
IIa	44
IIb	43
IIb/III	21
III	34
III/IV	28
IV	31
IV/V	25
V	40
Average	33

Current and potential land use

Crop production statistics for the Communal Lands are shown in Tables 9-14. The data in Tables 9-12 are taken from the results of the statistical survey of cropping in the CLs undertaken annually, since 1985/86, by the Crop Production Branch and National Early Warning Unit for Food Security, AGRITEX, Harare. The survey is based on a 10% random sample of aerial photos of Communal Land. Sample points (100) are located on each photo according to a grid overlay and an extension worker is expected to visit each point and record the land use, as crop type, fallow or uncultivated (Johnson, 1987).

As a separate exercise, AGRITEX make crop area and yield estimates for each CL based on a subjective assessment by local extension staff. A preliminary assessment is made in January, and a final one in April. The Central Statistical Office (CSO) conducts an annual National Household Survey of Communal Areas to obtain, amongst other information, crop area and production statistics. The data shown in Tables 13 and 14 are taken from Central Statistical Office (1989b).

Table 13 Communal Land maize, sorghum and groundnut production in tonnes, area in hectares and yield in kg/ha, 1969/70 to 1989/90 seasons

	Maize			Sorghum			Groundnuts		
Season	Production (tonnes)	Area (ha)	Yield (kg/ha)	Production (tonnes)	Area (ha)	Yield (kg/ha)	Production (tonnes)	Area (ha)	Yield (kg/ha)
1969/70	245 700	610 800	402	65 338	198 800	329	29 952	244 800	122
1970/71	455 000	672 000	677	136 500	240 000	569	16 200	216 000	75
1971/72	555 100	664 661	835	120 120	240 000	501	16 538	220 500	75
1972/73	145 000	475 000	305	22 750	122 000	186	24 000	200 000	120
1973/74	470 000	725 000	648	150 000	275 000	545	187 317	290 000	646
1974/75	435 000	725 000	600	105 000	210 000	500	110 000	310 000	355
1975/76	550 000	760 000	724	120 000	235 000	511	172 908	325 000	532
1976/77	400 000	600 000	667	36 000	90 000	400	129 681	275 000	472
1977/78	450 000	700 000	643	57 000	120 000	475	100 863	200 000	504
1978/79	420 000	600 000	700	30 000	76 000	395	100 000	240 000	417
1979/80	600 000	900 000	667	66 000	120 000	550	67 000	175 000	383
1980/81	1 000 000	1 000 000	1 000	100 000	200 000	500	100 000	300 000	333
1981/82	595 000	1 100 000	595	50 000	200 000	250	95 000	240 000	396
1982/83	285 000	1 050 000	271	44 000	280 000	157	22 500	180 000	125
1983/84	454 400	1 136 000	400	37 440	156 000	240	18 720	144 000	130
1984/85	1 558 000	1 018 000	1 394	76 000	211 000	360	61 000	118 000	512
1985/86	1 348 000	1 074 000	1 255	63 200	145 000	436	51 510	129 000	399
1986/87	627 690	1 064 000	590	40 394	172 722	234	58 388	186 845	312
1987/88	1 609 300	1 149 500	1 400	163 125	212 950	766	111 770	207 780	538
1988/89	1 188 180	1 030 000	1 154	65 310	158 000	413	77 625	172 500	450
1989/90	1 019 260	926 200	1 100	72 500	127 900	567	102 440	195 400	524

Table 14 Communal Land soyabean, cotton and tobacco (mainly burley) production in tonnes, area in hectares and yield in kg/ha, 1969/70 to 1989/90 season

	Soyabeans			Cotton			Tobacco		
Season	Production (Tonnes)	Area (ha)	Yield (kg/ha)	Production (tonnes)	Area (ha)	Yield (kg/ha)	Production (tonnes)	Area (ha)	Yield (kg/ha)
1969/70	334	680	491	NO DATA	NO DATA	NO DATA	381	429	888
1970/71	228	708	322	15 909	18 000	884	564	599	942
1971/72	1 227	3 000	409	27 000	30 000	900	757	1 824	415
1972/73	NO DATA	NO DATA	NO DATA	13 000	26 000	500	418	546	766
1973/74	NO DATA	NO DATA	NO DATA	55 000	62 000	887	798	950	840
1974/75	413	861	480	40 000	54 000	741	760	940	809
1975/76	383	1 577	243	28 000	35 000	800	325	530	613
1976/77	3 000	5 500	545	22 300	35 000	637	285	410	695
1977/78	8 600	11 000	782	31 000	41 000	756	169	381	420
1978/79	3 000	7 500	400	15 000	20 000	750	197	360	547
1979/80	8 000	12 000	667	12 000	15 000	800	231	365	633
1980/81	6 750	9 000	750	45 000	59 000	763	195	367	531
1981/82	3 000	7 000	429	27 000	51 000	529	774	1 080	717
1982/83	2 000	4 000	500	32 500	65 000	500	645	1 400	460
1983/84	970	2 260	429	70 000	100 000	700	774	1 210	640
1984/85	1 675	2 000	837	110 000	130 000	846	1 190	1 700	700
1985/86	1 160	1 900	611	107 000	125 000	856	NO DATA	NO DATA	NO DATA
1986/87	1 221	3 468	352	96 300	153 000	629	1 240	1 743	711
1987/88	3 240	4 225	767	159 950	182 000	879	1 407	1 321	1 065
1988/89	4 885	5 550	880	141 860	169 704	836	1 278	1 148	1 113
1989/90	NO DATA	NO DATA	NO DATA	113 643	168 681	674	1 770	1 462	1 211

Compared to the large scale commercial farming sector, with over 90% of the farms cooperating in an annual crop census organised through postal survey by the CSO, the official agricultural statistics for the CLs are, in most cases, very rough estimates. Substantial differences are to be found in the areas under specific crops as estimated by the CSO and AGRITEX. Nevertheless, the general trends in area planted and yield obtained are apparent. For most crops, the area planted was reduced in the late 1970s, owing to the unstable war conditions and creation of protected villages which depopulated the countryside, mainly in the northeast and east. Livestock were similarly affected during this period, particularly in the northeast, by an increase in mortality caused by disease and the spread of tsetse flies (Table 15).

After Independence, rural stability and infrastructural development, initially in Mashonaland, resulted in a remarkable increase in agricultural productivity. Maize, the key crop for communal farmers, saw a virtual doubling of area planted and yield between the early 1970s and late 1980s. By the 1989/90 season, nearly 83% of the total area planted to maize was in the communal sector, providing 57% of national production (Table 13). It is the main CL crop in all Natural Regions other than Region V and nearly half the area planted is in Region IV (Table 10). Early maturity hybrid seed is generally available and used by communal farmers in low rainfall areas with a short growing season. In the Middleveld, hybrids such as R200 mature in about 110 days at lower elevations increasing to 130 days bordering the Highveld (Wilson, 1971). Given the vagaries of rainfall amount and distribution in the CLs, the introduction of short season, 80 to 100 days, hybrids would offer great potential benefits to farmers by providing more flexibility in planting dates.

Sorghum production does not show a similar trend of increasing production and has remained fairly steady with fluctuation in output appearing to relate mainly to quality of the season. The CLs normally account for more than 90% of the total area under sorghum, almost entirely white local composite varieties. New open pollinated varieties have been introduced since 1985 (Seed Co-op Company, 1990) but do not appear to be widely available in the CLs. These are likely to increase productivity by up to 70%. Bird damage, however, remains a major problem with this crop. Sorghum assumes greater importance in the drier Natural Regions and is the principal grain crop in Region V.

Table 15 Approximate numbers of livestock held in Communal Lands, 1970 to 1990

	('000 head)			
Year	Cattle	Sheep	Goats	Pigs
1970	2 451	387	1 504	99
1971	2 600	392	1 689	101
1972	2 691	403	1 813	90
1973	2 847	444	1 877	94
1974	2 936	466	1 909	89
1975	3 123	494	1 872	96
1976	3 183	440	1 694	85
1977	3 388	451	1 748	99
1978	2 950	494	1 872	96
1979	2 860	400	1 300	NO DATA
1980	2 869	214	935	39
1981	2 895	297	1 203	84
1982	3 262	248	862	77
1983	3 189	245	1 024	76
1984	3 234	267	1 445	97
1985	3 409	422	1 564	92
1986	3 657	343	1 916	121
1987	3 905	447	2 090	120
1988	3 815	545	2 234	143
1989	3 856	410	2 290	197
1990	4 172	456	2 466	175

Source: Central Statistical Office (1990)

Mhunga (pearl millet), like sorghum, is a minor crop except in the drier CLs where it can play a crucial role during drought periods since its water requirements are the lowest of all cereals. Rapoko (finger millet) is another minor crop widely grown for consumption and brewing. No data on production and yield for the millets are available from CSO, but average yield is likely to be of the order of 400 kg/ha.

Cotton has been a major success as a cash crop in the communal sector with a tenfold increase in area planted between 1971 and 1988 (Table 14). Much of the increase has taken place in the Sanyati-Sengwa Basin and Mid Zambezi Valley regions where the climate and soils appear to be well suited to the crop (Plate 3). The average yield, which is about 40% of that on commercial farms, has ranged from 500 to 900 kg/ha. During the three years 1988-90, the CLs accounted for 50% of total crop production.

Groundnuts are a traditional CL cash crop second in importance to cotton and accounting for about 80% of total output. Production has recently stabilized after a marked decline following peak years in the mid 1970s. Sunflower appears to have a somewhat lower importance than groundnuts in the CLs but has the advantage of being more tolerant of marginal conditions of rainfall and soil fertility. Total soyabeans production has increased fourteen-fold since 1970 but the communal sector accounted for only 4% of output in 1989. It is probably the least suited of the oilseeds to CL conditions having climatic and soil requirements very similar to that of maize.

Other cash crops may be of importance locally. Tobacco, mainly burley, is grown in Hurungwe, Chiweshe and Muzarabani, above the escarpment, within the general zone of commercial tobacco farming. Dry season vegetable production, based on micro-scale irrigation from wells in the granitic terrains of Mutoko and Chinamora, for example, supplies a large market in the Harare area. Vegetable gardens, providing mainly for home consumption, are found in all CLs. They may be particularly common in the vlei terrain characteristic of parts of the Highveld region (Dambo Research Unit, 1987) but can also be found near any dry season water source such as springs, river bed excavations and boreholes (Plate 4).

Livestock, particularly cattle, play a vital role in the communal farming system which is based on agropastoralism or mixed farming with the livestock element becoming more important in the drier regions of the south. The CL herd is multipurpose with cattle used for ploughing and other draught functions, the provision of milk, manure and meat, as a form of investment and in traditional cultural and spiritual matters. Barrett (1992) has estimated that ploughing followed by milk production are the main economic outputs from the herd with beef offtake being a relatively minor factor. Cattle numbers in the CLs have fluctuated over the years through the effect of drought and, prior to independence, a policy of enforced destocking particularly during the 1940s and the Native Land Husbandry Act period when stock numbers were limited according to carrying capacity perceptions at that time. Cattle numbers exceeded 4 million for the first time in 1990 (Table 15) but are likely to drop substantially as a result of the severe drought following the failure of the 1991/92 rainy season.

Geza and Reid (1983) consider the main problems of cattle production in the CLs to be:

1. Too many cattle for the amount of fodder available.
2. Poor herd composition, especially the age factor.
3. Poor calving.
4. Late weaning.
5. Poor management.
6. Too few cattle for draught, especially ploughing, and manure.

However, the concept of livestock carrying capacity is controversial. While most commentators on the livestock situation would agree with 6 above, the thesis in 1, that the carrying capacity is generally exceeded, has been questioned from both economic and ecological standpoints (Sandford, 1982; Scoones, 1989a and b; Barrett *et al.*, 1991).

Nevertheless, pressure on the land, by way of increasing human population and livestock numbers, is certainly a matter for concern in several CLs. Allan (1949, 1967) describes a method of assessing critical population density based on environmental factors and existing farming systems in the then Northern Rhodesia. The critical population or carrying capacity for a particular farming system is a limit above which a cycle of degenerative changes is set in motion, a process usually referred to as land degradation. In assessing the factors relevant to the estimation of land carrying capacity in several systems of subsistence agriculture, Allan found that the area cultivated each season varied very little on average from a figure of about 0.45 ha (1.1 ac) per head of population in the farming community regardless of the system of production. Also, there was little correlation between soil fertility and the area cultivated. Robinson (1953), in a detailed survey of Chinamora CL, found that 14% of the land was cultivated in 1950. Excluding 366 ha of micro-scale irrigated vegetable gardens, the area being cultivated was equivalent to 0.44 ha (1.08 ac) per person in the CL. In the same year the total communal farming population was estimated at 1 955 000 and the total area cultivated in that sector at 939 300 ha, resulting in a per capita cultivated area of 0.48 ha (1.19 ac). Approximately the same area of cultivated land per person is given by Weinmann (1975) for the 1948/49 cropping season.

More recent data on the cultivated area in the CLs is available in Whitlow (1979a), Central Statistical Office (1986) and from the AGRITEX Crop Production Branch crop sample survey. Data from these sources are summarized below in Table 16.

The data above again highlight the very imprecise nature of even the most basic cropping statistics from the CLs. However, if the CSO crop data are disregarded, since they appear improbably low, then some general trends may be surmised. Although the area cultivated per person in the CLs, about 0.65 ha (1.6 ac), has not changed significantly between the mid 1970s and the late 1980s, it is about 35% greater than the estimates for the 1950/51 season in Robinson (1953) and for the 1948/49 season in Weinmann (1957). As a result of the increase in CL population from about 3.7 millions (1975) to 4.9 millions (1987), the percentage of CL cultivated annually has risen from about 15% to

Table 16 Summary of comparative data on area cultivated in relation to population dynamics in the Communal Lands

Source and year(s) considered	Area cultivated km²	Population millions	Area cultivated per capita ha (ac)	Percentage of Communal Land cultivated %	Fallow proportion of cultivated area %
Whitlow (1979)*					
1972 to 1977	22 236 (lower estim.)	3.7 (1975)	0.60 (1.48)	13.6	82
	26 160 (upper estim.)		0.71 (1.75)	16.0	54
CSO (1986)†					
1984/85	16 501	4.5 (1984)	0.37 (0.90)	10.1	No data
1985/86	16 038	4.6 (1985)	0.35 (0.86)	9.8	10
AGRITEX crop sample survey‡ 1985/86 to 1988/89 average	31 529	4.9 (1987)	0.64 (1.59)	19.3	33

* based on air photo interpretation using photographs taken over the period 1972 to 1977.
† based on interview and field measurement of crop area and estimate of yield for selected households.
‡ based on a random sample with field checking.

19%. The increase of about 7 300 km² is mainly at the expense of fallow, which has decreased by about 5 700 km² or 35% over the same period, but also presumably by encroachment on traditional exclusive grazing areas. Pressure on this latter area is likely to intensify as the fallow resource diminishes. It is interesting to note that estimates of arable land available for allocation under the Land Husbandry Act are given as 12 900 km² by Floyd (1959) and 11 340 km² by Yudelman (1964). The area of arably disturbed land, cultivated plus fallow, is currently about three and a half times these estimates.

Weinmann (*op.cit.*) also provides data to show that African cropping of grain of all kinds, although increasing substantially in extent and total production, declined in average yield from about 720 kg/ha in the first decade of the century to about 425 kg/ha during the 1930s and 1940s. This period coincided with the abandonment of shifting cultivation and the advent of the plough, which replaced the hoe. The lower yields appear to be associated with a loss in soil fertility following continuous cropping and the inefficient use of the plough over larger areas.

Yudelman (*op. cit.*) records that a significant increase in productivity occurred from about 1953 onwards. This was partly a result of the series of good rainy seasons during the 1950s but also appears to herald the start of a period of higher yields and income associated with improved methods of production, the introduction of cash crops such as cotton and Turkish tobacco, the benefits of soil and water conservation structures created during the implementation of the Land Husbandry Act and, of particular importance, the introduction of the hybrid maize seed (Davies, 1956). Yudelman notes, however, that only about a third of farmers, those with, or aspiring to, master farmer status, were participating in the agrarian regeneration after the many years of stagnation.

Allowing for wide swings in levels of production caused by the liberation war and, from time to time, drought years, this period of relative productivity has continued into the 1990s, led by the minority group of communal farmers who have the resources and commitment to farm well.

Communal Land physical resources and general aspects of potential land use have been described in several studies. The most detailed and the only one to describe resources in each of the Tribal Trust Lands and Special Native Areas then existing, is that produced by Working Party D of the Robinson Commission (1961/62). The report of the advisory committee on the development of the economic resources of Southern Rhodesia with particular reference to the role of African agriculture (Phillips *et al.*, 1962) provides a comprehesive and authoritative overview of the agricultural situation at the time when the Native Land Husbandry Act was facing repeal. The range of problem areas considered by the committee included several topical issues including appropriate farming systems, particularly for the low rainfall southeast lowveld, the development of irrigated agriculture, research priorities for communal farming and livestock production and grazing management. These issues were mainly associated with problems connected with arable land shortages which had been accentuated during implementation of the Land Husbandry Act (Advisory Committee on African Agricultural Production, 1961a,b,c).

An approach to land classification at farm planning level was developed in the early 1960s (Federal Department of Conservation and Extension, 1964) along lines similar to the land capability classification system used in the USA (Klingebiel and Montgomery 1961). Hazard of use, mainly the degree of susceptibility to erosion, is the principal classification criterion. The local system was subsequently revised by AGRITEX (1981) and now forms the basis for land use planning in the Communal Lands (AGRITEX, 1989). The assessment of the suitability of land for irrigation in Zimbabwe is made according to the method described by Thompson and Purves (1979). Both these classification systems are described in more detail in Appendix 3.

At a national level, the first attempt to map and describe agroclimatic or natural regions and provide recommendations of farming systems suitable for these regions was made by Staples and Murray (1951). Five main natural regions were identified according to differences in effective rainfall, a modification of the mean annual rainfall to take account of rainfall losses to the root zone through runoff, seepage and deep percolation. Mapping was at 1:3 million scale.

This study was the forerunner of a more comprehensive survey, during the 1950s, which produced an agroecological and agroeconomic classification of Southern Rhodesia (Vincent and Thomas, 1960; Anderson, 1961). The five natural regions were reconfirmed although several sustantial boundary changes affected the disposition of the drier regions. Natural Region V was introduced into the northern half of the country, along part of the Zambezi Valley and in the extreme northeast. The most important innovation in this later survey was the definition of 22 natural areas, subdivisions of the natural regions according, primarily, to soil characterisics relevant to agricultural use and, secondarily, to slope characteristics affecting land use. A study of the relationship between climate, soil and natural vegetation, the ecological components, was employed to elucidate and assess the farming systems which a particular region is capable of supporting on a sustainable basis. The natural regions and areas were mapped at 1:1 million scale to accompany the report by Vincent and Thomas (*op. cit.*).

This map has subsequently been modified by the predecessor of AGRITEX, the Department of Conservation and Extension (Department of the Surveyor-General, 1984a), and has reverted to an agroclimatic zonation showing five main natural regions whose definitions are essentially the same as those used in the earlier surveys. Regional boundaries have again been revised, with a rainy pentad analysis (Griffiths, 1959) replacing the concept of effective rainfall as the main criterion for defining natural regions II and III. Ivy (1978, 1979) found a high positive correlation between five-year average crop yields for maize, flue-cured tobacco and cotton and the number of rainy pentads per season in these two regions. This relationship was less apparent in natural regions IV and V where less stringent criteria, based on rainfall and elevation, have been applied. A description of the natural regions, as presently defined, is given below.

Natural Region I – 7 000 km² (1.8% of Zimbabwe)

Specialized and diversified farming region. Rainfall is high (more than 1 000 mm per annum in areas lying below 1 700 m altitude and more than 900 mm per annum at greater altitudes), normally with some precipitation in all months of the year. Temperatures are normally comparatively low and the rainfall is consequently highly effective enabling afforestation, fruit and intensive livestock production to be practiced. In frost-free areas plantation crops such as tea, coffee and macadamia nuts can be grown; where the mean annual rainfall is below 1 400 mm, supplementary irrigation of these plantation crops is required for top yields. 0.8% of the Communal Land total area occurs in this region.

Natural Region II – 58 600 km² (15% of Zimbabwe)

Intensive farming subregion IIa. Rainfall is confined to summer and is moderately high (750-1 000 mm). This subregion receives an average of at least 18 rainy pentads per season and normally enjoys reliable conditions, rarely experiencing severe dry spells in summer. The region is suitable for intensive systems of farming based on crops and/or livestock production.

Intensive farming subregion IIb. Rainfall as for subregion IIa but receiving an average of 16-18 rainy pentads per season and subject either to rather more severe dry spells during the rainy season or to the occurrence of relatively short rainy seasons. In either event, crop yields in certain years will be affected, but not sufficiently frequently to change the overall utilization from intensive systems of farming. The subregions together comprise 7.8% of the Communal Land.

Natural Region III – 72 900 km² (18.7% of Zimbabwe)

Semi-intensive farming region. Rainfall in this region is moderate in total amount (650-800 mm), but, because much of it is accounted for by infrequent heavy falls and temperatures are generally high, its effectiveness is reduced. This region will receive an average of 14-16 rainy pentads per season. The region is also subject to fairly severe mid season dry spells and is therefore marginal for maize, tobacco and cotton production, or for enterprises based on crop production alone. The farming systems, in conformity with the natural conditioning factors, should therefore be based on both livestock production (assisted by the production of fodder crops) and cash crops under good management on soils of high available moisture potential. 17.2% of the Communal Land.

Natural Region IV – 147 800 km² (37.8% of Zimbabwe)

Semi-extensive farming region. This region experiences fairly low total rainfall (450-650 mm) and is subject to periodic seasonal droughts and severe dry spells during the rainy season. The rainfall is too low and uncertain for cash cropping except in certain very favourable localities, where limited drought resistant crops can afford a sideline. The farming system, in accord with natural factors, should be based on livestock production, but it can be intensified to some extent by the growing of drought resistant fodder crops. 44.9% of the Communal Land.

Natural Region V – 104 400 km² (26.7% of Zimbabwe)

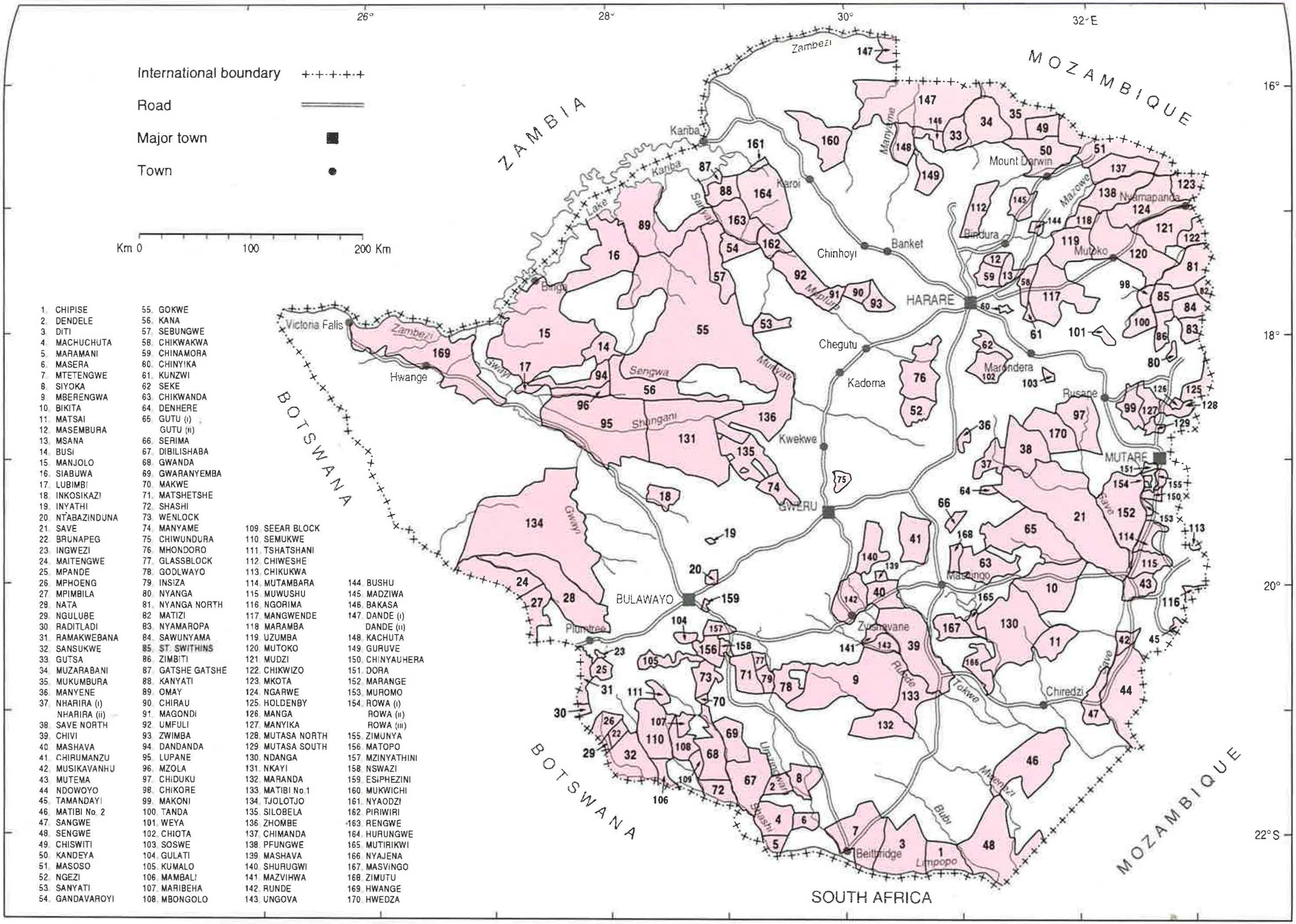
Extensive farming region. The rainfall in this region is too low and erratic for the reliable production of even drought resistant fodder and grain crops, and farming has to be based on the utilization of the veld alone. The extensive form of cattle ranching or game ranching is the only sound farming system for this region. Included in this region are areas below 900 m altitude, where the mean rainfall is below 650 mm in the Zambezi Valley and below 600 mm in the Save-Limpopo valleys. 29.3% of the Communal Land.

The need for revision of the current natural regions map has been recognised for some time. Whitlow (1980a) has analysed agricultural potential by combining natural region climatic quality with ratings for soil suitability and slope, drainage and rock outcrop limitations using simple factor analysis of the environmental variables according to a 1:1 million map grid sample. Hussein (1987) in an agroclimatological analysis of the growing season in Natural Regions III, IV and V found considerable climatic variation within each region. Of the 16 stations examined in Natural Region IV, defined as having a total annual rainfall in the range 450-650 mm, all have a mean annual rainfall greater than 540 mm and a combined mean of 643 mm. With 38% of Zimbabwe and 45% of the total CL occurring in Natural Region IV, there is clearly a need to reassess the prevailing agroclimatic factor before any reasonably accurate statements can be made about optimising yield levels for rainfed crops in this critical zone.

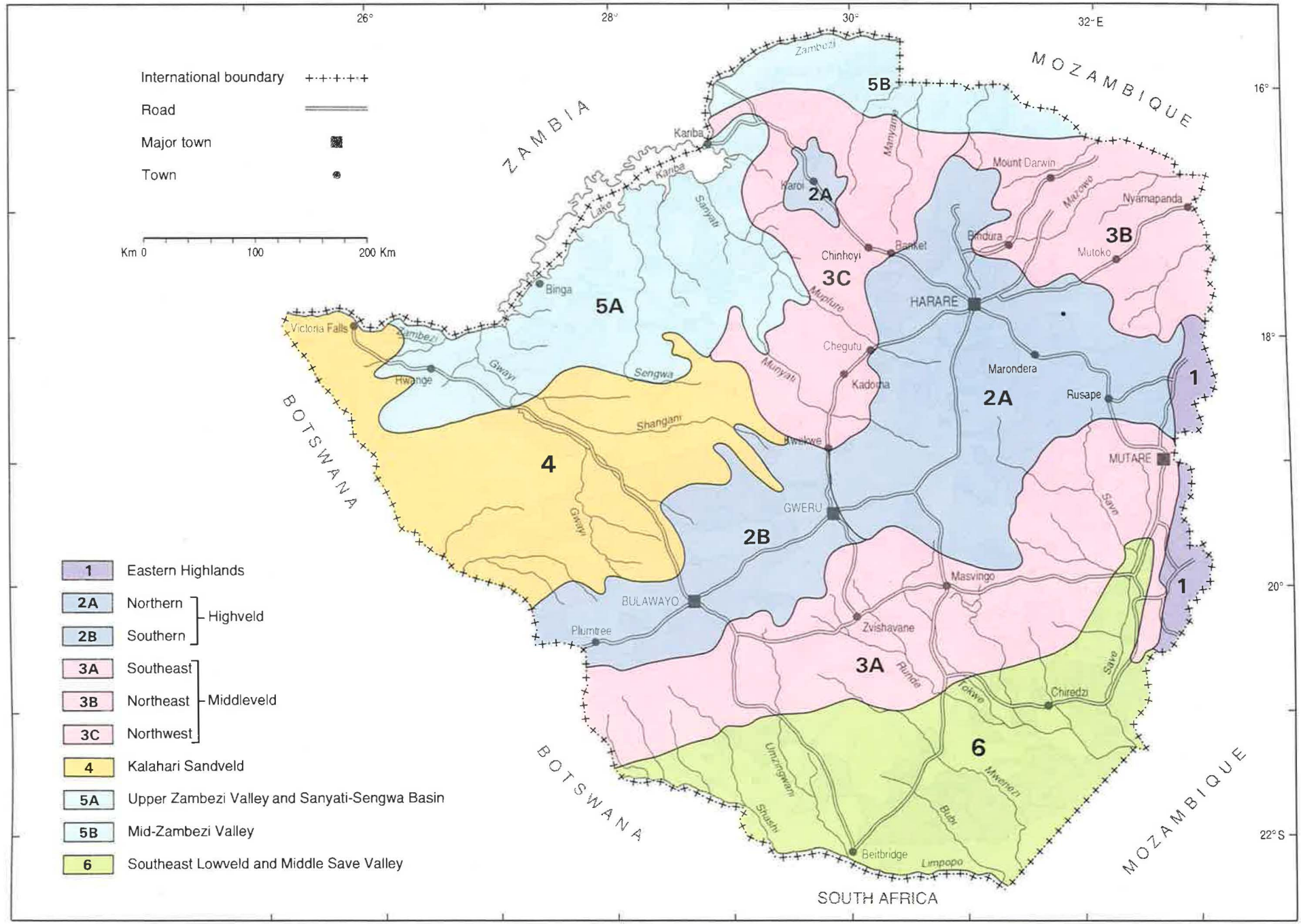
Recommendations on communal land farming systems, crop types and their general management requirements, in relation to natural regions and areas, are outlined by Anderson (1961) and Phillips *et al.* (1962). However, the reference crops implicit in the suitability assessments of Vincent and Thomas (1960) and Department of the Surveyor-General (1984a and b) are maize and flue-cured tobacco grown under large scale commercial conditions at the wetter end of the agroclimatic spectrum, in Natural Region II, and beef production as a ranching enterprise at the drier end, in Natural Regions IV and V.

Grain cropping for subsistence requirements is paramount in all CLs and must be included in any recommended land use system for this sector. As a broad generalization, Natural Regions II and III are best suited to maize, Natural Region IV to sorghum and Natural Region V to pearl millet, albeit at a low expected average yield. Maize is the preferred grain in all regions and any shift in preference to the small grains will require improvements through breeding to

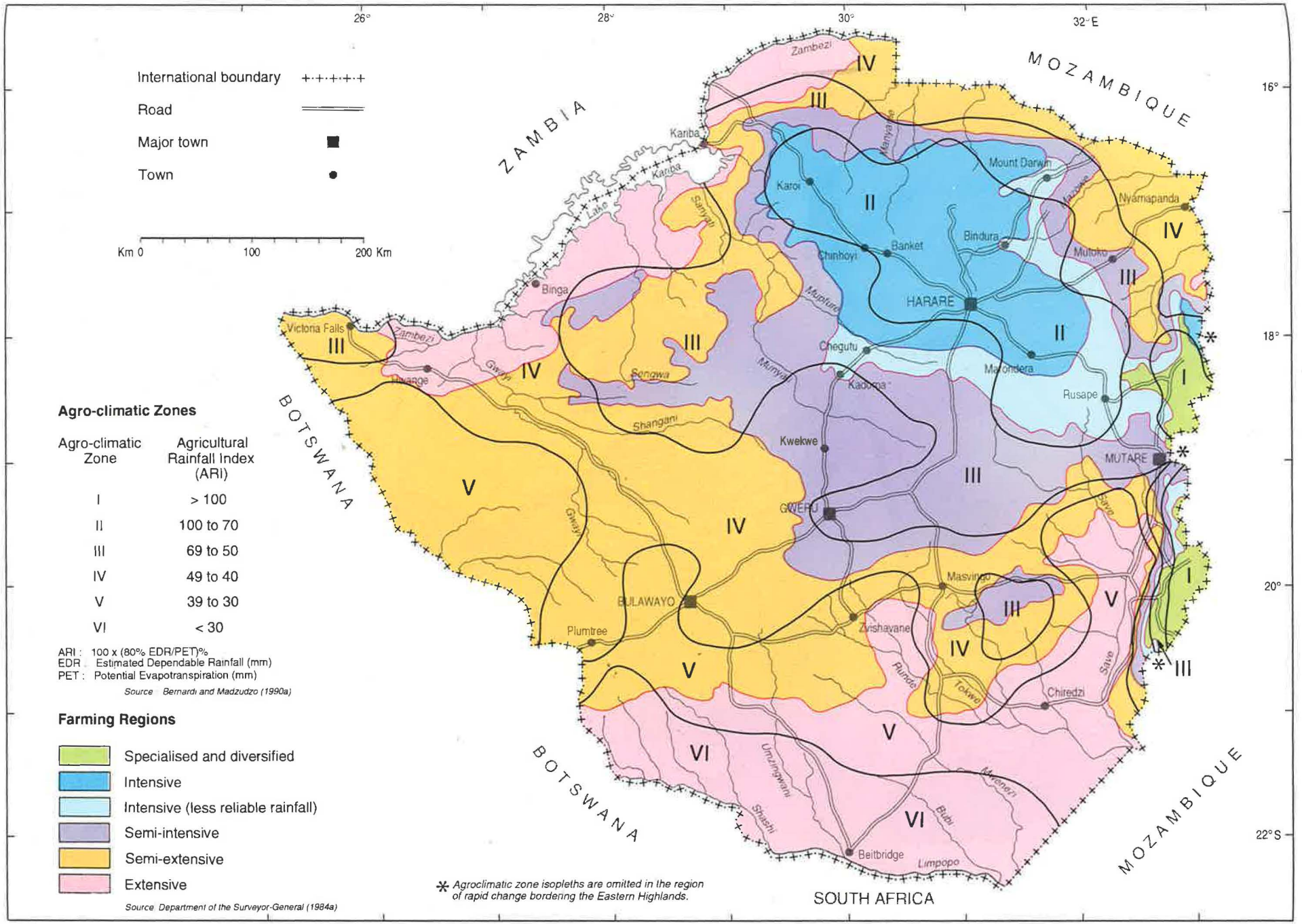
increase yield, palatability and reduce bird depredation as well as improvements in processing technology (Biscoe, 1988). If maize continues as the most popular grain, as is likely, then a new maize hybrid is required with earlier maturing characteristics, than are available with current varieties. This would increase the reliability and volume of output from Natural Region IV, the region with nearly half of the CL maize hectareage (Table 10). In Natural Region V, Jones *et al.* (1987) have shown that maize is likely to fail two years in five, and sorghum one year in five. Research has shown that yields can be improved and stabilized by soil moisture conservation and concentration techniques. Also, the effects of poor yields in years of drought can be mitigated by improvements to on-farm grain storage facilities in order to preserve the considerable surplus to domestic requirements that can be reaped in the years of plenty.



TEXT MAP 1 The Communal Lands of Zimbabwe



TEXT MAP 2 The physical regions of Zimbabwe



Agro-climatic Zones

Agro-climatic Zone	Agricultural Rainfall Index (ARI)
I	> 100
II	100 to 70
III	69 to 50
IV	49 to 40
V	39 to 30
VI	< 30

ARI : 100 x (80% EDR/PET)%
EDR : Estimated Dependable Rainfall (mm)
PET : Potential Evapotranspiration (mm)

Source Bernardi and Madzudzo (1990a)

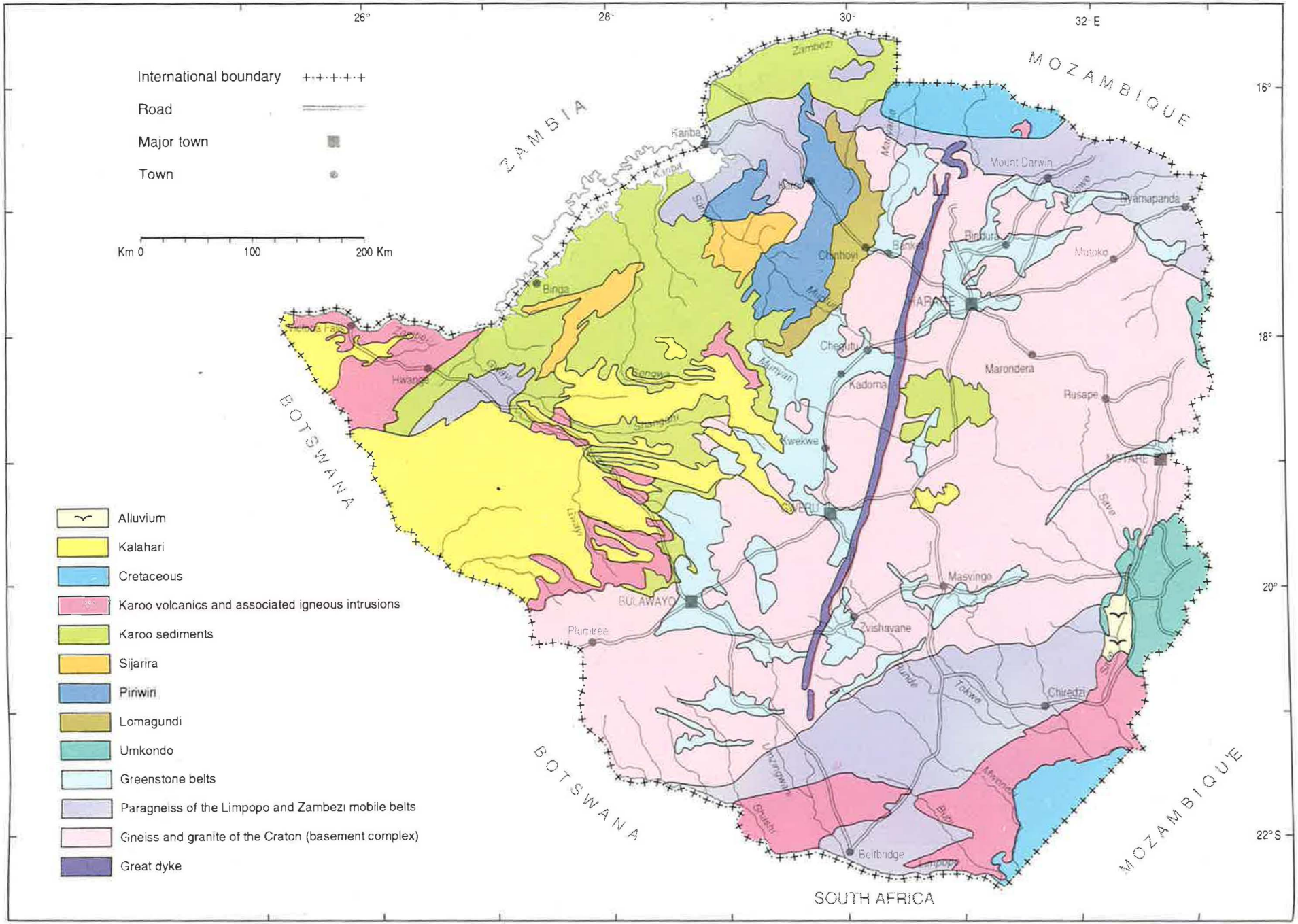
Farming Regions

- Specialised and diversified
- Intensive
- Intensive (less reliable rainfall)
- Semi-intensive
- Semi-extensive
- Extensive

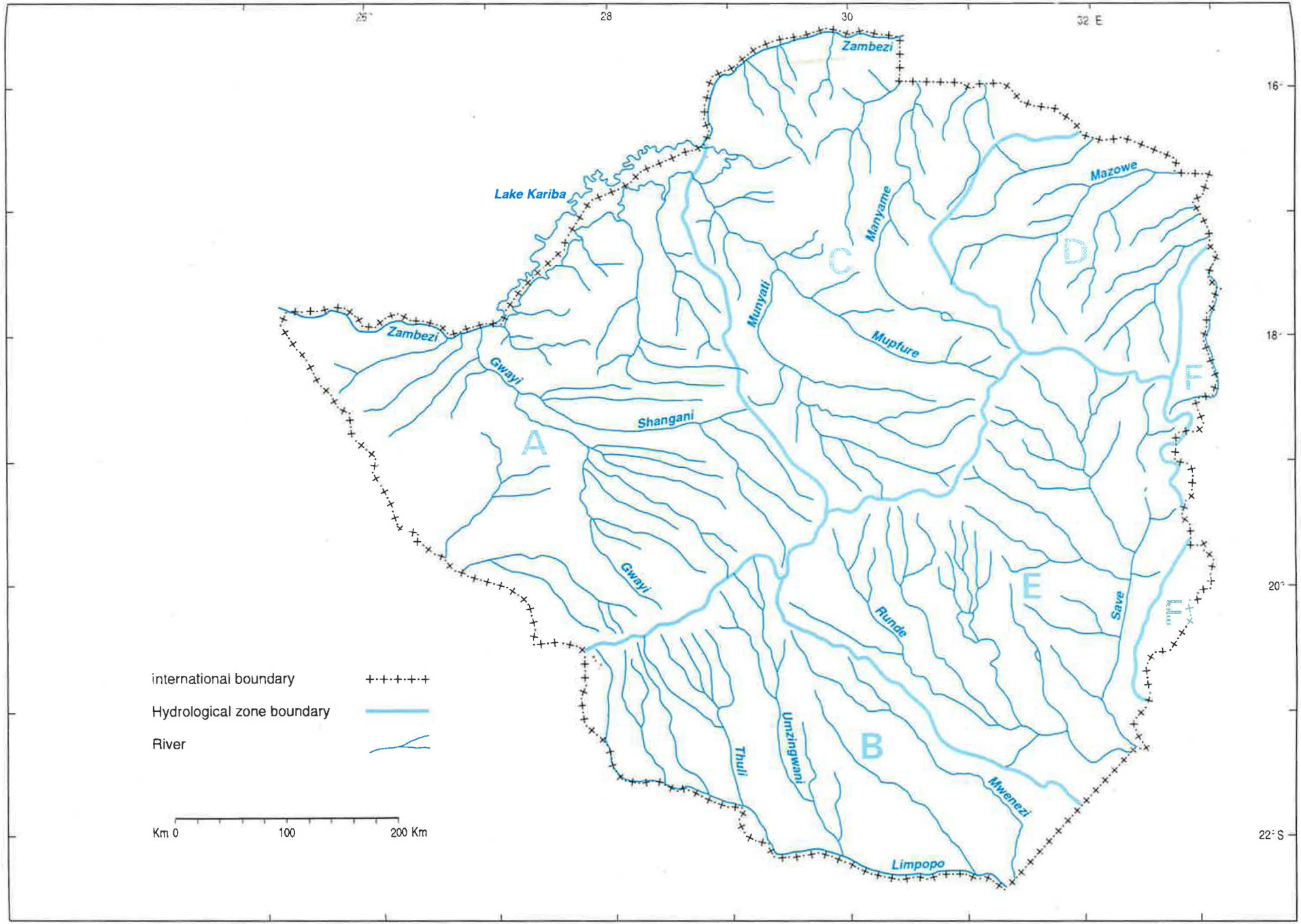
Source Department of the Surveyor-General (1984a)

* *Agroclimatic zone isopleths are omitted in the region of rapid change bordering the Eastern Highlands.*

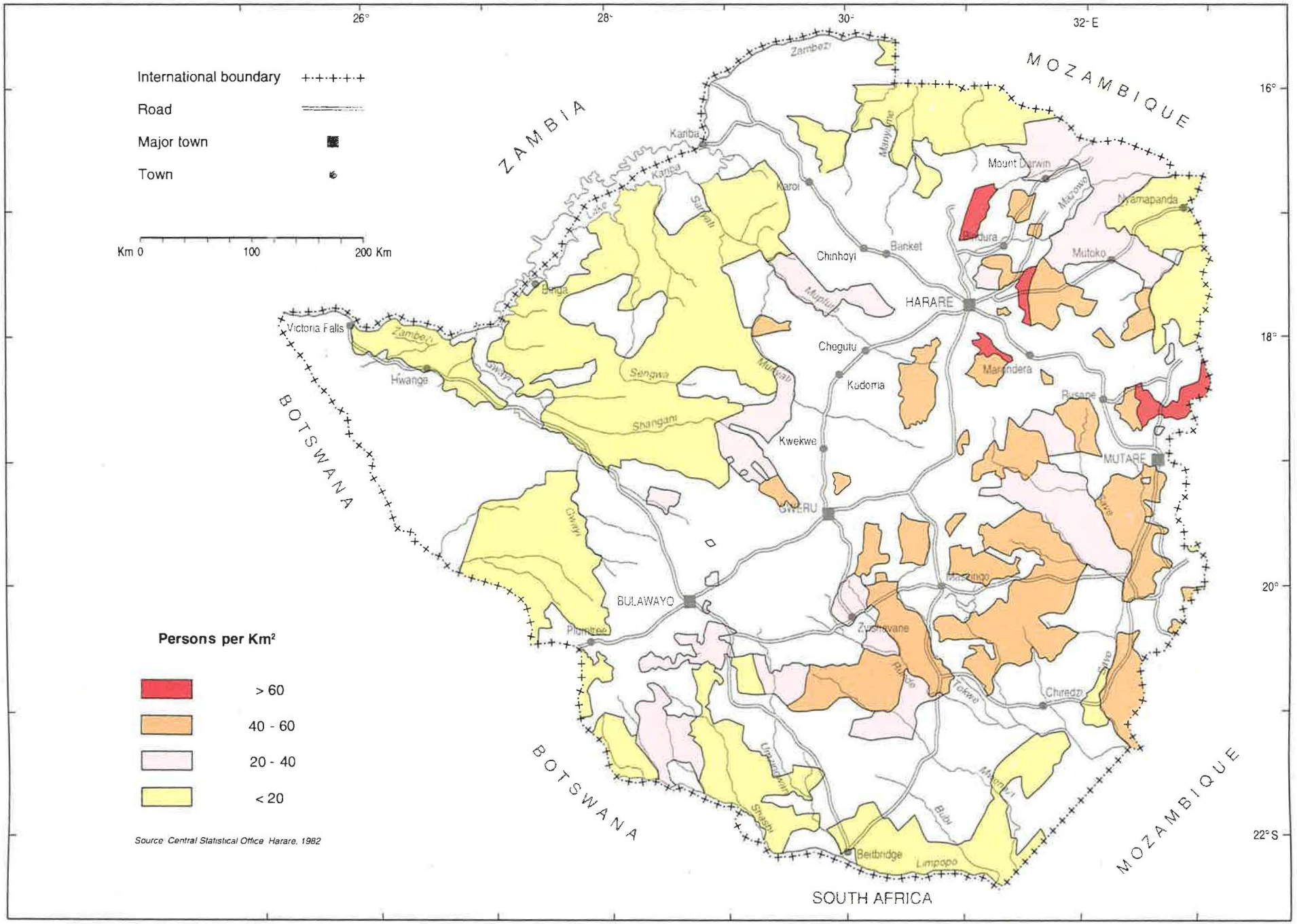
TEXT MAP 3 Comparison of agroclimatic zones and natural regions



TEXT MAP 4 Generalized geological map of Zimbabwe



TEXT MAP 5 Hydrological zones of Zimbabwe



TEXT MAP 6 Population distribution in the Communal Lands

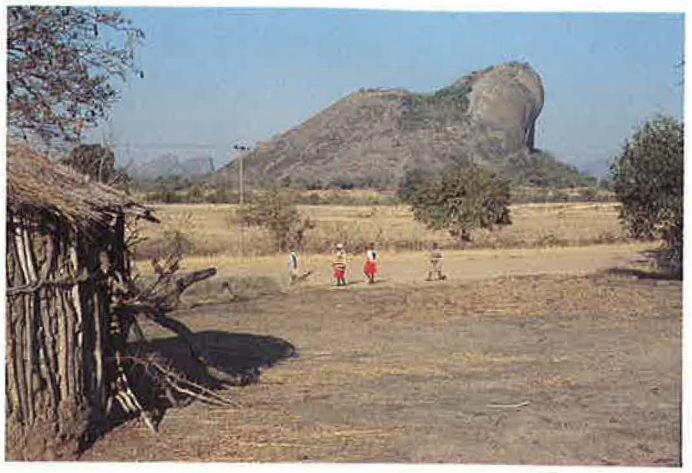


Plate 1. Rufetu Hill, one of several conspicuous bornhardts with steep northern sides, occurring near Mataga, Mberengwa CL.

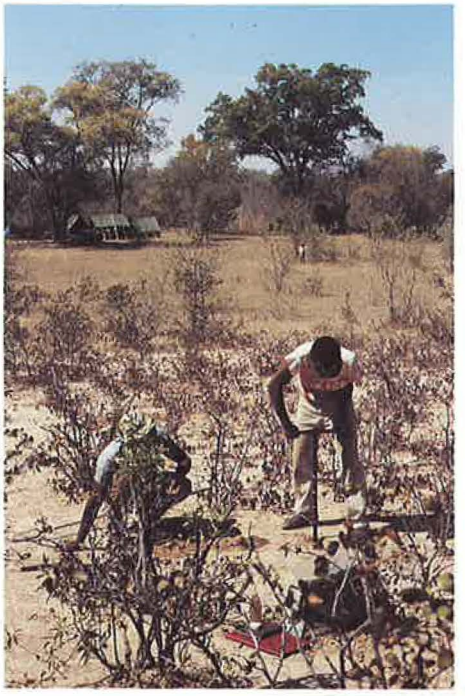


Plate 2. Land Unit M7 site showing soil-vegetation variation: foreground, eroded residual soil with *Colophospermum mopane* scrub; middleground, imperfectly drained valley head alluvium with grassland and scattered *Combretum imberbe*; background, well-drained levée alluvium with tall *Brachystegia spiciformis* woodland. Near Benzies Bridge, Lupane CL.

Plate 3. Cotton baling by communal farmer, Gokwe CL.

Plate 4. Manuring fenced garden, irrigated from a shallow well in redistributed Kalahari Sand by Mangweze Vlei, Nkayi CL.

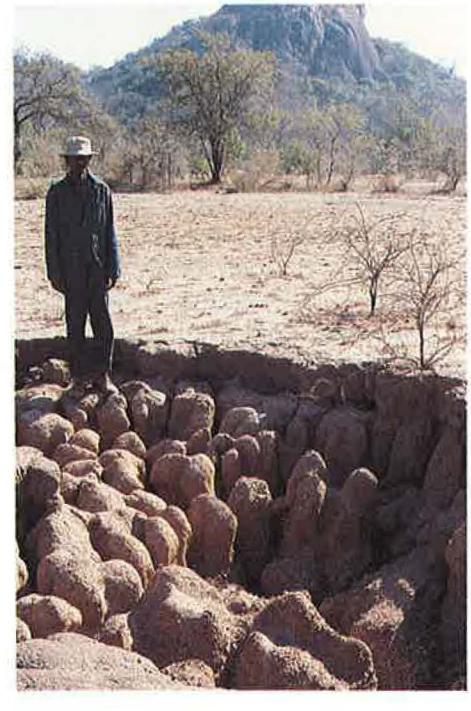


Plate 5. Gully erosion caused by runoff from road drain, Godlwayo CL.

Plate 6. Masonry reservoir providing village water supply collected from rock surface runoff, Insiza CL.

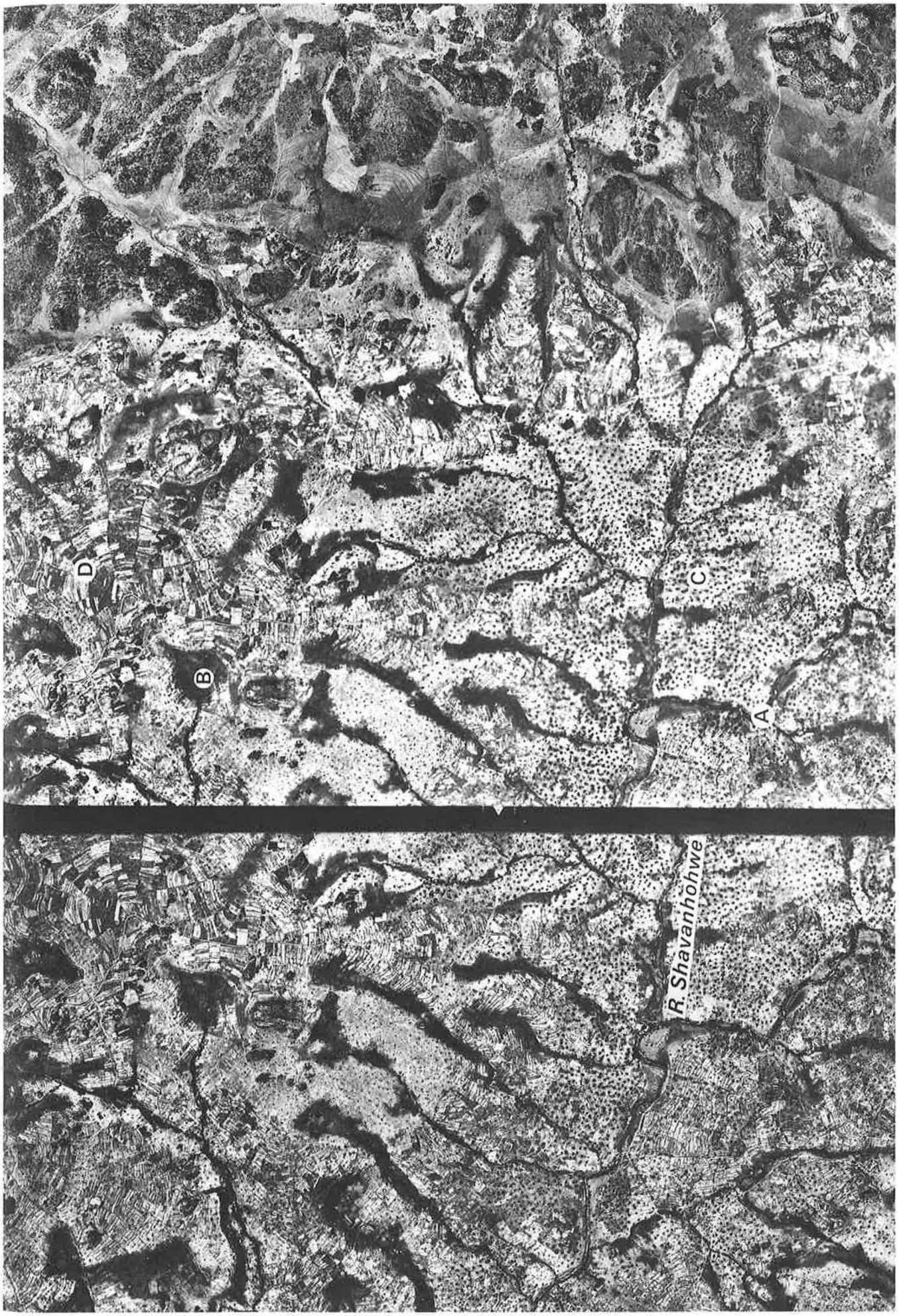


Plate 7. Air photo stereo pair of Land Unit G3, in part of Mangwende CL, showing (a) incised Shavanhohwe River with (b) vlei tributaries; (c) many large, vegetated termite mounds; and (d) Land Husbandry Act period conservation layout of arable block.

Plate 8. Termite mound material being used as a soil amendment, Mberengwa CL.

Plate 9. Overland flow in Matshetshe CL after thunderstorm on 24 November 1990.

Plate 10. Land Unit E8 vertisol on basalt plain near Chisumbanje, Ndowoyo CL. Moribund *Lonchocarpus capassa* in foreground.

Part 3

Land units and soils

LAND UNITS

Fifty land units have been identified, described and mapped. Although the survey is restricted to the Communal Lands, 42% of the area of Zimbabwe, the land units are considered to be representative of the country as a whole since all the main types of land, from an agricultural viewpoint, occur in the communal sub-sector. In fact, a survey of the large-scale commercial farming sub-sector, the next largest, occupying 29% of the country, would show a much more restricted range of land types owing to its preponderance in the Highveld and Southeast Lowveld/Middle Save Valley regions and virtual absence in the Zambezi Valley/ Sanyati-Sengwa Basin regions.

The land units are areas which have been identified, mainly by interpretation of aerial photography, as having a more or less unique combination of landform and soil pattern and which can be conveniently shown on a map at 1:500 000 scale. Although soil type cannot usually be recognised directly from air photographs, it can generally be inferred from a knowledge of the geology, related terrain forms and natural vegetation, although this last feature is often too degraded in the CLs to have a useful interpretive value. Some examples of geology-landform-soil-vegetation relationships are:

(a) granitic terrain with 20% rock outcrops of the bornhardt or domed inselberg type. Gently sloping, concave pediment slopes separate the rock outcrops from vlei bottomlands which occupy about 5% of the unit. These three very different types of land cannot be mapped separately because of the scale although their proportions can be estimated. Most of the natural vegetation has been cleared or is very disturbed. The soil distribution has the form of a catenary association;

(b) undulating to rolling gneissic terrain with few rock outcrops and widely spaced, incised drainage lines. The long planar slopes show patches of severe erosion. Although this is a simple landform, the soil pattern often proves on field inspection to be complex because of banding in the gneiss and the formation of an intimate association of substantially different parent materials. The natural vegetation has been cleared or is very disturbed. The soil distribution comprises a complex the components of which are unmappable except at a very large scale;

(c) almost level Kalahari Sand plateau with a distinctive cover of *Brachystegia spiciformis-Baikiaea plurijuga* woodland often cleared at the plateau edge for cultivation. Apart from a paling of soil colour towards the plateau centre and some subtle variation in tree species composition, this unit shows remarkably little internal variation over large areas. It can be mapped accurately at small scale and comprises a very simple soil association.

The land unit boundaries vary in significance. They may be precise in relation to a significant change in geology and/or landform over a short distance or they may be located within a transitional zone where one landform-soil association merges with another, in which case the location of the boundary is subjective. The agroclimatic characteristics of the land units have not been defined satisfac-

torily owing to a lack of relevant data in the CLs necessary for a mesoclimatic zonation significant at land unit level. At a macroclimatic level the reliability of the criteria used to define the natural regions and farming areas, particularly in the drier zones, has already been questioned.

The land units have therefore been described in relation to the Agroclimatic Zones, defined by Bernardi and Madzudzo (1990a) and described in section 2.1.2., as well as the established Natural Regions.

LAND AND SOIL CLASSIFICATION

Land can be classified for many purposes, at different scales, varying in level of detail, and on the basis of inherent land qualities or an interpretation of these qualities according to land suitability or potential for a particular purpose.

In Zimbabwe land classification is a term usually used to indicate the tenurial status of land (Department of the Surveyor-General, 1985). Several other classifications however have been made and mapped, usually at 1:1 million scale, of land attributes such as relief (Surveyor-General, 1984b), geology (Department of Geological Survey, 1985), erosion surfaces (Lister, 1987), soil types (Department of Research and Specialist Services, 1979), hydrological zones (Department of the Surveyor-General, 1970), erosion hazard (Stocking and Elwell, 1973 and Madhiri and Manyanza, 1989) and climatic variables (Department of Meteorological Services, 1984). Maps of the biotic attributes, natural vegetation and land use, are conspicuous by their absence.

For agricultural purposes at national level mention has already been made of classification applied to climatic variables to arrive at an interpretation of regional suitability for particular farming systems (Department of the Surveyor-General, 1984a). More recently, agroclimatic conditions have been used to assess at a national level suitability for specific crops, on the basis of crop temperature requirements and length of period when rainfall exceeds half potential evapotranspiration (Bernardi and Madzudzo, 1990b). Other classification assessments of a regional or national nature include: Laing (1980) who has identified a zone in northern Zimbabwe, encompassing several CLs, suitable, on the basis of temperature, for Arabica coffee; Law (1973) who provides the climatic requirements for a range of annual and perennial crops; O'Brien (1989) who describes a land classification of Zimbabwe according to forage resources; and Kay (1975) and Whitlow (1980a, 1982) who apply a land classification to evaluate potential for rural development.

Land classification is also used for land use planning at farm level. The local system is adapted from the US Department of Agriculture's Soil Conservation Service method of rating land capability which is defined according to the hazard of use, principally erosion, for different kinds of land use (Klingebiel and Montgomery, 1961). The procedures are described in Federal Department of Conservation and Extension (1964) partly revised by the Department of Agricultural, Technical and Extension Services (1981) and applied in the CLs using the guidelines in Department of Agricultural, Technical and Extension Services (1989).

Criteria for the assessment of land capability in Natural Region I have not been defined. However, Bromley *et al.* (1968) consider 25% to be the upper slope limit for field crops in this region. TILCOR (1977) give a slightly lower limit of 20% for arable land. Both are substantially higher than the recommended slope limit for the normal cropping areas of Natural Regions II and III, reflecting the physical stability of the highly weathered soils typical of the wetter parts of the Eastern Highlands. In the driest part of the country, Natural Region V, cropping is not considered to be a commercially viable activity and vegetation survey instead of soil survey is used to assess grazing resources and carrying capacity for extensive livestock production. In Natural Region IV and the adjacent parts of Natural Region III, arable cropping is not considered an appropriate commercial enterprise owing to low and poorly distributed rainfall. Planning is therefore done on

the basis of a vegetation survey although soil survey may be used to select areas for a specific use, such as fodder or irrigated cash crop production. The land capability classification criteria for these lower rainfall areas are a modification of those applied in the normal cropping areas of Natural Regions II and III. The land capability classification system is described in more detail in Appendix 3.

The classification of land for irrigation in Zimbabwe has a somewhat longer history than that for dryland farming, mainly as a result of the rapid development of large scale irrigation in the the Southeast Lowveld during the 1950s. The system of classification and assessment of the suitability of land for irrigation was based originally on the methods of the Division of Chemical Services of the Department of Agricultural Technical Services in the Union of South Africa (Thomas and Thompson, 1959) and progressively adapted to meet local needs (Metelerkamp and Thompson, 1967; Thompson, 1968). The irrigability classes have also been redefined to conform broadly with the land classes of the United States Bureau of Reclamation (United States Department of the Interior, 1953). Definitions of irrigability classes and the criteria used to assess irrigable values for soil profiles are given in Appendix 3.

There is currently no recognised methodology in Zimbabwe for assessing suitability of land for micro-irrigation. At this scale of production and using labour intensive methods, soil type becomes less important than it would be for larger scale, conventional surface irrigation.

Concern about problems related to erosion, particularly in the CLs, is longstanding and has expressed itself in a number of studies on the nature and distribution of erosion (Whitlow, 1985b, 1987) or on the hazard of erosion according to an analysis of a number of factors considered to have an influence on the erosion processes (Stocking and Elwell, 1973; Madhiri and Manyanza, 1989). The quantitative aspects of erosion are, however, controversial and open to reassessment (Barrett *et al.*, 1991; Biot *et al.*, 1992).

The small-scale photography, used in the present survey, is unsuitable for identifying, by stereoscopic examination, the presence of erosion features other than large gullies. The degree of erosion was therefore estimated visually at soil observation points and along survey traverses (Plate 5) on an ordinal scale as shown in Table 17.

As with land classification, the classification of soil, a narrower environmental concept, takes several forms depending on the objectives of the exercise. Traditional systems of soil classification in Zimbabwe have been described by Nyamapfene (1983) and Barrett *et al.* (1991). These generally have an agronomic bias but include classes of soils recognised as useful for other practical purposes such as pottery.

Table 17 Ordinal scale measurements of soil erosion intensity

Type of Erosion	Erosion Class	Description
Sheet erosion	1	No apparent sheet erosion
	2	Slight erosion; less than 25% of the A horizon removed
	3	Moderate erosion; between 25% and 75% of the A horizon removed
	4	Severe erosion; more than 75% of the A horizon removed or exposure of subsoil
Gully erosion	1	No gully erosion
	2	Slight – gullying recorded within 100 m of observation point and considered to be stable
	3	Moderate – gullying recorded within 100 m of observation point and considered to be unstable
	4	Severe – very frequent or destructively large gullies within 100 m of observation point

Source: Dunne and Leopold, 1978

Since the creation of Rhodesia, soils have been classified, in the broadest sense, into two main types recognised by both the indigenous and settler agriculturists, especially in the highveld region. These are the relatively infertile, but easily worked, granite sands or sandveld soils, often used for tobacco production, and the less tractable but relatively fertile red clays, used predominantly before recent crop diversification for commercial maize production. Land allocation during the implementation of the NLHA was in some areas based on the distribution of sandveld, red clay and vlei soils (Floyd, 1959). The granite sands and the red clays have been the reference soil types in many studies including erosion susceptibility and control (Hudson, 1957), fertility problems (Grant 1967a, 1967b, 1970, 1976, 1981) and general aspects of taxonomy and management (Nyamapfene *et al.*, 1988). The importance of these soil types is reflected in the distribution of government agricultural research and experiment stations with Harare Research Station situated on red clay, Grasslands Research Station at Marondera in a high rainfall sandveld area and Makoholi Experiment Station in a medium rainfall sandveld area.

Land capability classification for farm planning purposes uses a comprehensive and practical system of soil classification based on a parametric coding of agronomically significant soil and land characteristics (Thomas, 1960; Department of Agricultural, Technical and Extension Services, 1981). Mapping units are demarcated by the grouping of soils with similar code descriptions, aided by air photo interpretation, and a land capability class is allocated to each mapping unit according to the criteria shown in Appendix 3.

In the following land unit descriptions, soils are classified according to: (a) the Zimbabwe system which is described in section 2.1.6 and Appendix 2; (b) Soil Taxonomy (Soil Survey Staff, 1990) at the great group or subgroup level of classification; and (c) the FAO (1988) system at the first or second level of classification. Typical soils are also classified according to the land capability classification system of AGRITEX (Department of Agricultural, Technical and Extension Services, 1981) and suitability for irrigation (Thompson & Purves, 1979).

LAND UNIT AND SOIL DISTRIBUTION

Group G – Land units on felsic igneous and metamorphic rocks

LAND UNIT G1

General description This unit occurs in Guruve, Seke, Chiota, Wedza, Zwimba, Hurungwe, Mhondoro and Chiduku Communal Lands and is restricted to the northern Highveld region. The landform is characteristically almost flat to gently undulating with slopes mainly less than 2%. There are few, low rock outcrops occupying less than 10% of the unit and drainage is of the vlei type occupying up to 30% of the unit. The unit is classified as Natural Regions IIa and IIb, Agroclimatic Zones 2 and 3 and has an area of 3 220km^2.

Geology Unjointed or weakly jointed granitic and gneissic rocks of the Basement Complex. The proportion of rock outcrops tends to be lowest in terrain predominantly gneissic or where granitic rocks are relatively low in potash feldspar (tonalites and granodiorites).

Soils The soils of this unit show a catenary association (Table 18). Upper slopes comprise moderately well-drained sands, with a thickness greater than 50 cm, generally abruptly over bedrock or over yellowish brown to reddish yellow, frequently mottled sometimes concretionary, coarse-grained sandy loams to sandy clay loams. These pass downslope to a vlei edge, yellow over very pale brown coarse sand (>100 cm), mottled and concretionary at depth, passing into more variable but usually medium-textured, imperfectly to poorly drained vlei soils, some of which are sodic.

Table 18 Typical catenary relationship of soils – Land Unit G1

Landscape position	Soil Classification		
	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Upper to mid slope	5G	Arenic Paleustalfs/Paleustults Plinthic Paleustalfs/Paleustults	Ferric/Haplic Lixisols Ferric/Haplic Acrisols
Lower slope	5G	Aquic Ustipsamments	Ferralic/Haplic Arenosols
Vlei bottomland	5GU 8N	(Aeric) Umbric Kandiaqualfs Typic Natrustalfs	Gleyic Lixisols Haplic Solonetz

Natural vegetation The woody vegetation has either been cleared or is in a highly disturbed state, usually a secondary grassland or wooded grassland on upland sites with scattered trees commonly dominated by *Parinari curatellifolia* but also including some other trees of value for their fruit such as *Uapaca kirkiana, Strychnos* spp., *Lannea edulis* and *Vangueriopsis lanciflora*. In the rare patches of disturbed woodland *Brachystegia spiciformis, Terminalia sericea, Combretum zeyheri, Monotes glaber, Swartzia madagascariensis* and *Dichrostachys cinerea* are common species. The shrubs *Lantana camara* and *Lopholaena coriifolia* have invaded locally, the latter indicative of overgrazing. In depressions and vleis with sodic soils, *Colophospermum mopane* is characteristic; it is generally scrubby, dominant and mixed with other species forming clumps of shrub and tree thicket on large termite mounds. The wetter vleis are grasslands often with a scattering of the subshrub *Syzygium guineense* subsp. *huillense*.

Land use About 60-70% of this unit is arably disturbed with 20-30% being cultivated in any one year. The vleis are used for dry season grazing and, to a variable extent, for micro-scale irrigation, mainly of vegetables. Some 4% of Chiota CL is under this type of vlei irrigation (Dambo Research Unit, 1987).

Land capability Slope is not normally a limitation but most areas are downgraded to Class III owing to the sandy nature of the topsoil and upper subsoil. Seasonal wetness (w) may affect up to 30% of the unit in some areas in which case the land is classified as Class V or Subclass IVw. The occasional sodic soil, if showing evidence of deflocculation of the clay fraction and relative impermeability, warrants the non-arable Subclass VIf (f denoting low fertility) but, in practice, is often of such localized extent as to make a demarcation of land class impracticable except in the most detailed of mapping.

Ivy *et al.* (1972) describe soils similar to these in commercial farming areas adjacent to Seke and Chiota CLs and recommend a farming system based on intensive mixed farming comprising early planted summer-crop production combined with semi-intensive livestock production.

The overall rating for this unit is Class III predominant with subdominant Class V (vlei) and Subclass IVw (seasonally wet upland and vlei margin).

Irrigability Assessment of irrigability according to the criteria of Thompson and Purves (1979) broadly separates this unit into three classes corresponding to the catenary landscape positions shown in Table 18: upper to mid slope corresponding to Class C (very restricted suitability), lower slope to Class S (very restricted suitability) and vlei bottomland to Class D (unsuitable for normal irrigation). Traditional practice shows however that successful sustainable irrigation can be applied on some of the vlei soils and non-vlei sandy soils where groundwater is available at shallow depth, manure is applied to improve fertility status, of the sands in particular, and drainage of the root zone improved by using, for example, raised beds.

Erosion There is below average to average erosion hazard according to Stocking and Elwell (1973). Most of the upland soils show evidence of the effect of slight to moderate, locally severe, sheet erosion judged by the thickness of the A horizon. However, there is little evidence, in the form of plant pedestals, rilling or the presence of alluvial deposits, that this is a generally active process. Indeed, it may be that a state of relative equilibrium normally exists and that the degree of soil degradation is significantly exacerbated on rare occasions by some biotic interference or by an exceptional rainfall event. There are local occurrences of gullies in many of the vleis, related usually to livestock movement and footpaths.

Development Potential This unit has moderate potential. There is a severe fertility constraint compounded by a drainage deficiency in many of the upland soils, although there appears to be no technical reasons why yields should not be improved. With improved fertiliser use and technical innovations to improve drainage, Gubbins (1984) suggests that land of this type could support up to 80% more households than at present. There are also opportunities to increase horticultural output through the development of more irrigated gardens in upper vlei positions with high winter watertables. The unit subdivisions have the advantage of a good agroclimate, well-developed communications and proximity to Harare.

Typical Profile Description Land Unit G1 – Upper to mid slope landscape position

Profile number:	40-GG-88 described on 22 April 1988. Profile pit.
Location:	At junction to Kawara school, Mhondoro CL. Map reference TQ 5276.
Site:	Mid-upper slope of very gently undulating terrain, slope <2%. Coarse grained reddish sand patches on surface.
Vegetation/land use:	Open woodland, very disturbed by cutting. Grazed with very sparse herbaceous cover, surface 80% bare. Tree species include *Brachystegia spiciformis, Terminalia sericea, Combretum zeyheri, Swartzia madagascariensis, Lannea discolor, Monotes glaber* and *Ochna pulchra*. The shrub *Lopholaena coriifolia* is common.
Parent material:	Granite and redistributed granitic material (drift). Apparent discontinuity in parent material at 125/130 cm depth.
Erosion:	Moderately severe sheet erosion.
Land capability:	Class III.
Profile irrigable value:	3.
Soil classification:	5G (Zimbabwe) Plinthic Paleustult (Soil Taxonomy) Haplic Acrisol (FAO/UNESCO/ISRIC)
0-13 cm	Brown (10YR 4/3m), coarse sand; very weak fine subangular blocky; very friable moist; 5% 2-3 mm gravel; common fibrous roots; clear smooth boundary to:
13-34 cm	Yellowish brown to strong brown (7.5YR-10YR 5/6m), coarse sand; very weak fine and medium subangular blocky;
34-67/71 cm	Reddish yellow (7.5YR 6/6m), coarse sand; very weak coarse subangular blocky; very friable moist; 8% 2-10 mm gravel; few fibrous few woody roots; abrupt wavy boundary to:
67/71-125/130 cm	Strong brown (7.5YR 5/6m), coarse gravelly sandy loam; weak medium coarse subangular blocky; friable moist; 20% 2-10mm gravel including angular 2-3mm quartz grains in matrix of fine sandy loam; few fibrous few woody roots; weak thin clay cutans mainly in pores; abrupt wavy boundary to:

125/130-160 cm +	Variegated colour, very gravelly fine sandy clay loam; structureless; 90% 20-30mm angular to subround acid metamorphic gravel; few fibrous roots; 20% soft red concretionary R_2O_3 in gravel interstices; 2% moderately hard irregular Mn concretions; patchy thick light yellowish brown clay cutans between gravel.

ANALYSIS PROFILE 40-GG-88

Depth (cm)	0-13	15-30	45-60	85-100	135-150
Lab No.	X0544	X0545	X0546	X0547	X0548
DM %	99.8	99.3	99.8	99.6	99.3
Texture	cS	cS	cS	cSaL	fSaCL
Gravel %	5	6	5	14	67
Coarse Sand %	24	27	27	39	2
Medium Sand %	17	16	16	12	19
Fine Sand %	51	47	49	33	55
Silt %	5	4	3	5	3
Clay %	3	5	5	11	21
pH ($CaC1_2$)	3.9	3.8	3.8	3.8	3.8
Carbonates %	0	0	0	0	0
EX Ca (me %)	.2	.2	.4	.2	.5
EX Mg (me %)	.2	.2	.1	.3	.5
EX Na (me %)	.02	.02	.02	.02	.02
EX K (me %)	.10	.04	.04	.06	.06
TEB (me %)	.5	.4	.6	.6	1.1
CEC (me %)	1.6	1.5	1.9	2.8	4.6
Base Sat %	30	29	29	23	23
E/C	50.6	29.1	37.4	25.1	21.4
S/C	15.3	8.5	10.8	5.7	5.0
ESP	1.2	1.3	1.0	.7	.4
EKP	6.2	2.6	2.1	2.1	1.3

Typical Profile Description Land Unit G1 – Vlei bottomland landscape position

Profile number:	166-GG-88 described on 18 August 1987. Auger boring.
Location:	Kapare Vlei, Hurungwe CL. Map reference QM 6428.
Site:	Vlei bottom. Fault controlled drainage. Small, 0.5-1 m high, grey mushroom termitaria. Low, rounded outcrops of medium-grained porphyroblastic gneissic granite at edge of vlei.
Vegetation/land use:	Coarse, short grass with common, low spreading *Syzygium huillense*. Grazing area.
Parent material:	Granite with some alluvial contributions.
Erosion:	No evidence.
Land capability:	Class V.
Profile irrigable value:	4.
Soil classification:	5GU (Zimbabwe) Aeric Umbric Kandiaqualf (Soil Taxonomy) Gleyic Lixisol (FAO/UNESCO/ISRIC)
0-15 cm	Black (10YR 2/1m), fine sandy clay loam; common, fine yellowish brown mottles; slightly moist;
15-68 cm	Greyish brown (2.5Y 5/2m), fine sandy clay; common, medium yellowish brown mottles; moist;
68-100 cm	Light brownish grey (2.5Y 6/2m), coarse sandy clay loam; many, coarse strong brown mottles; frequent, large, moderately hard, subround manganese nodules; moist;
100-116 cm +	Light brownish grey (2.5Y 6/2m), medium sandy clay loam; many, coarse strong brown mottles; frequent, large, moderately hard, subround manganese nodules; moist;

ANALYSIS PROFILE 166-GG-88

Depth (cm)	0-15	30-45	75-90	100-115
Lab No.	W1615	W1616	W1617	W1618
DM %	97.5	98.1	99.1	99.3
Texture	fSaCL	fSaC	cSaCL	mSaCL
Gravel %	4	0	6	6
Coarse Sand %	11	3	12	12
Medium Sand %	11	12	24	35
Fine Sand %	34	33	11	21
Silt %	18	14	20	7
Clay %	26	38	34	24
pH ($CaCl_2$)	4.1	4.2	4.4	4.7
Carbonates %	0	0	0	0
EX Ca (me %)	5.2	3.6	3.3	2.1
EX Mg (me %)	1.9	1.7	1.6	1.0
EX Na (me %)	0.33	0.27	0.22	0.16
EX K (me %)	0.41	0.18	0.32	0.12
TEB (me %)	6.4	5.7	4.4	3.3
CEC (me %)	6.4	5.7	4.4	3.5
Base Sat %	100	100	100	100
E/C	24.4	14.9	13.0	14.5
S/C	24.4	14.9	13.0	14.0
ESP	5.1	4.6	5.0	4.7
EKP	6.4	3.2	7.3	3.5

LAND UNIT G2

General description This unit comprises several areas with a relief characterised by frequent bornhardts as exemplified in northeast Zimbabwe by parts of Mutoko, Ngarwe, Maramba, Uzumba, Nyanga North and Makoni CLs. It is confined to the Middleveld Region, mainly the basin drained by the Mazowe and Ruenya rivers. The steep-sided, domed rock outcrops, which may occupy 20-50% of the unit, are separated by planar to concave pediments with slopes not usually exceeding 8%. Drainage generally shows strong structural control in the form of a rectangular pattern caused by faults and jointing in the granitic rocks. A less definite but characteristic drainage feature is the presence of seepage zones or areas with a high watertable which occur at a variety of landscape positions, related probably to variation in depth to a poorly jointed bedrock floor underlying the pediments. The unit comes within Natural Regions III and IV, Agroclimatic Zones 3 and 4 and has an area of 2 800 km^2.

Geology Basement Complex, predominantly poorly jointed, coarse-grained adamellite with some older bodies of granodiorite and gneiss comprise this unit. Dolerite dykes and sills are common. Most of the dykes trend northeastwards and appear to be joint controlled.

Soils The granite outcrops comprise lithosols with some pockets of very shallow, black, organic coarse-grained sand. The pediment soils show a weakly developed toposequence but a regular catenary pattern is often interrupted by the presence of one or more zones of imperfectly to poorly drained soils at variable positions on the mid to upper slopes. In addition, and in common with many granite-derived soils, the parent materials show evidence of a polycyclic history of several phases of erosion and deposition as indicated by the presence of stone lines and lithological discontinuities (Loxton & Associates, 1971 and Verster, 1989). Soils in upper slope positions on the pediments tend to have slightly higher clay contents in the subsoil compared to those in mid slope positions. However, most of the upland soils are deep, very well-drained coarse-grained sands or loamy sands over yellowish brown to yellowish red similar sands to sandy loams. The lower footslope and valley bottom soils have the highest clay contents and may be locally sodic. The perched vlei soils show hydromorphic properties at shallow depth, have a sandy texture and are moderately shallow to deep (Table 19).

Natural vegetation The pediment slopes are largely cleared of natural woodland which is of the miombo type, now only preserved at sacred sites and

Table 19 Typical toposequence of soils – Land Unit G2

Landscape position	Soil Classification		
	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Crest (rock outcrops)	2	Lithic Ustorthents	Lithic/Umbric Leptosols
Pediment slope (upper to mid)	5G	Typic Ustipsamments (Gross) Arenic Paleustalfs	Ferralic/Luvic Arenosols Haplic Lixisol
Pediment slope (perched vlei)	5G	Aquic Ustipsamments Hum/Tropaquepts	Gleyic Arenosols Mollic/Eutric Gleysols
Pediment footslope and valley bottom	5GU 8N	(Aeric) Umbric Kandiaqualfs Typic Natrustalfs	Gleyic Lixisols Haplic Solonetz

in some riparian situations. Individual specimens of *Parinari curatellifolia* are locally conspicuous where preserved for shade and their fruit. The rock outcrops provide a limited and specialised repository for woody vegetation in often inaccessible nooks, crannies and kloofs. Similarly, the veneers of organic rich sand, protected in bevelled hollows, support an unusual flora including the resurrection plant *Myrothamnus flabellifolia*, the broom plant *Vellozia equisetoides* and rock sedge *Coleochloa setifera*.

Land use Most of the pediment slopes have been cleared for cultivation. Vestiges of the conservation layouts of arable land, created during implementation of the Land Husbandry Act, are still evident from the degraded contour ridges demarcating fields. From a detailed examination of air photographs of Mutoko CL, it was estimated that 35% of this unit showed signs of arable disturbance in 1982, the balance being 46% rock outcrop, 5% permanently wet land and 14% other land such as village sites and roads. Mangoes are an important tree crop and small irrigated gardens are common, growing vegetables in the dry season and rice in the wet.

Land capability Up to about one half of the unit may be non-agricultural land comprising sheet rock, extremely steep hills and excessively rocky koppies having a land capability of Class VIII. The pediment slopes are usually Class MIII on the basis of texture and slope. The wet zones are either Subclass MIVw or Class V. Overall this unit is rated an approximately equal proportion of Class VIII and Class MIII land.

Irrigability Excluding the obviously unsuitable rock outcrops, most of the unit is composed of land of irrigability Class S or C owing to soil textural limitations. However, in considering suitability for traditional forms of small scale irrigation, the same caveat applies as for Land Unit G1.

Erosion Stocking and Elwell (1973) rate this type of land unit as having an above average to very high erosion hazard based on the factors of high rainfall erosivity, steep slopes and a moderate to high population density. They consider that this unit, in Mutoko CL, warrants the highest hazard rating in Zimbabwe. Whitlow (1985b) conducted a survey of actual erosion in the Mutoko region using airphoto interpretation. The area of study includes most of Land Unit G2. He concludes that the incidence of erosion in 1981 was extremely patchy, that whilst gullying was locally serious, sheet and rill erosion were more widespread especially on non-croplands and that extensive degradation was characteristic in areas with a high population density and a high proportion of massive granitic domes.

The regional assessment of erosion status during the current survey was necessarily limited to points of access dictated by the road network. Nevertheless, a considerable number of field observations suggest that this type of granitic terrain is not intrinsically susceptible to accelerated soil erosion. There is a clear

positive correlation between population density and the degree of land degradation used in its broadest sense. There is indeed evidence of widespread erosion, particularly of the sheetwash type, but not to a significantly greater extent than in any other Communal Land where cropping and grazing of livestock are extensively practiced. There is no clear evidence that the erosion process is a regularly active one apart from the evidence from some notorious gullies where specific causes can usually be identified.

Development potential Moderate with similar constraints and potentials to Land Unit G1, although with a significantly drier climate. The advantages of rain water harvesting from the numerous rock outcrops for domestic, livestock and garden irrigation requirements are well known (Richards, 1972; United Nations Environment Programme, 1983; Natural Resources Board, 1985) but examples of this low technology development are rarely seen in the CLs (Plate 6).

Typical Profile Description Land Unit G2 – Upper to mid position on pediment slope

Profile number:	540-FF-85 described on 7 August 1985. Profile pit.
Location:	Manyika Business Centre, 15 km west of Nyaderi Mission, Uzumba CL, Murehwa District. Map reference UR 8581.
Site:	Mid slope of gently undulating pediment, 3% slope. Few, low rock outcrops.
Vegetation/land use:	Cultivated field, fallow last season. Contour ridged.
Parent material:	Probably colluviated material derived from leuco- adamellite.
Erosion:	Slight sheet erosion.
Land capability:	Class MIII.
Profile irrigable value:	4.
Soil classification:	5G (Zimbabwe) Typic Ustipsamment (Soil Taxonomy) Ferralic Arenosol (FAO/UNESCO/ISRIC)
0-23 cm	Brown (10YR 5/3m, 10YR 6/2d) coarse sand, single-grained structure; loose consistence; common fine roots; rapid permeability and well drained; clear wavy transition to:
23-100 cm	Brownish yellow (10YR 6/6m, 10YR 7/4d) coarse sand, apedal; friable; few fine roots; rapid permeability and well drained; diffuse transition to:
100-205 cm +	Yellowish brown (10YR 5/6m, 10YR 7/6d) coarse loamy sand, apedal; friable; few fine roots; rapid permeability, (possibly) moderately well drained; moist from 100 cm.

ANALYSIS PROFILE 540-FF-85

Depth (cm)	0-15	45-60	150-165
Lab No.	U1747	U1748	U1749
DM %	99.8	99.8	99.9
Texture	cS	cS	cLS
Gravel %	1.8	2.0	1.8
Coarse Sand %	26.9	37.0	33.6
Medium Sand %	37.6	33.0	30.0
Fine Sand %	28.6	22.1	23.8
Silt %	2.4	3.9	3.8
Clay %	4.4	3.9	8.8
pH ($CaC1_2$)	4.8	4.8	5.5
Carbonates %	0	0	0
EX Ca (me %)	0.64	0.56	0.72
EX Mg (me %)	0.08	0.08	0.16
EX Na (me %)	0.02	0.02	0.02
EX K (me %)	0.04	0.04	0.04
TEB (me %)	0.78	0.7	0.94
CEC (me %)	1.56	0.52	1.04
Base Sat %	50.1	100.0	90.6
E/C	35.4	13.3	11.8
S/C	17.7	13.3	10.7
ESP	1.3	3.9	1.9
EKP	2.6	3.9	3.9

Typical Profile Description Land Unit G2 – Perched vlei on pediment slope

Profile number:	40-FF-86 described on 30 September 1986. Profile pit.
Location:	Irrigated garden of Mr S Gondo, near the Sorore River and north of Katsukumya Business Centre, Mutoko CL. Map reference VR 065804.
Site:	Lower mid slope of pediment, 4% slope.
Vegetation/land use:	Irrigated garden for three generations. Rice grown in the wet season; tomatoes, maize and onions in the dry season. Irrigated from small, shallow wells.
Parent material:	Colluviated material derived from adamellite.
Erosion:	Not evident.
Land capability:	Class MIVw.
Profile irrigable value:	3.
Soil classification:	5G (Zimbabwe) Typic Humaquept (Soil Taxonomy) Mollic Gleysol (FAO/UNESCO/ISRIC)
0-24 cm	Very dark grey (10YR 3/1m; 10YR 5/1d) coarse loamy sand, very weak crumb structure/apedal, plough zone, very friable when moist; slightly hard to hard dry consistence; many fine and medium vesicular pores; abundant medium and fine roots; poorly drained with common small iron segregation mottles; wavy clear transition to:
24-31 cm	Very dark grey (10YR 3/1m) coarse sandy loam, apedal; very friable moist consistence; many fine and medium vesicular pores; abundant medium and fine roots; poorly drained with common small iron segregation mottles; abrupt smooth boundary to:
31-42 cm	Grey (5Y 5/1m) coarse loamy sand, apedal; very friable moist consistence, few pores; common fine roots; very poorly drained; common iron mottles; smooth clear transition to:
42-90 cm	Light olive grey (5Y 6/2) coarse loamy sand, apedal, very friable moist (very hard dry) consistence; no pores observed; few fine roots; feldspar and quartz 3-10cm diameter in a band between 30-50cm; very poorly drained; common iron streaks and mottles.
Remarks:	Free water at 90 cm 24 hours after digging pit.

ANALYSIS PROFILE 40-FF-86

Depth (cm)	0-15	24-31	31-42	50-65
Lab No.	V1268	V1269	V1270	V1271
DM %	99.4	99.4	99.8	99.7
Texture	clS	cSal.	clS	clS
Gravel %	0	4	5	7
Coarse Sand %	44	37	43	36
Medium Sand %	24	21	23	25
Fine Sand %	19	21	22	24
Silt %	9	12	8	10
Clay %	5	10	4	5
pH ($CaC1_2$)	6.1	4.4	4.5	4.9
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	3.2	2.0	1.0	0.8
EX Mg (me %)	0.7	0.3	0.1	0.1
EX Na (me %)	0.12	0.12	0.10	0.10
EX K (me %)	0.26	0.28	0.08	0.08
TEB (me %)	4.0	2.6	1.3	1.1
CEC (me %)	4.0	2.6	1.8	2.8
Base Sat %	100	100	71	39
E/C	87.0	26.7	48.0	58.9
S/C	87.0	26.7	33.9	22.9
ESP	3.0	4.6	5.6	3.6
EKP	6.5	10.8	4.4	2.9
Org Carbon %	1.03	1.07	0.23	0.23

LAND UNIT G3

General description This unit is restricted to Kunzwi, Chiota, Seke and Mangwende Communal Lands which lie to the east and south of Harare in the northern Highveld region. Elevations exceed 1 500 metres in parts of Seke and Chiota CLs and correspond to the level of the African erosion surface (Lister, 1987). The landform is almost flat to gently undulating with slopes usually less than 4%. Vleis occupy up to 30% of the unit. There are few, low, irregular granitic rock outcrops and occasional low dolerite ridges. Large termite mounds, up to 5m high and 15m in diameter, are a conspicuous feature of the landscape, associated with the upland areas adjacent to incised drainage lines such as the Shavanhohwe River in Mangwende CL (Plate 7). These termitaria are absent or much fewer in number on the very gently sloping interfluves separating the vlei tributaries feeding the incised rivers. The unit occurs in Natural Regions IIa and minor IIb, Agroclimatic Zone 2 and has an area of 1 400 km^2

Geology Well-jointed granitic and gneissic rocks of the Basement Complex form this unit.

Soils A catenary association is not particularly well developed owing to the very subdued relief (Table 20). The interfluve crests and upper slope positions comprise well-drained, moderately deep to deep, dark brown coarse-grained sands with a clear transition to strong brown to yellowish red coarse-grained sandy loams and sandy clay loams. These are transitional to similar but slightly lighter-textured soils at mid slope positions, becoming sandier towards the vleis. The vlei soils are permanently or seasonally wet, black coarse-grained sands over grey mottled coarse-grained sands or loamy sands, occasionally with a higher clay content. Compared with the upland soils of Land Unit G1, which have a similar landform and hydrological regime, the soils of this unit are markedly more ferrallitic.

Natural vegetation Most of the natural vegetation, of the *Brachystegia* woodland type, has been cleared apart from scattered specimens of trees such as *Parinari curatellifolia* and *Acacia sieberana* var. *woodii*. Fallowland is typically colonized by perennial thatching grass, *Hyparrhenia filipendula*. The large termitaria usually have a thickety cover of woody species and are conspicuous on air photographs. Species composition is diverse on the mounds and includes those, such as some of the Capparaceae family, with a preference for base rich soils and which are otherwise only found in drier areas off the Highveld plateau (Wild, 1952).

Land use A high proportion of the land is arably disturbed. In Mangwende CL several large upland blocks have been set aside as semi-permanent grazing areas, a demarcation probably dating back to the Land Husbandry Act. Contour ridging of most of the arable blocks is also a relict of that era, although neither the soil conservation layout in general nor the basic contour ridges in particular are now maintained and the system is degenerate, a feature common to all the Communal Lands affected by this aspect of the Act.

Table 20 Typical catenary relationship of soils – Land Unit G3

	Soil Classification		
Landscape position	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Upper to mid slope	6G	Typic Kandiustalfs Typic Kandiustults	Haplic Lixisols Haplic Acrisols
Lower slope	5G	Typic Ustipsamments	Ferralic/Haplic Arenosols
Vlei bottomland	5GU	Aquic Ustipsamments Mollic Psammaquents	Gleyic Arenosols Mollic Gleysols

Small irrigated vegetable gardens are a common feature of the vlei fringe where early planting of maize is also practiced. Some wheat is reported to be grown in the vleis during the dry season utilizing residual moisture. The large termitaria are occasionally cultivated or dug out and the chemically fertile material incorporated with the surrounding topsoil (Plate 8).

Land capability Most of the unit has a Class III capability owing to the low clay content of topsoils and upper subsoils. Some of the crest and upper slope sites rate Class II where the texture below the topsoil, taken to be the surface 20-25 cm, is a sandy loam or heavier. The vleis are Class V land. An agro-ecological survey of commercial farmland bordering Kunzwi, Chiota, Seke and Mangwende CLs recommends, as appropriate to this type of land unit, a farming system based on intensive crop production supported by livestock. Tobacco is the recommended cash crop along with side crops such as maize and sorghum and supported by intensive animal production on pasture (Ivy *et al.*, 1972).

This land unit has an overall capability rating of Class III with minor Class II. Vlei and vlei margin soils, Class V and Subclass IVw, occupy between 25% and 30% of the unit.

Irrigability A few crest and upper slope areas are suitable for irrigation, Class B. Otherwise, the unit is predominantly Class C, of very restricted suitability.

Erosion The effects of slight to moderate sheet erosion are evident throughout the upland cropping areas. Gully erosion was observed in some of the vleis. Whitlow (1988) has mapped the distribution of active and stabilised gullies in relation to past and present irrigated gardens in part of Mangwende CL.

Development potential The potential for yield increases and crop diversification is high in this area especially in view of the good agroclimate (Agroclimatic Zone 2). Constraints include the relatively high population density, over 60 persons per km^2, with many people having employment in Harare and therefore not fully committed to farming. The upland soils have moderately good physical properties but are generally very acid with a low cation exchange capacity characteristic of ferrallitic soils. The vleis are a very important resource for small scale irrigation, out of season cropping and dry-season grazing.

Typical Profile Description Land Unit G3 – Upper to mid slope landscape position

Profile number:	92-DD-88 described on 12 May 1988. Profile pit.
Location:	One kilometre north of Sadza Business Centre on the road to Chivake school. Chiota CL.
Site:	Upper slope position. Slope less than 2%. Contour ridged.
Vegetation/land use:	Fallow or reverted land within an arable block. *Hyparrhenia filipendula* grass cover with scattered mature *Parinari curatellifolia.*
Parent material:	Granite.
Erosion:	Slight sheet.
Land capability:	Class II.
Profile irrigable value:	2.
Soil classification:	6G (Zimbabwe) Typic Kandiustalf (Soil Taxonomy) Haplic Lixisol (FAO/UNESCO/ISRIC)
0-13 cm	Dark brown (10YR 3/3m; 6/2d) coarse sand; dry loose, non sticky, non plastic wet consistence; structureless; numerous fine roots; rapid permeability and very well drained; clear smooth transition to:
13-25 cm	Dark yellowish brown (10YR 4/4m; 6/4d) similar sand; apedal, single-grain structure; dry loose, non sticky, non plastic wet consistence; numerous fine roots; rapid permeability and very well drained; clear smooth transition to:

25-48 cm	Strong brown (7.5YR 5/6m) coarse sandy loam; weak, fine sub-angular blocky structure; very friable moist, slightly sticky, slightly plastic wet consistence; fairly numerous fine roots; rapid permeability and very well drained; gradual smooth transition to:
48-80 cm	Strong brown (7.5YR 5/6m) coarse sandy clay loam; weak medium sub-angular blocky structure; firm moist, sticky and plastic wet consistence; few fine roots; good permeability and well drained; diffuse transition to:
80-105 cm	Similar sandy clay loam; weak fine sub-angular blocky structure; friable moist, slightly sticky and slightly plastic wet consistence; occasional fine roots; rapid permeability and very well drained; diffuse transition to:
105-172 cm	Strong brown (7.5YR 5/8m) coarse sandy clay loam; weak fine sub-angular blocky structure; very friable moist, slightly sticky and slightly plastic wet consistence; occasional fine roots; rapid permeability and very well drained.

ANALYSIS PROFILE 92-DD-88

Depth (cm)	0-13	13-25	30-45	55-70	85-100	140-155
Lab No.	X0873	X0874	X0875	X0876	X0877	X0878
DM %	99.5	99.8	99.1	98.9	99.5	99.4
Texture	cS	cS	cSaL	cSaCL	cSaCL	cSaCL
Gravel %	0	2	1	0	2	0
Coarse Sand %	31	27	29	18	23	19
Medium Sand %	44	43	36	26	27	23
Fine Sand %	22	22	19	21	20	24
Silt %	0	3	3	1	4	6
Clay %	3	6	13	33	27	29
pH ($CaC1_2$)	4.2	3.8	3.8	3.9	4.3	3.8
Carbonates %	0	0	0	0	0	0
EX Ca (me %)	1.0	1.2	1.2	1.4	0.5	0.5
EX Mg (me %)	0.0	0.1	0.1	0.2	0.1	0.1
EX Na (me %)	0.06	0.02	0.02	0.12	0.02	0.12
EX K (me %)	0.02	0.02	0.06	0.10	0.08	0.06
TEB (me %)	1.1	1.2	1.4	1.5	0.7	0.8
CEC (me %)	1.1	1.2	1.4	1.5	1.4	1.4
Base Sat %	100	100	96	100	51	54
E/C	36.7	21.8	11.2	4.5	5.2	4.9
S/C	36.7	21.8	10.8	4.5	2.7	2.6
ESP	5.5	1.7	1.4	8.0	1.4	8.6
EKP	1.8	1.7	4.3	6.7	5.7	4.3

Typical Profile Description Land Unit G3 – Vlei bottomland landscape position

Profile number:	95-DD-88 described on 13 May 1988. Profile pit.
Location:	About 5 km from Mahusekwa on the Mahusekwa to Marondera road, at the junction to Sadza Business Centre.
Site:	Vlei.
Vegetation/land use:	Grassland, 90% cover, used for grazing. Several irrigated gardens growing vegetables and sugar cane. Common *Syzygium huillense.*
Parent material:	Granite.
Erosion:	Not evident.
Land capability:	Class V.
Profile irrigable value:	Unsuitable for normal irrigation.
Soil classification:	5G (Zimbabwe) Mollic Psammaquent (Soil Taxonomy) Mollic Gleysol (FAO/UNESCO/ISRIC)
0-20 cm	Black (2.5Y 2/0m) coarse sand; root-induced fine sub-angular blocky structure; moist friable, non sticky, non plastic wet consistence; root channel mottling; numerous fine roots; good permeability and well drained; clear smooth transition to:

20-42 cm	Dark brown (10YR 4/3m) coarse sand with common, fine, distinct yellowish red (5YR 5/8m) mottles; apedal structure; moist friable, non sticky, non plastic wet consistence; fairly numerous fine roots; good permeability and moderately well drained; gradual smooth transition to:
42-68 cm	Variegated colours, pale brown (10YR 6/3m), strong brown (7.5YR 5/8m) and red (2.5YR 4/8m); similar sand; few fine roots; good permeability and moderately poorly drained; diffuse transition to:
68-143 cm	Variegated colours, light grey (10YR 7/2m) and strong brown (7.5YR 5/8m); coarse loamy sand; apedal structure; non sticky, non plastic wet consistence; occasional fine roots; good permeability and moderately poorly drained.
Remarks:	Milky water (due to dispersed clay) at 103 cm from the surface.

ANALYSIS PROFILE 95-DD-88

Depth (cm)	0-15	25-40	45-60	105-120
Lab No.	X0883	X0884	X0885	X0886
DM %	99.1	99.8	99.8	99.9
Texture	cS	cS	cS	cLS
Gravel %	0	0	0	1
Coarse Sand %	37	27	25	25
Medium Sand %	35	43	42	39
Fine Sand %	20	25	26	25
Silt %	6	2	2	4
Clay %	3	3	5	6
pH ($CaC1_2$)	3.4	3.5	3.5	3.8
Carbonates %	0	0	0	0
EX Ca (me %)	0.8	0.7	0.8	0.9
EX Mg (me %)	0.1	0.1	0.1	0.1
EX Na (me %)	0.10	0.04	0.04	0.04
EX K (me %)	0.08	0.02	0.02	0.02
TEB (me %)	1.1	0.8	0.9	1.1
CEC (me %)	1.6	1.1	1.1	1.2
Base Sat %	67	73	81	87
E/C	59.3	32.8	23.6	21.3
S/C	39.6	23.9	19.2	18.5
ESP	6.2	3.6	3.5	4.8
EKP	5.0	1.8	1.7	1.6

LAND UNIT G4

General description This unit occurs in Masembura, Chinamora, Msana, Gutu, Serima, Chikwanda and Zimutu Communal Lands in positions bridging the northern Highveld region's boundary with the Middleveld at elevations between 1 100 and 1 500 metres. The landform comprises a dissected plateau, part of the Post-African erosion surface, with 30-50% of the unit composed of granitic rock outcrops of the bornhardt and castle koppie types separated by gently sloping (2-5%) pediment slopes. There are few to common vleis with drainage often by incised perennial streams, paticularly in the area north of Harare. Natural Regions IIa, III and IV; Agroclimatic Zones 2 and 3; area 4 570 km^2.

Geology Usually granodiorites and adamellites, with gneissic inclusions, of the Basement Complex form this unit. The Chinamora batholith demarcates this unit to the north of Harare.

Soils A catenary association of soils occurs on the pediment slopes (Table 21). The upper slopes adjacent to rock outcrops comprise well-drained, moderately shallow to deep, coarse-grained sands to sandy loams over yellowish red to red coarse-grained sandy clay loams of the Zimbabwe 6G family. In mid to lower slope positions, the soils are well- to moderately well-drained, moderately shallow to deep, coarse-grained sands or loamy sands over strong brown to

Table 21 Typical catenary relationship of soils – Land Unit G4

Landscape position	Soil Classification		
	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Crest (rock outcrops)	2	Lithic Ustorthents	Lithic/Umbric Leptosols
Upper pediment slope	6G	Typic Kandiustalfs	Haplic Lixisols
Mid to lower pediment slope	5G/6G	Typic/Aquic Ustipsamments Plinthic Kandiustalf	Luvic Arenosols Plinthic Lixisol

reddish similar sands often with mottling at about 1 metre depth or with a marked clay increase to sandy clay loam and the development of plinthite. A few soils are shallow over a petroferric layer. Nearly all the soils described, during September, were found to be moist below the topsoil, a feature common to many granitic soils throughout the dry season, particularly where rock outcrops are common.

Natural vegetation As with Land Unit G2, the granitic bornhardts are mainly bare of soil and vegetation except where a thin cover of black organic sand supports some xerophilous species. The castle koppies, by contrast, are often well wooded owing to the abundance of rock joints and may be host in these niches to species of the miombo type or trees well adapted to the rocky conditions such as the rock-splitting figs and *Brachystegia glaucescens.*

Most of the pediment slopes have been cleared of their natural vegetation. Common remnant species include *Uapaca kirkiana, Parinari curatellifolia, Swartzia madagascariensis* and *Syzygium guineense.*

Land use Chinamora CL, with most of its arable land representative of this unit, was estimated to be 19% cultivated during the 1987/88 season, with 90% of this cropped area under maize (AGRITEX second crop forecast). This corresponds to a cultivated area of 0.32 ha (0.80 ac) per person. Robinson (1953) estimated that 14% of Chinamora CL was cultivated in 1950, providing 0.44 ha (1.08 ac) of cultivated land per person.

Land capability Most of the rock outcrops, which may occupy up to about half the unit's area, are non-agricultural land or offer limited scope for rough grazing and have a land capability of Class VII or VIII. The pediment slopes are mainly Class III with limited areas of Class II in upper slope positions where topsoils meet the clay requirements for a sandy loam.

Irrigability Suitability for irrigation is related to the catenary distribution of soils. The heavier-textured soils in upper slope positions are Class B passing downslope to the sandier soils of Class C or S. Micro-scale irrigation is important in this unit in the Communal Lands north of Harare; Robinson (1953) identified 366 ha of irrigated gardens in Chinamora CL in 1950.

Erosion Evidence of slight to moderate sheet erosion, related to cultivation, is widespread on the pediment slopes. Robinson (1951) describes the relationship between livestock management and erosion hazard within Land Unit G4 in Zimutu CL.

Development potential The northern occurrences of this unit have the benefit of the better agroclimate, Agroclimatic Zone 2, compared to the areas northeast of Masvingo, Agroclimatic Zone 3 or slightly drier. Micro-irrigation is widely practised in Chinamora and adjacent CLs, for the Harare market. The vlei areas in the Gutu area appear to be under-used in this respect (Dambo Research Unit, 1987).

Typical Profile Description Land Unit G4 – Upper slope landscape position

Profile number:	211-GG-87 described on 17 September 1987. Auger boring.
Location:	Masembura CL, about 6 km west of Manhenga.
Site:	Upper part of long pediment slope declining south, 3%. Well jointed and vegetated granite koppie to north.
Vegetation/land use:	Previously maize. Scattered *Bauhinia thonningii, Parinari curatellifolia* and cultivated *Mangifera indica.*
Parent material:	Granite.
Erosion:	Slight sheet.
Land capability:	Class III.
Profile irrigable value:	2.
Soil classification:	6G (Zimbabwe) Typic Kandiustalf (Soil Taxonomy) Haplic Lixisol (FAO/UNESCO/ISRIC)
0-20 cm	Brown to dark brown (10YR 4/3m), coarse sand; dry.
20-53 cm	Strong brown (7.5YR 5/6m), coarse sandy loam; moist.
53-140 cm	Red (2.5YR 4/6m), coarse sandy clay loam; moist.

ANALYSIS PROFILE 211-GG-87

Depth (cm)	0-15	30-45	80-95
Lab No.	W2138	W2139	W2140
DM %	99.4	99.5	98.2
Texture	cS	cSaL	cSaCL
Gravel %	8	4	0
Coarse Sand %	40	36	33
Medium Sand %	27	25	15
Fine Sand %	26	22	16
Silt %	5	8	6
Clay %	3	10	30
pH ($CaC1_2$)	4.8	4.3	5.5
Carbonates %	0	0	0
EX Ca (me %)	1.8	1.3	2.4
EX Mg (me %)	0.4	0.2	0.7
EX Na (me %)	0.02	0.02	0.02
EX K (me %)	0.08	0.10	0.08
TEB (me %)	2.3	1.6	1.4
CEC (me %)	3.1	3.1	1.4
Base Sat %	72	51	100
E/C	115.6	32.2	4.6
S/C	83.7	16.5	4.6
ESP	0.6	0.6	1.5
EKP	2.6	3.2	5.9

Typical Profile Description Land Unit G4 – mid to lower slope landscape positions

Profile number:	207-GG-87 described on 17 September 1987. Auger boring.
Location:	Chinamora CL.
Site:	Col position, mid slope between large granite bornhardts, 4-5% slope.
Vegetation/land use:	Previous crop maize. Scattered specimens of *Parinari curatellifolia, Combretum molle* and *Swartzia madagascariensis.*
Parent material:	Granite.
Erosion:	Slight sheet.
Land capability:	Class III.
Profile irrigable value:	2.
Soil classification:	6G (Zimbabwe) Plinthic Kandiustalf (Soil Taxonomy) Plinthic Lixisol (FAO/UNESCO/ISRIC)
0-15 cm	Brown to dark brown (7.5YR 4/4m), coarse loamy sand.
15-66 cm	Strong brown (7.5YR 5/6m), coarse sandy clay loam; few medium soft black and red R_2O_3.
66-116 cm	Strong brown (7.5YR 5/8m), coarse sandy clay loam; common medium moderately hard black and red R_2O_3.

116-140 cm	Red (2.5YR 4/8m) and brownish yellow (10YR 6/8m) plinthitic coarse sandy clay loam.

ANALYSIS PROFILE 207-GG-87

Depth (cm)	0-15	30-45	80-95	120-135
Lab No.	W2125	W2126	W2127	W2128
DM %	99.4	98.8	98.7	98.6
Texture	cLS	cSaCL	cSaCL	cSaCL
Gravel %	0	0	5	8
Coarse Sand %	22	20	17	20
Medium Sand %	40	25	18	17
Fine Sand %	24	20	33	25
Silt %	5	6	6	9
Clay %	9	29	25	29
pH ($CaCl_2$)	5.0	4.9	5.1	4.6
Carbonates %	0	0	0	0
EX Ca (me %)	1.7	1.9	1.7	1.2
EX Mg (me %)	0.4	0.4	0.4	0.3
EX Na (me %)	0.02	0.02	0.03	0.02
EX K (me %)	0.20	0.08	0.07	0.16
TEB (me %)	2.2	2.3	2.1	1.7
CEC (me %)	2.6	2.6	2.1	6.1
Base Sat %	86	89	100	28
E/C	28.9	9.0	8.2	20.8
S/C	24.8	8.0	8.2	5.8
ESP	0.8	0.8	1.7	0.3
EKP	7.7	3.1	3.3	2.7

Land unit G5

General description This unit is typical of many areas straddling the boundary between the northern Highveld and Middleveld regions including parts of Mangwende, Uzumba, Tanda, Chiweshe, Chikwakwa, Hwedza, Denhere, Gutu, Chirau and Zwimba Communal Lands. The landform comprises an almost flat to gently undulating plateau, part of the Post-African erosion surface at elevations between 1 100 m and 1 300 m, with few to common rock outcrops, mainly of castle koppie type, and broad pediments coalescing to form a pediplain. There are few to common vleis. This unit occurs within Natural Regions IIa, IIb and III; Agroclimatic Zones 2 and 3; and has an area of 4 340 km^2.

Geology A variety of felsic rocks of the Basement Complex form this unit ranging in composition from tonalites through granodiorites to adamellites, generally well jointed and gneissic in places.

Soils There is a catenary association with, in upper slope positions, well-drained, moderately shallow to deep, medium- or coarse-grained sands or loamy sands over strong brown to red, often gravelly, coarse-grained sandy loams or sandy clay loams. Downslope, the soils become progressively more sandy, with lower slope or vlei edge soils typically moderately well- or imperfectly drained, deep, very pale brown coarse-grained sands. Some of the soils on almost flat interfluve crests also show signs of hydromorphy. The vlei soils generally have a higher clay content than the upland soils and a few are strongly sodic. Similar soils, mainly of the Banket G. Catena, occurring in the Banket area some 90 km north west of Harare, are described by Purves *et al.* (1981).

Natural vegetation The natural woodland, formerly dominated by *Brachystegia spiciformis* and *Julbernardia globiflora*, has nearly all been removed with the exception of non-arable rocky outcrops. Other species described include *Parinari curatellifolia, Dodonaea viscosa, Uapaca kirkiana* and, locally, *Brachystegia boehmii*.

Land use Dryland cultivation of maize is the main land use. This crop may also be planted as an early crop in the vleis, particularly in Mangwende and Chikwakwa CLs, followed by winter wheat to take advantage of residual moisture. Micro-scale irrigation of vegetables is also locally important.

Table 22 Typical catenary relationship of soils – Land Unit G5

Landscape position	Soil Classification		
	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Upper slope	5G/6G	Typic Kandiustalfs	Haplic Lixisols
Mid to lower slope	5G	Typic/Aquic Ustipsamments Grossarenic Paleustalfs	Luvic/Gleyic Arenosols
Vlei bottomlands	5G 8N	Umbric Kandiaqualfs Typic Natrustalfs	Gleyic Lixisols Haplic Solonetz

All of Chirau CL falls within this unit. ARDA (1983) notes the presence of substantial tracts of abandoned land in this area and this is reflected in the high proportion, about 60%, of fallow recorded by AGRITEX in their crop estimates for 1986-87.

Land capability Based on survey data from Chirau CL where rock outcrops are few, the unit comprises 75% Class III, 20% Class IV and 5% Class V land Other occurrences of this unit in, for example Mangwende CL, may have a higher proportion of Class V vlei land, up to 20%, and include a significant proportion of non-arable Class VII land.

Irrigability Some of the heavier-textured upper slope soils are Class B. Otherwise the sandy soils are Class C or S and the vlei soils are Class D, unsuitable for normal irrigation, with the exception of rice in some circumstances. For the special case of traditional micro-irrigation, most of the soils are suitable and groundwater availability is the usual constraint.

Erosion Slight sheet erosion is ubiquitous. Gully erosion is occasional.

Development potential The unit normally receives adequate rainfall for dryland cropping. In the commercial farming areas, similar soils have been shown to be suitable for rainfed maize, flue-cured tobacco and soya beans. In the drier areas, Agroclimatic Zone 3, the unit is well suited to cotton. There are, however, local problems of fertility depletion exacerbated by slight drainage restrictions.

Typical Profile Description Land Unit G5 – Upper slope landscape position

Profile number:	297-FF-87 described on 9 September 1987. Profile pit.
Location:	Near St. Mathias School, between the Korongono and Mare Rivers, Hwedza CL, Hwedza District. Map reference UQ 704 187.
Site:	Gently undulating landform between large granitic rock outcrops. Upper slope position, 2%. No close rainfall station – Dendenyore 15 km to the north 898 mm, Zinyambe 19 km to the south 680 mm. Site rainfall estimated to be 750 mm.
Vegetation/land use:	Contour-ridged field with maize as last crop (fertilizer and manure applied).
Parent material:	Granodiorite.
Erosion:	Not evident.
Land capability:	Class II.
Profile irrigable value:	2
Soil classification:	6G (Zimbabwe) Typic Kandiustalf (Soil Taxonomy) Haplic Lixisol (FAO/UNESCO/ISRIC)
0-20 cm	Strong brown (7.5YR 4/6m; 10YR 6/4d) medium loamy sand, plough layer composed of large clods; slightly sticky, non plastic, very friable moist, soft dry consistence; very few medium pores; few fine roots; well drained and permeable; clear wavy transition to:

20-40 cm	Yellowish red (5YR 4/6m; 7.5YR 6/6d) medium sandy loam; very weak coarse and medium subangular blocky structure; slightly sticky, slightly plastic, friable moist; slightly hard dry consistence; few medium and fine pores; few fine roots; well drained and permeable; diffuse smooth transition to:
40-68 cm	Red (2.5YR 4/6m; 5YR 6/8d) coarse sandy clay loam; weak coarse, medium and fine subangular blocky structure; some 3mm diameter gravel; few medium and fine pores; few fine roots; well drained and permeable; diffuse smooth transition to:
68-125 cm	Red (2.5YR 4/8m; 5YR 6/8d) coarse sandy clay; weak coarse, medium and fine subangular blocky structure; some 3mm diameter gravel; few patchy thin cutans; few manganese stains; few fine pores; few fine roots; well drained and permeable; diffuse smooth transition to:
125-178 cm +	Yellowish red (5YR 5/8m; 5YR 7/8d) coarse sandy clay loam; weak, coarse, medium and fine subangular blocky structure; slightly less gravel than the above horizon; no cutans observed; few manganese stains and manganese nodules; many fine pores; few fine roots; well drained and permeable.

ANALYSIS PROFILE 297-FF-87

Depth (cm)	0-15	25-40	50-65	90-105	163-178
Lab No.	W1895	W1896	W1897	W1898	W1899
DM %	99.7	99.2	98.8	98.2	98.6
Texture	mLS	mSaL	cSaCL	cSaC	cSaCL
Gravel %	1	3	6	9	25
Coarse Sand %	17	17	20	20	18
Medium Sand %	32	26	22	16	15
Fine Sand %	38	31	24	20	25
Silt %	8	8	5	5	9
Clay %	4	18	29	39	33
pH ($CaCl_2$)	4.0	4.2	5.0	5.2	4.7
Carbonates %	0	0	0	0	0
EX Ca (me %)	0.7	1.1	1.8	1.5	1.6
EX Mg (me %)	0.1	0.2	0.6	0.7	0.6
EX Na (me %)	0.02	0.02	0.02	0.02	0.02
EX K (me %)	0.24	0.12	0.24	0.14	0.16
TEB (me %)	0.9	1.5	2.7	2.3	2.4
CEC (me %)	0.9	2.0	3.1	4.1	4.0
Base Sat %	100	75	87	57	59
E/C	21.3	11.4	10.6	10.6	12.2
S/C	21.3	8.5	9.2	6.0	7.2
ESP	2.1	1.0	0.7	0.5	0.5
EKP	25.6	6.1	8.0	3.5	4.0
Org Carbon %	0.29	0.19	0.14	0.17	0.07

LAND UNIT G6

General description This unit commonly occupies peripheral areas of the northern and southern Highveld regions and the adjacent Middleveld at elevations between 950 metres and 1 400 metres. It occurs in Gokwe, Chiota, Chiweshe, Hwedza, Tjolotjo, Manyame and Zhombe CLs. The landform is an almost flat to gently undulating plateau with very few rock outcrops. Vleis are locally common, particularly in higher rainfall areas. Large termite mounds are a characteristic feature; in Gokwe, lines of these termitaria define a set of fractures in the tonalite bedrock (Sutton, 1979). The unit is represented in Natural Regions II, III and IV; Agroclimatic Zones 2, 3 and 4 and has an area of 2 670 km^2.

Geology Mainly felsic gneisses and tonalites comprise this unit.

Soils A catenary association of soils is not evident. They are very shallow to shallow, well- to imperfectly drained sands over very gravelly sands to sandy clay loams containing a high proportion of coarse feldspar grains. Soils in some wetter positions may be underlain by ironstone. Similar soils in the Marondera area are described by Ivy *et al.* (1972). A typical soil classifies as 5G in the Zimbabwe

system, a Typic or Aquic Ustorthent according to Soil Taxonomy and a Eutric Regosol or Gleysol according to FAO/UNESCO/ISRIC.

Natural vegetation In the higher rainfall areas, disturbed remnants of *Brachystegia spiciformis – Julbernardia globiflora* woodland are found. With decreasing rainfall *J. globiflora* may become dominant and *Brachystegia boehmii* may be locally common along with *Monotes glaber*, particularly in conditions of impeded drainage or where gravel or ironstone occurs near the soil surface. In the driest situations, Agroclimatic Zone 4, *Julbernardia globiflora* may be locally dominant but the miombo species are generally minor constituents of a very depleted mixed woodland which includes *Sclerocarya birrea, Terminalia sericea, Lonchocarpus capassa, Combretum apiculatum, C. zeyheri, C. fragrans, Kirkia acuminata* and *Cassia abbreviata*. Species typically growing on the large termitaria in these drier areas are *Colophospermum mopane, Balanites aegyptiaca, Manilkara mochisia, Berchemia discolor* and *Markhamia acuminata*.

Land use About 80% of the unit is arably disturbed in the moister northern areas to about 60% arably disturbed in the drier south. The large termitaria are frequently dug out and spread as a traditional soil amendment or used as brick-making material.

Land capability This unit comprises poor quality arable land mainly of Classes III and IV. It has a variable proportion of Class IVw and Class V land, as high as 35% in the Chiota and Hwedza CLs.

Irrigability The soils are unsuitable for normal irrigation.

Erosion Much of the unit is affected by severe sheet erosion. The profiles give the impression of regolith or granitic drift that has accumulated as the result of natural erosion processes on a parent material susceptible to weathering and subsequent loss of the finer products, particularly clay, by dispersion.

Development potential Owing to poor quality soils and lack of scope for extending the area under dryland cultivation the development potential is low. There are, however, many areas where traditional forms of groundwater irrigation can be developed and extended.

Typical Profile Description Land Unit G6

Profile number:	157-GG-90 described on 26 June 1990. Auger boring.
Location:	Between the Vungu River and Sombibi Dam, Manyame CL, Gweru District.
Site:	Mid slope, 3%, in gently undulating terrain. About 1 250 m elevation. Great variation in surface soil colour, from red to light grey, over distances of less than 50 metres. Gravel and stone layers seen at shallow depth in exposures. Cloddy surface, liable to crust. Farmer indicated that part of the field is subject to ponding during the rains.
Vegetation/land use:	Previous crop maize. Sparse *Colophospermum mopane* on lower slopes. Site with occasional shrubs of *Securinega virosa*.
Parent material:	Tonalitic gneiss.
Erosion:	None evident.
Land capability:	MIVw.
Profile irrigable value:	4.
Soil classification:	5P (Zimbabwe) Aquic Arenic Paleustalf or Aeric Arenic Albaqualf (Soil Taxonomy) Gleyic Luvisol or Eutric Planosol (FAO/UNESCO/ISRIC)
0-13 cm	Greyish brown (2.5Y 5/2m) medium loamy sand; dry.

13-69 cm	Pale yellow (2.5Y 7/4m) medium loamy sand; common medium strong brown mottles; moist becoming wet.
69-79 cm	Light grey (2.5Y 7/2m) coarse sandy loam; many coarse brownish yellow mottles, 5% moderately hard, <5 mm diameter MnO_2, common thick greyish brown clay cutans, few subround quartz gravel; wet with watertable at 74 cm depth.
>79 cm	Too gravelly to auger below this depth.

ANALYSIS PROFILE 157-GG-90

Depth (cm)	0-13	13-69	69-79
Lab No.	Y3380	Y3381	Y3382
DM %	99.6	99.7	99.7
Texture	mLS	mLS	cSaL
Clay %	5	8	17
Silt %	5	7	7
Fine Sand %	36	39	31
Medium Sand %	32	31	24
Coarse Sand %	22	14	21
pH ($CaC1_2$)	6.0	5.9	5.2
Carbonates %	0	0	0
EX Ca (me %)	1.8	1.0	2.0
EX Mg (me %)	0.5	0.5	1.8
EX Na (me %)	0.08	0.06	0.17
EX K (me %)	0.18	0.02	0.02
TEB (me %)	2.6	1.5	4.0
CEC (me %)	2.7	2.9	6.0
Base Sat %	98	53	67
E/C	53.3	35.6	35.0
S/C	52.0	18.7	23.4
ESP	3.0	2.2	2.8
EKP	6.7	0.7	0.4
Free Fe	0.20	0.30	0.58

LAND UNIT G7

General description This unit is restricted to the Eastern Highlands region and parts of the adjacent Highveld. It is represented in the Communal Lands of Manyika, Mutasa North and South, Manga, Holdenby, Sawunyama, Nyamaropa, Makoni and Chiduku. Elevations are generally high, up to 1 900 metres in Sawunyama CL, but may be as low as 500 metres on the eastern flank of the Highlands in river valleys such as the Pungwe. The landform comprises a complex of plateaux and valleys, locally very steep. The unit occurs in Natural Regions I and II; Agroclimatic Zones 1 and 2 and has an area of 1 360 km^2.

Geology Complex but mainly granitic rocks of adamellite and granodiorite composition with minor gneissic inclusions. Dolerite intrusions are common.

Soils The soils of this unit do not show significant catenary variation. They are typically well-drained, deep, dark reddish brown sandy clay loams over red clays with rather less clay in the less-strongly weathered soils. In the Zimbabwe classification, the soils are either Ortho- or Paraferrallitic with the soil family dependent on the nature of the parent material resulting in a broad range of soils including 6G, 7G, 7P, 7E, 6GE and 7GE. In Soil Taxonomy these include Typic and Rhodic Hapludox, Typic and Rhodic Kandiudults or Kandiudalfs and Typic Kandiustalfs or Kandiustults. According to FAO/UNESCO/ISRIC the soils include Haplic and Humic Acrisols and Ferralsols.

Natural vegetation This unit includes very limited areas of forest which are representative of the dry extreme of tropical rainforest development. A high- to medium-altitude rainforest zone, above about 1 400 m, is not well represented by the Communal Lands and at lower elevations, most of the forest has been completely destroyed by communal agriculture. In drier situations woodland of the miombo type is the climax vegetation.

Land use Maize is the main annual crop, with cotton important in some CLs. In higher rainfall areas, perennial crops such as coffee, tea and bananas are grown. The river terraces of the Pungwe valley are cropped throughout the year with various combinations of maize, rice, beans and *Colocasia* sp.

Land capability The land capability criteria of the Department of Agricultural, Technical and Extension Services (1981) are not relevant in the humid climate of Natural Region I. In general terms, Tilcor (1977) in planning land use in the Pungwe valley uses a slope limit of 20% for identifying arable land. Bromley *et al.* (1968) in part of Chimanimani District, including Ngorima CL, use a limit of 25% for arable crops and note that plantation crops can safely be planted on slopes approaching 50%.

Irrigability Although most of the soils are satisfactory for irrigation, topography is usually a constraint for any developments above micro-scale. Where sources of water are available, there are common examples of channel diversions over considerable distances to provide supplementary and dry season irrigation on a small scale.

Erosion Slopes of up to 40% are cultivated in this unit without any indications of severe erosion. The soils are deep, permeable and have a stable structure with a considerable capacity to accept and store rainfall without runoff. However, the long term effects of cultivation on steep slopes without measures to protect against erosion are not known.

Development potential The combination of reliable rainfall, with local sources of irrigation water and deep soils with high clay contents has significant advantages. However the soils are chemically infertile, very acid and the topography is frequently limiting in terms of both cultivation and transport. Sustainable production on the steeper land should be mainly orientated around perennial crops.

Typical Profile Description Land Unit G7

Profile number:	436-FF-87 described on 14 October 1987. Profile pit.
Location:	Near the Pungwe River, 7 km north of Ruda on the road to Katiyo. Holdenby CL, Mutasa District. Map reference VQ 895 622.
Site:	Mid slope position on 32% slope at 740 m elevation. The landform is hilly with steep sided valleys, close drainage spacing and narrow crests.
Vegetation/land use:	Recently cleared land, stumps still present. Maize previous crop, bananas to be planted in small holes filled with leaf cuttings. *Anthocleista grandiflora* and *Lantana camara* are common. *Psidium guajava* has become naturalized.
Parent material:	Granitic rock with a small outcrop nearby.
Erosion:	Deep gullies seen locally but not as extensive as might be expected on such steep cleared slopes, possibly owing to the very permeable nature of the soil.
Land capability:	Should be considered as not suitable for arable crops but suitable for perennial crops provided a cover crop is maintained.
Profile irrigable value:	2
Soil classification:	7G (Zimbabwe) Mollic Kandiudalf (Soil Taxonomy) Haplic Ferralsol (FAO/UNESCO/ISRIC)
0-13 cm	Dark reddish brown (5YR 3/3m) medium sandy clay loam, ploughed layer, slightly cloddy with weak medium crumb structure; slightly sticky, slightly plastic, very friable moist, slightly hard dry consistence; common fine pores; common fine, few medium and coarse roots; rapid permeability and well drained; abrupt smooth transition to:

13-45 cm	Red (2.5YR 4/6m) clay; moderate medium subangular blocky with fine crumb structure; 50-60% of surface area of ped faces with thin cutans, associated with manganese staining; slightly sticky, slightly plastic, very friable moist, slightly hard dry consistence; common fine pores; few fine, medium and coarse roots; rapid permeability and well drained; diffuse transition to:
54-125 cm	Red (2.5YR 4/6m) clay; moderate/weak subangular blocky with fine crumb structure; slightly sticky, slightly plastic, friable moist, slightly hard dry consistence; few cutans; some manganese staining on ped faces; common fine pores; few fine and medium roots; rapid permeability and well drained; gradual smooth transition to:
125-170 cm +	Yellowish red (5YR 5/8m) clay; weak medium subangular block and fine crumb structure; slightly sticky, slightly plastic, very friable moist, soft dry consistence; few cutans; this horizon has a proportion of soft weathering parent material (7.5YR 5/8) throughout; some manganese staining on ped faces; few irregular quartz and feldspar 4cm diameter stones; common fine pores; few medium roots; rapid permeability and well drained.

ANALYSIS PROFILE 436-FF-87

Depth (cm)	0-13	25-40	60-75	110-125	155-170
Lab No.	W2638	W2639	W2640	W2641	W2642
DM %	98.0	97.9	97.9	98.0	98.2
Carbon %	3.2	0.9	0.4	0.4	0.3
Texture	cSaCL	C	C	C	C
Gravel %	4	0	0	0	5
Coarse Sand %	20	14	14	16	15
Medium Sand %	18	8	10	10	9
Fine Sand %	15	10	13	10	12
Silt %	15	14	14	14	14
Clay %	32	53	49	51	51
pH ($CaCl_2$)	4.6	3.8	3.4	3.2	4.5
Carbonates %	0	0	0	0	0
EX Ca (me %)	1.7	0.3	0.8	0.6	1.3
EX Mg (me %)	1.1	0.3	0.1	0.3	0.1
EX Na (me %)	.06	.04	.02	.22	.22
EX K (me %)	.37	.10	.02	.06	.10
TEB (me %)	3.3	.7	.9	1.3	1.6
CEC (me %)	5.6	3.4	3.0	2.9	1.6
Base Sat %	59	21	32	44	100
E/C	17.6	6.3	6.0	5.6	3.2
S/C	10.3	1.3	1.9	2.4	3.2
ESP	1.1	1.2	.7	7.8	13.7
EKP	6.5	3.0	.7	2.1	6.3

LAND UNIT G8

General Description This unit is characteristic of the Middleveld granitic terrain in the upper Save Basin. It is best developed in an arc through Gutu, Save, Marange, Mutambara, Muwushu and Mutema CLs. The landform comprises undulating pediment slopes between few to common castle koppies and bornhardts. Drainage is dominated by the Save River and its tributaries the Odzi and Nyazvidzi Rivers. Flow in the majority of the smaller tributaries is ephemeral owing to the well jointed granitic bedrock. Locally, however, poorly jointed subsurface granite results in areas with a high watertable unrelated to slope position and the occurence of small perennial streams. This unit occurs within Natural Regions IV and V, Agroclimatic Zones 4 and 5 and has an area of 7 670 km^2.

Geology Younger intrusive granites of granodiorite and adamellite composition predominate in this unit.

Soils These are well-drained, moderately deep to deep, brown to reddish brown coarse-grained sands over strong brown to red coarse-grained sands to loamy sands or sandy loams. Although slightly heavier textures often occur in upper slope positions close to rock outcrops, a catenary association of soils is not usually evident. There are a few hydromorphic soils affected by a perched watertable in mid to upper slope positions. Associated soils are gravelly and shallow or they may be influenced by dolerite intrusions (intergrades between Groups G and E). The soils of this unit have been described by Loxton & Associates (1971) in Gutu CL.

The typical upland soils are 5G in the Zimbabwe classification system, Typic Ustipsamments in Soil Taxonomy and Haplic or Luvic Arenosols in the FAO/UNESCO/ISRIC legend.

Natural vegetation Very disturbed remnants of miombo woodland, dominated by *Julbernardia globiflora* occur throughout the moister high-lying parts of the unit. *Colophospermum mopane* becomes dominant in Natural Region V.

Land use Although maize is important throughout the unit, sorghum and millet assume prominence in the drier areas.

Land capability Where the slope is less than 5% the land is Class III. Where the slope is greater, it is Class IV.

Irrigability The soils are downgraded to generally Class C or Class S, because of their very low clay content and coarse grain size of the sand fraction.

Erosion There is evidence of considerable erosion and movement of material, sometimes referred to as granitic drift, having taken place in the geological past. Present day processes are accelerated by human activities and livestock, particularly in the grazing areas.

Development potential For dryland cropping, this unit is suitable only for drought-tolerant varieties. Livestock production is important and open to improvement through better management. Dry season micro-irrigation is practiced in areas with a high watertable and appears to be capable of expansion.

Typical Profile Description Land Unit G8

Profile number:	153-FF-87 decribed on 24 June 1987. Profile pit.
Location:	2 km northwest of Mukwada school, near Chapungu Dam, Marange CL, Mutare District. Map reference VP 305 440.
Site:	Undulating landform with convex slopes, elevation 840 m. Mid-slope position, 4%. Mean annual rainfall about 590 mm (Mutsago). Many very large termite mounds, about 80 m apart, 50 m in circumference at the base and 5 m high.
Vegetation/land use:	Land cleared and stumped for cultivation in 1986. No soil conservation structures. *Brachystegia spiciformis* and *Parinari curatellifolia* common.
Parent material:	Granitic drift.
Erosion:	Not observed at the site.
Land capability:	Class MIII.
Profile irrigable value:	4
Soil classification:	Presumed Fersiallitic 5G (Zimbabwe) Typic Ustipsamment (Soil Taxonomy) Haplic Arenosol (FAO/UNESCO/ISRIC)
0-1 cm	Dark brown [10YR 3/3m] and pale brown [10YR 6/3d] single-grained, very loose, very coarse sand; disturbed surface layer; abrupt smooth transition to:

1-19 cm	Dark brown [10YR 3/3m] and pale brown [10YR 6/3d] coarse sand; very weak, very coarse granular and very thick platy structure; non plastic, non sticky, friable moist, very soft dry consistence; no pores observed; common fine and few medium and coarse roots; rapid permeability and excessively well drained; clear wavy transition to:
19-51 cm	Strong brown [7.5YR 4/6m] and light brown [7.5YR 7/4d] coarse sand; weakly coherent apedal structure; non plastic, non sticky, friable moist, soft dry consistence; few fine and medium pores; few fine, medium and coarse roots; rapid permeability, and very well drained; smooth gradual transition to:
51-177 cm	Strong brown [7.5YR 5/6m] with pink [7.5YR 7/4d] and yellowish red [5YR 5/6d] coarse sand [moist at the base of the horizon]; weakly coherent apedal; non plastic, non sticky, friable moist, soft dry consistence; few medium pores; few medium and very few fine roots; gradual increase with depth of 0.5-3 mm-diameter quartz gravel and stones; rapid permeability and very well drained; clear wavy transition to:
177-200+cm	Yellowish red [5YR 5/6m] similar coarse sand with 25% 5-20 mm-diameter angular quartz stones.

ANALYSIS PROFILE 153-FF-87

Depth (cm)	0-15	25-40	70-85	135-150	185-200
Lab No.	W1053	W1054	W1055	W1056	W1057
DM %	99.8	99.8	99.8	99.8	99.6
Texture	cS	cS	cS	cS	clS
Gravel %	4	5	8	9	48
Coarse Sand %	47	46	55	61	60
Medium Sand %	29	30	24	20	16
Fine Sand %	19	18	14	12	12
Silt %	3	3	3	3	4
Clay %	1	3	3	3	8
pH ($CaCl_2$)	4.2	4.1	4.3	4.4	4.4
Carbonates %	0	0	0	0	0
EX Ca (me %)	0.1	0.0	0.0	0.0	0.0
EX Mg (me %)	0.4	0.3	0.7	0.6	0.8
EX Na (me %)	0.02	0.02	0.02	0.04	0.08
EX K (me %)	0.06	0.06	0.06	0.10	0.16
TEB (me %)	0.5	0.4	0.8	0.8	0.5
CEC (me %)	0.5	1.2	1.2	1.1	0.5
Base Sat %	100	32	66	73	100
E/C	54.4	40.6	40.6	37.2	6.2
S/C	54.4	13.1	26.9	27.2	6.2
ESP	4.1	1.7	1.7	3.7	16.3
EKP	12.2	5.1	5.1	9.3	32.7
Org Carbon %	0.03	0.01	0.00	0.00	0.00

LAND UNIT G9

General description This unit occurs in some of the drier parts of the Middleveld and is represented in Nkayi, Mashava, Wenlock, Kumalo and Matopo CLs at elevations between 1 000 m and 1 200 m. There are generally few high rock outcrops but many low exposures characteristic of much of the Older Gneiss Complex. An undulating pediplain with a few vlei drainage ways, marks the southern limit of this feature in places. The unit occurs in Natural Region IV, Agroclimatic Zones 3, 4 and 5, and has an area of 4 720 km^2.

Geology Mainly felsic metamorphic cratonic rocks of the Older Gneiss Complex comprise the geology of this unit.

Soils The soils form an association, usually catenary, comprising, in upper slope positions, gravelly sands where eroded or well-drained, moderately deep, medium- to coarse-grained sands and loamy sands over strong brown to reddish sandy loams at depth (Table 23). Hydromorphic soils, sometimes sodic and

Table 23 Typical catenary relationship of soils – Land Unit G9

Landscape position	Soil Classification		
	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Upper slopes	5G/5P	Typic Ustropepts Typic Haplustalfs/Paleustalfs	Chromic Cambisols Haplic Luvisols
Mid to lower slopes	5G/5P	Typic/Aquic Ustipsamments Typic/Aquic Hapl/Paleustalfs	Luvic/Gleyic Arenosols Haplic/Gleyic Luvisols
Lower slopes and vlei bottomlands	5GU	Aeric Albaqualfs	Eutric Planosols
	8N	Typic Natrustalfs	Haplic/Stagnic Solonetz

exhibiting a duplex or textural contrast profile, are common in mid slope positions. The lower slope position soils may be the sheet eroded product of the duplex soil, the loss of topsoil resulting in a mosaic of bare ground and scrub mopane. In an environmentally similar area of Transvaal, Verster (1989) discusses the spacial pattern of soils along a drainage-toposequence transect.

Natural vegetation In Nkayi CL, the natural vegetation, although very depleted, shows a good correlation with the soil catena. On shallow eroded gravelly soils in upper slope positions there is an association of *Julbernardia globiflora, Brachystegia boehmii, Monotes glaber* and minor *Colophospermum mopane*. The deeper, sandy soils in mid to upper slope positions are associated with *Brachystegia spiciformis, Julbernardia globiflora, Terminalia sericea, Kirkia acuminata, Xeroderris stuhlmannii* and minor mopane. Well-grown mopane becomes dominant on the duplex soils being replaced by a mosaic of bare ground and scrub mopane where severely sheet eroded. At the southern limits of this unit, in Wenlock CL, *Brachystegia spiciformis* is absent and is replaced by a dominant *Combretum-Terminalia* tree savanna.

Land use About 50% of the unit is arably disturbed. The very shallow and severely eroded soils are used for rough grazing.

Land capability There are estimated to be about equal proportions of Classes MIII, MIV and VI land in this unit.

Irrigability The unit is not generally recommended or is unsuitable for irrigation, Class C or Class D.

Erosion Severe sheet erosion, locally very severe, is common. Pipe erosion occurs in some of the duplex profiles.

Development potential The potential is limited. Moisture conservation, through practices conducive to a reduction in runoff and soil loss, is a primary requirement in raising dryland crop yields.

Typical Profile Description Land Unit G9 – Upper to mid slope landscape position

Profile number:	1-GG-89 described on 30 November 1989. Auger boring.
Location:	1.5 km north of Godfrey Huggins bridge across the Shangani River, Nkayi CL, Nkayi District. Map reference PK 8913.
Site:	Convex slope, less than 2%. Common 1-2 m high termitaria. Few granitic boulders on surface. Thin discontinuous layer of light red coarse sand on surface.

Vegetation/land use:	Fallow, maize previous year. 20% herbaceous cover, some mopane regrowth. Mopane dominant in surrounding area, with some *Grewia flavescens*.
Parent material:	Gneiss.
Erosion:	None observed.
Land capability:	Class III owing to restricted subsoil permeability.
Profile irrigable value:	3.
Soil classification:	4G (Zimbabwe) Aquic Haplustalf (Soil Taxonomy) Gleyic Luvisol (FAO/UNESCO/ISRIC)
0-15 cm	Dark yellowish brown (10YR 4/4m), coarse loamy sand.
15-34 cm	Yellowish brown (10YR 5/4m), coarse sandy loam; few fine strong brown mottles.
34-72 cm	Light olive brown (2.5Y 5/4m), coarse sandy clay loam; many coarse yellowish brown mottles; common grey clay cutans.
72-120 cm	Light yellowish brown (10YR 6/4m), coarse sandy clay loam; common medium brownish yellow and light brownish grey mottles; common weathering calcareous rock fragments.

ANALYSIS PROFILE 1-GG-89

Depth (cm)	0-15	15-34	34-72	72-120
Lab No.	Y1647	Y1648	Y1649	Y1650
DM %	98.9	97.2	95.1	94.9
Texture	cLS	cSaL	cSaCL	cSaCL
Clay %	6	16	31	29
Silt %	7	9	6	9
Fine Sand %	24	25	18	20
Medium Sand %	20	21	14	13
Coarse Sand	43	29	30	29
Gravel %	1	2	2	5
pH ($CaC1_2$)	4.4	4.5	5.0	7.4
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	1.4	2.4	7.4	12.8
EX Mg (me %)	1.0	2.4	5.1	6.4
EX Na (me %)	0.02	0.07	0.49	1.07
EX K (me %)	0.21	0.09	0.23	0.36
TEB (me %)	2.6	4.9	13.2	19.9
CEC (me %)	4.8	6.3	17.1	19.9
Base Sat %	54	78	77	100
E/C	79.6	40.6	54.3	69.3
S/C	43.1	31.6	42.1	69.3
ESP	0.4	1.2	2.9	5.4
EKP	4.4	1.5	1.3	1.8
Free Fe	0.64	0.84	1.24	0.67

Typical Profile Description Land Unit G9 – Lower slope landscape position

Profile number:	6-GG-89 described on 1 December 1989. Auger boring.
Location:	Road junction 1 km north of William Farrar bridge over the Gweru River, Nkayi CL, Nkayi District. Map reference PK 9132.
Site:	Slope less than 2%. Surface bare, crusted and with a coarse sand veneer.
Vegetation/land use:	Open mopane bushland with a few trees to 12 m, many cut back. Few other species including *Aloe* sp., *Lonchocarpus capassa, Combretum zeyheri, Xeroderris stuhlmannii* and *Albizia antunesiana*.
Parent material:	Gneiss or old alluvium derived from gneiss. A nearby quarry exposes pebbly alluvium overlying weathered gneiss.
Erosion:	Very severe sheet erosion.
Land capability:	Class VIf.
Profile irrigable value:	4.
Soil classification:	8N (Zimbabwe) Typic Natrustalf (Soil Taxonomy) Haplic Solonetz (FAO/UNESCO/ISRIC)
0-10 cm	Brown (10YR 4/3m) coarse sandy loam; few medium strong brown mottles; platy structure.

10-68 cm	Very dark grey (10YR 3/1m) coarse sandy clay.
68-117 cm	Light yellowish brown (2.5Y 6/4m) clay; few medium brownish yellow mottles; calcareous.

ANALYSIS PROFILE 6-GG-89

Depth (cm)	0-10	10-68	68-117
Lab No.	Y1666	Y1667	Y1668
DM%	98.9	95.5	94.4
Texture	cSaL	cSaC	C
Clay %	11	35	43
Silt.%	25	14	15
Fine Sand %	15	17	16
Medium Sand %	22	16	12
Coarse Sand %	28	18	13
Gravel %	1	1	4
pH ($CaCl_2$)	4.7	6.9	8.0
pH (H_2O)			7.9
Carbonates %	0	0	3.7
Ex Ca (me %)	2.9	16.4	86.6
Ca (water soluble)			0.01
Ex Mg (me %)	2.2	6.7	11.3
Mg (water soluble)			0.0
Ex Na (me %)	0.04	1.92	4.67
Na (water soluble)			0.02
Ex K (me %)	0.29	0.38	0.32
K (water soluble)			0.01
TEB (me %)	5.5	25.4	30.1
CEC (me %)	6.6	29.5	30.1
Base Sat %	83	86	100
E/C	59.4	85.4	70.6
S/C	49.1	73.7	70.6
ESP	0.5	6.5	15.4
EKP	4.3	1.3	1.0
Free Fe	0.49	0.49	0.73

LAND UNIT G10

General description This unit is characteristic of parts of the southern Middleveld and the South-east Lowveld with the most arid climate in Zimbabwe. The landform is an almost flat to undulating pediplain with local, structurally controlled hills. It includes several of the Communal Lands of Bulilimamangwe, Matobo and Gwanda Districts. The unit occurs in Natural Region V, Agroclimatic Zone 6 and has an area of 10 180 km².

Geology Felsic rocks, mainly gneiss, of the Basement Complex comprise this unit.

Soils These are well- to very well-drained, very to moderately shallow, greyish brown to yellowish red gravelly coarse-grained sands to sandy loams. Associated soils are extremely shallow. There are no clear catenary relationships. Similar soils in northeastern Botswana have been described by Venema and De Wit (1990). These are 4P, 5G and 2 (Lithosols) in the Zimbabwe system. The unit has an aridic soil moisture regime (Van Wambeke, 1982) and the soils are therefore classified as Ustalfic Haplargids and Lithic or Ustic Torriorthents. The soils are Chromic Luvisols and Eutric or Dystric Regosols according to FAO/UNESCO/ISRIC.

Natural vegetation *Colophospermum mopane* is the predominant tree species although in most of the unit it takes the form of a many-stemmed shrub or very small tree branching close to the base, often forming a continuous fairly dense cover. Scattered specimens of the baobab, *Adansonia digitata* are conspicuous. Other species associated with the mopane are *Combretum* spp., *Commiphora* spp., *Boscia albitrunca* and *Kirkia acuminata*. Where rock outcrops occur, mopane may be absent, replaced by an association of *Acacia tortilis, Commiphora* spp. and *Euphorbia* spp.

Land use The unit is about 30% arably disturbed with the remainder heavily grazed. In these particularly dry areas sorghum and pearl millet are important but maize remains the most commonly planted grain crop. ARDA (1982) provides some baseline land use data for communal agriculture in this unit and also notes that crop yields are occasionally reduced through waterlogging (season 1980/81 is cited). This is to be expected in these shallow gravelly sands which are not only poorly buffered chemically but also lack the physical moisture-storage capacity to cope with heavy rainfall.

Land capability The AGRITEX land capability system is not applied in Natural Region V as commercial dryland cropping is not a viable proposition and land would normally be assessed according to criteria developed for ranch planning (Vincent, 1962 and Federal Department of Conservation and Extension, 1964) In a communal farming context, the unit is suited to grazing, although the type of management required, in both social and environmental contexts, is controversial.

Irrigability According to the conventional criteria used in assessing land for commercial irrigation, the soils can be considered unsuitable. For traditional forms of small-scale irrigation, the soils are perfectly adequate, water availability being the major constraint. Dryland production of sorghum and millet should benefit from the effect of water harvesting in landscape positions receiving runoff.

Erosion Severe sheet erosion is widespread and many of the incised drainage lines are badly eroded.

Development potential The potential is very low. It is primarily suited to extensive grazing.

Typical Profile Description Land Unit G10

Profile number:	85 (not sampled for analysis) described on 19 January 1991. Auger boring.
Location:	Approximately 2 km from Botswana border, Mambali CL, Matobo District.
Site:	Gently undulating, mid slope, 2%.
Vegetation/land use:	Grazing land.
Parent material:	Gneiss.
Erosion:	Moderate erosion, sheet and rill.
Land capability:	Not classified.
Profile irrigable value:	3.
Soil classification:	5G/P (Zimbabwe) Ustalfic Haplargid (Soil Taxonomy) Chromic Luvisol (FAO/UNESCO/ISRIC)
0-16 cm	Dark reddish brown (5YR 3/4m) coarse loamy sand;
16-45 cm	Yellowish red (5YR 4/6m) coarse sandy loam;
45 cm+	gravel or stones limit auger penetration.

LAND UNIT GE1

General description This is a common unit typical of much of the Middleveld region, with examples in Rushinga, Mudzi, Mutoko, Hwedza, Hurungwe, Ndanga, Chivi and Mberengwa Districts at elevations between 600 m and 1 200 m. The landform is commonly a relatively featureless pediplain, undulating to rolling with long slopes and few distinct rock outcrops. It contrasts with adjacent units in the G or RG groups where rock outcrops are common and soils are much sandier and frequently less drouthy. The unit occurs in Natural Regions III, IV and V, Agroclimatic Zones 3, 4 and 5 and has an area of 17 770 km^2.

Geology This unit is characteristically orthogneiss, frequently banded into felsic and mafic segregations. Granodiorites, migmatites, tonalites and more homogeneous gneisses are also common.

Soils A complex of soils in this unit is commonly the result of variation in the composition of the parent rock. The more felsic types produce shallow to very shallow, medium-grained sands or loamy sands over yellowish brown to strong-brown gravelly loamy sands or sandy loams. The soils derived from more mafic types are well-drained, often shallow medium-grained loamy sands or sandy loams over yellowish brown to yellowish red sandy loams or sandy clay loams. Stony land is common. These include 4P, 5P and 5G in the Zimbabwe system and appear to correspond to Typic Haplustalfs or Paleustalfs and Typic or Lithic Ustorthents in Soil Taxonomy. They are Typic, Chromic or Ferric Luvisols and Eutric Regosols according to FAO/UNESCO/ISRIC.

Natural vegetation At higher elevations, *Julbernardia globiflora* and *Brachystegia boehmii* are common with *Afzelia quanzensis* and *Brachystegia glaucescens* closely associated with the very shallow soils and rocky knolls. At lower elevations *Acacia* spp. may become dominant and *Colophospermum mopane* common, particularly in lower slope positions where soils are often more or less sodic. *Sclerocarya birrea* and, in the southeast, *Lonchocarpus bussei* may be locally common.

Land use Overall about 25% of the unit is arably disturbed but this varies considerably depending on population density and access. There are many examples of large grazing areas demarcated from arable blocks, particularly in the southern arc of Communal Lands between Wenlock and Bikita. Most arable areas show vestiges, in the form of degraded contour-bund field boundaries, of the conservation works undertaken during the Land Husbandry Act era.

Land capability There is a very limited area of Class MII land where slope is less than 2% and the surface is free from the tendency to crust. Generally, slope and the presence of soil crusting downgrade most of the unit to MIII or MIV.

Irrigability Many blocks of land with a slope of less than 5% have satisfactory soils and are suitable for irrigation with special precautions or practices (Class B). Most of the unit is Class C.

Erosion The soils of this unit show widespread evidence of severe sheet erosion and locally severe gully erosion. This appears to be a result of frequent runoff, in the absence of maintained soil conservation structures, and a tendency for these soils to form a surface crust. Conditions are often worse in the grazing areas where poor herbaceous cover on these capped soils, cattle track channels and runon from upland arable blocks have combined to encourage soil loss.

Development potential This unit appears to be especially prone to poor yields related to moisture stress caused by low rainfall acceptance. A high proportion of rainfall from convectional storms is probably lost from the unit by runoff (Plate 9). A general emphasis on moisture conservation is required to increase crop yields and improve grazing resources. Wilson (1988) provides useful views on appropriate land use for soils occurring in this unit based on research in Mazvihwa CL.

Typical Profile Description Land Unit GE1

Profile number:	203-GG-90 described on 30 August 1990. Profile pit.
Location:	By Pumula Apostolic Store near Masase in southwest Mberengwa CL, Mberengwa District.
Site:	Profile from freshly dug Blair toilet pit. Mid slope, 2% planar. Hard crusted surface, bare of herbaceous cover.
Vegetation/land use:	*Acacia* spp. dominant but sparse, 1-2 m high. Occasional *Colophospermum mopane, Sclerocarya birrea, Albizia amara, Dichrostachys cinerea, Ziziphus mucronata, Combretum imberbe* and *C. apiculatum*. Crops in this area said to be a total failure.
Parent material:	Gneiss.

Erosion:	Site appears to have suffered severe sheet erosion, but it may be that the undisturbed hard crusted surface is now resistant to erosion by overland flow.
Land capability:	Zimbabwe system not appropriate for Natural Region V. In NR IV this type of soil would be downgraded to Class MIV because of the poor surface conditions.
Profile irrigable value:	2.
Soil classification:	4/5P (Zimbabwe) Typic Haplustalf (Soil Taxonomy) Ferric Luvisol (FAO/UNESCO/ISRIC)
0-10 cm	Pale brown (10YR 6/3d) and dark yellowish brown (10YR 3/4m), medium sandy loam; friable, dry; strong medium platy transitional down to weak fine subangular blocky; few fine fibrous, few medium woody roots.
10-24 cm	Yellowish brown (10YR 5/4d) and dark brown (10YR 3/3m), medium sandy loam; slightly hard, dry; weak medium subangular blocky; few fine fibrous, few medium woody roots.
24-48 cm	Yellowish brown (10YR 5/4d) and dark yellowish brown (10YR 4/4m), coarse sandy loam; hard, dry; weak medium angular blocky; few fine fibrous, few medium woody roots.
48-88 cm	Yellowish brown (10YR 5/6m) and dark yellowish brown (10YR 4/6m), coarse sandy clay loam; very hard, dry; weak coarse angular blocky; weak thin clay cutans; very few fibrous roots.
88-125 cm	Yellowish brown (10YR 5/6d) and dark yellowish brown (10YR 4/4m), medium sandy clay loam; very hard, slightly moist; weak coarse angular blocky; weak thin clay cutans; few 5 mm moderately hard yellowish red round R_2O_3 nodules; 1% increasing with depth to 10% sub-round quartz gravel and stones to 20 cm diameter; very few fibrous roots.

ANALYSIS PROFILE 203-GG-90

Depth (cm)	0-10	10-24	24-48	48-88	88-125
Lab No.	Y4338	Y4339	Y4340	Y4341	Y4342
DM %	99.5	98.8	98.5	97.0	97.8
Texture	mSaL	mSaL	cSaL	cSaCL	mSaCL
Clay %	9	14	18	27	33
Silt %	7	7	7	8	7
Fine Sand %	37	32	27	23	28
Medium Sand %	33	30	29	26	20
Coarse Sand %	14	18	19	17	12
Gravel %	4	7	6	5	7
pH ($CaC1_2$)	4.8	4.6	5.0	5.2	5.3
Carbonates %	0	0	0	0	0
EX Ca (me %)	2.6	3.7	3.1	4.6	5.6
EX Mg (me %)	1.6	1.4	1.9	2.6	2.7
EX Na (me %)	0.04	0.09	0.14	0.18	0.20
EX K (me %)	0.22	0.23	0.07	0.10	0.11
TEB (me %)	4.4	5.4	3.8	7.5	8.6
CEC (me %)	5.1	6.8	3.8	10.1	11.2
Base Sat %	87	79	100	74	76
E/C	54.2	50.5	20.5	38.1	34.3
S/C	46.9	39.8	20.5	28.1	26.1
ESP	0.9	1.3	3.6	1.8	1.8
EKP	4.4	3.3	1.8	1.0	1.0
Free Fe	0.74	0.83	1.30	1.72	2.10

LAND UNIT GE2

General description This unit is restricted to the northeast of Zimbabwe on the Highveld and, locally, the Middleveld regions at elevations between 1 000 m and 1 500 m. It is represented in the Communal Lands of Bushu, Madziwa, Chiweshe, Nyanga, Zimbiti, St. Swithins, Chikore, Weya, Makoni and Chiduku. Landform is a weakly dissected plateau, undulating to rolling with long slopes and few prominent rock outcrops. It occurs in Natural Regions II and III, Agroclimatic Zones 2 and 3 and has an area of 2 430 km².

Geology Mainly relatively mafic gneisses and tonalites comprise this unit.

Soils The soils show no clear catenal relationships. They are well- to moderately well-drained, very shallow to moderately shallow, medium-grained loamy sands and sandy loams over medium- to coarse-grained sandy clay loams. They are frequently gravelly, stony or mottled in the subsoil with a marked increase in clay content at depth. Plinthite and ferricrete are locally common. The soils classify as 5G, 5P, 5GE or 5PE in the Zimbabwe system, Haplustalfs, Paleustalfs or Ustorthents according to Soil Taxonomy and Luvisols, Lixisols or Regosols in the FAO/UNESCO/ISRIC system.

Natural vegetation There are a few remnants of *Brachystegia-Julbernardia* woodland.

Land use About 70% of the unit is arably disturbed. Some large areas are restricted to grazing and have the shallowest of soils although old field boundaries in the form of contour bunds indicate that they have been within the cultivation cycle at some time.

Land capability The unit is classed as mainly III and IV, or MIII and MIV in the drier parts of Natural Region III, owing to depth and surface-texture limitations.

Irrigability Generally this unit is not suited to irrigation because of slope or depth limitations. Small sections of stream terraces are suitable for irrigated plots.

Erosion The shallowest soils, particularly with parent material exposed, are vulnerable to erosion. In some areas the topsoil has been completely lost and the fields abandoned.

Development potential This is generally poor quality degraded land with low arable potential and a high hazard for further degradation.

Typical Profile Description Land Unit GE2

Profile number:	99-FF-87 described on 26 May 1987. Profile pit.
Location:	1 km from Tayengwa Business Centre, Zimbiti CL, Nyanga District. Map reference VR 601 009.
Site:	Undulating, mid slope position, 5%. Elevation 1 220 m.
Vegetation/land use:	Contour-ridged field, previous crop maize.
Parent material:	Reworked material derived from hornblende tonalite.
Erosion:	Sheet and rill erosion noted, with much evidence of past erosion.
Land capability:	Class MIII.
Profile irrigable value:	3.
Soil classification:	5G (Zimbabwe) Typic Haplustalf (Soil Taxonomy) Chromic Luvisol (FAO/UNESCO/ISRIC)
0-8 cm	Dark yellowish brown (10YR 4/6m) and light yellowish brown (10YR 6/4d) medium loamy sand; weak medium crumb and platy structure; non sticky, non plastic, friable moist, soft dry consistence; few fine and coarse pores; few fine roots; good permeability and well drained; abrupt smooth transition to:
8-22 cm	Dark yellowish brown (10YR 4/6m) and light yellowish brown (10YR 6/4d) medium sandy clay loam; massive structure; non sticky, non plastic, friable moist, slightly hard dry; few fine pores; few fine roots; good permeability and well drained; abrupt smooth transition to:
22-33 cm	Stone line composed of smooth and irregular-shaped quartz and granitic stones 2-8 cm in diameter.

33-50 cm	Strong brown (7.5YR 4/6m) and brownish yellow (10YR 6/6d) coarse sandy loam; massive structure; slightly sticky, plastic, friable moist, hard dry consistence; few thin cutans; common manganese concretions; stones and weathering material increasing with depth; common fine pores; very few fine and medium roots; slightly restricted permeability, moderately well drained; diffuse boundary to:
50-100 cm	Weathering parent material with few illuvial clay cutans, and few fine roots; fewer manganese concretions from 76 cm.
100-137 cm	Similar compact hard weathering parent material with cutans, no roots observed.

ANALYSIS PROFILE 99-FF-87

Depth (cm)	0-8	8-11	33-48
Lab No.	W0620	W0621	W0622
DM %	99.6	98.6	98.1
Texture	mLS	mSaCL	cSaCL
Gravel %	2	0	21
Coarse Sand %	15	17	29
Medium Sand %	34	24	18
Fine Sand %	42	30	19
Silt %	3	4	9
Clay %	6	25	25
pH ($CaC1_2$)	4.1	4.8	5.3
Carbonates %	0	0	0
EX Ca (me %)	0.7	3.5	4.7
EX Mg (me %)	0.2	1.7	2.5
EX Na (me %)	0.06	0.06	0.10
EX K (me %)	0.14	0.10	0.8
TEB (me %)	1.0	5.4	7.3
CEC (me %)	2.4	6.7	8.6
Base Sat %	44	81	85
E/C	39.9	26.4	35.3
S/C	17.5	21.3	29.2
ESP	2.6	0.9	1.2
EKP	6.0	1.5	0.9
Organic Carbon %	0.22	0.31	0.16

LAND UNIT GE3

General description This is a minor unit occurring in the south of Marange CL in Mutare District. It forms part of the Middleveld transitional to the Middle Save Valley lowveld at elevations between 600 m and 800 m. The landform is gently undulating with slopes mainly not exceeding 3%. Surface stones and boulders, mainly spheroidally weathered dolerite, are locally common. The unit occurs in Natural Region V, Agroclimatic Zone 5 and has an area of 165 km^2.

Geology The main rock type is granitic with a small area of Umkondo system rocks in the south, including basalt. Dolerite intrusions are common.

Soils The soils appear to be derived from reworked material of mixed granitic, doleritic and, in the south, basaltic origin. They are variable but frequently well-drained, moderately shallow to deep, dark reddish brown coarse-grained loamy sands to sandy loams over often stony red or dark red coarse-grained sandy loams and sandy clay loams. These are associated with soils of slightly heavier texture, usually medium-grained sandy loams over calcareous sandy clay loams. There was no evidence of a catenary relationship between the different soils. They are either 4EG or 4GE in the Zimbabwe system, Typic Rhodustalfs according to Soil Taxonomy and Chromic Luvisols according to FAO/UNESCO/ISRIC.

Natural vegetation The vegetation is a tree savanna with *Colophospermum mopane* locally dominant. *Dalbergia melanoxylon* is common and *Adansonia digitata* conspicuous.

Land use More than 50% of the unit is arably disturbed, much having been brought into cultivation recently. Mhunga (pearl millet) appears to be the main

crop together with some sunflower. The older fields have been contour ridged but areas recently cleared for cultivation have not.

Land capability No classification criteria are available for cropping suitability in Natural Region V.

Irrigability The soils have a reasonably high chemical fertility, combined with good nutrient- and water-retention properties. Slopes are not limiting for irrigation. Soil depth and locally restricted drainage are the major constraints. Profile irrigable values are usually 2. More detailed surveys are required to locate irrigable areas. Land in the vicinity of the typical profile, 161-FF-87, appears to be well suited to irrigation, possibly 40-50 ha close to the Odzi River.

Erosion With the exception of severe gullying adjacent to the larger rivers, the unit shows only local evidence of slight to moderate sheet erosion.

Development potential The unit has the benefit of level terrain together with chemically fertile soils and appears to be well suited to irrigation. The major soil limitation is depth or high gravel content. For dryland cultivation, water conservation practices such as tied ridges and basins have been shown to be effective, particularly on heavy-textured soils in other areas of Natural Region V in Zimbabwe (Jones *et al.*, 1987).

Typical profile description Land Unit GE3

Profile number:	161-FF-87 described on 24 June 1987. Profile pit.
Location:	1.5 km southwest of Hot Springs Bridge over the Odzi River, Marange CL, Mutare District. Map reference VP 415 248.
Site:	Very gently undulating area between the Odzi River and low hills to the west. Mid slope, 0.5%. Few mafic igneous boulders on surface. Elevation is 580 m and mean annual rainfall at Hot Springs is 527 mm.
Vegetation/land use:	The site, under a tree savanna dominated by *Colophospermum mopane* and *Acacia* spp., was in the process of being cleared at the time of survey.
Parent material:	Probably reworked, possibly alluvial material of mixed felsic and mafic origin, overlying basalt or dolerite.
Erosion:	No evidence observed at the site.
Land capability:	Not assessed.
Profile irrigable value:	1.
Soil classification:	4EG (Zimbabwe) Rhodic Paleustalf (Soil Taxonomy) Rhodic Nitisol (FAO/UNESCO/ISRIC)
0-15 cm	Dark reddish brown (5YR 3/3m) and reddish brown (5YR 4/4d) medium sandy loam; moderate medium to coarse granular structure; slightly sticky, slightly plastic, friable moist, slightly hard dry consistence; few medium pores; few fine roots; good permeability and well drained; gradual transition to:
15-30 cm	Dark reddish brown (5YR 3/3m) and dark reddish brown (5YR 3/4d) medium sandy clay loam; weak medium prismatic structure; sticky, slightly plastic, friable moist, and slightly hard dry consistence; common medium pores; few fine and medium roots; good permeability and well drained; gradual transition to:
30-50 cm	Dark reddish brown (5YR 3/3m) and dark reddish brown (5YR 3/4d) medium sandy clay loam; moderate to weak coarse prismatic structure; sticky, plastic, friable moist and hard dry consistence; few thin cutans mainly on vertical ped faces; few medium pores; few medium and fine roots; good permeability and well drained; gradual transition to:

50-100 cm	Dark reddish brown (2.5YR 3/4m and d) coarse sandy clay loam; moderate medium subangular blocky structure; sticky, plastic, friable moist and hard dry consistence; common thin cutans mainly on vertical ped faces; thin pseudo-mycelia of carbonate covering 10% of the ped surface; few fine pores; few medium roots; slightly restricted permeability, well drained; gradual transition to:
100-155+cm	Red (2/5YR 4/6m) and yellowish red (5YR 5/6d) coarse sandy clay loam (slightly coarser sand than the above horizon and slightly less clay); moderate to weak coarse prismatic structure; sticky , plastic, friable moist and hard dry consistence; fewer cutans than the horizon above, thin and occurring on vertical and horizontal ped faces; thin carbonate pseudo-mycelia as in the horizon above; few fine pores; few fine and medium roots; slightly restricted permeability and well drained.

ANALYSIS PROFILE 161-FF-87

Depth (cm)	0-15	15-30	35-50	70-85	105-120
Lab No.	W1079	W1080	W1081	W1082	W1083
DM %	98.8	98.1	97.4	97.1	96.8
Texture	mSaL	mSaCL	cSaCL	cSaCL	cSaCL
Gravel %	0	0	0	13	7
Coarse Sand %	15	15	15	20	18
Medium Sand %	22	19	15	14	17
Fine Sand %	35	30	27	21	22
Silt %	13	11	16	16	16
Clay %	15	25	28	30	28
pH ($CaC1_2$)	5.6	6.4	6.6	7.0	7.3
EX Ca (me %)	8.1	9.9	10.1	17.9	16.2
EX Mg (me %)	3.3	3.4	3.4	53.3	4.5
EX Na (me %)	0.02	0.02	0.02	0.08	0.50
EX K (me %)	1.62	0.55	0.37	0.37	0.33
TEB (me %)	12.0	13.9	13.9	14.0	21.6
CEC (me %)	12.0	14.1	19.7	14.0	22.4
Base Sat %	100	98	71	100	97
E/C	79.6	55.5	71.4	47.0	80.5
S/C	79.6	54.7	50.4	47.0	77.7
ESP	0.2	0.1	0.1	0.6	2.2
EKP	13.5	3.9	1.9	2.7	1.5
Org. Carbon %	0.05	0.03	0.40	0.29	0.26

Group E – Land units on mafic igneous and metamorphic rocks

LAND UNIT E1

General description Soils representative of this unit can be found in most Communal Lands in the Highveld and Middleveld regions where Basement Complex rocks occur. Where mapped, the unit generally conforms to parts of the schist belts and is represented in the Districts of Darwin, Mutoko, Murewa, Makoni, Chegutu, Nkayi, Chimanimani and Gutu. Many other occurrences are too small to map, being associated with narrow igneous intrusions into the cratonic granites and gneisses. Landform is variable but mainly of a linear type. This unit occurs in Natural Regions II, III and IV, Agroclimatic Zones 2, 3 and 4 and has an area of 935 km^2.

Geology The geology of the schist, or gold, belts represented by this unit comprise mafic metavolcanics or less commonly gabbro. Dolerite and epidiorite dykes and sills are particularly common in the northeast.

Soils These are well-drained, shallow to deep, typically dark reddish brown sandy loams, sandy clay loams, sandy clays, clay loams or clay over reddish brown, red or dark red, well-structured clays. Some soils with a relatively high proportion of fine sand or silt in the topsoil may develop a platy surface structure, indicative of poor structural stability and liable to induce poor rainfall acceptance. None of the Communal Land examples of this unit exhibit well-developed

catenary sequences of soils. Examples of catenas are, however, given by Purves *et al.*, (1981), in a large scale commercial farming area near Harare. The soils classify as 4E or 5E (Zimbabwe), Kandiustalfs, Rhodustalfs or Paleustalfs (Soil Taxonomy) and Lixisols, Luvisols or Nitisols (FAO/UNESCO/ISRIC).

Natural vegetation In Agroclimatic Zones 2 and 3, the natural vegetation is a *Brachystegia spiciformis – Julbernardia globiflora* woodland with *Brachystegia boehmii* becoming locally dominant with a decrease in effective rainfall. Other species becoming common in drier areas at lower elevations include *Acacia sieberana, A. polyacantha, Bauhinia petersiana, B. thonningii* and *Combretum* spp. In the driest areas, Agroclimatic Zone 4, *Colophospermum mopane* is usually the dominant species in an open tree savanna.

Land use The soils of this unit are widely used for cultivation, both in the communal and commercial farming subsectors and can be very productive in areas with a reliable rainfall. Where rainfall is lower and less reliable, these soils can be susceptible to drought as unfavourable physical characteristics of the soil surface cause surface runoff and also large amounts of water are required to raise the soil to field capacity (Purves *et al.*, 1981). In a resettlement area between Zhombe and Silobela CLs, on the boundary between Natural Regions III and IV, Vaughan-Evans (1981) recommends, for dryland cultivation, deep but infertile sands derived from Kalahari and Karoo sediments in preference to epidiorite-derived clays of Land Unit E1 in view of the low and ineffective rainfall. However, where irrigation water is available and topography level, the soils of this unit are very productive. Many small- to medium-sized Communal Land irrigation schemes have been intentionally and precisely located on small inclusions of these soils within the more familiar terrain of the granitic Basement Complex. Examples of these schemes include the Tuli-Makwe in Makwe CL and the Silalabuhwa in Insiza CL where the irrigation water is received by canal under gravity flow from a dam some 10 km distant.

Land capability Where slopes are less than 2%, Class I land is found to a limited extent and is largely specific to the red clay or clay loam soils on basic igneous rocks (Department of Agricultural, Technical and Extension Services, 1981). Where surface capping is a problem, the land is downgraded to Class II or III. In drier areas with slopes of less than 2%, the land is Class MI or MII. Where surface capping occurs or the topography is undulating, land is downgraded to Class MIII or MIV.

Irrigability Where slope is less than 5%, the land has an irrigability Class of A or B, depending on soil depth.

Erosion Many of these soils are sensitive to erosion caused by runoff on capped soils. In the Communal Lands, moderate to severe sheet erosion is widespread owing to the very poor condition of soil conservation structures in long-established arable areas or the more recent clearing of land in topographically unsuitable areas.

Development potential This unit is representative of the type of land preferred, in commercial farming areas of the northern Highveld, for arable cropping, particularly maize. In the communal subsector, it is a less common land unit, but is similarly widely used for cropping. There is little scope for an expansion of cultivation, but there are opportunities for increasing yield through improved management adapted from commercial practices. The unit will continue to be the focus for conventional irrigation schemes although the main constraint to development appears to be concerned with problems of surface water storage and supply.

Typical Profile Description Land Unit E1

Profile number:	16-GG-89 described on 17 April 1988. Auger boring.
Location:	Side road to St. Marks school, off Mubayira to Chegutu road, Mhondoro CL, Chegutu District. Map reference TQ 3081.
Site:	Mid slope on planar slope rising 2% north along road. Few 2-3 cm wide surface cracks. Loose, apparently sandy surface with black ilmenite grains.
Vegetation/land use:	Extensively cultivated area with very little woody vegetation. Field with very poor maize.
Parent material:	Gabbro or norite of the Great Dyke.
Erosion:	Moderately severe sheet erosion.
Land capability:	Class II owing to erosion status; Class I before degradation.
Profile irrigable value:	1.
Soil classification:	5E (Zimbabwe) Rhodic Kandic Paleustalf (Soil Taxonomy) Rhodic Nitisol (FAO/UNESCO/ISRIC)
0-25 cm	Dark red (2.5YR 3/6m) fine sandy clay; slightly moist.
25-62 cm	Dark red (2.5YR 3/6m) clay; slightly moist.
62-112 cm	Dark red (2.5YR 3/6m) clay; moist.
112-140+cm	Dark red (2.5YR 3/6m) clay; moist.

ANALYSIS PROFILE 16-GG-89

Depth (cm)	0-15	33-50	80-95	115-130
Lab No.	X0450	X0451	X0452	X0453
DM %	97.3	96.1	95.7	95.9
Texture:	fSaC	C	C	C
Gravel %	0	0	0	20
Coarse Sand %	3	2	2	3
Fine Sand %	20	6	6	5
Fine Sand %	35	22	20	20
Silt %	12	11	15	16
Clay %	40	58	57	56
pH ($CaC1_2$)	4.8	5.2	5.4	5.5
Carbonates %	0	0	0	0
EX Ca (me %)	7.5	9.1	14.0	14.5
EX Mg (me %)	3.5	3.4	4.3	4.1
EX Na (me %)	0.04	0.06	0.06	0.08
EX K (me %)	0.10	0.06	0.04	0.06
TEB (me %)	11.1	12.7	13.2	18.6
CEC (me %)	14.0	17.0	13.2	18.6
Base Sat %	80	75	100	100
E/C	35.1	29.2	23.1	33.1
S/C	27.9	21.8	23.1	33.1
ESP	0.3	0.4	0.5	0.4
EKP	0.7	0.4	0.3	0.3

LAND UNIT E2

General description This unit comprises a more or less dissected plateau, undulating to rolling, locally hilly and, characteristically, with long slopes. It is restricted to the Middleveld region and has been mapped in the Districts of Darwin, Rushinga, Centenary, Guruve, Hurungwe, Ndanga, Masvingo and Chivi. It occurs in Natural Regions II, III and IV, Agroclimatic Zones 2, 3 and 4 and has an area of 3 190 km^2.

Geology The rocks of this unit are associated with the Zambezi mobile belt and the northern zone of the Limpopo mobile belt. They include migmatitic gneisses, paragneisses and mafic granulites.

Soils The soils are mainly well-drained, shallow to moderately deep, fine- or medium-grained loamy sands to sandy clay loams over brown to red sandy clay loams to clays. They may be moderately to very stony. There are no clear catenary relationships since there is often considerable lateral variation in the composition of the parent rock over short distances. Classification is 4P, 5P or 5PE in the Zimbabwe system, with the more siallitic soils tending to occur in the drier areas or on base rich parent materials. They are Chromic Luvisols, Typic or

Udic Haplustalfs, Kandic Paleustalfs or Kanhaplic Haplustalfs according to Soil Taxonomy and Haplic Lixisols or Ferric Lixisols (FAO/UNESCO/ISRIC).

Natural vegetation The unit includes a wide range of vegetation types from the typical miombo woodland at higher elevations to a mopane-dominated tree savanna at lower Middleveld elevations transitional to the Lowveld. At medium altitudes, the strongly fire-resistant *Pericopsis angolensis* is a characteristic tree in open communal farmland.

Land use The proportion of land arably disturbed in the unit was estimated, by grid-point sampling on air photographs, as 68% in Kandeya CL, Darwin District, 60% in Masoso and Chimanda CLs, Rushinga District and 40% in Hurungwe CL, Hurungwe District. Maize is the main grain crop and cotton is an important cash crop. In the higher rainfall areas, cropping in this unit appears to be particularly productive.

Land capability The predominant capability classes are II or MII and III or MIII, the main limitations being slope and soil depth. Soils derived from micaceous parent materials appear to be prone to surface capping and are consequently further downgraded. Non-arable Class VI land or marginally arable Class IV land is locally common where slopes exceed 8%.

Irrigability The soils are generally suitable for irrigation with many having a profile irrigable value of 2. There are no large areas suitable for conventional irrigation development, owing to slope limitations, but many small areas exist with relatively uniform slopes of less than 5% and are well suited to communal schemes.

Erosion There is an above-average erosion hazard related to long slopes up to about 8% in most arable blocks, a general absence of woody cover and the poor condition of the soil conservation contour ridges. Severe, locally very severe, sheet erosion is common.

Development potential This unit has a moderate to high potential for rainfed cropping in the northeast and northwest and a significantly lower potential in the drier southeast. However there appears to be evidence that productivity is declining as poorly managed soil conservation and its corollary moisture conservation is widespread. The prospects for small-scale irrigation development are attractive especially in Hydrological Zone D where this unit is common and surface water resources have not been developed to any extent.

Typical Profile Description Land Unit E2

Profile number:	164-GG-88 described on 18 August 1987. Auger boring.
Location:	2 km north of Magunge Growth Point, Hurungwe CL, Hurungwe District. Map reference QM 5637.
Site:	Lower slope towards the Buhove River. Undulating topography. Few stones. Dark cloddy surface.
Vegetation/land use:	Sorghum (1986-87 season). Sparse woody vegetation including *Pericopsis angolensis* and *Bauhinia thonningii*.
Parent material:	Probably augen biotite gneiss.
Erosion:	None evident.
Land capability:	Class II.
Profile irrigable value:	1.
Soil classification:	5PE (Zimbabwe) Kandic Paleustalf (Soil Taxonomy) Haplic Lixisol (FAO/UNESCO/ISRIC)
0-17 cm	Dark yellowish brown (10YR 4/4m), medium sandy loam; moist below 10 cm.
17-52 cm	Brown (7.5YR 4/4m) coarse sandy clay/clay.
52-104 cm	Yellowish red (5YR 4/6m) clay.

104-140 cm+ Yellowish red (5YR 4/6m), clay; few small gravel; patches of strong brown and red associated with weathering parent material.

ANALYSIS PROFILE 164-GG-88

Depth (cm)	0-15	25-40	70-85	115-130
Lab No.	W1608	W1609	W1610	W1611
DM %	99.3	97.7	97.5	96.9
Texture	mSaL	cSaC/C	C	C
Gravel %	5	0	2	6
Coarse Sand %	14	11	14	15
Medium Sand %	22	13	12	12
Fine Sand %	31	21	17	16
Silt %	15	12	12	12
Clay %	19	43	45	45
pH ($CaCl_2$)	5.0	4.7	4.8	4.9
Carbonates %	0	0	0	0
EX Ca (me %)	3.7	3.9	3.6	3.8
EX Mg (me %)	2.1	2.5	3.0	3.4
EX Na (me %)	0.04	0.02	0.02	0.02
EX K (me %)	0.60	0.41	0.47	0.39
TEB (me %)	6.5	6.8	7.1	7.6
CEC (me %)	7.1	8.8	8.6	8.7
Base Sat %	91	77	82	87
E/C	38.0	20.8	19.3	19.3
S/C	34.5	16.1	15.9	16.9
ESP	0.6	0.2	0.2	0.2
EKP	8.5	4.6	5.5	4.5

LAND UNIT E3

General description This unit occurs as small areas mainly in the Middleveld region where it is associated with Gold Belt lithologies and various landforms, mainly of a linear or arcuate ridge and valley type, with a topography varying from almost flat to hilly. Examples are found in the Districts of Mudzi, Mutoko, Murewa, Gokwe, Kwekwe, Gutu, Masvingo and Umzingwane. The unit occurs in Natural Regions III and IV, Agroclimatic Zones 3 and 4 and has an area of 1 950 km^2.

Geology There are mainly metasediments, volcanic and metavolcanic rocks in this unit.

Soils The upland soils are well-drained, often stony, very shallow to moderately deep, fine-grained reddish sandy loams, sandy clay loams and clay loams over dark reddish brown to red clay loams and clays. No clear catenary association was observed. These soils characteristically have a thin, hard platy surface structure which severely restricts rainfall acceptance, increases the probability of runoff and gives rise to poor emergence of seedlings. This feature appears to be associated with a high fine-sand and silt content in the topsoil. These are 4S or 5S soils in the Zimbabwe classification, Typic Haplustalfs, Rhodustalfs or Paleustalfs according to Soil Taxonomy and Chromic Luvisols according to FAO/UNESCO/ISRIC.

Natural vegetation At higher elevations *Brachystegia spiciformis* and *Julbernardia globiflora* are dominant. With a decrease in elevation and effective rainfall these species are replaced by *Brachystegia boehmii* and *Acacia* spp. *Colophospermum mopane* occurs locally as an indicator of shallow, eroded soils.

Land use This unit is favoured for cropping and shows evidence in most areas of 70% or more arable disturbance. In Gokwe CL this unit shows a regular field pattern suggesting that parcels of land were developed under government direction, probably in the 1960s. Where used for grazing, grass cover is sparse and bare patches common.

Land capability Land is generally downgraded for dryland cropping to Class II or III in higher rainfall areas or MIII or MIV in lower rainfall areas because of

unfavourable surface characteristics conducive to the formation of a hard surface crust. For this reason, these soils can pose serious management problems and high crop yields are possible only with the best management practices. In a commercial production context, these include the correct timing of cultivation, the return to the soil of a considerable bulk of organic matter in the form of crop residues and the establishment of grass leys (Hannington, 1972).

Irrigability Where surface crusting is not severe, the soil profile irrigable value is 1 or 2. Where severe crusting results (from frequent irrigation applied in small amounts or a high hazard of runoff and consequent erosion), the irrigable value is downgraded to 3 or 4. In Uzumba CL, soils of this unit receive supplementary irrigation through diversion of streams rising in the Makuruanopamaenza Hills, a Gold Belt formation bordering the Mazowe River.

Erosion Severe sheet erosion is widespread at both cultivated and permamently grazed sites. Gully erosion is frequent near most drainage lines related to lines of livestock movement and conditions are generally deteriorating.

Development potential There is very little potential for extending rainfed cultivation. However, the soils are fertile with a high water-holding capacity but require appropriate management to improve infiltration capacity thus allowing a potentially high productivity under dryland conditions. Prospects are good for intensifying production through small-scale irrigation.

Typical Profile Description Land Unit E3

Profile number:	129-GG-90 described on 14 June 1990. Profile pit.
Location:	By the Kwekwe to Gokwe road, at junction to Chief Ndbeni's kraal. About 50 m from communal land boundary with State Land. Map reference QK 5923.
Site:	Gently undulating with maximum slope about 4%, slope at site <2%. 1 100 m elevation. Few surface stones and boulders. Surface crust. Natural Region III, Agroclimatic Zone 4.
Vegetation/land use:	Fallow for one year, sunflower during 1988/89 season. Very sparse grass and weeds, 90% of surface bare. Contour ridges but unmaintained. Very few trees including *Colophospermum mopane, Diospyros kirkii, Lonchocarpus capassa, Combretum imberbe, Bauhinia thonningii* and common *Acacia* spp. including *A. gerrardii.*
Parent material:	Tuff of the Bulawayan Group.
Erosion:	Severe sheet erosion.
Land capability:	Class MIII, downgraded owing to slightly unfavourable physical characteristics of the soil surface and evidence of severe sheet erosion.
Profile irrigable value:	1.
Soil classification:	4S (Zimbabwe) Typic Rhodustalf (Soil Taxonomy) Chromic Luvisol (FAO/UNESCO/ISRIC)
0-10 cm	Reddish yellow (5YR 6/8d), clay loam; hard, dry; moderate thin platy over moderate coarse angular blocky structure; few fibrous roots; clear, smooth boundary to:
10-42 cm	Yellowish red (5YR 5/8d), clay; slightly moist; moderate to strong, fine and medium angular blocky structure; moderate thin clay cutans; few, angular quartz gravel; few, fibrous roots; gradual, smooth boundary to:
42-68/94 cm	Red (2.5YR 5/6d), clay; slightly moist; moderate to strong coarse angular blocky structure; moderate thin clay cutans; few, angular quartz gravel; 10% 5 mm diameter subround soft to moderately hard MnO_2; few, fibrous roots; clear, wavy boundary to:
68/94-97/100 cm	Dark red (2.5YR 3/6m) and red (2.5YR 4/6d), gravelly clay; slightly moist; structureless; moderate thin clay cutans; >70% angular quartz

	gravel and stones; 10% 5 mm diameter subround soft to moderately hard MnO_2; few, fibrous roots; clear, wavy boundary to:
97/100-122/132 cm	Variegated red, yellow and black coarse sandy clay loam with distinct rock structure; moist; weak fine and medium angular blocky structure; few angular quartz gravel; 10% 5 mm diameter subround moderately hard to hard MnO_2; few fibrous roots; clear, irregular boundary to:
122/132-150 cm	Variegated red, yellow and black coarse sandy loam comprising soft strongly weathered rock; moist; structureless; no roots.

ANALYSIS PROFILE 129-GG-90

Depth (cm)	0-10	10-42	42-68	68-97	97-122	122-150
Lab No.	Y3279	Y3280	Y3281	Y3282	Y3283	Y3284
DM %	97.4	96.3	96.0	96.1	96.7	97.3
Texture	CL	C	C	C	cSaCL	cSaL
Clay %	37	55	56	50	33	6
Silt %	20	19	16	17	21	14
Fine Sand %	33	18	17	16	21	20
Medium Sand %	7	4	5	6	12	21
Coarse Sand %	3	3	7	10	14	40
pH ($CaC1_2$)	5.2	5.8	6.0	6.6	6.6	6.8
Carbonates %	0.0	0.0	0.0	0.0	0.0	0.0
EX Ca (me %)	7.3	7.4	7.0	8.1	9.8	12.2
EX Mg (me %)	8.1	9.1	8.5	9.5	12.4	13.3
EX Na (me %)	0.03	0.07	0.29	0.10	0.17	0.14
EX K (me %)	0.16	0.07	0.06	0.03	0.02	0.00
TEB (me %)	15.5	16.6	15.9	17.7	20.4	15.2
CEC (me %)	15.6	17.8	17.6	20.3	20.4	15.2
Base Sat %	100	94	90	87	100	100
E/C	42.1	32.2	31.7	40.4	61.4	274.1
S/C	41.9	30.1	28.6	35.3	61.4	274.1
ESP	0.2	0.4	1.7	0.5	0.8	0.9
EKP	1.0	0.4	0.4	0.1	0.1	0.0
Free Fe	5.56	5.08	8.72	8.20	5.51	2.22

LAND UNIT E4

General description This unit occurs to a very limited extent in the Communal Lands and is associated with the Great Dyke and certain of the Gold Belt lithologies. It has been mapped in Hwedza and Mberengwa CLs and occurs in Natural Regions II to IV, Agroclimatic Zones 2 to 5. The unit has an area of 265 km^2.

Geology The rocks of this unit are ultramafic lavas and intrusions, such as sepentinite and pyroxenite, associated with basaltic greenstones, other mafic metavolcanics and gabbro.

Soils The soils derived from ultramafic rocks are commonly well-drained, moderately shallow to deep, dark reddish brown clay loams and clays over dark red clays sometimes with well-developed nitic properties. Exchangeable magnesium is higher than calcium and sometimes toxic levels of nickel or chromium are present. Soils toxic to all but a few plant species are associated with serpentinised olivine rocks such as dunite. These have very high levels of exchangeable magnesium and may have magnesite present and high percentages of nickel and chromium (Soane and Saunder, 1959). The associated soils derived from mafic rocks are similar to the soils of Land Unit E1. In the Zimbabwe system, the soils are classified as 4E, 5E, 4X or 5X. Soil Taxonomy defines them as mainly Typic Rhodustalfs or Typic/Rhodic Paleustalfs. According to FAO/UNESCO/ISRIC they are Chromic Luvisols or Haplic/Rhodic Nitisols.

Natural vegetation In areas of maximum toxicity, only almost pure grassland survives. This changes gradually into shrub or small tree savanna in which the woody species are few and include *Euclea linearis, Diplorhynchus condylocarpon, Faurea speciosa* and *Protea* spp. (Wild, 1965, 1975). Soils derived

from ultrabasic rocks such as pyroxenite are markedly less toxic and normally show evidence of woodland with miombo components.

Land use The highly mineralized soils are not used agriculturally but occur in areas where chromite may be mined. The relatively deep red clays with only slight calcium/magnesium imbalance and non-toxic contents of nickel or chromium are commonly cultivated and do not appear to be any less fertile than the red clays derived from mafic rocks.

Land capability The soils containing severely toxic amounts of nickel and chromium are classified as Class IVf or MIVf because of the fertility constraint although Class VI, non-arable, is probably more appropriate. In some soils the apparent toxicity may be due to extremely low or even zero levels of exchangeable calcium (see profile example below). This possibility has been suggested by Walker (1954). The grazing value of the grasses on these soils is very low, owing to high contents of the above metals. Where the fertility constraints are not apparent, many of the clay soils on almost flat slopes are Class I or MI.

Irrigability The constraints on irrigation are similar to those for dryland capability. Many of the non-toxic red clays are highly suitable.

Erosion Erosion was not seen to be a serious problem in this unit.

Development potential The areas with toxic soils have a negligible agricultural potential. The associated red clays are of local importance but there is limited scope for increasing productivity other than through the benefits of irrigation.

Typical Profile Descriptions Land Unit E4 – Non-toxic soil

Profile number:	298-FF-87 described on 9 September 1987. Profile pit.
Location:	Near Mount St. Marys Mission, Hwedza CL, Hwedza District. Map no. 1831 D1. Map reference UQ 630 315.
Site:	Gently undulating, mid slope 2%. Few stones on surface. Elevation 1 340 m. Mean annual rainfall at Dendenyore Business Centre is 900 mm.
Vegetation/land use:	Contoured field, maize previous crop, area intensively cropped.
Parent material:	Basement schists, ultramafic suite. Cordierite-gedrite rock.
Erosion:	Not observed.
Land capability:	Class I.
Profile irrigable value:	1.
Soil classification:	5X (Zimbabwe) Typic Rhodustalf (Soil Taxonomy) Rhodic Nitisol (FAO/UNESCO/ISRIC)
0-15 cm	Dark red (2.5YR 3/6m, 2.5YR 4/6d) clay, plough layer composed of large clods; sticky, plastic, friable moist, slightly hard dry; common fine and medium pores; few fine roots; well drained and permeable; clear smooth transition to:
15-23 cm	Stone line, at other points in the pit between 35-57 and 36-61 cm, composed of mainly angular quartz 2-3 cm diameter with some parent material mixed with soil from above horizon.
23-44 cm	Dark red (10R 3/6m, 2.5YR 3/6d) clay; moderate coarse subangular blocky and medium to coarse crumb structure; sticky, plastic, friable moist, slightly hard dry; few fine pores; few fine roots; few manganese stains on ped faces; clear wavy transition to:
44-112 cm	Dark red (2.5YR 3/6m, 2.5YR 4/4d) clay; moderate to strong coarse subangular blocky with medium crumb structure; very shiny ped faces with cutans; sticky, plastic, friable moist,

	hard dry; few fine pores; few fine roots; smooth diffuse transition to:
112-155+cm	Dark red (2.5YR 3/6m, 2.5YR 4/6d) similar to the above horizon, but with 15-25% soft weathering parent material, and fewer cutans.

ANALYSIS PROFILE 298-FF-87

Depth (cm)	0-15	15-23	50-65	85-100	135-150
Lab No.	W1900	W1901	W1902	W1903	W1904
DM %	96.2	94.6	93.1	93.1	92.6
Texture	C	C	C	C	C
Gravel %	0	8	0	0	0
Coarse Sand %	4	5	2	1	0
Medium Sand %	4	3	1	1	2
Fine Sand %	26	21	10	14	14
Silt %	20	16	12	18	29
Clay %	46	55	75	67	55
pH ($CaC1_2$)	4.0	4.4	4.9	4.9	4.9
Carbonates %	0	0	0	0	0
EX Ca (me %)	4.8	6.6	4.9	4.9	6.4
EX Mg (me %)	6.3	7.0	10.4	9.8	13.1
EX Na (me %)	0.02	0.04	0.04	0.04	0.04
EX K (me %)	0.08	0.08	0.06	0.04	0.04
TEB (me %)	11.2	13.7	15.4	14.9	19.5
CEC (me %)	15.1	17.5	21.1	22.5	25.4
Base Sat %	74	78	73	66	77
E/C	32.8	31.6	28.3	33.5	45.7
S/C	24.2	24.7	20.6	22.2	35.2
ESP	0.1	0.2	0.2	0.2	0.2
EKP	0.5	0.5	0.3	0.2	0.2
Org. Carbon %	0.75	0.48	0.30	0.21	0.21

Typical Profile Description Land Unit E4 – Toxic soil

Profile number:	199-GG-90 described on 28 August 1990. Auger boring.
Location:	At the 43.5 km peg by the West Nicholson to Zvishavane road. Mberengwa CL, Mberengwa District.
Site:	Southern end of the Great Dyke on 3% midslope down from outcropping pyroxenite towards abrupt boundary with granitic terrain. Mine excavations upslope. Surface crusted.
Vegetation/land use:	Short grassland, 50% cover.
Parent material:	Serpentinite.
Erosion:	None evident.
Land capability:	Class VIf.
Profile irrigable value:	Not suitable for irrigation.
Soil classification:	4X (Zimbabwe) Typic Ustropept (Soil Taxonomy) Chromic Cambisol (FAO/UNESCO/ISRIC)
0-17 cm	Dark brown (7.5YR 3/4m), fine sandy loam; many reflective mineral grains; dry.
17-57 cm	Strong brown (7.5YR 3/6m), fine sandy clay loam; fine, angular blocky structure; many reflective mineral grains; slightly moist.
57-127 cm	Strong brown (7.5YR 4/6m), fine sandy clay loam; fine, angular blocky structure; many reflective mineral grains; slightly moist.
127-140 cm	Yellowish red (5YR 3/6m), soft rock.

ANALYSIS PROFILE 199-GG-90

Depth (cm)	0-17	17-57	57-127	127-140
Lab No.	Y4326	Y4327	Y4328	Y4329
DM %	95.6	94.1	93.9	93.8
Texture	cSaL	cSaCL	cSaCL	cLS
Clay %	14	23	24	6
Silt %	13	7	9	11
Fine Sand %	29	19	26	33
Medium Sand %	23	24	20	21
Coarse Sand	21	26	20	29
Gravel %	10	10	20	8
pH ($CaC1_2$)	6.1	6.6	7.3	7.6
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	1.9	0.0	0.0	0.0
EX Mg (me %)	14.2	19.8	20.4	21.3
EX Na (me %)	0.06	0.03	0.09	0.10

EX K (me %)	0.09	0.06	0.03	0.05
TEB (me %)	16.2	19.9	20.5	21.4
CEC (me %)	17.2	23.6	20.9	21.5
Base Sat %	94	84	98	100
E/C	124.9	104.0	87.2	375.0
S/C	117.8	87.4	85.8	374.7
ESP	0.3	0.1	0.4	0.5
EKP	0.5	0.3	0.1	0.2
Free Fe	3.18	6.98	5.75	5.08

LAND UNIT E5

General description This unit occurs at the edge of the Karoi plateau outlier of the northern Highveld region at elevations between 1 100 m and 1 300 m above sea level and is transitional to more dissected terrain of the Middleveld in places. The landform is undulating to rolling and many of the river courses show a marked adjustment to geologic structure. It is restricted to Mukwichi CL in Hurungwe District. The unit occurs in Natural Region II, Agroclimatic Zone 2 and has an area of 400 km^2.

Geology The Precambrian rocks of the Piriwiri System typically range through various types of mica schist to granitic gneisses and gneissic granites. Part of the unit is in the Mwami Mica Field, formerly of economic importance.

Soils These are very to moderately shallow, fersiallitic, highly micaceous, fine- or medium-grained loamy sands or sandy loams over yellowish red medium-grained sandy loams to sandy clays. The subsoil often comprises soft but little-altered rock. The high mica content results in some weak surface capping. There are some deeper and finer-textured soils derived from biotite gneiss. There are no clear catenary relationships. The soils classify as 5F (Zimbabwe), Ustorthents or Ustropepts (Soil Taxonomy) and Regosols or Cambisols (FAO/UNESCO/ISRIC).

Natural vegetation Remnants of *Brachystegia boehmii* dominated woodland are common and may be associated with *Uapaca kirkiana* on the shallower soils. Other common species include *Julbernardia globiflora, Faurea speciosa, F. saligna, Diplorhynchus condylocarpon, Pseudolachnostylis maprouneifolia, Pericopsis angolensis* and *Ximenia caffra*. In areas with deeper, less micaceous soils, apparently with good soil moisture conditions, *Brachystegia boehmii* is uncommon and is replaced by *Acacia polyacantha* associated with *Erythrina latissima* and *Bauhinia* spp.

Land use An estimated 15% of the unit is arably disturbed. This proportion is slightly higher in the south compared with the north of Mukwichi CL where population is lower and communications poorer. New settlement is common, particularly in the remoter eastern parts. Maize is the predominant crop. Prior to 1961 this area was designated a European Area in terms of the Land Apportionment Act. Subsequently a Special Native Area, the precursor of Mukwichi CL, was created by amendment to the Act. However, it was not considered a favourable area for arable cultivation and is described by Vincent and Thomas (1960) and the Robinson Commission (1962) as part of Natural Area XX, defined as land unsuitable for any form of agricultural utilization. The gross percentage of Mukwichi CL considered to be arable was estimated as 6% by the Robinson Commission (*op. cit.*).

Land capability Based on an evaluation at 16 sites and airphoto interpretation, there appears to be an approximately equal proportion of Classes III, IV and VI. Slope and soil depth are the main limitations. Since this unit occupies about 30% of Mukwichi CL, approximately 20% of the CL can be considered as marginally suitable arable land in terms of hazard of use.

Irrigability On average, the land has a very restricted suitability (Class C) or is unsuitable for irrigation (Class D) owing mainly to slope limitations. Very small

irrigated gardens are common using water from boreholes or shallow wells in or by stream lines.

Erosion Moderate to severe sheet erosion is evident throughout the arably disturbed areas. This unit is given an above average to high erosion hazard rating by Stocking and Elwell (1973).

Development potential There is limited potential owing to the constraints of steep slopes, shallow soils and a moderately high population density.

Typical Profile Description Land Unit E5

Profile number:	140-GG-88 described on 11 August 1987. Profile pit.
Location:	The southern section of Mukwichi CL, Hurungwe District. Near the site of a former DC camp. Map refence RM 0365.
Site:	Col position on interfluve. Undulating to rolling topography. Upper slope about 6% steepening. Ridge and furrow. Micaceous surface with slight capping.
Vegetation/land use:	Fallow, probably one year. Good dry grass cover. Common fallow fields in this area. Contour ridging but unmaintained. Banana and vegetable garden on lower slope irrigated from borehole.
Parent material:	Piriwiri Group mica schist with almost vertical foliation.
Erosion:	Moderately severe sheet erosion.
Land capability:	Class III.
Profile irrigable value:	3.
Soil classification:	5F (Zimbabwe) Typic Ustorthent (Soil Taxonomy) Eutric Regosol (FAO/UNESCO/ISRIC)
0-13 cm	Dark brown (10YR 6/4d, 10YR 3/3m), medium sandy loam; dry slightly hard consistence; weakly developed medium and fine subangular blocky over strongly developed fine platy structure; common fibrous roots; abrupt wavy transition marked by thin discontinuous layer of quartz gravel and stones, subrounded and probably transported, to:
13-235 cm+	Soft, weathered mica schist mainly yellowish red (5YR 5/6m), coarse sandy clay loam; slightly moist becoming moist firm consistence; structureless; few fibrous roots to 165 cm; moderately restricted permeability.

ANALYSIS PROFILE 140-GG-88

Depth (cm)	0-13	20-35	50-65
Lab No.	W1540	W1541	W1542
DM %	97.7	98.0	97.9
Texture	mSaL	cSaCL	cSaCL
Gravel %	3	6	24
Coarse Sand%	17	19	25
Medium Sand %	37	27	23
Fine Sand %	27	16	15
Silt %	5	4	4
Clay %	13	34	33
pH ($CaC1_2$)	5.1	5.3	5.6
Carbonates %	0	0	0
EX Ca (me %)	2.4	2.4	2.1
EX Mg (me %)	0.5	0.6	1.6
EX Na (me %)	0.02	0.04	0.08
EX K (me %)	0.39	0.20	0.20
TEB (me %)	3.3	3.3	3.9
CEC (me %)	3.5	3.7	5.2
Base Sat %	95	88	76
E/C	26.4	11.0	15.9
S/C	25.2	9.7	12.0
ESP	0.6	1.1	1.6
EKP	11.1	5.5	3.9

LAND UNIT E6

General description This unit is associated with flat to almost flat pediplains, pediments and small plateau outliers where removal of Kalahari Sand deposits has exposed Karoo-age basalt flows. It occurs in the Highveld, Middleveld and Upper Zambezi Valley regions with examples in Ngezi, Mzola, Lupane, Hwange and Tjolotjo CLs. The unit occurs in Natural Regions III, IV and V, Agroclimatic Zones 3 and 4 and has an area of 1 520 km^2.

Geology Basaltic lavas of the Karoo succession form this unit.

Soils The soils are imperfectly to moderately well-drained, moderately shallow to moderately deep, very dark greyish brown to black sometimes calcareous heavy clay vertisols. These are associated with a variable proportion of extremely or very shallow, stony or rocky reddish brown to yellowish red fine-grained sandy clay loams to clays. No catenary relationships are evident. The deeper soils are classified as 3B (Zimbabwe), Typic Chromusterts or Pellusterts (Soil Taxonomy) and Eutric or Calcic Vertisols (FAO/UNESCO/ISRIC).

Natural vegetation At Highveld elevations this unit is mainly cleared for cultivation but remnants of a low open woodland or shrubland of *Acacia* and *Combretum* species can be found. These include *Acacia karroo, A. nilotica, A. gerrardii, A. goetzei, A. rehmanniana, Combretum hereroense* and *C. imberbe.* At Middleveld and lower elevations, the natural vegetation is a *Colophospermum mopane* shrubland characterized by an absence of trees, other than on termitaria. Other species in this milieu include *Bauhinia petersiana, Commiphora africana, Terminalia randii, Combretum apiculatum, C. hereroense* and *C. nigrescens.*

Land use In Ngezi CL this unit is intensively cultivated mainly under maize. In fallow, the herbaceous cover provides quality grazing for livestock, although quantity is lacking in the dry season. As rainfall decreases through the Middleveld towards Hwange, cotton becomes an important crop on the vertisols. Government-supported irrigation schemes have been located on some of these soils, for example at the Agricultural Development Authority's estate at Tjotjolo in Lupane CL. The associated stony shallow red soils are not normally cultivated.

Land capability Most of the vertisols are Class MII. The areas with shallow, stony red soils are commonly very severely eroded and classify as Class VI land.

Irrigability About 10% of the unit is estimated to have a Class B suitability for conventional irrigation.

Erosion Locally there is very severe sheet and rill erosion, especially of the shallow reddish soils which are prone to capping and runoff.

Development potential There appear to be substantial blocks of deep vertisols in Mzola CL and around Tshongokwe, Lupane CL, suitable for irrigation development. Sources of water include the Shangani River and seepage areas from the higher-lying Kalahari Sand deposits. Conservation measures to reduce runoff are required to improve the grazing resources.

Typical Profile Description Land Unit E6

Profile number:	119-DD-88. Profile pit.
Location:	About 15 km southeast of Victoria Falls, Hwange CL, Hwange District. Map reference LL 896 075.
Site:	Almost flat, 900 m elevation. Surface mulch of crumb aggregates and deep cracks up to 60 mm wide.
Vegetation/land use:	Previous crop was a mixture of sorghum and maize.
Parent material:	Basalt.

Erosion:	Slight sheet erosion.
Land capability:	Class MII.
Profile irrigable value:	2.
Soil classification:	3B (Zimbabwe) Typic Pellustert (Soil Taxonomy) Calcic Vertisol (FAO/UNESCO/ISRIC)
0-17 cm	Very dark greyish brown (10YR 3/2m) clay loam; medium crumb structure; dry hard, moist friable sticky and plastic wet consistence; few fine roots; good permeability and well drained; clear smooth transition to:
17-33 cm	Very dark brown (10YR 2/2m) clay loam; moderate medium subangular blocky structure; few, patchy thin clayskins; dry hard; few medium roots; crack in-filling with material from above horizon, good permeability and well drained; clear smooth transition to:
33-65 cm	Similar clay loam with hard carbonate concretions and cracks; good permeability and well drained.
65-100 cm	Black (10YR 2/1m) clay; strong angular blocky structure; dry hard, moist firm, sticky and plastic wet consistence; few slickensides; few small carbonate concretions; few fine roots; slightly restricted permeability and well drained; diffuse transition to:
100-138 cm+	Similar clay but with no carbonate concretions.
REMARKS:	Cracks extend to 65 cm below the surface and are likely to go deeper when the profile is dry.

ANALYSIS PROFILE 119-DD-88

Depth (cm)	0-17	17-33	33-65	65-100	100-138	190-208
Lab No.	X2082	X2083	X2084	X2085	X2086	X2087
DM %	91.6	90.4	91.5	90.4	90.6	91.1
Texture	CL	CL	CL	C	C	C
Gravel %	0	0	0	0	0	0
Coarse Sand %	3	6	5	4	6	3
Medium Sand %	14	12	12	13	13	20
Fine Sand %	24	23	23	18	16	16
Silt %	22	21	21	20	19	14
Clay %	37	39	39	45	46	47
pH ($CaCl_2$)	6.1	6.4	7.3	7.5	7.7	8.0
Carbonates %	0.0	0.0	0.0	0.0	0.0	0.7
EX Ca (me %)	31.2	33.6	31.6	57.1	54.1	136.4
EX Mg (me %)	19.7	20.4	15.1	22.1	25.5	42.8
EX Na (me %)	0.26	0.42	0.31	0.44	0.68	1.32
EX K (me %)	0.55	0.13	0.61	0.31	0.29	0.15
TEB (me %)	35.1	37.1	39.8	52.5	38.5	52.4
CEC (me %)	35.1	37.1	39.8	52.5	38.5	52.4
Base Sat %	100	100	100	100	100	100
E/C	94.2	95.4	100.8	115.4	82.8	110.8
S/C	94.2	95.4	100.8	115.4	82.8	110.8
ESP	0.7	1.1	0.8	0.8	1.8	2.5
EKP	1.6	0.4	0.5	0.6	0.7	0.3

LAND UNIT E7

General description This unit is restricted to part of the Mafungabusi Plateau in Gokwe CL, Gokwe District. It includes the area known as Sidaga Flats and comprises a plateau, part of the Post-African erosion surface, with a few minor step features marking the edge of the component lava flows. The western edge of the plateau is deeply incised by the headwaters of the Sasame and Ume Rivers. On the eastern flank, several tributaries of the Munyati River have eroded deep gorges. The escarpment edge of the plateau forms the boundary between the Middleveld and Sanyati – Sengwa Basin. It occurs in Natural Regions III and IV, Agroclimatic Zone 3 and has an area of 675 km^2.

Geology Four flows have been identified in the Karoo System basalt forming this unit.

Soils These are predominantly dark-coloured vertisols with a high clay content. A surface mulch of crumb aggregates is rare. Weathering basalt usually

occurs at 50 cm to 100 cm depth. The soils are often gravelly or stony and a few are lithosolic. Where the external and internal soil drainage is good, as occurs on the higher flow levels and near the plateau edge, the soils comprise red clays without the swelling clay content typical of the vertisols. Gilgai microtopography is occasionally weakly developed. Seasonal waterlogging will occur in places owing to slow runoff and severely restricted subsoil permeability. Some soils have surprisingly low base saturation or E/C and a report by the Agricultural Development Authority (1973) notes that field experiments have shown that the cropping potential of isidhaka soils is very low, even when large dressings of fertilizers are applied. There may be a catenary relationship between the red and black clays but this was not established during the reconnaissance survey. The vertisols classify as 3B (Zimbabwe), Typic Chromuderts (Soil Taxonomy) and Dystric and Eutric Vertisols (FAO/UNESCO/ISRIC). The red clays classify as 5ES (Zimbabwe), Paleustults and Rhodustults (Soil Taxonomy) and Haplic Acrisols and Eutric/Dystric Regosols (FAO/UNESCO/ISRIC).

Natural vegetation This unit is mainly *Andropogon, Setaria* and *Brachiaria* spp. grassland with common *Becium obovatum* and *Boophane disticha* and scattered low *Bauhinia petersiana, B. thonningii* and *Combretum hereroense.* The red clays have a better developed woody cover, mainly *Brachystegia boehmii.*

Land use Approximately 10% of the unit is arably disturbed and this is mainly confined to the red clay soils. The area is grazed but apparently not intensively.

Land capability Most of the vertisols classify as MII or MIII. However, the AGRITEX classification does not appear to be appropriate for assessing arable potential of vertisols. The red clays are mainly Class MII or MIII. The shallowest soils are Class VI and the wetter areas Class MIVw.

Irrigability Irrigation is problematic in this unit; the red clays are generally suitable and the vertisols may be successfully irrigated during the dry season given good management. Problems with water supply and storage and fertility constraints are probably important factors.

Erosion There is no evidence of significant erosion and the hazard is low owing to the very gentle slopes and good grass cover. Vertisols are however easily eroded if mismanaged.

Development potential This is difficult to assess but may be high for a crop such as cotton provided an appropriate cultivation technique, such as raised beds, is used to improve wet-season drainage. The grazing potential of this unit requires investigation.

Typical Profile Descriptions Land Unit E7 – Vertisol

Profile number:	108-GG-88 described on 19 June 1988. Profile pit.
Location:	North of Gokwe town, at kilometre peg 14.5 on road to Nembudzia. Mafungabusi Plateau, Gokwe CL, Gokwe District. Map reference QK 0399.
Site:	Slope WSW, declination 1%. Weak gilgai development. Surface strongly cracked to 2-3 cm wide but not yet deep as subsoil moist. Termitaria strongly cracked and mainly bare, about 20 m apart and 30-60 cm high. 2% surface cover of basalt and agate gravel and stones.
Vegetation/land use:	Grassland with scattered *Bauhinia petersiana, B. thonningii* and *Combretum hereroense* about 40 m apart and 1 to 3 m high. Occasional *Aloe* sp. *Becium obovatum* and *Boophone disticha* common.
Parent material:	Karoo basalt.

Erosion:	None evident.
Land capability:	Class MIII.
Profile irrigable value:	3.
Soil classification:	3B (Zimbabwe) Typic Chromudert (Soil Taxonomy) Eutric Vertisol (FAO/UNESCO/ISRIC)
0-18 cm	Dark greyish brown (2.5Y 4/2d&m), clay; very hard, slightly moist; strong coarse prismatic breaking to medium prismatic and angular blocky structure; common fine fibrous roots; moderately restricted permeability, moderately poorly drained; few agate and quartz gravel; weakly developed slickensides; diffuse smooth boundary to:
18-52 cm	Dark greyish brown (2.5Y 4/2d) and very dark greyish brown (2.5Y 3/2m) clay; very firm, moist; strong coarse angular blocky structure; common fine fibrous roots; severely restricted permeability, moderately poorly drained; weakly developed slickensides; gradual smooth boundary to:
52-101/109 cm	Dark greyish brown (2.5Y 4/2d) and very dark greyish brown (2.5Y 3/2m) gravelly clay; very firm, moist; strong coarse angular blocky structure; common fine fibrous roots; common agate and quartz gravel; severely restricted permeability, moderately poorly drained; well-developed slickensides; gradual wavy boundary.
101/109-120 cm	90% fractured basalt with clay inclusions; variable colour, moist; structureless, severely restricted permeability, moderately poorly drained.
120 cm +	Too rocky to dig deeper.

ANALYSIS PROFILE 108-GG-88

Depth (cm)	0-18	18-52	52-101
Lab No.	X1759	X1760	X1761
DM %	87.6	86.7	88.8
Texture	C	C	C
Gravel %	0	0	57
Coarse Sand %	9	15	21
Medium Sand %	5	4	4
Fine Sand %	14	9	9
Silt %	14	17	14
Clay %	58	56	52
pH ($CaC1_2$)	5.6	6.0	6.4
Carbonates %	0	0	0
EX Ca (me %)	5.6	3.9	3.3
EX Mg (me %)	2.8	1.6	1.5
EX Na (me %)	0.14	0.28	0.29
EX K (me %)	0.18	0.39	0.16
TEB (me %)	8.7	5.8	5.3
CEC (me %)	9.4	5.8	5.9
Base Sat %	93	100	91
E/C	16.3	10.3	11.2
S/C	15.1	10.3	10.2
ESP	1.5	4.8	5.0
EKP	1.9	6.8	2.7

Typical Profile Description Land Unit E7 – Red Clay

Profile number:	47-GG-88 described on 4 June 1988. Auger boring.
Location:	Near Njelele, Gokwe CL, Gokwe District. Mafungabusi Plateau. Map reference QK 2379.
Site:	Almost level but slightly elevated area on plateau probably representing a remnant of a basalt flow more recent than surrounding area dominated by less well drained, black vertisols. Common surface stones and boulders. Near edge of steep escarpment.
Vegetation/land use:	Previous crop sunflower. Poor grass cover. Clumps of 1-3 m high woody vegetation including *Brachystegia boehmii, Pseudolachnostylis maprouneifolia, Bridelia catharsis* and *Tylosema fassoglensis.*
Parent material:	Karoo basalt.
Erosion:	None evident.

Land capability:	Class MII/MIII. Adjacent auger hole was 40 cm deep over stones. Surface slightly capped.
Profile irrigable value:	3.
Soil classification:	5ES (Zimbabwe) Typic Rhodustult (Soil Taxonomy) Haplic Acrisol (FAO/UNESCO/ISRIC)
0-15 cm	Dark reddish brown (5YR 3/4m) clay with a slightly silty feel; dry.
15-50 cm	Dark red (2.5YR 3/6m) clay; slightly moist.
50 cm+	Stones impenetrable to auger.

ANALYSIS PROFILE 47-GG-88

Depth (cm)	0-15	25-40
Lab No.	X1560	X1561
DM %	95.9	95.5
Texture	C	C
Gravel %	3	7
Coarse Sand %	1	3
Medium Sand %	6	5
Fine Sand %	26	17
Silt %	15	14
Clay %	51	62
pH ($CaC1_2$)	5.0	5.5
Carbonates %	0	0
EX Ca (me %)	5.6	1.6
EX Mg (me %)	2.9	1.1
EX Na (me %)	0.4	0.2
EX K (me %)	0.50	0.08
TEB (me %)	9.1	2.8
CEC (me %)	12.9	12.4
Base Sat %	70	22
E/C	25.2	20.1
S/C	17.8	4.5
ESP	.3	.2
EKP	3.9	.7

LAND UNIT E8

General description This unit comprises a basalt plain extending through the communal lands of Matibi No. 2, Sangwe and Ndowoyo in the Southeast Lowveld and Middle Save Valley regions. The landform is characteristically flat to almost flat with slopes less than 1% (Plate 10). It occurs in Natural Regions IV and V, Agroclimatic Zones 4 and 5 and has an area of 3 060 km².

Geology Rocks of this unit are Jurassic basalts of the Upper Karoo. They differ from those occurring west of the central watershed, Land Units E6 and E7, by the predominance of Limburgite, a basalt glass containing olivine and augite phenocrysts.

Soils The soils are mainly well- to moderately well-drained, moderately shallow to moderately deep, dark greyish brown to black, calcareous, heavy clay vertisols with a well-developed surface mulch of crumb aggregates. These are associated with well-drained, very shallow to moderately deep, dark brown to dark reddish brown fine-grained sandy clay loams to clay loams over dark reddish brown clays. Variations in the physical and chemical characteristics of these soils have been described by Low *et al.* (1984). The reddish soils associated with the vertisols are considered by these authors to have developed on intrusive rocks within the basalt in which case a catenary relationship is not valid. The vertisols classify as 3B (Zimbabwe), Typic Pellusterts (Soil Taxonomy) and Eutric Vertisols (FAO/UNESCO/ISRIC). The reddish soils are 4E (Zimbabwe), Typic Haplustalfs (Soil Taxonomy) and Chromic Luvisols (FAO/UNESCO/ISRIC).

Natural vegetation The natural vegetation of this unit has been described by Farrell (1968b). *Colophospermum mopane* is the dominant tree species through Matibi No. 2 CL commonly in the form of dense low coppices or as branchings from an underground stock. The deeper vertisols in areas where the soil's self-ploughing action is most pronounced are under a grassland dominated by *Setaria* sp. Northeastwards into Ndowoyo CL, the climate is marginally more humid and

the mopane is largely replaced by a more mixed shrub or woodland savanna generally dominated by *Combretum fragrans* with occasional stunted examples of *Lonchocarpus capassa*. On the better-drained redder soils *Terminalia stenostachya* and *Acacia nigrescens* may be common.

Land use Sorghum and maize as well as some cotton and sunflower are the principal dryland crops. The effects of fairly intensive grazing by cattle and goats on the ecology of part of Matibi No. 2 is described by Kelley and Walker (1976). Over a thousand hectares of vertisols near Chisumbanje, in Ndowoyo CL, are planted to irrigated crops, usually summer cotton and winter wheat.

Land capability The deep vertisols have a capability of MII. The reddish soils normally have a high fine-sand and silt content conducive to poor structural stability at the surface and are downgraded to MIII.

Irrigability The deep vertisols have been shown to be well suited to irrigation and areas with a high proportion of soils with an irrigable value of 1 or 2 are given an irrigability class of A or B. Seasonal irrigation requirements for various crops on these soils are estimated by Wilson and Metelerkamp (1974) and cropping potential is discussed by Cackett and Patterson (1965). Hussein (1984) describes various characteristics of these vertisols under irrigation, comparing them with some vertisols from Land Unit E6. Many trials have been conducted on these soils at the Chisumbanje Experiment Station, opened in 1953. The reddish clay soils have received less attention. Low *et al.* (1984) regard them as suitable for irrigated cropping but less so than the vertisols owing to the frequency of shallow profiles.

Erosion Drainage lines and minor drainage ways on the basalt plain show much peripheral gullying. The climate is characterized by infrequent and brief convectional thunderstorms which can lead to considerable sheet runoff despite the very slight gradients.

Development potential There is scope for improvement in dryland crop production using techniques of rainwater conservation and concentration described by Jones *et al.* (1989). A large area of vertisols in Ndowoyo CL, extending beyond the Chisumbanje scheme, is suitable for irrigation and has been the subject of studies and surveys over many years. However, further substantial irrigation developments appear to be constrained by an inadequacy of water supply from the Save River.

Typical Profile Description Land Unit E8 – Vertisols

Profile number:	5-GG-91 described on 6 January 1991. Auger boring.
Location:	Just north of 21° South, approximately 100 metres west of border with Mozambique. Ndowoyo CL, Chipinge District.
Site:	Mid slope less than 2%. Common basalt stones and boulders.
Vegetation/land use:	Field ploughed and planted with cotton seeds not yet germinated. Very sparse woody vegetation including *Bauhinia thonningii* and *Acacia* spp.
Parent material:	Basalt.
Erosion:	Not evident at site.
Land capability:	Class MII.
Profile irrigable value:	2.
Soil classification:	3B (Zimbabwe) Typic Pellustert (Soil Taxonomy) Eutric Vertisol (FAO/UNESCO/ISRIC)
0-20 cm	Black (10YR 2/1m) clay; strongly developed coarse crumb structure.
20-60 cm	Black (10YR 2/1m) clay; 2% 5 mm round $CaCO_2$.
>60 cm	Too hard to auger.

ANALYSIS PROFILE 5-GG-91

Depth (cm)	0-20	20-60
Lab No.	Z1288	Z1289
DM %	85.1	84.7
Texture	C	C
Clay %	76	59
Silt %	12	12
Fine Sand %	8	8
Medium Sand %	2	9
Coarse Sand %	1	12
pH ($CaC1_2$)	6.8	7.2
Carbonates %	0.0	0.0
EX Ca (me %)	46.3	48.6
EX Mg (me %)	42.4	38.5
EX Na (me %)	0.29	0.41
EX K (me %)	0.94	0.27
TEB (me %)	89.9	87.8
CEC (me %)	97.5	98.1
Base Sat %	92	90
E/C	128.0	165.5
S/C	118.81	148.2
ESP	0.3	0.4
EKP	1.0	0.3
Free Fe	2.23	2.50

Typical Profile Description Land Unit E8 – Reddish clay soils

Profile number:	2-GG-91 described on 6 January 1991. Auger boring.
Location:	3 km southeast of Quinton Bridge, near east bank of Save River. Ndowoyo CL, Chipinge District.
Site:	Midslope less than 2%. Weak surface crust.
Vegetation/land use:	Grazing area. Open low woodland comprising *Colophospermum mopane, Acacia nigrescens, Flacourtia indica, Combretum fragrans, C. imberbe, Pterocarpus rotundifolius, P. angolensis* and *Lonchocarpus capassa*. 30% cover of green grass, dying owing to lack of rain.
Parent material:	Basalt.
Erosion:	None evident.
Land capability:	Not applied in Natural Region V.
Profile irrigable value:	1.
Soil classification:	4E (Zimbabwe) Typic Paleustalf (Soil Taxonomy) Chromic Luvisol (FAO/UNESCO/ISRIC)
0-20 cm	Dark brown (7.5YR 3/4m) clay loam.
20-57 cm	Dark brown (7.5YR 3/4m) clay.
57-104 cm	Dark reddish brown (5YR 3/4m) clay.
104 cm plus	Gravel.

ANALYSIS PROFILE 2-GG-91

Depth (cm)	0-20	20-57	57-104
Lab No.	Z1282	Z1283	Z1284
DM %	95.9	95.5	93.2
Texture	CL	C	C
Clay %	30	40	41
Silt %	36	26	21
Fine Sand %	22	17	17
Medium Sand %	6	6	6
Coarse Sand %	7	11	15
Gravel %	0	0	13
pH ($CaC1_2$)	6.2	5.8	6.3
EX Ca (me %)	14.3	14.6	20.4
EX Mg (me %)	9.9	13.1	14.0
EX Na (me %)	0.09	0.10	0.15
EX K (me %)	1.48	0.59	0.42
TEB (me %)	23.7	26.0	23.1
CEC (me %)	23.7	26.0	23.1
Base Sat %	100	100	100
E/C	79.1	64.5	56.4
S/C	79.1	64.5	56.4
ESP	0.4	0.4	0.6
EKP	6.2	2.3	1.8
Free Fe	6.62	5.47	5.32

Group M – Land units on arenaceous sedimentary rocks

LAND UNIT M1

General description This is an extensive unit in the Mid Zambezi Valley region, occurring in Dande, Muzarabani, Mukumbura, Chiswiti and Masoso Communal Lands. It takes the form of a gently undulating plain, locally dissected and stony. There are many minor, seasonal, well incised streams. The unit occurs in Natural Region IV, Agroclimatic Zones 3 and 4 and has an area of 1 660 km^2.

Geology The unit comprises mainly sandstones and minor siltstones of the Upper Jurassic Kadzi Beds. Between the Manyame and Angwa Rivers the unit includes Forest Sandstone and Pebbly Arkose which are part of the Upper Karoo succession. The sediments are pebbly in places and are usually calcareous.

Soils The mainly residual soils are well-drained, shallow to moderately deep, fine-grained sandy loams over brown to yellowish red sandy loams or sandy clay loams. They are locally sodic particularly in lower slope positions near alluvial margins. Some of the soils are calcareous, superficially stony or shallow over weathered sandstone. These soils appear to be prone to rapid surface runoff. The occasional presence of strongly sodic soils in lower slope positions seems to be a result of a catenary effect and is discussed by Nyamapfene (1986). In general, however, there is a marked variability in chemistry and morphology of these soils with slope position, likely to be caused by lateral variation in lithofacies of the underlying sediments. The typical soils classify as 4M (Zimbabwe), Ustropepts or Ustorthents (Soil Taxonomy) and Cambisols or Regosols (FAO/UNESCO/ISRIC).

Natural vegetation The main vegetation is an association of *Combretum-Terminalia-Colophospermum mopane*. In some areas the mopane is dominant but elsewhere may be absent, commonly where the soils are shallow and relatively sandy. The generally open woodland is 5-10 m in height, locally with good tufted grass cover. Species recorded include *Terminalia stuhlmannii, T. prunioides, Combretum apiculatum, Acacia nigrescens, Diospyros kirkii, Pterocarpus brenanii* and *Commiphora* spp. The more open areas with good grass cover appear to be burnt frequently.

Land use There is some grazing but the unit is generally little used with less than 5% of the unit arably disturbed.

Land capability The unit is predominantly Class MIII with minor areas of Class VI, Class MII and Class MIV land with soil depth and surface stoniness the most important limitations.

Irrigability The irrigability is classified as Class D with some Class C inclusions.

Erosion There is an above average hazard of erosion as the soils appear to have a low surface intake rate for rainfall, conducive to runoff. Loss of soil is retarded by the frequently good cover of tufted grass but vague microchannels between tufts indicate the direction of periodic runoff.

Development potential The soils of this unit are only marginally suitable for cultivation being drouthy and liable to erode unless suitably managed. The unit has some value as an extensive grazing resource but suffers from poor access and water supply.

Typical Profile Description Land Unit M1

Profile number:	86-GG-86 described on 16 November 1986. Auger boring.
Location:	By the Muzarabani to Kaitano road, 8 km west of the Hoya River, Muzarabani CL, Centenary District. Map reference US 1095.
Site:	Gently undulating with slopes about 2%. Mid-slope position. Few sub-rounded stones, mainly quartz, on surface.
Vegetation/land use:	Sparse, fairly low woodland with *Colophospermum mopane* dominant and common *Combretum apiculatum* and *Terminalia* sp. Patchy grass growth.
Parent material:	Fine sandstone with carbonate inclusions.
Erosion:	Moderate sheet erosion. Weak surface crust.
Land capability:	Class MIII.
Profile irrigable value:	2.
Soil classification:	4M (Zimbabwe) Typic Ustropept (Soil Taxonomy) Calcaric Cambisol (FAO/UNESCO/ISRIC)
0-15 cm	Dark brown (10YR 3/3m) fine sandy loam/sandy clay loam; calcareous.
15-30 cm	Dark brown (7.5YR 3/4m) fine sandy clay loam; calcareous.
30-107 cm+	Brown to reddish brown (7.5YR-5YR 5/4m) fine sandy loam; calcareous, slightly compact, weathered fine sandstone parent material; effective rooting depth taken as 50 cm.

ANALYSIS PROFILE 86-GG-86

Depth (cm)	0-15	15-30	60-75
Lab No.	V1977	V1978	V1979
DM %	96.0	89.6	93.1
Texture	fSaCL	fSaCL	fSaL
Gravel %	3	3	0
Coarse Sand %	3	5	17
Medium Sand %	4	8	12
Fine Sand %	64	53	46
Silt %	10	13	15
Clay %	20	22	9
pH ($CaCl_2$)	6.8	7.0	7.0
Carbonates %	0.4	0.2	0.4
EX Ca (me %)	27.6	88.0	166.5
EX Mg (me %)	3.0	50.4	5.4
EX Na (me %)	0.13	0.04	0.09
EX K (me %)	0.83	0.78	0.86
TEB (me %)	27.4	34.1	34.2
CEC (me %)	27.4	34.1	34.2
Base Sat %	100	100	100
E/C	134.2	155.8	370.6
S/C	134.2	155.8	370.6
ESP	0.5	0.1	0.3
EKP	3.0	2.3	2.5

LAND UNIT M2

General description Although this unit is mapped exclusively in Dande CL, Guruve District, similar land and associated vegetation, of the broad jesse-bush type, is also found in the Communal Lands of the Upper Zambezi Valley region but the occurrences are of insufficient size to allow mapping at 1 : ½ million scale. In Dande CL the landform associated with this unit is a subdued ridge or crest cap, almost level to gently undulating with slopes not usually exceeding 5%. There are very few drainage lines and runoff is probably rare owing to the rapid permeability of the sands. This unit occurs in Natural Regions IV and V, Agroclimatic Zone 4 and has an area of 335 km^2.

Geology The probably unconsolidated aeolian sands of Tertiary Kalahari System age appear to have their origin in the redistribution of Karoo sediments. Whereas the sand fraction in the Dande area is predominantly fine, the deposits in Kariba and Binga Districts have a medium to coarse grain size.

Soils These are deep, fine- or medium-grained sands over yellowish red to red fine or medium-grained sands and loamy sands. They are siallitic occasionally fersiallitic, non-calcareous with very strongly acid subsoils, in places with inverse calcium/magnesium ratios and a very low base saturation. No catenary relationships were observed. Similar soils have been described in Mana Pools National Park by Bennett *et al.* (1985). They classify as 1K or 4M (Zimbabwe), Ustic Quartzipsamments (Soil Taxonomy) and Luvic Arenosols (FAO/UNESCO/ISRIC).

Natural vegetation The variation in vegetation type on this unit has been described by Timberlake *et al.* (1991) and recommendations have been made for the conservation of some examples of vegetation types either unknown elsewhere in Zimbabwe or because of their largely undamaged form. North of Gonono the vegetation type is a *Terminalia brachystemma* bushed woodland which includes *Combretum collinum, Acacia eriocarpa* and *Baphia massaiensis.* Farther west, occupying smaller areas, are examples of dense woodland thickets which are transitional in places to dry layered forest and commonly referred to as "jesse bush". These areas comprise a scatter of large emergent trees including *Pteleopsis myrtifolia, Pterocarpus lucens* and *Entandrophragma caudatum. Xylia torreana* occurs as a lower tree layer over a shrub layer which includes *Monodora junodii* and the climber *Combretum kirkii.*

Land use There is no evidence of arable disturbance. In some areas disturbance by game is common.

Land capability This land is most appropriately designated as Class MIVf, indicating very low inherent soil fertility.

Irrigability The soils are excessively pervious sands of very restricted suitability, owing to inadequate available water capacities, unavoidable high water losses and low inherent fertility, Class S.

Erosion There is a below average hazard and no evidence of contemporary erosion was seen. If cleared of vegetation, deflation is likely.

Development potential This unit has negligible agricultural potential, very few useful timber trees and is best considered as an area suitable for conservation especially as it appears to be an attractive habitat for game. Hawkins Associates (1982) propose National Park or Safari Area status for an area including most of this unit.

Typical Profile Description Land Unit M2

Profile number:	69-GG-87 described on 24 June 1987. Auger boring.
Location:	The Kandeya enclave of Dande CL, Guruve District. Near road 3 km north of boundary with Dande Safari Area.
Site:	Very slightly elevated area in an otherwise almost flat plain, slope less than 2%. Surface cover of leaves and very sparse dry grass.
Vegetation/land use:	Dense dry deciduous woodland thicket of the jesse-bush type having a discrete boundary with a surprisingly green *Combretum-Terminalia* bushland with good grass cover. This area possibly receives seepage from the thicket sand cap and shows much evidence of game disturbance. The thicket includes large emergents of *Entandrophragma caudatum* and *Kirkia acuminata.*
Parent material:	Aeolian deposits.
Erosion:	None.
Land capability:	Class MIVf.
Profile irrigable value:	4.

Soil classification:	4M (Zimbabwe) Ustic Quartzipsamment (Soil Taxonomy) assuming there is a low content of weatherable minerals Luvic Arenosol (FAO/UNESCO/ISRIC)
0-20 cm	Dark brown (7.5YR 3/2m) fine sand; dry
20-56 cm	Brown to dark brown (7.5YR 4/4m) fine sand; dry
56-96 cm	Yellowish red (5YR 4/6m) fine sand; dry
96-128 cm	Yellowish red (5YR 5/8m) fine loamy sand; dry

ANALYSIS PROFILE 69-GG-87

Depth (cm)	0-15	30-45	65-80	105-120
Lab No.	W0897	W0898	W0899	W0900
DM %	98.1	98.2	96.4	97.6
Texture	fS	fS	fS	fLS
Gravel %	0	0	0	0
Coarse Sand %	0	0	0	0
Medium Sand %	21	21	23	21
Fine Sand %	76	74	70	68
Silt %	0	0	3	3
Clay %	4	5	4	8
pH ($CaC1_2$)	4.5	3.7	3.7	3.7
Carbonates %	0	0	0	0
EX Ca (me %)	1.7	0.4	0.4	0.5
EX Mg (me %)	1.1	0.5	0.8	1.0
EX Na (me %)	0.02	0.02	0.04	1.04
EX K (me %)	0.14	0.31	0.29	0.20
TEB (me %)	2.8	1.2	1.5	1.8
CEC (me %)	2.8	3.6	4.3	6.2
Base Sat %	100	34	35	28
E/C	76.2	76.7	108.3	79.9
S/C	76.2	26.1	38.2	22.8
ESP	0.7	0.6	1.0	0.7
EKP	5.1	8.5	6.8	3.3

LAND UNIT M3

General description This unit has the form of a moderately dissected plateau edge shelving gradually towards the Sanyati River. It bridges an indistinct transition between the Middleveld and the Sanyati-Sengwa Basin regions which respectively correspond in this area to the Post-African and Pliocene erosion surfaces. It occurs mainly in Piriwiri CL extending as a narrow strip into Hurungwe CL where it borders the northern edge of a klippe (Land Unit MG1) but has not been mapped in this latter area. The landform is mainly undulating with slopes less than 9%. The unit occurs in Natural Regions III and IV, Agroclimatic Zone 3 and has an area of 300 km².

Geology The unit is restricted to Precambrian Sijarira Group sediments, mainly red grits, sandstones, shales and conglomerates.

Soils These are well-drained, shallow to moderately deep, medium- or fine-grained loamy sands over strong brown to yellowish red medium-grained sandy loams or sandy clay loams. They commonly show ferric properties and are fersiallitic although these conclusions are based on a small number of samples. They classify as 5M (Zimbabwe), Kanhaplic Haplustalfs (Soil Taxonomy) and Ferric Lixisols (FAO/UNESCO/ISRIC).

Natural vegetation The natural vegetation varies with elevation. At higher levels there is woodland characterised by miombo constituents, especially *Brachystegia boehmii*. Below about 900 m *Colophospermum mopane* becomes dominant, with associated *Euphorbia ingens, Ximenia americana, Combretum* spp. and *Diospyros* spp.

Land use The 1982 air photography indicates that approximately 5% of the unit was arably disturbed at that time. This proportion has probably increased to a current level of 10% owing to an influx of new settlers. Cultivation decreases from east to west.

Land capability Access is limited and insufficient data were obtained for a reliable assessment. The unit is topographically favourable but sites are usually downgraded to MIII because of sandy topsoils. The major constraint to agriculture will be rainfall amount and distribution.

Irrigability Probably this unit contains a mosiac of Class B and Class C land.

Erosion The area is considered to have an average to above average hazard by Stocking and Elwell (1973). Evidence of actual erosion was minimal, limited to the normal slight sheet erosion consequent on clearing and cultivation and to a general fretting of the banks of drainage lines caused by human and livestock passage.

Development potential The potential is moderate. Access to Chinhoyi has been improved recently by bridging the Piriwiri River and this will encourage further settlement. Approximately 30% of the unit may be well suited to cultivation of crops adapted to the relatively dry conditions. The prospects for small-scale irrigation development, using water from the Sanyati River, require investigation.

Typical Profile Description Land Unit M3

Profile number:	194-GG-88 described on 26 August 1987. Auger boring.
Location:	By north-south axis road, Piriwiri CL, Hurungwe District. Map reference QL 5087.
Site:	Gently undulating terrain with maximum slope of about 5%. Mid slope rising from drainage line to the north. Sandy light brown surface. Reddish purple surface where soils are shallow over Sijarira sediments.
Vegetation/land use:	Groundnuts during the 1986-87 season. Uncultivated to the east comprising an open woodland with *Colophospermum mopane* dominant. The site is close to a borehole being used to irrigate a vegetable garden.
Parent material:	Sijarira sediments, possibly thinly-bedded fine sandstone and shale.
Erosion:	None seen.
Land capability:	Class MIII.
Profile irrigable value:	2.
Soil classification:	5M (Zimbabwe) Kanhaplic Haplustalf (Soil Taxonomy) Ferric Lixisol (FAO/UNESCO/ISRIC)
0-18 cm	Brown to dark brown (7.5YR 4/4m) medium loamy sand; dry.
18-56 cm	Yellowish red (5YR 5/6m) medium sandy clay loam; slightly moist.
56-111 cm	Strong brown (7.5YR 5/8m) medium sandy clay loam; many, moderately hard, 1-3 cm diameter R_2O_3 spherical concretions with black centre and red skin; few tabular sandstone gravel; moist.
111-140 cm	Weathered parent material; stratified clay, light grey (10YR 7/1m) and sand, strong brown (7.5YR 5/8m) with mixed texture of coarse sandy clay loam; moderately restricted permeability; common, soft, black MnO_2; few, subround quartz gravel; very moist.

ANALYSIS PROFILE 194-GG-88

Depth (cm)	0-15	30-45	75-90	120-135
Lab No.	W1703	W1704	W1705	W1706
DM %	99.2	98.3	96.8	97.0
Texture	mLS	mSaCL	mSaCL	cSaCL
Gravel %	8	0	0	21
Coarse Sand %	1	1	8	18
Medium Sand %	36	28	22	24
Fine Sand %	51	43	27	29
Silt %	6	6	10	8
Clay %	6	23	33	21
pH ($CaCl_2$)	4.5	4.8	4.8	4.9

Carbonates %	0	0	0	0
EX Ca (me %)	2.5	3.1	9.5	6.1
EX Mg (me %)	0.9	1.1	4.1	2.0
EX Na (me %)	0.02	0.04	0.33	1.14
EX K (me %)	0.18	0.10	0.19	0.10
TEB (me %)	2.8	4.0	8.6	7.4
CEC (me %)	2.8	4.0	8.6	7.4
Base Sat %	100	100	100	100
E/C	43.9	17.6	25.7	35.2
S/C	43.9	17.6	25.7	35.2
ESP	0.7	1.0	3.8	2.0
EKP	6.4	2.5	2.2	1.4

LAND UNIT M4

General description The landform of this unit is flat to gently undulating, occurring at an altitude range of 1 250 – 1 350 m above sea level. The unit is demarcated by the boundary of a sedimentary cap with the more normal Basement Complex rocks of the northern Highveld region. It is the major unit in the southern half of Mhondoro CL, Chegutu District as well as in most of Ngezi CL, Kadoma District. Vleis are common, some of which are perched. The unit occurs in Natural Region III, Agroclimatic Zone 3 and has an area of 1 150 km^2.

Geology Triassic Upper Karoo sediments probably unconsolidated and partly reworked Forest Sandstone.

Soils The soils are unusual and have been the subject of several studies encompassing aspects of soil fertility (Grant, 1962), soil genesis (Purves & Blyth, 1969) and their susceptibility to erosion (Keech 1969, 1990 and Stocking 1976). The soil profile characteristically comprises 50 cm to 100 cm of fine sand, sometimes without measurable clay, abruptly overlying a mottled fine sandy loam or sandy clay loam with a weak blocky or prismatic structure and well-developed clay and sand cutans. The overlying sandy material appears to meet the requirements of an Albic E horizon: one that has lost clay and free iron oxides and colour comes from the uncoated sand particles, typically very pale brown in these soils when dry. Subsoil permeability is restricted creating a seasonal perched watertable. The subsoil is often very acid with a low base saturation and higher exchangeable magnesium than calcium. Some subsoils are sodic and may contain free carbonate. Others may have a fragipan or comprise plinthite.

The soils appear to have developed through a process of solodization. The deeply eluviated A and E horizons have lost their clay by downward and lateral dispersion. The sodic B horizon has accumulated clay and become relatively impermeable. The majority of soils have gone beyond this stage and, with further weathering, lost most of the exchangeable sodium and become acid with a blocky or prismatic structure. At this stage of weathering clays also tend to release magnesium.

The soils show a well-developed catenary relationship (Table 24). A few soils at better-drained sites, usually subdued crest positions, have the textural contrast or duplex profile but the subsoils are reddish with few mottles and a higher pH and base saturation than the more hydromorphic soils. These better-drained soils are clearly associated with areas of better crop production. They are similar in many respects to the upper-slope granitic soils of Land Unit G1.

Mid-slope sites are often subject to seepage and take the form of perched vleis. They are imperfectly to poorly drained and may be sodic or have plinthite at depth. The soils at lower slope positions do not show evidence of a high watertable but are water-receiving areas subject to run-on from upslope and may be sodic.

Natural vegetation The soil catena is reflected in the distribution of natural vegetation which ranges through open woodland, wooded grassland to grassland. The better-drained soils, usually in crest positions, support a *Brachystegia spiciformis* woodland. Associated species include *Parinari curatellifolia,*

Table 24 Typical catenary relationship of soils – Land Unit M4

Landscape position	Soil Classification		
	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Crests	5M	Arenic Paleustalfs	Ferric Lixisols
Upper slopes and level plateaux	5M	Aeric/Arenic Albaqualfs Arenic Fragiudults	Dystric Planosols Gleyic Acrisols
Mid slopes	5M 8N	Plinthaquic Kandiudult Albic Natraqualfs	Ferric/Plinthic Acrisols Gleyic Solonetz
Lower slopes and vlei bottomlands	5MU/8n 8N	Aeric Kandiaqualfs Typic Natrustalfs	Gleyic Lixisols Stagnic Solonetz

Pseudolachnostylis maprouneifolia, Ozoroa insignis, Piliostigma thonningii, Brachystegia boehmii, Acacia nilotica, Combretum molle, Terminalia sericea and *Ximenia caffra*. A few crest positions where drainage is particularly good, such as that followed by the road between Chief Nherera and Hungwe School, have an open woodland dominated by *Julbernardia globiflora*. Some upper-slope positions having subsoils rich in plinthite are dominated by *Brachystegia boehmii*.

The most widespread vegetation type, an open grassland with scattered mature *Parinari curatellifolia*, occurs on the almost flat interfluves. Associated species include *Brachystegia spiciformis, Acacia sieberiana, A. nilotica, Terminalia sericea, Swartzia madagascariensis* and *Maytenus senegalensis*. The soils are of the type described in the typical profile example. The grasses are generally of low nutritive value. These include *Hyperthelia dissoluta, Hyparrhenia filipendula, Digitaria* spp., *Aristida congesta, Urochloa mosambicensis* and *Cynodon dactylon* in better-drained areas. In poorly drained areas the grasses and sedges include *Andropogon eucomus, Brachiaria humidicola, Panicum repens* and *Cyperus denudatus*. Species characteristic of heavily grazed areas are *Perotis vaginata*, the boot protector *Dicerocaryum zanguebarium* and the woody herb *Lopholaena coriifolia*.

Woodland or shrubland dominated by *Colophospermum mopane* occurs in some mid-slope to lower-slope positions where the soils are sodic. Mopane trees can form a nearly pure stand, associated with *Combretum hereroense*. Other species include *Acacia karroo, A. gerrardii, A. nilotica, Pappea capensis, Peltophorum africanum* and *Ziziphus mucronata*. Grass cover is characteristically poor.

A grassland with woodland thicket on abandoned or active termitaria occurs on lower-slope to vlei edge positions which receive runoff from higher-lying areas. The grassland is associated with low shrubs of *Syzygium guineense*. The woodland thicket patches are slightly raised, better drained and well demarcated. Species include *Gardenia ternifolia, Ziziphus mucronata* and *Maytenus heterophylla*. Mopane occurs where the soils are sodic.

Land use About 70% of the unit is arably disturbed but much of this land has been out of production for a long time and signs of cultivation are evident now only from field-boundary ridges. Land is no longer cultivated in many areas because of the combined effects of low soil fertility and a seasonally high watertable. In consequence, substantial areas are now reserved for grazing. The patterns of land use and population distribution imposed by the Land Husbandry Act (Southern Rhodesia, 1951) are still very clear. Arable and grazing blocks are usually well segregated with housing sites aligned in relation to these areas. Change in settlement patterns in part of Mhondoro CL has been studied by Keech (1969).

The extreme south of Ngezi CL was, until the 1960s, part of Mafindefinde African Purchase Area, a type of holding now called a Small Scale Commercial

Farming Area. Here fields are fenced and farmed to a higher standard than is the case farther north.

Land capability As a rough estimate, based on evaluation at 23 sites, the unit comprises 48% Class III, 44% Class IVw, 4% Class V and 4% Class VIf land. The fertility subclass, f, denotes the presence of strongly sodic soils. It may also be appropriate to downgrade some of the Class III land to Class IVf owing to serious fertility constraints. Most of the immature maize seen during the survey of this unit had strong reddish discolouration of the leaves probably as a result of phosphorus deficiency. Foliar analysis results were nitrogen 1.17%, phosphorus 0.076% and potassium 1.14%. Grant (1962) identified trace element deficiencies of boron and sulphur in these soils.

Irrigability The soils of this unit are classified as mainly Class S, excessively pervious sands of very restricted suitability, according to the empirical assessment of Thompson and Purves (1979). Groundwater at shallow depth , analysed by Purves and Blyth (1969), was found to be of low salinity and sodium hazard suitable for irrigating most crops on most soils. With some control of subsoil drainage, to maintain the perched watertable at an appropriate level and with an improvement in the fertility status, these soils may be suitable for small-scale irrigation of crops, probably horticultural rather than field.

Erosion Some of the soils are affected by very severe erosion, mainly gully erosion. This is particularly the case in the Umsweswe River catchment where, according to Worst (1962), it is primarily of geological origin but exacerbated by inappropriate land use. Part of the catchment is underlain by arkosic sandstone containing a high proportion of sodium feldspars, the breakdown of which ultimately causes release of sodium and dispersion of clay in the soil profile. Tunnel erosion is common and is discussed by Stocking (1976) with particular reference to this area.

Development potential There is a modest potential for rehabilitation providing the fertility and drainage constraints are overcome. The unit has an advantage of proximity to Harare. It is probably a suitable area for the use of wind-pumps.

Typical Profile Description Land Unit M4

Profile number:	39-GG-88 described on 21 April 1988. Profile pit.
Location:	Opposite Mr Gwavava's house, 9 km south of Mubayira on the road to Makaure School, Mhondoro CL, Chegutu District. Map reference TQ 4966.
Site:	Almost flat, less than 2% slope, near crest of very subdued interfluve. Few agates on surface which is very weakly crusted.
Vegetation/land use:	Adjacent to mature *Eucalyptus* plantation. Grazing area but with old field-boundary ridges evident. Sparse grass cover, about 60% bare, mainly *Perotis vaginata*. Common *Dicerocaryum zanguebarium*. Wooded grassland including *Parinari curatellifolia, Terminalia sericea, Acacia nilotica, Gardenia volkensii, Flacourtia indica, Brachystegia spiciformis* and dwarf *Syzygium guineense*.
Parent material:	Karoo sandstone.
Erosion:	None evident.
Land capability:	Class IVw.
Profile irrigable value:	3.
Soil classification:	5M (Zimbabwe) Arenic Fragiudult (Soil Taxonomy) Ferric Acrisol (FAO/UNESCO/ISRIC)
0-15 cm	Pale brown (10YR 6/3d) and brown (10YR 4/3m), fine sand; soft, slightly moist; very weak medium and fine subangular blocky; common fibrous roots; clear smooth boundary to:

15-33 cm	Very pale brown (10YR 7/4d) and light yellowish brown (10YR 6/4m) fine sand; soft, slightly moist; structureless; 1% brownish yellow mottles; common fibrous and few woody roots <1 cm; clear smooth boundary to:
33-63 cm	Very pale brown (10YR 8/3d) and light yellowish brown (10YR 6/4m); fine sand; 1% brownish yellow mottles; loose, moist; structureless; few fibrous and few woody roots <4 cm; abrupt wavy boundary to:
63-115 cm*	Yellow (10YR 7/6d) and brownish yellow (10YR 6/6m) fine sandy clay loam; 20% medium and coarse red mottles; firm, moist; weak coarse angular blocky; few fibrous roots; moderately thick grey clay and white fine sand cutans on vertical ped faces, well-developed thick light grey clay and fine sand cutans in pores; diffuse wavy boundary to:
115-165 cm+	Yellow (10YR 7/6d) and brownish yellow (10YR 6/6m) fine sandy clay loam; 20% coarse red mottles; friable, moist; very weak coarse angular blocky; few fibrous roots; weakly-developed thin clay and fine sand cutans on ped faces, well-developed thick clay and fine sand cutans in pores.

* Opposite face of pit shows 114 cm of sand over the abrupt boundary.

ANALYSIS PROFILE 39-GG-88

Depth (cm)	0-15	15-30	40-55	80-95	130-145
Lab No.	X0539	X0540	X0541	X0542	X0543
DM %	99.8	99.7	99.8	99.1	99.1
Texture	fS	fS	fS	fSaCL	fSaCL
Gravel %	0	0	0	0	0
Coarse Sand %	2	2	2	2	2
Medium Sand %	24	24	23	20	19
Fine Sand %	69	72	73	53	54
Silt %	3	1	0	2	3
Clay %	1	1	1	22	21
pH ($CaC1_2$)	4.2	3.9	4.0	3.9	3.9
Carbonates %	0	0	0	0	0
EX Ca (me %)	0.7	0.5	1.6	0.7	0.6
EX Mg (me %)	0.1	0.0	1.3	0.0	0.9
EX Na (me %)	0.02	0.04	0.04	0.04	0.04
EX K (me %)	0.04	0.04	0.04	0.8	0.12
TEB (me %)	0.8	0.6	1.2	0.8	1.7
CEC (me %)	1.5	1.4	1.2	5.2	4.6
Base Sat %	56	46	100	16	37
E/C	126.0	117.0	99.0	23.4	21.4
S/C	70.0	53.3	99.0	3.7	7.9
ESP	1.3	2.8	3.4	0.8	0.9
EKP	2.6	2.8	3.4	1.5	2.6

LAND UNIT M5

General description This unit occurs in the Sanyati-Sengwa Basin region of Omay CL and the Middle Save Valley in Ndowoyo and Sangwe CLs. The altitude range is from about 400 m to 600 m above sea level with the higher elevations found in the Zambezi Valley. The landform is locally complex where the sediments are much cut by faults to produce low scarps and koppies. The less resistant sandstones have weathered to produce a featureless almost flat plain. Fault-springs are common and an important source of water supply. This unit occurs in Natural Regions IV and V, Agroclimatic Zones 4 and 5 and has an area of 660 km^2.

Geology A geological description of the rocks comprising this unit in the Save Valley is given by Swift *et al.* (1953). Two distinct types of Upper Karoo sandstones are recognised. The lower sandstones are red, fine grained, calcareous and contain a proportion of shale. The upper sandstones are more resistant and frequently form isolated koppies or more extensive stretches of broken country. These are white, massive and show dune-bedding indicative of aeolian origin. Minerals consist of quartz and feldspars with little cementing material.

Soils The soils derived from the red sandstones are mainly well-drained, deep, reddish brown, fine-grained (up to 80% fine sand) loamy sands and sandy loams over red, fine-grained sandy loams and sandy clay loams. They are commonly calcareous at depth. Sodic subsoils may occur or an accumulation of illuviated clay resulting in reduced permeability and these soils show signs of spells of waterlogging as indicated by yellower colours and the presence of mottling. Rainfall acceptance of some soils is severely limited by the development of surface capping, characteristic of many fine-grained poorly-structured topsoils. The typical soils classify as 4M (Zimbabwe), Typic Haplustalfs (Soil Taxonomy) and Calcic or Chromic Luvisols (FAO/UNESCO/ISRIC).

The soils derived from the white sandstones are, by contrast, very much sandier, generally brown to yellowish brown fine sands to a depth of at least one metre. Mottling may be present, indicating a drainage restriction at greater depth. Most of these soils are sufficiently deep to classify as regosols, 1 (Zimbabwe), Ustipsamments (Soil Taxonomy) and Arenosols (FAO/UNESCO/ISRIC). The catenary relationships of these soils require further investigation.

Natural vegetation The natural vegetation characteristic of the heavier soils is a *Colophospermum mopane* woodland. This species may be present as a single dominance or in a catenary relationship with other species, particularly *Julbernardia globiflora*. In the sandier areas, *Colophospermum mopane* is likely to be absent except in lower-slope positions with drainage impedence. Well-drained sites are characterised by species such as *Julbernardia globiflora, Terminalia sericea, Burkea africana, Afzelia quanzensis, Pteleopsis myrtifolia, Combretum apiculatum, Vangueria infausta* and *Cordyla africana*. The vegetation in the Save Valley area has been described by Farrell (1968b) and in Omay CL by Timberlake *et al.* (1992).

Land Use Access is reasonably good and about 10% of the unit shows signs of arable disturbance. Sorghum appears to be the principal crop. A small amount of cotton is grown in Omay CL.

Land capability Where surface crusting and sealing is absent, drainage is good and slope is not greater than 2%, the land is classified as MII. However, crusting and sealing is prevalent, downgrading an area to MIII or, where severe, MIV.

Irrigability Many of the heavier-textured soils are suitable for irrigation. In some cases, it may be possible to tap water from spring sources to implement small-scale schemes.

Erosion Because of the prevalence of surface sealing erosion is locally severe. The fine-sand soils are affected by wind erosion although this is not severe.

Development potential This unit comprises an important dryland cropping area in Omay CL and appears to be an area where an intensification of production is feasible through the introduction of small-scale irrigation schemes. Tsetse fly, which has been particularly persistent in this part of the Zambezi Valley, presently limits the use of cattle as a source of draught power. In the Middle Save region, this unit has a high proportion of very sandy soils and is less well suited to irrigation although Ellis *et al.* (1953) consider these sands to be suitable for irrigation if adequate water is available.

Typical Profile Description Land Unit M5 – Soil derived from red sandstone

Profile number:	229-FF-87 described on 27 July 1987. Profile pit.
Location:	Chief Mola's area. At junction of road from Siakobvu to Bumi Hills and road to Marembera school. Omay CL, Kariba District. Map reference PM 371 241.

Site:	Scarp-faulted topography comprising small basins of relatively flat land with low, steep-sided ridges frequently elongated and not more than 15 m high. Frequent springs indicating faults. Elevation 530 m above sea level.
Vegetation/land use:	Cultivated field. Most of the immediate area has been cleared and is used for sorghum and millet with a little maize and cotton. Medium to tall *Colophospermum mopane* woodland occurs as remnants.
Parent material:	Upper Karoo sediments comprising fine-grained calcareous sandstones and shale.
Erosion:	Occasional gully erosion.
Land capability:	Class MIII.
Profile irrigable value:	1.
Soil classification:	4M (Zimbabwe) Typic Haplustalf (Soil Taxonomy) Calcic Luvisol (FAO/UNESCO/ISRIC)
0-24 cm	Dark brown (7.5YR 3/4 moist) and yellowish brown (10YR 5/4 dry) fine sandy loam; weak medium and coarse granular with weak platy structure; slightly sticky, non plastic, friable moist, slightly hard dry consistence; few fine pores; few fine medium and coarse roots; good permeability and well drained; clear wavy transition to:
24-68 cm	Yellowish red (5YR 5/6 moist) and reddish yellow (5YR 6/6 dry) fine sandy clay loam; weak coarse prismatic structure; slightly sticky, slightly plastic, friable moist and slightly hard dry consistence; few thin clayskins; common medium, few fine and coarse pores; few fine, medium and coarse roots; good permeability and well drained; diffuse smooth transition to:
68-100 cm	Red (2.5YR 5/6 moist) fine sandy loam; massive structure; slightly sticky, non plastic, friable moist consistence; very few patchy thin clayskins; few fine pores; few fine medium and coarse roots; some inclusions of material from the above horizons due to termite activity; good permeability and well drained; diffuse smooth transition to:
100-168 cm+	Red (2.5YR 5/6 moist) fine sandy loam; massive structure; slightly sticky, non plastic, friable moist consistence; frequent soft carbonate nodules; few fine pores; few fine and medium roots; inclusions of material from the horizon above due to termite activity; good permeability and well drained.

ANALYSIS PROFILE 229-FF-87

Depth (cm)	0-15	40-55	75-90	100-115	145-160
Lab No.	W1370	W1371	W1372	W1373	W1374
DM %	97.9	96.5	98.3	98.3	97.4
Texture	fSaL	fSaCL	fSaL	fSaL	fSaL
Gravel %	0	0	0	0	0
Coarse Sand %	0	0	0	1	1
Medium Sand %	0	0	0	1	1
Fine Sand %	83	74	81	79	79
Silt %	5	5	4	7	7
Clay %	11	20	14	12	11
pH ($CaC1_2$)	6.1	6.2	7.1	7.3	7.2
Carbonates %	0	0	0	6.0	6.7
EX Ca (me %)	6.7	10.5	10.7	117.4	128.9
EX Mg (me %)	1.4	1.1	1.2	1.5	2.6
EX Na (me %)	0.06	0.08	0.04	0.10	0.08
EX K (me %)	0.47	0.33	0.28	0.20	0.18
TEB (me %)	8.6	12.0	12.0	11.3	10.1
CEC (me %)	9.6	12.7	12.0	11.3	10.1
Base Sat %	89	95	100	100	100
E/C	85.5	64.5	84.0	92.3	89.1
S/C	76.3	61.1	84.0	92.3	89.1
ESP	0.6	0.7	0.3	0.9	0.8
EKP	4.9	2.6	2.4	1.8	1.8
Org. Carbon %	0.14	0.09	0.05	0.05	0.04

Typical Profile Description Land Unit M5 – Soil derived from white sandstone

Profile number:	7-GG-91 described on 7 January 1991. Auger boring.
Location:	By tarred road about 10 km north of St. Peters, Ndowoyo CL, Chipinge District.
Site:	Upper slope below low white sandstone koppie. On short 2%-3% slope down from rock outcrop, thereafter continuing almost flat. Surface condition is loose.
Vegetation/land use:	Fallow land with few trees including *Terminalia sericea, Afzelia quanzensis* and *Cordyla africana*.
Parent material:	Upper Karoo sandstone.
Erosion:	Minor accumulations of windblown fine sand and patches of deflation.
Land capability:	Class MIII.
Profile irrigable value:	2.
Soil classification:	1 (Zimbabwe) Aquic Ustipsamment (Soil Taxonomy) Haplic Arenosol (FAO/UNESCO/ISRIC)
0-50 cm	Dark brown (10YR 3/3m) fine sand; moist after rain.
50-100 cm	Brown (10YR 4/3m) fine sand; few fine strong brown mottles or soft concretions; dry
100-140 cm	Light yellowish brown (10YR 6/4m) fine sand; common medium yellowish brown mottles.

ANALYSIS PROFILE 7-GG-91

Depth (cm)	0-50	50-100	100-140
Lab No.	Z1293	Z1294	Z1295
DM %	99.6	100.0	99.8
Texture	fS	fS	fS
Clay %	3	3	2
Silt %	1	2	2
Fine Sand %	78	80	78
Medium Sand %	17	15	18
Coarse Sand %	0	0	0
Gravel %	0	0	0
pH ($CaCl_2$)	4.7	4.7	4.7
Carbonates %	0	0	0
EX Ca (me %)	0.9	0.6	0.4
EX Mg (me %)	0.6	0.6	0.2
EX Na (me %)	0.03	0.03	0.03
EX K (me %)	0.12	0.10	0.11
TEB (me %)	1.7	1.3	1.7
CEC (me %)	4.0	2.5	1.1
Base Sat %	42	53	66
E/C	135.6	86.9	52.3
S/C	57.5	45.6	34.5
ESP	0.8	1.0	2.3
EKP	3.0	4.0	10.2
Free Fe	0.25	0.20	0.20

LAND UNIT M6

General description This is an important unit in the Upper Zambezi Valley and Sanyati-Sengwa Basin region and adjacent Middleveld, occurring in the Communal Lands of Kariba, Gokwe and Binga Districts at elevations between 600 m and 1 100 m above sea level. The landform is typically an almost level or gently-dipping plateau with well defined and imposing escarpment boundaries. In places this surface has been considerably eroded resulting in the formation of mesas and buttes. Surface drainage is frequently lacking or very ill-defined owing to the rapid permeability of the soils and underlying strata. An area in the Southeast Lowveld with similar soils and landform but comprising more recent sediments has been included in this unit. Examples are found in Sengwe and Matibi No. 2 CLs. It is represented in Natural Regions IV and V, Agroclimatic Zones 3, 4, 5 and 6 and has an area of 5 930 km^2.

Geology Upper Karoo sediments comprise the geology of this unit, probably mainly Escarpment Grit and, to a lesser extent, Pebbly Arkose, the two most

resistent members of the succession. Some superficial sandy deposits may be reworked remnants of unconsolidated Forest Sandstone and Kalahari Sand. In the Southeast Lowveld the unit is represented by the Malvernia Beds of Cretaceous age. These comprise a succession of gently dipping, red and white sandstones, grits and conglomerates, variably cemented by calcite (Stagman, 1978).

Soils The soils are generally very well-drained, shallow to deep, medium- and coarse-grained sands and loamy sands over yellowish red to red medium- and coarse-grained loamy sands and sandy loams. These are associated with soils, in the Zambezi Valley, supporting jesse-bush thickets. The thicket soils are physically similar to the dominant soils of the unit but with ferrallitic characteristics such as depletion of bases, apart from potassium, and extreme acidity in the subsoil with pH ($CaCl_2$) less than 4. The soils in the drier environment of the Southeast Lowveld are siallitic.

Catenary patterns, relating to depth to stone-lines, have been observed but are not strongly expressed. The soils are 5M, or 4M in the Southeast Lowveld, (Zimbabwe), Ustipsamments and Kandiustalfs (Soil Taxonomy) and Arenosols and Lixisols (FAO/UNESCO/ISRIC).

Natural vegetation Northwest of the central watershed, this unit supports a frequently well-developed woodland dominated by *Brachystegia spiciformis, Julbernardia globiflora* or *Brachystegia boehmii*. Where the soils are very deep, the trees retain their foliage well into the dry season as is the case over much of the primary Kalahari Sand. *Colophospermum mopane* may occur but is uncommon. Other species include *Xeroderris stuhlmannii, Terminalia sericea, Combretum zeyheri, C. fragrans, C. apiculatum, Burkea africana* and *Kirkia acuminata*.

The boundary between the miombo woodland and the woodland thicket is usually sharp. The thicket types have been classified by Timberlake *et al.* (1992) and, in this unit, include *Baikiaea plurijuga* woodland thickets and *Xylia torreana* woodland thickets. These have in common a dense shrub layer, 2-4 m high, characteristically including the scandent species *Combretum celastroides* and *C. elaeagnoides*.

To the southeast of the central watershed, the miombo element is reduced to the presence of *Julbernardia globiflora* and minor occurrences of *Brachystegia glaucescens* in an open woodland on the Cretaceous sandstone plateau. The more widespread vegetation type is, however, a very open *Combretum apiculatum* woodland associated with *Pteleopsis myrtifolia, Strychnos decussata, Terminalia sericea, Diplorhynchus condylocarpon, Adansonia digitata* and *Combretum collinum*. Mopane becomes dominant around pans and drainage lines.

In places, thicket communities form a mosaic with this woodland. These include dense thickets of *Androstachys johnsonii* on level areas of deep soil and on escarpment slopes at the plateau edge. Another thicket type, similar to a community found in Hwange and Binga Districts, comprises co-dominant *Guibourtia conjugata* and *Baphia massaiensis* associated with *Pterocarpus lucens, Pteleopsis myrtifolia, Croton scheffleri* and *Monodora junodii* (Farrell, 1968b).

Land use Most of the unit remains uncultivated woodland, mainly because access is poor and population low. Where access is better, northwest of Nembudziya, Gokwe District, and in the vicinity of Siakobvu, Kariba District, about 15% of the unit is arably disturbed, mainly in recent years. Sorghum and millet are the principal crops in these areas. In Sengwe and Matibi No. 2 CLs, the unit forms the periphery of a large extension of this type of land into Gonarezhou National Park.

Land capability The unit is predominantly MII and MIII according to the AGRITEX capability classification which is based on hazard-of-use criteria. The soils have, in addition, constraints of low natural fertility and low water-holding capacity for shallow rooting crops. Bromley (1966) considers these soils in Busi CL, Binga District, to be suitable for cultivation but cautions that they will deteriorate rapidly if cropped continuously for any length of time.

Irrigability The potential for irrigation is very limited owing to the sandy soil textures and the lack of water sources.

Erosion For most of the unit there is a low erosion hazard owing to the almost level terrain, permeable soils and good vegetation cover. However, in the Escarpment Grit formation, there are a number of thin, clay-rich beds which can, on exposure, act as the foci for undercutting or sapping and the very rapid development of gully erosion (Bromley & Jones, 1966).

Development potential Potential for development is limited by the presence of tsetse fly in part of the Zambezi Valley, poorly developed communications, a widespread lack of surface water supplies, an absence of tested extension advice on appropriate land use and the hazard of depredation by wild animals. The soils of this unit also have low moisture and nutrient retention, high acidity and low chemical fertility. Despite these unattractive properties they represent some of the most extensive cultivable soils that are presently little utilized, particularly in the Upper Zambezi Valley region. Their positive properties include soil depth, ease of cultivation, receptivity of rainfall and gentle slopes. The question of whether units such as this should be recommended as suitable for clearing for cultivation is a moot point.

Typical Profile Description Land Unit M6 – soil derived from Escarpment Grit, Upper Zambezi Valley region

Profile number:	213-FF-87 described on 23 July 1987. Profile pit.
Location:	Approximately 4 km along the Binga road from Siakobvu. Omay CL, Kariba District. Map reference PM 451 018.
Site:	Gently undulating landform, midslope 4%. 740 m elevation.
Vegetation/land use:	Medium to tall woodland with common *Brachystegia spiciformis, B. boehmii, Julbernardia globiflora* and *Diplorhynchus condylocarpon*. Clumps of perennial grasses constitute a 20% basal cross section. No signs of previous cultivation but sorghum field nearby.
Parent material:	Escarpment Grit comprising red, coarse-grained grit containing pebbles.
Erosion:	Not observed.
Land capability:	Class MIII.
Profile irrigable value:	4.
Soil classification:	5M borderline 6M (Zimbabwe) Typic Ustipsamment (Soil Taxonomy) Ferralic Arenosol (FAO/UNESCO/ISRIC)
0-16 cm	Dark brown (7.5YR 3/4m) and brown (10YR 5/3d) medium sand; weak medium and coarse root-induced crumb structure; non sticky, non plastic, very friable moist, soft dry consistence; few fine pores; locally abundant fine, few medium and coarse roots; rapid permeability and very well drained; clear smooth transition to:
16-50 cm	Yellowish red (5YR 4/6m) and light brown (7.5YR 6/4d) coarse sand; apedal; non sticky, non plastic, very friable moist and soft dry consistence; few fine pores; few fine and medium roots; some small inclusions of material from the horizon above due to termite activity; rapid permeability and very well drained; diffuse smooth transition to:

50-94 cm	Strong brown (7.5YR 5/6m) and reddish yellow (5YR 6/6d) coarse sand; apedal; non sticky, non plastic, very friable to loose moist and soft dry consistence; few medium and coarse pores; few fine, medium and coarse roots; rapid permeability and well drained; diffuse smooth transition to:
94-149 cm	Yellowish red (5YR 5/6m) and reddish yellow (5YR 7/6d) very coarse grained sand; apedal, slightly less compact than the horizons above; non sticky, non plastic, loose moist and soft dry consistence; few medium and coarse pores; few fine, medium and coarse roots; rapid permeability and very well drained; abrupt smooth transition to:
149 cm+	Horizon of 0.5-4 cm-diameter rounded quartz pebbles, with isolated fragments of hard weathering coarse sandy sediment.

ANALYSIS PROFILE 213-FF-87

Depth (cm)	0-16	25-40	65-80	115-130
Lab No.	W1323	W1324	W1325	W1326
DM %	99.7	99.7	99.8	99.8
Texture	mS	cS	clS	cS
Gravel %	0	0	0	1
Coarse Sand %	21	27	33	53
Medium Sand %	54	46	44	31
Fine Sand %	20	20	13	7
Silt %	1	3	3	2
Clay %	5	5	7	6
pH ($CaCl_2$)	5.1	5.3	4.6	4.7
Carbonates %	0	0	0	0
EX Ca (me %)	2.8	0.0	0.6	0.6
EX Mg (me %)	1.3	0.4	0.5	0.7
EX Na (me %)	0.02	0.02	0.02	0.02
EX K (me %)	0.08	0.08	0.08	0.06
TEB (me %)	2.2	0.5	0.6	0.8
CEC (me %)	2.2	1.2	0.6	0.8
Base Sat %	100	43	100	100
E/C	44.9	24.5	7.9	13.3
S/C	44.9	10.6	7.9	13.3
ESP	0.9	1.7	3.4	2.6
EKP	3.7	6.8	13.6	7.7
Org. Carbon	0.52	0.12	0.05	0.04

Typical Profile Description Land Unit M6 – soil derived from Malvernia Beds, Southeast Lowveld region

Profile number:	12-GG-91 described on 11 January 1991. Auger boring.
Location:	Near most southerly point in Zimbabwe, Crooks Corner. Sengwe CL, Chiredzi District.
Site:	Plateau, almost flat, less than 2% slope, near edge of minor escarpment bordering the Limpopo River alluvial terrace.
Vegetation/land use:	Open woodland with no evidence of cultivation in surrounding area. *Colophospermum mopane* and *Adansonia digitata* are common, associated with *Commiphora* spp., *Gardenia* sp. and *Markhamia acuminata*.
Parent material:	Malvernia Beds of Cretaceous age.
Erosion:	Not observed.
Land capability:	Class MII.
Profile irrigable value:	4.
Soil classification:	4M (Zimbabwe) Typic Ustipsamment (Soil Taxonomy) Luvic Arenosol (FAO/UNESCO/ISRIC)
0-30 cm	Brown to dark brown (7.5YR 4/4m) coarse sand; moist after rain.
30-70 cm	Reddish brown (5YR 4/4m) coarse sand; moist after rain.
70-111 cm	Yellowish red (5YR 4/6m) coarse loamy sand; moist transitional down to dry after rain.

ANALYSIS PROFILE 12-GG-91

Depth (cm)	0-30	30-70	70-111
Lab No.	Z1306	Z1307	Z1308
DM %	99.2	98.9	98.3
Texture	cS	cS	cLS
Clay %	3	5	9
Silt %	3	3	3
Fine Sand %	8	5	7
Medium Sand %	21	18	17
Coarse Sand %	65	68	63
pH ($CaCl_2$)	6.2	5.5	6.3
EX Ca (me %)	2.9	1.9	5.5
EX Mg (me %)	1.1	2.5	2.6
EX Na (me %)	0.02	0.06	0.07
EX K (me %)	0.25	0.43	0.31
TEB (me %)	4.3	4.8	5.8
CEC (me %)	5.7	6.1	5.8
Base Sat %	75	79	100
E/C	163.9	116.9	64.2
S/C	123.3	92.9	64.2
ESP	0.4	1.0	1.2
EKP	4.4	7.1	5.5
Free Fe	0.63	0.88	1.11

LAND UNIT M7

General description This is an important unit in Zhombe CL, the southern part of Gokwe CL and in Lupane and Nkayi Districts. It forms part of the Kalahari Sandveld region where the aeolian sand deposits have, for the most part, been removed by the action of the larger rivers such as the Sengwa and Shangani. The landform varies from almost flat to undulating, comprising gently sloping valley sides with gradients less than 8%. Parts of the unit are closely dissected by short, sometimes actively eroding, tributaries feeding from the sands capping the interfluve crests. The altitude range is from 850 m to 1 200 m above sea level. This unit occurs in Natural Regions III and IV, Agroclimatic Zones 3 and 4 and has an area of 4 310 km^2.

Geology The geology consists of Upper Karoo sediments with inclusions of Cretaceous sediments and secondary Kalahari Sand.

Soils The soils are variable owing to lateral changes in the lithology of the Karoo sediments and complex colluviation processes involving cycles of deposition and erosion. However, the majority of soils are moderately deep to deep, well- to moderately well-drained, siallitic or fersiallitic, fine- to medium-grained sands or loamy sands over pale brown to yellowish red, frequently mottled, fine- to coarse-grained sandy loams or sandy clay loams. Some soils show an abrupt increase in clay at depth and a morphology similar to sodic profiles although chemically non-sodic. An interpretation of the nature of the parent material and its significance in terms of soil development is given by Watson *et al.* (1984). A number of soil toposequences are probably present but these could not be elucidated during the course of this survey. The soils classify as 4M or 5M (Zimbabwe), Haplustalfs or Paleustalfs (Soil Taxonomy) and Luvisols or Alisols (FAO/UNESCO/ISRIC).

Natural vegetation Much of the natural woodland, a mosaic dominated by either miombo species or mopane, has been cleared for cultivation. The heavier soils, commonly with a slight drainage restriction, are typically associated with *Colophospermum mopane* accompanied by *Brachystegia boehmii, Combretum apiculatum, Diospyros kirkii* and *Euclea divinorum.* The lighter, freely drained soils are indicated by an association of *Brachystegia spiciformis, B. boehmii, Julbernardia globiflora* and *Terminalia sericea.*

Land use This unit is favoured for cultivation. In Nkayi and Lupane CLs about 70% of the unit is arably disturbed. Government reports since the 1950s have commented on problems in these areas related to overpopulation and overstocking. In the Kalahari Sandveld region these problems are largely caused

by the high proportion of land with very sandy, low fertility soils, generally referred to as "gusu", which have a problematic cropping and grazing potential. The valleys comprise a relatively small area, particularly in Lupane District, and it is here that the main cropping and grazing areas are found, associated with soils having a higher clay content, sometimes referred to as contact and "isidhaka" soils.

The Robinson Commission (1961/62) district survey reports for Nkayi and Lupane elaborate on this problem and recommend, as a palliative, irrigation development. There is little evidence of current agronomic research into farming systems suitable for this environment despite its chronic problems concerning crop and livestock production, and not withstanding the fact that the Kalahari and related sandy soils (of sedimentary origin) occupy more than 10% of Zimbabwe, mainly in the Communal Lands. Before independence, some research was conducted at the Lukampa Research Station in Nkayi.

There is less pressure on this unit in Gokwe and Zhombe CLs where between 20% and 40% of the unit is arably disturbed.

Land capability The unit is generally arable apart from the frequent drainage lines. Mainly Class MII and MIII with minor Class MIV and VI.

Irrigability This unit is classed as mainly Class C with minor Class B.

Erosion There is an above-average hazard owing to poor soil cover, longish slopes, the tendency for some soils to cap and textural contrast profiles which are prone to erode. Many of the small tributaries of the Shangani River are associated with active gullying.

Development potential Potential is limited by the current high intensity of use for dryland cropping, grazing and as dwelling sites. There is a need for conservation of resources since soil erosion, in particular, is very severe in this unit. There is scope for improvement of yield of dryland crops, the introduction of new crops and cropping intensification through the introduction of small-scale irrigation or simple water-harvesting schemes.

Typical Profile Description Land Unit M7

Profile number:	163-GG-88 described on 5 August 1988. Gully exposure.
Location:	North bank of the Shangani River, near Benzies Bridge, on road west to Tshongokwe. Edge of the Dhloba Dhloba River, a tributary of the Shangani. Lupane CL, Lupane District. Map reference NK 9324.
Site:	Gully exposure by dry river. Lower slope, 2%-4%.
Vegetation/land use:	Disturbed woodland comprising *Colophospermum mopane, Terminalia sericea, Peltophorum africanum, Brachystegia spiciformis* and *Combretum fragrans.*
Parent material:	Current-bedded red, white and purple Upper Karoo sandstone. Superficial deposit of alluvio-colluvial secondary Kalahari Sand. Discontinuous stone line at the base of this deposit containing Stone Age artefacts, agate and lateritic gravel.
Erosion:	Severe erosion, gullying. Deposition of sandy material from upslope primary Kalahari Sand (Land Unit K1).
Land capability:	Class VI.
Profile irrigable value:	Site not suitable for irrigation.
Soil classification:	5M (Zimbabwe) Arenic Haplustalf-borderline (Soil Taxonomy) Albic Luvisol (FAO/UNESCO/ISRIC)
0-7/11 cm	Very pale brown (10YR 8/4d) and light yellowish brown (10YR 6/4m) fine sand; soft; depositional sand of variable thickness – 60 cm thick 10 m downstream.

7/11-24 cm	Greyish brown (10YR 5/2d) and very dark greyish brown (10YR 3/2m) medium loamy sand; buried A horizon, porous; common fibrous and large woody roots of *Terminalia sericea*; slightly hard; very weak, coarse subangular blocky structure.
24-47 cm	Pale brown (10YR 6/3d) and brown (10YR 5/3m) medium sandy loam; common fine strong brown and common medium light grey mottles; strong brown mottles associated with root and pore channels; very porous elluviated appearance; hard consistence; very weak, coarse subangular blocky structure.
47-85 cm	Very pale brown (10YR 7/3d) and pale brown (10YR 6/3m) fine loamy sand; common medium strong brown and yellowish red mottles; porous elluviated appearance; hard consistence; very weak, coarse subangular blocky structure.
85-117 cm	White (10YR 8/2d) and pale brown (10YR 6/3m) fine loamy sand; few fine strong brown mottles in pore and root channels; few incipient <5 cm strong brown ferruginous concretions; porous elluviated appearance; hard consistence; very weak, coarse subangular blocky structure.
117-205 cm	Very pale brown (10YR 8/3d) and (10YR 7/3m) fine sandy clay loam; few fine and medium strong brown to red pore and old root-channel mottles; moderate medium 7.5YR 4/2 clay cutans on faces and in pores; very hard consistence; strong coarse columnar structure.

Augering in bottom of gully indicated soft, weathered, white sandstone at 320 cm depth

ANALYSIS PROFILE 163-GG-88

Depth (cm)	0-11	11-24	25-40	60-75	95-110	130-165
Lab No.	X2668	X2669	X2670	X2671	X2672	X2673
DM %	99.6	99.1	98.9	99.2	99.2	97.2
Texture	fS	mLS	mSaL	fLS	fLS	fSaCL
Gravel %	0	0	0	0	0	0
Coarse Sand %	3	7	8	5	5	3
Medium Sand %	20	27	25	26	21	14
Fine Sand %	73	50	48	56	61	55
Silt %	1	8	8	4	4	4
Clay %	3	6	11	10	9	24
pH ($CaC1_2$)	5.4	4.4	4.0	3.9	3.9	4.2
Carbonates %	0.0	0.0	0.0	0.0	0.0	0.0
EX Ca (me %)	2.7	1.3	1.3	0.7	0.8	3.4
EX Mg (me %)	0.4	0.6	0.3	0.2	0.3	1.4
EX Na (me %)	0.04	0.12	0.14	0.14	0.20	0.68
EX K (me %)	0.12	0.24	0.26	0.26	0.24	0.54
TEB (me %)	3.3	2.3	2.2	1.3	1.5	6.0
CEC (me %)	3.7	3.1	3.1	2.6	3.6	7.8
Base Sat %	90	73	72	50	42	77
E/C	142.7	38.5	27.6	27.2	39.1	32.9
S/C	128.2	28.3	19.8	13.5	16.4	25.4
ESP	1.1	3.8	4.6	5.4	5.7	8.7
EKP	3.3	7.7	3.5	10.0	6.8	6.8

LAND UNIT M8

General description This is a large, undivided unit centred on Nembudziya town in the south of Sebungwe CL and east of Gokwe CL. It presents a remarkably even, almost flat extension of the Pliocene landsurface and takes the form of a pediplain at 800 m to 950 m above sea level. Bordering the unit to the southwest, the Mafungabusi Escarpment marks a spectacular nickpoint between this surface and the Post-African erosion surface of Land Unit E7. There are many seasonal streams draining east to northeastwards mainly into the Bvumvudze River, a tributary of the Sanyati River. The unit has been described and mapped as a land system by Bromley and Jones (1966). It occurs in Natural Region III, Agroclimatic Zone 3 and has an area of 760 km^2.

Geology Leyshon (1969) and Sutton (1979) have mapped most of this unit giving the underlying rocks a Karoo age but they were unable to subdivide the succession into its various stages and series because of lack of exposures and the presence of a discontinuous veneer of old alluvium. Nevertheless, sufficient is known to allocate most of the unit to the Lower Karoo with only the southern part representing the more arenaceous Upper Karoo sediments. The overlying deposits of old alluvium were probably produced by intermittent sheet floods.

Soils The soils are variable but in the main can be described as moderately deep to deep, fersiallitic, medium-grained loamy sands to sandy loams over medium-grained sandy loams to sandy clay loams. Soils under jesse-bush thicket are extremely acid and may have a coarse sand fraction where derived from Upper Wankie Sandstone (Broderick, 1991), although other textural classes and Karoo sediments can be associated with this vegetation type. Some of the soils in the south, east of Chinyenyetu, are moderately well drained and appear to have a seasonally high watertable. A minor proportion of soils are clays over mudstone or shale. Some lower-slope positions have calcareous and sodic soils. The classification of the main soil types according to parent material is shown in Table 25.

Natural vegetation There is a good correlation between vegetation and soil type in this unit although the natural woodland has mostly been cut back for cultivation. *Brachystegia spiciformis* is characteristic of sites with deep, well-drained and moderately sandy soils. *Colophospermum mopane* is widespread and may be dominant on the clay soils, sodic soils or other soils where drainage is restricted. *Brachystegia boehmii* is also indicative of poorer drainage or may indicate the presence of shallow soils. *Combretum fragrans* is common as a coppicing shrub on soils with a seasonally high watertable. Jesse bush, taking the form of a *Xylia torreana* dry forest, occupies several large sites on interfluves north of Nembudziya.

Land use About 65% of the unit is arably disturbed, the only areas of any size not showing signs of cultivation being some jesse-bush and mopane clay terrain. Cotton is an important cash crop.

Land capability Slope is not a significant constraint and capability is determined by soil texture and subsoil permeability. The unit is an association of Class II and Class III land, with the former probably predominant. Owing to a probably severe fertility constraint, the jesse-bush areas are classified, tentatively, as MIVf.

Irrigability There are probably large blocks of Class B land but a more detailed survey would be required to ascertain this.

Table 25 Soil classification according to parent material – Land Unit M8

	Soil Classification		
Parent material	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Arenaceous Karoo sediments (the modal parent material)	5M	Typic/Kanhaplic Haplustalfs	Haplic Luvisols/Lixisols
Argillaceous Karoo sediments (mainly Madumabisa Mudstones)	4M	Vertic Ustropepts	Vertic Cambisols
Upper Wankie Sandstone (jesse-bush soil)	5M/6M	Ustoxic Dystropepts	Dystric Cambisols

Erosion There is a below-average hazard owing to the lack of significant slopes of any length. Some of the lower-slope sodic soils may be prone to erosion.

Development potential Moderate improvements can be expected in dry-land production, although there is little scope for extending the area under cultivation. Irrigation prospects may be good.

Typical Profile Description Land Unit M8 – Example of imperfectly drained soil

Profile number:	68-GG-88 described on 7 June 1988. Auger boring.
Location:	By Copper Queen road east of Chinyenyetu, Gokwe CL, Gokwe District. Map reference QL 2016.
Site:	Almost level but probably with complex microtopography. Common 1-2 m high brown termitaria. Seasonal high watertable.
Vegetation/land use:	Previous crop maize. Surrounding area mainly cotton and fallow. Field-boundary trees include *Brachystegia boehmii, Combretum fragrans, Terminalia sericea, Flacourtia indica, Dichrostachys cinerea, Colophospermum mopane, Diospyros kirkii* and *Crossopteryx febrifuga.*
Parent material:	Probably old colluvio-alluvium.
Erosion:	None evident.
Land capability:	Class MII.
Profile irrigable value:	3.
Soil classification:	5UM (Zimbabwe) Ustic Aquic Dystropept (Soil Taxonomy) Dystri-Gleyic Cambisol (FAO/UNESCO/ISRIC)
0-19 cm	Dark brown (10YR 3/3m) medium sandy loam, dry.
19-55 cm	Yellowish brown (10YR 5/6m) medium sandy loam, slightly moist.
55-92 cm	Brownish yellow (10YR 6/6m) coarse sandy loam, common fine red to strong brown mottles, moist.
92-140 cm	Light grey (10YR 7/2m) medium sandy clay loam, common fine and medium red mottles, moist.

ANALYSIS PROFILE 68-GG-88

Depth (cm)	0-15	25-40	70-85	105-120
Lab No.	X1627	X1628	X1629	X1630
DM %	97.4	98.7	98.2	98.4
Texture	mSaL	mSaL	cSaL	mSaCL
Gravel %	0	4	0	0
Coarse Sand %	4	3	33	6
Medium Sand %	36	34	35	34
Fine Sand %	44	41	10	34
Silt %	6	5	4	4
Clay %	10	16	18	21
pH ($CaCl_2$)	4.6	4.7	4.0	3.9
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	1.7	2.0	0.5	0.4
EX Mg (me %)	.3	1.7	1.5	1.5
EX Na (me %)	0.04	0.02	0.06	0.04
EX K (me %)	0.45	0.30	0.20	0.47
TEB (me %)	2.1	3.7	2.3	2.4
CEC (me %)	2.1	3.7	4.3	5.8
Base Sat %	100	100	52	41
E/C	21.4	23.2	24.1	27.6
S/C	21.4	23.2	12.6	11.4
ESP	1.9	0.5	1.4	0.7
EKP	21.2	8.2	4.7	8.1

LAND UNIT M9

General description The unit is restricted to the Kalahari Sandveld region and occurs in Lupane, Dandanda and Mzola CLs of Lupane District and in Nkayi CL, Nkayi District. The landform is a very slightly dissected plateau surface, almost flat to gently undulating with a maximum slope of about 5%. Pans and vleis are present but there is a low drainage density, especially where the soils are sandy with a rapid permeability. The unit occurs in Natural Region IV, Agroclimatic Zones 3 and 4 and has an area of 2 010 km^2.

Geology The geology is considered to comprise reworked Upper Karoo and Kalahari Sand sediments. No geological maps are available for this area.

Soils Most of the soils are moderately sandy with less than 20% clay, yellowish red in the subsoil and fersiallitic with a very to extremely acid soil reaction, pH in $CaCl_2$ less than 4.5. These classify as 5M in the Zimbabwe system. Some of the sands are possibly Regosols (Zimbabwe) and a few other soils classify as siallitic, 4M, or paraferrallitic, 6M. Unlike the primary Kalahari Sand, which is predominantly medium grained, 35% of the soils in this unit are coarse grained in the sand fraction, mainly in the subsoil, this coarseness probably resulting from the Karoo influence or the loss of finer particles by water and wind action. Of the 26 soils sampled for analysis, 13 have an inverse calcium/magnesium ratio. A few soils with 10YR or 7.5YR hues are red to yellow mottled in the subsoil, strongly acid and have normal calcium/magnesium ratios. Where vleis occur, for example at Lukampa, the soils are poorly drained calcareous clays. According to Soil Taxonomy, most of the soils are Kandiustalfs or Ultic/Kanhaplic Haplustalfs which correspond to Acrisols, Lixisols or Luvisols in the FAO/UNESCO/ISRIC legend. There are no obvious catenary trends in the distribution of the soils; change in soil type may follow a toposequence related to differences in parent material.

Natural vegetation Jesse bush, of the *Baikiaea plurijuga* woodland thicket type, is a characteristic component of this unit and appears to be associated with the most acid soils in relatively high, very well-drained positions. Elsewhere, the natural vegetation is a woodland of the *Brachystegia spiciformis – B. boehmii – Erythrophleum africanum* type.

Land use The unit is little used for cultivation, especially in the east of Nkayi, probably in recognition of low soil fertility and poor water supply. No more than 20% of the unit is arably disturbed.

Land capability This land unit is predominantly MII and MIII according to the AGRITEX capability classification which is based on hazard-of-use criteria. These soils have, in addition, constraints of low natural fertility and low water-holding capacity for shallow rooting crops.

Irrigability A Class C and Class S classification is given for this unit.

Erosion There is a low erosion hazard and minimal erosion was observed.

Development potential The potential is low. The land is of low quality for dryland cultivation, is generally unsuitable for conventional irrigation and provides a poor grazing resource. The unit also suffers from limited access and poor surface water supply.

Typical Profile Description Land Unit M9 – Jesse-bush Soil

Profile number:	208-GG-88 described on 17 August 1988. Auger boring.
Location:	13 km south of the Shangani River, Lupane CL near the boundary with Nkayi CL. Map reference PK 3508.

Site:	Mid-slope < 2% sloping down north from primary Kalahari Sand plateau (Land Unit K1). Hard subsoil exposed at track. Common surface termite activity; few low termitaria.
Vegetation/land use:	Jesse bush of the *Baikiaea plurijuga* woodland thicket type. Common *Combretum elaeagnoides, C. celastroides, Baphia massaiensis, Strychnos madagascariensis, Croton gratissimus* and *Brachystegia spiciformis.* Many of the *Baikiaea plurijuga* trees are moribund or dead.
Parent material:	Assumed to be redistributed Kalahari Sand and Karoo sediments.
Erosion:	Loss of topsoil along track; otherwise none observed.
Land capability:	Class MII.
Profile irrigable value:	3.
Soil classification:	5M (Zimbabwe) Kandic Paleustalfs (Soil Taxonomy) Haplic Acrisols (FAO/UNESCO/ISRIC)
0-15 cm	Yellowish brown (10YR 5/4m) medium loamy sand; dry.
15-51 cm	Strong brown (7.5YR 5/6m) medium loamy sand; dry.
51-96 cm	Strong brown (7.5YR 5/6m) medium sandy loam; slightly moist.
96-140 cm	Strong brown (7.5YR 5/6m) medium sandy loam; slightly moist.

ANALYSIS PROFILE 208-GG-88

Depth (cm)	0-15	25-40	65-80	110-125
Lab No.	X2832	X2833	X2834	X2835
DM %	99.5	99.5	99.2	99.2
Texture	mLS	mLS	mSaL	mSaL
Gravel %	0	0	0	0
Coarse Sand %	7	6	6	7
Medium Sand %	45	39	38	37
Fine Sand %	39	45	41	39
Silt %	2	2	3	3
Clay %	7	8	12	14
pH ($CaCl_2$)	4.1	3.9	4.0	4.0
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	0.9	0.4	0.3	0.4
EX Mg (me %)	0.1	0.2	0.6	0.6
EX Na (me %)	0.10	0.12	0.12	0.12
EX K (me %)	0.14	0.14	0.24	0.32
TEB (me %)	1.3	0.9	1.2	1.5
CEC (me %)	2.2	2.1	2.5	2.9
Base Sat %	59	41	47	49
E/C	32.6	25.4	20.5	21.3
S/C	19.1	10.4	9.6	10.5
ESP	4.6	5.8	4.8	4.1
EKP	6.4	6.7	9.6	11.0

LAND UNIT ME1

General description The unit is restricted to the Eastern Highlands region and forms a high plateau, locally very dissected. It occurs in Mutema CL, Chipinge District and Muwushu, Chikukwa and Ngorima CLs in Chimanimani District. The altitude range is considerable, mainly between 1 400 m and 1 800 m above sea level, but in the Rusitu Valley occurring at the lower elevations of 500 m to 1 200 m. Moderate slopes are associated with the undulating plateau surfaces but where incised, the topography is rolling to steeply dissected. The main drainage lines are those of the Rusitu and Musapa Rivers and part of Save River catchment. The unit occurs in Natural Region I with small inclusions of Natural Regions IIb and III, Agroclimatic Zones 1 and 2 and has an area of 410 km^2.

Geology The unit comprises fine-grained feldspathic quartzites and phyllites or argillites of the Umkondo Group. These are affected by numerous intrusions of dolerite in the form of dykes, sheets and sills. Small areas of alluvium are associated with terraces bordering the larger rivers.

Soils The soil pattern is related to the nature of the underlying sediments, the principal soil families being M (arenaceous Umkondo sediments), S (argillaceous Umkondo sediments) and E (Umkondo Dolerites). However, in the moister parts of the Eastern Highlands region, soil boundaries in relation to parent materials are much more diffuse than in drier regions of Zimbabwe. In places, the steep slopes result in much colluvial mixing of highly weathered parent materials with the result that many of the soils are intergrades at the Zimbabwean family level. In general, the soils as a group are well-drained, deep, dark brown fine-grained sandy loams, sandy clay loams, clay loams and clays over dark reddish brown, occasionally redder, fine-grained sandy clay loams to clays.

Surface reactions are mainly strongly acid becoming very strongly acid with depth. Organic matter content of the surface soil is high, averaging 1.9% organic carbon. Exchangeable calcium and magnesium levels are low and base saturation is around 40% reflecting the highly weathered status of the soil. Exchangeable potassium levels are frequently deficient in the lower horizons.

Variation in soils consistent with the catenary concept are not present. They classify as Orthoferrallitic 7M, 7E, 7S and their intergrades (Zimbabwe), Hapludox and Kandiudults (Soil Taxonomy) and Ferralsols and Acrisols (FAO/UNESCO/ISRIC). The soils derived from minor deposits of recent alluvium are stratified and of variable drainage status. They have higher base saturation and exchangeable cation levels than the soils in upland relief positions and classify as fersiallitic 5U (Zimbabwe), Fluvents (Soil Taxonomy) and Fluvisols (FAO/UNESCO/ISRIC).

Natural vegetation Below about 700 m, a small remnant of low altitude rainforest persists in Ngorima CL where the Rusitu valley borders Mozambique. The dominant tree species in the canopy is *Newtonia buchananii* with common *Maranthes goetzeniana* and *Xylopia aethiopica* (Müller, 1991). Remnants of moist evergreen forest are found in Ngorima CL. Elsewhere, the natural vegetation is a *Brachystegia spiciformis* woodland. Bracken, *Pteridium aquilinum*, is common in high-altitude areas.

Land use Maize is the principal crop except in Ngorima CL where perennial crops such as bananas, pineapples and coffee are important.

Land capability Bromley *et al.* (1968) provide a regional plan for the development of the land resources of part of Chimanimani District, including Ngorima and Chikukwa CLs. They conclude that land with a slope of less than 25% can be considered arable and that plantation crops can be planted on slopes approaching 50%. The range of dryland crops climatically suited to Ngorima CL is large, and includes tea, cocoa, sugar, sisal, grapefruit and various tropical fruits at lower elevations and coffee, avocado pear, confectionary nuts and timber plantations at the highest elevations.

Irrigability The soils are suitable for irrigation in terms of depth and texture; however, topography will frequently be a constraint. The reliable rainfall reduces the need for irrigation although below about 1 400 mm annual rainfall, most perennial crops will require supplementary irrigation.

Erosion Despite cultivation of very steep slopes, there is little evidence of soil erosion. The deep soils are very permeable and consequently runoff is unusual. Plant growth occurs throughout the year and the proliferation of roots and the high soil organic matter contents assist soil stabilization.

Development potential The soils and climate of the unit are favourable for a wide range of fairly intensive small-holder crop production, including perennials, although the potential is limited in many areas by topography and access.

Typical Profile Description Land Unit ME1

Profile number:	75-FF-88 described on 1 November 1988. Profile pit.
Location:	Near site of keep, Ngaono Business Centre, Mutema CL, Chipinge District. Map reference VN 545 895.
Site:	Gently undulating plateau, upper mid-slope 4%. 1 615 metres above sea level and mean annual rainfall about 1 340 mm (at Brakenbury).
Vegetation/land use:	Grazing area, grassland with encroaching *Solanum aculeastrum*.
Parent material:	Umkondo quartzite.
Erosion:	Generally little erosion observed, but nearby a major gully had developed, probably caused by concentration of runoff from the keep.
Land capability:	Classification not applied.
Profile irrigable value:	2.
Soil classification:	7M (Zimbabwe) Typic Hapludox (Soil Taxonomy) Haplic Ferralsol (FAO/UNESCO/ISRIC)
0-24 cm	Dark brown (10YR 3/3m) fine sandy loam, with relatively high organic matter content; weak root-induced medium crumb structure; non sticky, slightly plastic, very friable moist consistence; few medium pores; common fine roots; good permeability and well drained; diffuse smooth transition to:
24-35 cm	Dark yellowish brown (10YR 4/4m [rubbed]) colour is best described as a matrix of strong brown (7.5YR 5/8m) with inclusions of material from the horizon above – dark brown (10YR 3/3m) fine sandy loam with apedal structure; non sticky, slightly plastic, very friable moist consistence; few medium pores; common fine roots; good permeability and well drained; diffuse smooth transition to:
35-56 cm	Strong brown (7.5YR 5/8m) fine sandy loam/ sandy clay loam with apedal structure; non sticky , slightly plastic, very friable to loose moist consistence; many fine and medium pores; few fine roots; rapid permeability and well drained; diffuse smooth transition to:
56-100 cm	Red (2.5YR 5/8m, [rubbed]) with numerous inclusions of strong brown (7.5YR 5/6m) material from the horizon above fine sandy clay loam with apedal structure; non sticky, non plastic, very friable moist consistence; many fine and medium pores; few fine roots; good permeability and well drained; diffuse smooth transition to:
100-130 cm+	Red (10R 4/6m) fine sandy clay loam with apedal structure; non sticky, non plastic, friable moist consistence; many fine and medium pores; few fine roots; good permeability and well drained.

ANALYSIS PROFILE 75-FF-88

Depth (cm)	0-24	24-35	35-56	56-100	100-130
Lab No.	X4178	X4179	X4180	X4181	X4182
DM %	98.5	98.7	99.3	98.8	99.3
Carbon %	1.52	0.75	0.31	0.04	0.0
Texture	fSaL	fSaL	fSaCL	fSaCL	fSaCL
Gravel %	0	0	0	0	0
Coarse Sand %	0	0	0	0	0
Medium Sand %	3	3	3	2	1
Fine Sand %	70	69	68	65	58
Silt %	9	8	9	8	13
Clay %	17	19	20	26	28
pH ($CaC1_2$)	4.2	4.2	4.6	4.4	4.4
Carbonates %	.0	0	0	0	0
EX Ca (me %)	0.6	0.6	0.6	0.8	0.6
EX Mg (me %)	0.1	0.0	0.0	0.0	0.0
EX Na (me %)	0.24	0.18	0.10	0.18	0.16
EX K (me %)	0.06	0.04	0.02	0.02	0.02
TEB (me %)	1.1	0.9	0.7	1.0	0.8
CEC (me %)	3.3	2.3	1.7	2.5	3.2

Base Sat %	33	38	41	40	25
E/C	18.7	11.9	8.2	9.9	11.4
S/C	6.1	4.5	3.4	4.0	2.8
ESP	7.4	7.9	6.0	7.2	5.0
EKP	1.9	1.7	1.2	0.8	0.6

LAND UNIT MG1

General description This unit is based on a large, distinct geological structure comprising several rock types and derived soils. It occurs mainly in Hurungwe CL but extends into Rengwe and Piriwiri CLs. It has the form of a klippe or tectonic outlier with a complex internal topography. On the north and eastern sides, the edge of the klippe rises between 60 m and 90 m above the level of the surrounding country. On the south and west the relief is much greater. Internally, the landform ranges from gently undulating to rolling. The unit forms part of the Middleveld region at altitudes between 750 m and 1 250 m above sea level. Drainage is effected by the Tengwe, Badze and Musukwi Rivers and there are several examples of sinkholes in the limestone and dolomite areas. The unit occurs in Natural Region III, Agroclimatic Zone 3 and has an area of 605 km^2.

Geology There are several rock types including arkose, limestone, gneiss, quartzite and Karoo System tillites preserved in fault-bounded valleys.

Soils The soils are variable depending on the parent material. The arkose-derived soils are reddish, medium textured and often shallow; the limestone/dolomite soils are reddish and medium to fine textured, often occupying pockets amongst outcropping rock; the tillite soils are also reddish, relatively silty sandy loams and sandy clay loams, mottled in the subsoil but apparently well drained. Although most of the soils examined were moderately deep, shallow soils are common, particularly over the quartzite, gneiss and arkose, but not to the degree and extent indicated on the provisional soil map of Zimbabwe (Department of Research and Specialist Services, 1979) where this unit is shown as comprising lithosols. Catenary relationships were not investigated but if present, are likely to be obscure. The soils are an association of 5M, 5AE and 2 (Zimbabwe), Ustropepts and Kandiustalfs (Soil Taxonomy) and Cambisols and Lixisols (FAO/UNESCO/ISRIC).

Natural vegetation The vegetation ranges from a *Brachystegia boehmii – Julbernardia globiflora* dominated woodland to a *Colophospermum mopane* woodland at elevations below about 900 metres.

Land use Overall, about 20% of the unit is arably disturbed, but generally a higher percentage in the east and lower in the west. There is long established cultivation along the Tengwe and Badze Rivers and around Chidamoyo and Vureche.

Land capability The unit is mainly Class MII and MIII land with a smaller proportion of steep, stony or rocky Class VI land.

Irrigability The irrigability class of this unit is mainly C with small tracts of Class B.

Erosion There is an average to above-average hazard according to Stocking and Elwell (1973). Slight sheet erosion is evident in most areas cleared for cultivation.

Development potential There is a moderate potential for an expansion of the area under cultivation. The viability of groundwater irrigation based on the Tengwe River Group aquifer requires investigation (Interconsult, 1985b).

Typical Profile Description Land Unit MG1 – soil derived from dolomite

Profile number:	184-GG-88 described on 21 August 1987. Auger boring.
Location:	One kilometre west of Mudzimu Business Centre, Hurungwe CL, Hurungwe District. Map reference QM 4510.
Site:	Upper slope within gently undulating terrain. Slope about 3%. Bare surface.
Vegetation/land use:	Cotton during the 1986-87 season. Few mangoes but very little natural woody vegetation except occasional *Diospyros mespiliformis* left for their fruit. Close to borehole.
Parent material:	Impure dolomite.
Erosion:	Slight sheet erosion.
Land capability:	Class MIII.
Profile irrigable value:	1.
Soil classification:	5? (Zimbabwe) Rhodic Kandiustalf (Soil Taxonomy) Haplic Lixisol (FAO/UNESCO/ISRIC)
0-21 cm	Yellowish red (5YR 4/6m) medium sandy loam; dry.
21-67 cm	Dark red (2.5YR 3/6m) medium sandy clay; slightly moist.
67-105 cm	Dark red (2.5YR 3/6m) medium sandy clay; slightly moist.
105-142 cm+	Red (2.5YR 4/6m) sandy clay; few quartz gravel; slightly moist.

ANALYSIS PROFILE 184-GG-88

Depth (cm)	0-15	35-50	75-90	115-130
Lab No.	W1669	W1670	W1671	W1672
DM %	99.6	98.3	98.0	98.0
Texture	mSaL	mSaC	mSaC	SaC
Gravel %	0	0	0	21
Coarse Sand %	11	8	10	13
Medium Sand %	37	21	19	15
Fine Sand %	29	20	18	16
Silt %	12	12	10	12
Clay %	10	39	43	43
pH ($CaC1_2$)	5.2	6.2	6.2	6.3
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	1.4	10.7	3.1	3.3
EX Mg (me %)	0.8	4.1	1.7	1.6
EX Na (me %)	0.04	0.04	0.04	0.04
EX K (me %)	0.22	0.31	0.51	0.43
TEB (me %)	2.1	5.7	5.3	5.3
CEC (me %)	2.1	5.7	5.8	5.8
Base Sat %	100	100	91	91
E/C	20.0	14.6	13.5	13.5
S/C	20.0	14.6	12.3	12.3
ESP	1.9	0.7	0.7	0.7
EKP	10.6	5.3	8.7	7.3

Typical Profile Description Land Unit MG1 – soil derived from meta-arkose

Profile number:	181-GG-88 described on 21 August 1987. Auger boring.
Location:	Four kilometres southeast of Kapfunde, Hurungwe CL, Hurungwe District. Map reference QM 5910.
Site:	Gently sloping pediment at foot of arkose ridge, 3% slope. Few surface stones. Attractive area.
Vegetation/land use:	Grass fallow still green in places. Old furrow and ridge lines. Probably now a grazing area. Few *Strychnos* spp.
Parent material:	Meta-arkose.
Erosion:	No evidence.
Land capability:	Class MIII.
Profile irrigable value:	1.
Soil classification:	5M? (Zimbabwe) Typic Kandiustalf (Soil Taxonomy) Haplic Lixisol (FAO/UNESCO/ISRIC)

0-18 cm	Yellowish red (5YR 4/6m) medium sandy loam.
18-85 cm	Red (2.5YR 4/8m) medium sandy clay loam.
85-120 cm	Red (2.5YR 4/8m) coarse sandy clay loam.
120-143 cm+	Red (2.5YR 4/8m) coarse sandy clay loam; few gravel at 140 cm but not limiting.

ANALYSIS PROFILE 181-GG-88

Depth (cm)	0-15	40-55	95-110	125-140
Lab No.	W1660	W1661	W1662	W1663
DM %	99.0	99.1	98.8	98.2
Texture	mSaL	mSaCL	cSaCL	cSaCL
Gravel %	0	3	4	8
Coarse Sand %	18	15	15	17
Medium Sand %	32	23	20	18
Fine Sand %	27	22	22	20
Silt %	10	10	12	12
Clay %	13	29	31	34
pH ($CaCl_2$)	5.6	5.5	5.4	5.7
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	1.4	1.2	1.1	1.6
EX Mg (me %)	0.6	0.9	0.7	1.0
EX Na (me %)	0.02	0.04	0.06	0.06
EX K (me %)	0.30	0.30	0.28	0.33
TEB (me %)	2.3	2.4	2.1	3.0
CEC (me %)	2.9	3.1	3.2	4.9
Base Sat %	78	75	68	62
E/C	22.4	10.8	10.1	14.5
S/C	17.5	8.1	6.8	9.0
ESP	0.7	1.3	1.9	1.3
EKP	10.3	9.6	9.0	6.7

Typical Profile Description Land Unit MG1 – soil derived from tillite incorporating dolomite

Profile number:	188-GG-88 described on 25 August 1987. Auger boring.
Location:	Two kilometres southwest of Chidamoyo Mission, Rengwe CL, Hurungwe District. Map reference QM 3203.
Site:	Upper slope in strongly undulating terrain. Few surface stones and boulders. Very fine, floury layer on road probably derived from tillite matrix.
Vegetation/land use:	Maize during the 1986-87 season. Areas of lightly disturbed woodland with common *Acacia polyacantha, Brachystegia boehmii* and *Diplorhynchus condylocarpon.*
Parent material:	Lower Karoo tillite with inclusions of dolomite.
Erosion:	None evident.
Land capability:	Class MIII.
Profile irrigable value:	2.
Soil classification:	5AE (Zimbabwe) Oxic Ustropept (Soil Taxonomy) Ferralic Cambisol (FAO/UNESCO/ISRIC)
0-18 cm	Strong brown (7.5YR 5/6m) medium sandy loam.
18-95 cm	Reddish yellow (5YR 6/8m) medium sandy clay loam; common medium red and reddish brown mottles; moderately hard weathered fragments of parent material.
95-118 cm	Reddish yellow (7.5YR 6/8m) medium sandy clay loam; common coarse red mottles; parent material becoming less weathered.

ANALYSIS PROFILE 188-GG-88

Depth (cm)	0-15	30-45	75-90	100-115
Lab No.	W1683	W1684	W1685	W1686
DM %	99.7	98.9	98.6	98.1
Texture	mSaL	mSaCL	mSaCL	mSaCL
Gravel %	8	10	15	10
Coarse Sand %	7	7	7	8
Medium Sand %	26	16	16	17
Fine Sand %	43	33	31	31
Silt %	12	22	24	21
Clay %	12	23	23	23
pH ($CaCl_2$)	6.2	6.2	5.4	5.1
Carbonates %	0.0	0.0	0.0	0.0

EX Ca (me %)	1.7	0.6	0.3	0.3
EX Mg (me %)	0.8	2.4	3.1	4.2
EX Na (me %)	0.04	0.06	0.08	0.06
EX K (me %)	0.28	0.26	0.22	0.18
TEB (me %)	2.8	3.3	3.2	4.7
CEC (me %)	3.5	4.0	3.2	5.5
Base Sat %	80	80	100	86
E/C	28.5	17.9	13.9	24.1
S/C	22.9	14.4	13.9	20.7
ESP	1.1	1.5	2.6	1.1
EKP	7.9	6.5	7.1	3.3

LAND UNIT MU1

General description This unit combines two types of land of approximately equal area found in the southeast of Nyanga District in the Eastern Highlands region. The higher zone forms an undulating to rolling dissected plateau at an altitude of 1 000 m to 1 200 m. Drainage is by means of a network of seasonal and perennial streams, mostly flowing eastwards into the Gairezi River. The lower zone at an elevation of some 900 m occurs near the Gairezi River and has a flat to gently undulating topography with evidence of alluvial and colluvial deposition. The unit occurs in Natural Regions I and IIa, Agroclimatic Zones 1 and 2 and has an area of 155 km^2.

Geology The plateau area is underlain by a thick sequence of Umkondo sediments comprising ferruginous quartz-mica schists, phyllitic siltstones and massive to bedded sandstones. Dolerite intrusions are common. The colluvial and alluvial deposits found at lower elevations are probably derived from the Umkondo sediments.

Soils The soils derived from the ferruginous schists are typically dark reddish brown fine-grained sandy loams over red very uniform fine-grained sandy clay loams to clays, stone free, moderately deep to deep and well drained. Soils derived from more arenaceous sediments are fine-grained sands and loamy sands over fine-grained sandy clay loams usually more yellow than subsoils derived from the ferruginous material. They are also deep, stone free and well drained. The more argillaceous members give rise to some soils with a high silt content. The presence of dolerite dykes influences the soil by increasing the clay content of the resultant intergrade. All the analysed plateau soils are strongly acid with low cation exchange capacities and base saturations around 75%. The alluvio-colluvial soils are more heterogeneous, usually reddish brown or brown fine- to medium-grained relatively silty sandy loams and sandy clay loams over reddish brown to red sandy clay loams, clay loams and clays. They are moderately acid, deep and well drained.

Differentiated according to parent material, the soils are allocated in the Zimbabwean system to the families 5/7I, 5/7S and 5U. Using the international systems, they are Eutrustox and Haplustalfs (Soil Taxonomy) and Ferralsols, Luvisols and Lixisols (FAO/UNESCO/ISRIC).

Natural vegetation The mainly cultivated unit has patches of *Brachystegia spiciformis – Julbernardia globiflora* woodland. In the south of the unit *Uapaca kirkiana* is dominant. At the lowest elevations cultivation is even more widespread. Past reports on this area indicate that the natural vegetation was a tree savanna composed of *Bauhinia thonningii* in addition to *Strychnos* spp., *Protea* spp. and *Terminalia* spp.

Land use The plateau zone is used for the cultivation of dryland maize, cotton, rapoko and sunflower. Many fields occur on steep slopes; these have mainly been brought into cultivation recently and are not contour ridged. The longer-established fields are ridged, in accordance with the requirements of the Land Husbandry Act, but these are no longer maintained as a component of a conservation system.

The alluvial area includes the Nyamaropa irrigation scheme, established in 1961 and occupying 735 ha. The irrigated crops are mainly cotton and maize.

Land capability Where slope is not a major constraint, the land is Class II. Steeper land, about 25% of the plateau zone, is maginally arable Class IV or non arable Class VI. The almost flat alluvio-colluvial areas are Class 1 or 2.

Irrigability On the plateau there is an association of irrigability Class B and C land. Locally, the conditions for small-scale irrigation schemes are good. The irrigation suitability of the alluvio-colluvium is testified by the Nyamaropa scheme where two thirds of the land is Class A, the remainder Class B.

Erosion Slight sheet erosion is widespread.

Development potential The plateau soils have favourable physical properties. The chemical properties are not so attractive but can be ameliorated. Rainfall is reliable and perennial streams are common. Limitations include the locally steep topography which hinders road access. The valley soils have the highest potential although they are almost all within the cultivation cycle. Several small blocks are suitable for irrigation development provided water supplies are adequate. The area known locally as the "cotton belt" will benefit from the new tar road linking it with Troutbeck.

Typical Profile Description Land Unit MU1 – plateau zone

Profile number:	32-FF-87 described on 14 May 1987. Profile pit.
Location:	1.5 km north of Mutetwa School, Sawunyama CL, Nyanga District. Map reference VR 905 348.
Site:	Upper mid-slope position, 4%, within rolling terrain at 1 220 m elevation. Mean annual rainfall at nearest station, Regina Coeli, 850 mm.
Vegetation/land use:	Contour-ridged field with finger millet as previous crop.
Parent material:	Ferruginous quartz-mica schist.
Erosion:	Slight sheet erosion.
Land capability:	Class II.
Profile irrigable value:	2.
Soil classification:	7I (Zimbabwe) Typic Eutrustox (Soil Taxonomy) Haplic Ferralsol (FAO/UNESCO/ISRIC)
0-11 cm	Dark reddish brown (2.5YR 3/4m) and yellowish red (5YR 5/6d) fine sandy loam; plough layer; weak coarse subangular blocky with fine crumb and thin platy structure; slightly sticky, plastic, very friable moist and slightly hard dry consistence; few fine and medium vesicular pores; few fine roots; good permeability and well drained; abrupt smooth transition to:
11-155 cm+	Red (2.5YR 4/6m) and red (2.5YR 5/6d) clay; moderate coarse subangular blocky structure; slightly sticky, plastic, friable moist and hard dry consistence; Mn stains and small soft Mn concretions (increasing with depth); patchy thin cutans associated with Mn stains mainly on vertical ped faces; few fine vesicular pores; few fine roots; good permeability and well drained.

ANALYSIS PROFILE 32-FF-87

Depth (cm)	0-11	20-35	70-85	130-145
Lab No.	W0453	W0454	W0455	W0456
DM %	99.7	98.6	98.4	98.6
Texture	fSaL	C	C	C
Gravel %	8	0	0	0
Coarse Sand %	3	2	2	2
Medium Sand %	8	3	2	2
Fine Sand %	70	38	38	36
Silt %	6	8	9	12
Clay %	14	49	49	47

pH ($CaC1_2$)	4.4	4.8	4.7	5.1
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	1.1	1.2	1.0	1.2
EX Mg (me %)	0.6	1.4	1.3	1.7
EX Na (me %)	0.04	0.04	0.04	0.04
EX K (me %)	0.10	0.04	0.04	0.02
TEB (me %)	1.8	2.7	2.6	3.0
CEC (me %)	1.8	3.8	3.7	3.8
Base Sat %	100	72	71	79
E/C	13.0	7.7	7.5	8.0
S/C	13.0	5.5	5.3	6.3
ESP	2.3	1.1	1.1	1.1
EKP	5.7	1.1	1.1	0.5
Org. Carbon %	0.42	0.28	0.18	0.12

Group K – Land units on Kalahari sand

LAND UNIT K1

General description This unit is characteristic of much of the eastern and northern Kalahari Sandveld region, extending through the districts of Gokwe, Kwekwe, Nkayi, Lupane, Binga and Hwange. It has the form of a broad plateau with bevelled convex edges sloping to about 8% or, where more restricted in area, a whale-backed dune ridge. Altitude ranges from about 950 m in Hwange CL to 1 350 m on the Mafungabusi Plateau in Gokwe CL. The unit is normally without surface drainage expression owing to the very slight gradients and the rapid permeability of the sands. The unit occurs in Natural Regions III, IV and V, Agroclimatic Regions 3 and 4 and has an area of 4 420 km^2.

Geology This unit comprises undisturbed, unconsolidated Tertiary Kalahari Sand of aeolian origin up to about 100 m deep in places. The deposit is a reddish, bimodally sorted, moderately rounded sand containing about 5% clay. These primary sands are differentiated from secondary, redistributed sands (Land Unit KM1). The nature and distribution of both kinds of sands is discussed by Sutton (1979).

Soils The soils show little variation, either chemically or physically. They are very well-drained, uniform, deep, medium-grained sands over reddish yellow to red medium-grained sands occasionally loamy sands. Subsoil silt plus clay content ranges from 3% to 7% and profiles generally show a small clay increase with depth. Permeability is rapid and the soils are structureless below a thin topsoil. There appears to be a catenary relationship between these reddish sands and the pale sands of Land Unit K2 which occur towards the centre of the broader plateaux. These soils have a wide distribution within southern Africa extending west through Zambia into Angola and south into Botswana. They are discussed in a regional context by Wellington (1955) and by Trapnell and Clothier (1957) as part of the ecological survey of Northern Rhodesia. In the Zimbabwean system of classification they are allocated to the Regosol group, 1. A few soils have sufficient silt plus clay in the subsoil to meet the requirements of the siallitic or fersiallitic groups and classify at the family level as 4M or 5M. The deep sands are Ustic Quartzipsamments (Soil Taxonomy) and Ferralic or Luvic Arenosols (FAO/UNESCO/ISRIC).

Natural vegetation To the east, on the higher moister plateaux between Lupane and Gokwe, the natural vegetation is a well-grown *Brachystegia spiciformis – Baikiaea plurijuga* open woodland. Commonly associated species are *Ricinodendron rautanenii, Strychnos pungens, Erythrophleum africanum, Ochna pulchra, Combretum psidioides, C. collinum, C. zeyheri, Pterocarpus angolensis, Burkea africana, Lannea discolor, Guibourtia coleosperma, Commiphora mossambicensis, Pseudolachnostylis maprouneifolia, Julbernardia globiflora, Terminalia sericea* and *Bauhinia petersiana*. West of the miombo ecotone (Calvert, 1984), in the lower, drier parts of the Kalahari Sandveld, these soils support a *Baikiaea plurijuga* woodland with, for example, *Kirkia acuminata, Afzelia quanzensis, Pterocarpus angolensis* and *Terminalia sericea*.

Land use Between 10% and 20% of the unit is arably disturbed. Parts of the unit near centres of population, such as Gokwe, are being rapidly cleared for cultivation. Other more remote areas adjacent to the Kana – Mzola road show, on air photographs, palimpsest patterns of old, surveyed clearings made during some pre-independence settlement programme and now reverted to a thick, secondary regrowth. Cultivation is concentrated on the reddest soils along the bevelled edge of the broad plateaux and is usually widespread on the red soils of the narrow plateaux. This may be because these soils are considered to be more fertile than the pale soils of the broad plateau centres (Land Unit K2) or because of domestic water supply considerations, the valleys normally having surface or borehole sources. Most areas have been subject to periodic commercial logging of *Baikiaea plurijuga, Pterocarpus angolensis* and locally, *Guibourtia coleosperma*.

Land capability Land in the moister parts of the unit is Class III and, in the more arid western areas, Class MII. Low fertility is a severe production constraint as clearing of the woodland and soil cultivation leads to a rapid depletion of nutrients which are mainly restricted to the thin topsoil. The agricultural potential of these soils is discussed by Bromley (1964, 1966) and Bromley and Jones (1966).

Irrigability The irrigability of this unit is Class S, excessively pervious sands of very restricted suitability, according to the empirical assessment of Thompson and Purves (1979). No examples of micro-scale irrigation were observed in this unit.

Erosion Apart from the sloping edges of the unit where a few rills and small gullies were seen, water erosion is generally absent. Bromley and Jones (1966) suggest that sheet erosion may occur under high intensity rainfall and that wind erosion would be a hazard affecting extensive areas of cleared land lacking windbreaks.

Development potential The development potential is problematic. The unit is arable but the maintenance of fertility and yields will pose problems for many communal farmers. Maize is one of the least suitable crops yet it is the most widely grown. An agroforestry farming system may be appropriate, including a selective and sustainable extraction of commercial timber species. Given the rapid increase in area under cultivation, there is a need for a revitalization of farming systems research relevant to communal farming in this unit.

Typical Profile Description Land Unit K1 – eastern Kalahari Sandveld region

Profile number:	106-GG-88 described on 18 June 1988. Profile pit.
Location:	Close to southern edge of airfield, Gokwe town, Gokwe CL, Gokwe District. Map reference QK 0585.
Site:	Mafungabusi Plateau, almost flat, 1 280 m altitude, 790 mm mean annual rainfall. 70% surface leaf litter.
Vegetation/land use:	*Brachystegia spiciformis* woodland. Other species include *Baikiaea plurijuga, Pterocarpus angolensis, Erythrophleum africanum* and *Baphia massaiensis*. The woodland is slightly disturbed by firewood cutting.
Parent material:	Primary Kalahari Sand. Charcoal staining and carbonated roots to greater than 1 metre depth indicate a well-aerated material capable of sustaining deep burning.
Erosion:	None evident.
Land capability:	Class III in terms of hazard-of-use criteria.
Profile irrigable value:	4.
Soil classification:	1K (Zimbabwe) Ustic Quartzipsamment (Soil Taxonomy) Luvic Arenosol (FAO/UNESCO/ISRIC)

0-6 cm	Brown (10YR 5/3d) and dark brown (10YR 3/3m) medium sand; soft peds within a loose soil matrix, dry; very weak fine and medium subangular blocky and single grain; common fine and very fine and few coarse roots; rapid permeability, very well drained; clear wavy boundary to:
6-54 cm	Reddish yellow (7.5YR 6/6d) and strong brown (7.5YR 5/6m) medium sand; soft, slightly moist; structureless, weakly coherent; common fine and very fine and common coarse roots; rapid permeability, very well drained; diffuse smooth boundary to:
54-119 cm	Reddish yellow (5YR 6/6d) and yellowish red (5YR 5/6m) medium sand; slightly hard, slightly moist; structureless, moderately coherent; few fine, common coarse roots; rapid permeability, very well drained; diffuse smooth boundary to:
119-160 cm	Reddish yellow (5YR 6/6d) and yellowish red (5YR 5/6m) medium sand; soft, slightly moist; structureless, weakly coherent; few fine, few coarse roots; rapid permeability, very well drained; diffuse smooth boundary to:
160-230 cm	Reddish yellow (5YR 6/6d) and yellowish red (5YR 5/6m) medium sand; soft, slightly moist; structureless, weakly coherent; few fine roots; rapid permeability, very well drained; diffuse smooth boundary to:
230-300 cm	Reddish yellow (5YR 6/6d) and yellowish red (5YR 5/6m) medium sand; very friable, moist; structureless, weakly coherent; few fine roots; rapid permeability, very well drained.

Subsoil channels containing bleached white sand grains – probably insect and old root pathways.

ANALYSIS PROFILE 106-GG-88

Depth (cm)	0-6	20-35	75-90	125-140	190-205	260-275
Lab No.	X1825	X1826	X1827	X1828	X1829	X1830
DM %	99.6	99.9	99.7	99.6	99.9	99.7
Texture	mS	mS	mS	mS	mS	mS
Gravel %	0	0	0	0	0	0
Coarse Sand %	14	10	10	11	10	9
Medium Sand %	49	40	39	46	40	41
Fine Sand %	33	45	45	37	44	44
Silt %	2	2	2	1	2	2
Clay %	2	3	4	4	4	4
pH ($CaC1_2$)	4.6	4.6	4.4	4.7	4.6	4.5
Carbonates %	0.0	0.0	0.0	0.0	0.0	0.0
EX Ca (me %)	1.2	0.5	0.5	0.8	0.8	0.5
EX Mg (me %)	0.1	0.0	0.0	0.1	0.0	0.0
EX Na (me %)	0.10	0.04	0.06	0.02	0.04	0.04
EX K (me %)	0.26	0.08	0.16	0.03	0.06	0.22
TEB (me %)	1.7	0.6	0.7	0.5	0.9	0.5
CEC (me %)	1.7	1.1	0.7	0.5	2.1	0.5
Base Sat %	100	56	100	100	43	100
E/C	79.2	36.9	17.8	12.7	50.7	12.7
S/C	79.0	20.6	17.8	12.7	21.7	12.7
ESP	6.0	3.5	8.2	3.8	1.9	7.7
EKP	15.6	7.0	22.0	3.8	2.9	42.3

Typical Profile Description Land Unit K1 – western Kalahari Sandveld region

Profile number:	120-DD-88 described on 8 June 1988. Profile pit.
Location:	Near Victoria Falls airport, Hwange CL, Hwange District. Map reference LK 835 972.
Site:	Plateau, almost flat, 1 040 m elevation, 715 mm mean annual rainfall.
Vegetation/land use:	Pearl millet previous cropping season.
Parent material:	Primary Kalahari Sand.
Erosion:	Thin sheet-washed deposit on soil surface.
Land capability:	Class MII.
Soil irrigable value:	4.
Soil classification:	1K (Zimbabwe) Ustic Quartzipsamment (Soil Taxonomy) Ferralic Arenosol (FAO/UNESCO/ISRIC)

0-2 cm	Dark yellowish brown (10YR 4/4m+d) medium sand; apedal structure; loose dry and loose moist non sticky and non plastic wet consistence; rapid permeability and very well drained; abrupt smooth transition to:
2-7 cm	Dark brown (7.5 3/2m, 10YR 4/4d) similar sands; root-induced crumb structure; loose dry and loose moist, non sticky, non plastic wet consistence; fairly numerous fine roots; rapid permeability and very well drained; abrupt smooth transition to:
7-25 cm	Dark reddish brown (5YR 3/3m, 7.5YR 4/4d) similar medium sand; few fine roots; diffuse transition to:
25-52 cm	Reddish brown (5YR 4/4m, 5/6d) medium sand; apedal structure; loose dry and loose moist, non sticky and non plastic wet consistence; few fine roots; rapid permeability and very well drained; diffuse transition to:
52-275 cm	Red (2.5YR 4/6m, 5YR 4/6d) similar sand; few fine, medium and coarse roots.

ANALYSIS PROFILE 120-DD-88

Depth (cm)	2-7	7-25	25-52	52-67	148-163	260-275
Lab No.	X2088	X2089	X2090	X2091	X2092	X0974
DM %	99.7	99.8	99.9	99.7	99.6	99.1
Texture	mS	mS	mS	mS	mS	mS
Gravel %	0	0	0	0	0	0
Coarse Sand %	7	7	6	6	5	5
Medium Sand %	59	52	54	53	56	62
Fine Sand %	30	37	35	37	34	28
Silt %	1	0	1	1	1	2
Clay %	3	4	4	4	4	3
pH ($CaCl_2$)	5.7	5.4	5.1	5.2	5.6	5.8
Carbonates %	0.0	0.0	0.0	0.0	0.0	0.0
EX Ca (me %)	1.1	0.3	0.4	0.2	0.0	1.2
EX Mg (me %)	0.3	0.4	0.1	0.2	0.1	0.3
EX Na (me %)	0.06	0.04	0.04	0.04	0.04	0.08
EX K (me %)	0.02	0.08	0.20	0.00	0.22	0.02
TEB (me %)	1.0	0.8	0.7	0.4	0.4	0.9
CEC (me %)	1.0	1.1	0.8	0.9	0.9	0.9
Base Sat %	100	70	92	42	43	100
E/C	34.1	28.2	22.0	21.8	23.1	34.7
S/C	34.1	19.8	20.3	9.1	9.9	34.7
ESP	5.8	3.5	5.1	4.5	4.3	8.5
EKP	1.9	7.0	25.6	0.0	23.5	2.1

LAND UNIT K2

General description This unit is internally contiguous to Land Unit K1, occurring on the broader plateaux, mainly in Lupane District, towards the centre of the Kalahari Sandveld region. The landform is flat to slightly concave, associated with a few vleis and seasonally flooded pans. Tshongokwe vlei, between the Shangani and Kana Rivers, indicates an early stage in the development of surface drainage on the Kalahari Sand plateau, where most drainage passes underground. The headwaters to this vlei centre on the Tshumbi and Sikoba-Sina-Danka clay pans. This unit occurs in Natural Region IV, Agroclimatic Zones 3 and 4 and has an area of 505 km^2.

Geology Undisturbed, unconsolidated Tertiary Kalahari Sand of aeolian origin forms the geology of this unit similar to that of Land Unit K1 but leached to a pale yellow or white colour. The pale colours are due to the absence of a red ferric oxide coating on the sand grains, typical of the K1 soils.

Soils The soils appear to form a catenary sequence linking the red, very well-drained soils of Land Unit K1, through the pallid sands (gusu) of the plateau interior to the medium- to heavy-textured seasonally flooded pan soils which receive wet-season seepage from a fringe of podzolic sands. The catenary relationships and classification of the Kalahari Sand soils is outlined in Table 26.

Table 26 Catenary relationships and classification of the Kalahari Sand soils – Land Units K1 and K2

Landscape position	Soil Classification		
	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Plateau margin (Land Unit K1)	1K	Ustic Quartzipsamments	Ferralic/Luvic Arenosols
Plateau interior (Land Unit K2)	1K	Ustic Quartzipsamments	Albic Arenosols
Pan margin seepage zone (K2)	?	Typic Placaquods	Gleyic Podzols
Pan interior (K2)	4U	Typic/Fluvaquentic Haplaquolls	Mollic Gleysols

The classification of the pan-margin seepage zone soils as Podzols or Spodosols is tentative. These soils have a well-developed placic horizon comprising a medium-grained sand containing thin, brown, wavy to convoluted, bifurcating sheets of ferruginous material probably complexed with organic matter. A spodic horizon *sensu stricto* may or may not be present. Similar soils occur in South Africa and are classified in the Fernwood form (Department of Agricultural Development, 1991). Brammer (1973) speculates on the existence of an extensive area of podzols on the Barotse sands in the Western Province of Zambia.

Natural vegetation The vegetation is a variant of that described for Land Unit K1. It is a shorter woodland principally composed of *Brachystegia spiciformis* but without *Baikiaea plurijuga, Guibourtia coleosperma, Combretum collinum* and *Commiphora mossambicensis*. Additional tree species include *Swartzia madagascariensis, Monotes glaber, Parinari capensis, Terminalia brachystemma* and *Strychnos cocculoides*. Several of these species show signs of frost damage. The pans, vleis and their edges are open grasslands.

Land use There are a few irrigated vegetable gardens around the seepage zones of the vleis. The vleis and pans also form an important dry season grazing resource. The woodland areas may be lightly grazed and logging of *Pterocarpus angolensis* has been undertaken periodically.

Land capability Because of a soil fertility constraint, most of the unit is Class MIVf. The pans and vleis are Class V.

Irrigability This unit is mainly Class S irrigability, excessively pervious sands of very restricted suitability. Sites close to seepage zones often have soils with a fertile mollic A horizon and are successfully used for micro-scale irrigation using water from shallow hand-dug wells.

Erosion None of the sites described showed evidence of accelerated soil erosion.

Development potential This unit has a very low potential for cropping; the grazing value is low with the exception of the moist grasslands. Controlled and uncontrolled utilisation of the timber will doubtless continue but this is unlikely to be on a scale sufficient to interfere with the woodland's role as a regulator of water supply in the Kalahari sands.

Typical Profile Description Land Unit K2 – pale gusu sands of the plateau interior

Profile number:	157-GG-88 described on 3 August 1988. Auger boring.
Location:	4 km west of the Kashana River, Lupane CL, Lupane District. Map reference PK 0535.
Site:	Flat or slightly concave plateau surface. 70% bare soil. 1 100 m altitude.
Vegetation/land use:	Woodland with open canopy, no evidence of disturbance but probably logged at some time for *Pterocarpus angolensis*. Tree species include *Erythrophleum africanum, Brachystegia spiciformis, Julbernardia globiflora, Swartzia madagascariensis, Burkea africana, Ochna pulchra, Pavetta schumanniana. Baikiaea plurijuga* is absent.
Parent material:	Primary Kalahari Sand.
Erosion:	None evident.
Land capability:	Class MIVf.
Profile irrigable value:	4.
Soil classification:	1K (Zimbabwe) Ustic Quartzipsamment (Soil Taxonomy) Albic Arenosol (FAO/UNESCO/ISRIC)
0-15 cm	Very dark greyish brown (10YR 3/2m) medium sand; dry.
15-78 cm	Very pale brown (10YR 8/3m) medium sand; dry.
78-140 cm	Very pale brown (10YR 7/3m) medium sand; dry.

ANALYSIS PROFILE 157-GG-88

Depth (cm)	0-15	40-55	100-115
Lab No.	X2649	X2650	X2651
DM %	99.6	99.8	99.8
Texture	mS	mS	mS
Gravel %	0	0	0
Coarse Sand %	9	9	9
Medium Sand %	59	54	44
Fine Sand %	28	33	42
Silt %	1	0	1
Clay %	3	3	4
pH ($CaC1_2$)	4.7	4.4	4.5
Carbonates %	0	0	0
EX Ca (me %)	0.5	0.4	0.8
EX Mg (me %)	0.1	0.0	0.1
EX Na (me %)	0.02	0.02	0.02
EX K (me %)	0.02	0.02	0.02
TEB (me %)	0.6	0.5	0.9
CEC (me %)	1.8	1.0	2.0
Base Sat %	32	48	45
E/C	69.2	32.3	52.6
S/C	21.9	15.5	23.7
ESP	1.1	2.0	1.0
EKP	1.1	2.0	1.0

Typical Profile Description Land Unit K2 – podzolic sands fringing seasonally wet pans

Profile number:	153-GG-88 described on 2 August 1988. Profile exposure.
Location:	At edge of Sikoba-Sina-Danka Pan, Lupane CL, Lupane District. Map reference PK 1640.
Site:	Soil described in dry well formerly used for livestock watering. 90% cover of short grazed grass. Slope less than 2%.
Vegetation/land use:	Grazing area. Seasonally moist grassland.
Parent material:	Kalahari Sand.
Erosion:	None evident.
Land capability:	Class MIVw.
Profile irrigable value:	4.
Soil classification:	Not recognised in the Zimbabwean system Typic Placaquod (Soil Taxonomy) Gleyic Podzol (FAO/UNESCO/ISRIC)

0-13 cm	Black (10YR 2/1m) and greyish brown (10YR 5/2d) mainly organic matter with inclusions of light grey ash; moderate medium angular blocky structure; dry, slightly hard; many fibrous roots; clear smooth boundary to:
13-24/26 cm	Very dark grey (10YR 3/1m) medium sand; common fine strong brown root mottles; weak coarse angular blocky structure; dry, slightly hard; many fibrous roots; clear discontinuous boundary to:
24/26-66/84 cm	Greyish brown (10YR 5/2m) medium sand containing placic horizons comprising thin (<10 mm) brown (7.5YR 4/2), wavy to convoluted, bifurcating, hard sheets of an iron-organic matter complex some of which are partially burnt to ash; massive; slightly moist, slightly hard; common fibrous roots; clear irregular boundary to:
66/84-136 cm	Light grey (10YR 7/2m) medium sand; massive; slightly moist, soft; common fibrous roots; diffuse smooth boundary to:
136-200 cm	Light grey (10YR 7/2m) medium sand; massive; slightly moist, soft; common fibrous roots.

ANALYSIS PROFILE 153-GG-88

Depth (cm)	0-13	13-25	40-55	90-105	160-175
Lab No.	X2634	X2635	X2636	X2637	X2638
DM %	97.0	99.1	99.7	99.9	99.8
Texture	mSaL	mS	mS	mS	mS
Gravel %	0	0	0	0	0
Coarse Sand %	11	12	13	13	13
Medium Sand %	30	47	52	50	48
Fine Sand %	32	33	30	32	35
Silt %	16	5	3	3	3
Clay %	10	3	2	2	2
pH ($CaC1_2$)	4.9	4.8	5.1	5.1	5.2
Carbonates %	0	0	0	0	0
EX Ca (me %)	3.7	1.2	1.0	0.9	0.8
EX Mg (me %)	0.9	0.5	0.4	0.3	0.5
EX Na (me %)	0.06	0.06	0.06	0.06	0.04
EX K (me %)	0.83	0.08	0.06	0.04	0.04
TEB (me %)	5.5	1.9	1.5	1.2	1.4
CEC (me %)	6.7	4.2	5.2	3.5	2.0
Base Sat %	82	44	28	36	70
E/C	64.3	134.2	321.7	216.4	123.5
S/C	52.8	59.4	91.3	77.5	86.3
ESP	0.9	1.4	1.2	1.7	2.0
EKP	12.3	1.9	1.2	1.2	2.0

Typical Profile Description Land Unit K2 – seasonally wet pans

Profile number:	152-GG-88 described on 2 August 1988. Auger boring.
Location:	In the Sikoba-Sina-Danka Pan about 100 metres from profile 153-GG-88. Lupane CL, Lupane District. Map reference PK 1640.
Site:	Large pan surrounded by Kalahari Sand. Few scattered small termitaria. Flat but complex microtopography which appears to correspond to the distribution of several grass species.
Vegetation/land use:	80% short grass cover. Grazing area.
Parent material:	Probably alluvium of lacustrine origin. The clay is assumed to have been eluviated from the surrounding sands.
Erosion:	None evident.
Land capability:	Class V.
Profile irrigable value:	4.
Soil classification:	4U (Zimbabwe) Fluvaquentic Haplaquoll (Soil Taxonomy) Mollic Gleysol (FAO/UNESCO/ISRIC)
0-34 cm	Dark brown (10YR 3/3m) hydrophobic organic medium sandy loam with inclusions of grey ash; few 1 cm soft reddish R_2O_3.
34-55 cm	Greyish brown (10YR 5/2m) medium sandy loam; few fine brownish yellow mottles.

55-120 cm	Greyish brown (2.5Y 5/2m) medium sandy clay loam; few coarse red and common coarse strong brown mottles.

ANALYSIS PROFILE 152-GG-88

Depth (cm)	0-15	35-50	80-95
Lab No.	X2631	X2632	X2633
DM %	97.0	97.8	95.0
Texture	mSaL	mSaL	mSaCL
Gravel %	0	0	0
Coarse Sand %	9	9	7
Medium Sand %	30	38	27
Fine Sand %	37	31	26
Silt %	6	9	11
Clay %	18	13	29
pH ($CaCl_2$)	4.6	5.5	6.4
Carbonates %	0	0	0
EX Ca (me %)	5.0	4.4	11.4
EX Mg (me %)	2.0	2.0	5.3
EX Na (me %)	0.17	0.06	0.23
EX K (me %)	0.35	0.14	0.44
TEB (me %)	6.9	6.7	17.3
CEC (me %)	6.9	7.7	18.1
Base Sat %	100	86	96
E/C	37.8	59.6	62.6
S/C	37.8	51.3	60.0
ESP	2.4	0.8	1.3
EKP	5.1	1.8	2.4

LAND UNIT K3

General description This unit occurs in Tjolotjo CL in the western and driest part of the Kalahari Sandveld region. It is well developed in Hwange National Park and continues westwards into Botswana where its ecology has been described by Blair Rains and McKay (1968) and its edaphic characteristics described by Venema and De Wit (1990). A similar landform and catena in Sudan has been described by Williams (1968). The unit comprises a sandveld plain marked in places by a series of east-west trending longitudinal stabilised dunes of low relief. Elevations range from 950 m to 1 050 m above sea level within an almost flat to gently undulating landscape. Surface drainage is frequently ill-defined, associated with a few continuous stream lines draining westwards into the Gwabazabuya or, more frequently, pans and linear interdune depressions forming part of a fossil drainage system. This unit occurs in Natural Region IV, Agroclimatic Zone 5 and has an area of 2 120 km^2.

Geology The geology of the unit comprises Kalahari Sand and minor lacustrine deposits including calcrete. The sands are similar to those of Land Units K1 and K2 but are not as deep, thinning southwards, and have probably been reworked to some extent.

Soils The predominant soils are those associated with the dunes and other relatively high landscape positions. These are very well drained, deep, medium-grained sands over yellowish brown to strong brown, sometimes redder, medium-grained sand to loamy sand subsoils. Sands with some drainage impedance at depth are occasionally mottled. The soils of the depressions and pans are moderately well to imperfectly drained and have a heavier, usually sandy loam, subsoil which may abruptly overlie calcrete. These heavier textures appear to result from an accretion of clay eluviated from the higher-lying sands. The calcrete may be of lacustrine origin or may be due to the capillary rise of calcium-rich groundwater overlying a base-rich rock such as basalt (Goudie, 1973). The sands classify as 1K, the heavier-textured soils as 4M (Zimbabwe). According to the international systems, Quartzipsamments and Haplustalfs or Paleustalfs (Soil Taxonomy); the equivalents are Arenosols and Calcisols or Luvisols (FAO/UNESCO/ISRIC).

Natural vegetation In areas of subdued dune ridge and valley topography, a catenary sequence may be present comprising *Baikiaea plurijuga* woodland on

the crests passing downslope through *Terminalia sericea* tree savanna to the depressions where *Colophospermum mopane* and *Acacia* spp. are dominant. *Baikiaea plurijuga* requires a minimum of about 7 m to 8 m of free-draining sand for optimum development (Calvert, 1984). Fire and frost incidence appear to be additional important factors in determining the distribution and status of the vegetation types. The pans support a seasonally moist grassland.

Land use The deep sands, whether red or the yellower types, are not usually selected for cultivation. Local farmers consider that *Acacia* spp. indicate the best arable soils, mopane indicates moderately good soils and *Baikiaea plurijuga* is judged to be an indicator of worthless soils. Pre-independence settlement schemes are common, with arable blocks coincident with many of the vague drainage ways so as to take advantage of their water-receiving positions in the landscape. The proportion of the unit showing evidence of arable disturbance is small, estimated at between 5% and 10%. Sorghum and millet appear to be more important than maize.

Land capability The AGRITEX capability classification system does not provide a satisfactory assessment of land of this type in a dry environment. Land most suitable for dryland cropping occurs at water-receiving sites with soils of moderately restricted permeability. These areas generally coincide with linear inter-dune depressions. The higher-lying sands have a less general suitability but may be suitable for millet and some sorghums.

Irrigability The unit is predominantly Class S irrigability.

Erosion The unit does not appear to be affected by accelerated water or wind erosion.

Development potential The unit has a low agricultural potential; most of the soils are inherently infertile and the rainfall amount and distribution is marginal for dryland cropping. An assessment of land suitability for arable use at farm planning level requires an understanding of the effects of runoff and seepage in this particular landscape. This process results in an association of water-receiving and water-shedding sites. In Botswana, a water-receiving site is considered, for land evaluation purposes, to be one receiving a gain of moisture of more than 15% of the annual rainfall (Rhebergen, 1988). About 20% of this unit comprises seasonal water-receiving sites, the remainder being either water-shedding sites or normal sites, that is neither gaining nor losing moisture through runoff or lateral seepage.

Although the unit is very poorly served by roads, it is unusual, amongst the Communal Lands, in being crossed by a railway, the Bulawayo to Victoria Fall line, and is served by four sidings.

Typical Profile Description Land Unit K3 – deep sand with drainage impedance at depth

Profile number:	72-GG-90 described on 27 February 1990. Auger boring.
Location:	12 km west of Sipepa Hospital, Tjolotjo CL, Nyamandhlovu District. Map reference NJ 5971.
Site:	Almost flat, amorphous sand deposit slightly elevated above an extensive cultivated area farther east.
Vegetation/land use:	Open, disturbed woodland providing poor grazing. *Terminalia sericea, Erythrophleum africanum* and *Burkea africana* appear to be co-dominant associated with *Guibourtia coleosperma, Ricinodendron rautanenii, Swartzia madagascariensis, Combretum zeyheri, C. collinum, C. psidioides, Acacia erioloba, Albizia antunesiana, Peltophorum africanum* and *Pseudolachnostylis maprouneifolia*. Mopane and *Baikiaea plurijuga* are absent.

Parent material:	Kalahari Sand, possibly reworked, over material at depth, probably calcrete, which is restricting drainage through the sand.
Erosion:	There is no evidence of accelerated erosion.
Land capability:	Class MIII.
Profile irrigable value:	4.
Soil classification:	1K (Zimbabwe) Aquic Quartzipsamment (Soil Taxonomy) Gleyic Arenosol (FAO/UNESCO/ISRIC)
0-15 cm	Brown (10YR 4/3m) medium sand; slightly moist.
15-64 cm	Brownish yellow (10YR 6/6m) medium sand; few medium strong brown mottles; moist.
64-133 cm	Brownish yellow (10YR 6/6m) medium sand; common medium light grey and strong brown mottles; moist.
133-200 cm	Brownish yellow (10YR 6/6m) medium sand; many coarse light grey and strong brown mottles; moist.

ANALYSIS PROFILE 72-GG-90

Depth (cm)	0-15	15-64	64-133	133-200
Lab No.	Y2472	Y2473	Y2474	Y2475
DM %	99.5	99.7	99.5	99.3
Texture	mS	mS	mS	mS
Clay %	2	2	3	6
Silt %	1	1	1	1
Fine Sand %	47	44	44	44
Medium Sand %	47	48	47	45
Coarse Sand %	4	4	5	5
pH ($CaC1_2$)	4.8	4.9	5.1	4.2
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	1.7	1.3	1.3	1.0
EX Mg (me %)	0.4	0.2	0.4	1.3
EX Na (me %)	0.02	0.02	0.04	0.03
EX K (me %)	0.03	0.02	0.04	0.45
TEB (me %)	2.2	1.3	1.7	2.4
CEC (me %)	3.2	1.3	2.3	2.4
Base Sat %	67	100	75	100
E/C	166.7	83.2	73.7	43.3
S/C	112.3	83.2	55.3	43.3
ESP	0.5	1.4	1.7	1.3
EKP	1.1	1.4	1.7	18.7
Free Fe	0.29	0.24	1.34	0.15

Typical Profile Description Land Unit K3 – moderately deep Acacia soil overlying calcrete

Profile number:	71-GG-90 described on 27 February 1990. Auger boring.
Location:	4 km west of Sipepa Hospital, Tjolotjo CL, Nyamandhlovu District. Map reference NJ 6669.
Site:	Mid-slope on indefinite east-west depression, slope less than 2%.
Vegetation/land use:	Site in relict patch of *Acacia* woodland, used as toilet, surrounded by extensive cultivated area mainly under tall sorghum. Pre-independence resettlement area. Mainly *Acacia tortilis, A. nilotica* and *Combretum imberbe* with associated *C. hereroense, Lonchocarpus capassa, Diospyros mespiliformis, Peltophorum africanum* and *Vangueria infausta*. 100% herbaceous ground cover.
Parent material:	Secondary Kalahari Sand overlying calcrete.
Erosion:	No evidence recorded at site.
Land capability:	Class MII. An example of a relatively fertile soil in a slightly water-receiving position.
Profile irrigable value:	3.
Soil classification:	4M (Zimbabwe) Petrocalcic Paleustalf (Soil Taxonomy) Petric Calcisol (FAO/UNESCO/ISRIC)
0-19 cm	Dark yellowish brown (10YR 3/4m) medium loamy sand; moist.
19-46 cm	Strong brown (7.5YR 4/6m) medium loamy sand; moist.

46-78 cm	Yellowish brown (10YR 5/6m) medium sandy loam; moist.
78 cm +	Petrocalcic horizon.

ANALYSIS PROFILE 71-GG-90

Depth (cm)	0-19	19-46	46-78
Lab No.	Y2469	Y2470	Y2471
DM %	97.8	98.0	97.4
Texture	mLS	mLS	mSaL
Clay %	8	9	13
Silt %	2	1	2
Fine Sand %	48	46	45
Medium Sand %	36	38	34
Coarse Sand %	5	6	7
pH ($CaC1_2$)	7.2	6.6	7.3
Carbonates %	0.0	0.0	0.0
EX Ca (me %)	14.4	9.2	14.2
EX Mg (me %)	2.0	1.5	1.3
EX Na (me %)	0.02	0.04	0.04
EX K (me %)	0.64	0.08	0.06
TEB (me %)	13.3	10.3	13.8
CEC (me %)	13.3	10.3	13.8
Base Sat %	100	100	100
E/C	158.8	109.1	105.0
S/C	158.8	109.1	105.0
ESP	0.1	0.4	0.3
EKP	4.8	0.8	0.4
Free Fe	0.29	0.58	0.29

LAND UNIT KM1

General description This unit is widespread in the Districts of Lupane, Nkayi and the southern half of Gokwe. It comprises slightly convex to more or less planar 1% to 3% valley slopes where the primary Kalahari Sands have been incised and redistributed and usually occurs below the steeper convex slopes marking the edge of Land Unit K1. The unit also includes the Charama and Kwavanyangau Plateaux which are gently undulating and probably an association of primary and secondary Kalahari Sand.

The Kana, Lutope, Lupane, Gwampa and Sengwa Rivers' headwaters and tributaries receive seepage from the primary Kalahari Sand. Surface drainage zones are usually broad grassland vleis, weakly incised and showing no definite thalweg. An intermittent spring line occurs at the boundary between this unit and Land Unit K1. There are also some signs of shallow subsurface movement of water. The unit occurs in Natural Regions III and IV, Agroclimatic Zones 3 and 4 and has an area of 4 670 km^2.

Geology Redistributed or secondary Kalahari Sand with minor outcrops of Karoo basalt and Cretaceous or Karoo sediments. Ferricrete may occur locally and silcrete nodules are frequently found at depth. The ferricrete is the result of subsurface precipitation near seepage zones of iron oxide derived by leaching from the undisturbed red Kalahari Sand. Sutton (1979) gives an average of 14% for content of particles less than 0.037 mm (clay, silt and a small proportion of the fine sand fraction) in the redistributed sands compared to 5% in the undisturbed Kalahari Sand. The difference is considered to be the result of the winnowing action of water during redistribution and mixing with the barely consolidated underlying Karoo and Cretaceous sandstones.

Soils The soils are well- to moderately well-drained, deep, medium-grained sands or loamy sands over strong brown to red medium-grained loamy sands to sandy clay loams. Some are yellower and mottled in the subsoil and relatively impermeable horizons may occur at depth, caused by clay illuviation or underlying Karoo or Cretaceous rocks. A few soils show a duplex profile – a sharp increase in clay content with depth. Most of the soils are fairly strongly weathered and classify as fersiallitic 5M (Zimbabwe), Kanhaplic Haplustalfs and Kandic Paleustalfs (Soil Taxonomy) and Haplic or Ferric Lixisols (FAO/UNESCO/ISRIC).

Natural vegetation The natural vegetation is an open woodland of the *Brachystegia spiciformis – B. boehmii* type although this has been much cleared for farming, apart from individual specimens of fruit trees such as *Parinari curatellifolia*. Associated species occurring in remnants of the woodland include *Terminalia sericea, Julbernardia globiflora, Burkea africana, Acacia sieberana, Pericopsis angolensis* and *Monotes glaber*. Occasional groups of mature *Hyphaene benguellensis* palms are characteristic and may indicate the presence of perennially moist subsoils. The seasonally waterlogged vleis are under grass.

Land use A high proportion, about 80% in Nkayi-Lupane to 60% in Gokwe, is arably disturbed. Land within this unit was a focus for government-controlled settlement during the mid-sixties. The evidence for this is provided by the frequency of regular, surveyed field boundaries in blocks adjacent to the Kana and Lutope Rivers. Some of this land has been abandoned and is reverting to woodland. Agricultural experiments were conducted in this unit by the Southern Africa Regional Committee on the Conservation and Utilization of the Soil (SARCCUS) during the early 1960s at a site near Ganye Dam west of Gokwe town (Bromley, 1964).

Land capability Where this unit occurs in Natural Region IV most of the land is Class MIII with minor Class MII and Class MIVw. In the moister parts, in Natural Region III in Gokwe District and based on evaluation at 22 sites, the unit comprises 40% Class II, 50% Class III and 10% Class IVw land.

Irrigability Owing to the preponderance of irrigable value 3 profiles, this unit is assessed as mainly Class C but with inclusions of Class B land. The uniform, moderate slopes and the occasional spring line in upper-slope positions are, however, encouraging features and some small schemes may be viable.

Erosion Erosion is locally severe with gully development along some of the many seasonal drainage lines. Runoff is probably encouraged by the long slopes although the soils are mostly permeable. A few soils have a duplex textural profile and are particularly susceptible to erosion. Bromley and Jones (1966) draw attention to the erosion hazard and recommend a halt to unplanned settlement and the initiation of erosion research in this unit.

Development potential The potential for development is very limited. The unit is currently well populated and extensively cultivated with little scope for an increase in the area under crops. In common with the other Kalahari Sandveld units, the farmers of this area are poorly served by extension advice relevant to intensifying production owing to a long-standing absence of agricultural research in this region largely caused by the institutionalised prejudice against sandy soils in Zimbabwe. The vlei grazing areas are an important resource and should be protected especially since the adjacent woodland of Land Units K1 and K2 has a very low grazing value with only about four months' wet season utilisation (Robinson Commission, 1961/62).

Typical Profile Description Land Unit KM1

Profile number:	107-GG-88 described on 18 June 1988. Profile pit.
Location:	Near Gwehaya Mission, 10 km south of Gokwe town, Gokwe CL, Gokwe District. Map reference QK 0576.
Site:	Lower slope, planar 2%-3%. Old cultivation ridges. Some patchy, loose sand cover. Very active consumption of surface litter by harvester termites *Hodotermes mossambicus*.
Vegetation/land use:	Previous crop maize. Mainly cleared but with residual *Terminalia sericea, Bauhinia piliostigma, Brachystegia boehmii, Combretum molle, Bridelia cathartica, Burkea africana, Acacia sieberana, Julbernardia globiflora, Dichrostachys cinerea* and *Diplorhynchus condylocarpon*.

Parent material:	Redistributed Kalahari Sand overlying Karoo sandstone.
Erosion:	Several patchy deposits of loose sand, some of which originated from roadside drain runoff.
Land capability:	Class MIII (slope > 2%).
Profile irrigable value:	3.
Soil classification:	5M (Zimbabwe) Kanhaplic Haplustalf (Soil Taxonomy) Ferric Lixisol (FAO/UNESCO/ISRIC)
0-4/6 cm	Brown (10YR 5/3d) and dark yellowish brown (10YR 4/4m) medium sand; hard, dry; weakly developed medium platy structure; few small fibrous roots; slightly restricted permeability, well drained; abrupt wavy boundary to:
4/6-18 cm	Brownish yellow (10YR 6/6d) and yellowish brown (10YR 5/6m) medium loamy sand; hard, dry; structureless; few small fibrous and woody roots; good permeability, well drained; clear smooth boundary to:
18-40 cm	Brownish yellow (10YR 6/6d) and yellowish brown (10YR 5/6m) medium sandy loam; friable, moist; very weak medium subangular blocky; few small fibrous and woody roots; good permeability, well drained; gradual smooth boundary to:
40-83 cm	Reddish yellow (7.5YR 6/6d) and strong brown (7.5YR 5/6m) medium sandy clay loam; friable, moist; weak medium and fine subangular blocky; weak clay pore/ped cutans; few small fibrous and woody roots; good permeability, well drained; clear smooth boundary to:
83-107/116 cm	Reddish yellow (7.5YR 7/6m) and reddish yellow (7.5YR 6/6d) medium sandy clay loam; friable, moist; very weak medium and fine subangular blocky; weak clay pore/ped cutans; few small fibrous and woody roots; common medium brownish yellow mottles; good permeability, moderately poorly drained; abrupt wavy boundary to:
107/116-126/131 cm	Yellow (10YR 7/6m) and brownish yellow (10YR 6/6m) medium gravelly sandy loam; very moist; structureless; weak clay/pore cutans; many sub-round 1-2 cm hard R_2O_3 concretions; few small fibrous and woody roots; slightly restricted permeability, moderately poorly drained; clear wavy boundary to:
126/131-153 cm	Light grey (10YR 7/2m) and light brownish grey (10YR 6/2d) gravel comprising ferruginous and manganiferous highly weathered sandstone and few silcrete nodules; very moist; moderately restricted permeability, poorly drained.

ANALYSIS PROFILE 107-GG-88

Depth (cm)	0-4	4-18	20-35	55-70	90-105	116-131
Lab No.	X1831	X1832	X1833	X1834	X1835	X1836
DM %	99.4	99.2	98.7	97.9	98.0	98.1
Texture	mS	mLS	mSaL	mSaCL	mSaCL	mSaL
Gravel %	0	0	0	0	0	0
Coarse Sand %	5	6	6	9	9	13
Medium Sand %	42	42	41	39	34	38
Fine Sand %	44	41	38	30	35	30
Silt %	2	3	1	2	1	2
Clay %	6	8	13	21	22	17
pH ($CaCl_2$)	5.2	5.4	5.3	4.7	4.7	5.2
Carbonates %	0.0	0.0	0.0	0.0	0.0	0.0
EX Ca (me %)	1.0	2.9	3.6	3.7	3.5	4.0
EX Mg (me %)	0.1	0.3	1.0	1.5	1.8	1.6
EX Na (me %)	0.02	0.04	0.04	0.04	0.06	0.06
EX K (me %)	0.14	0.16	0.18	0.31	0.24	0.65
TEB (me %)	0.5	3.0	3.6	5.3	5.1	4.9
CEC (me %)	0.5	3.0	3.6	5.3	5.1	4.9
Base Sat %	100	100	100	100	100	100
E/C	8.5	36.6	27.0	25.9	23.7	28.0
S/C	8.5	36.6	27.0	25.9	23.7	28.0
ESP	3.8	1.3	1.1	0.8	1.2	1.3
EKP	26.9	5.4	5.1	5.8	4.8	13.4

LAND UNIT KM2

General description This unit is an extension southwards of the sandveld plain mapped as Land Unit K3 but represents an area where the Kalahari Sand thins out to expose, in places, Karoo sediments. There are many small pans which may be points of internal drainage or may be linked by indistinct linear depressions, in a deranged pattern, feeding into the Gwabazabuya River which itself is a very vague feature. Altitude varies little, from about 980 m to 1 100 m above sea level. The unit occurs in Natural Region IV, Agroclimatic Zones 4 and 5 and has an area of 4 000 km^2.

Geology The geology is not well known and comprises a discontinuous veneer of reworked Kalahari Sand overlying Karoo sediments. Minor areas of alluvium are associated with the pans and drainage ways.

Soils Four broad soil types were identified. These form an association comprising:

(i) Moderately well to imperfectly drained, medium- to coarse-grained sands and loamy sands over, sometimes abruptly, yellowish brown coarse-grained sandy loams and sandy clay loams, frequently mottled or occasionally gleyed with a perched watertable. These soils classify as 4M or 5M (Zimbabwe), Aeric or Arenic Albaqualfs (Soil Taxonomy) and Eutric Planosols (FAO/UNESCO/ISRIC). Soils with particularly deep coarse-textured E horizons are designated Aquic Quartzipsamments (Soil Taxonomy) and Gleyic Arenosols (FAO/UNESCO/ISRIC). These soils appear to be derived from a Karoo feldspathic sandstone or arkose and have some pedogenic similarities to those of Land Unit M4;

(ii) Well-drained, shallow to moderately deep, fine- to medium-grained sands to sandy loams over yellowish brown to yellowish red, fine- to coarse-grained sandy loams to sandy clay loams commonly abruptly overlying calcrete or a strongly calcareous layer. These are similar to the soils overlying calcrete in Land Unit K3. They classify as 4M (Zimbabwe), Paleustalfs (Soil Taxonomy) and Calcisols (FAO/UNESCO/ISRIC);

(iii) Very well-drained, deep, medium- or coarse-grained sands over strong brown to yellowish red, medium- or coarse-grained sands or loamy sands. These are similar to the dune soils of Land Unit K3 but are more extensively reworked and have probably incorporated material of Karoo origin. They classify mainly as 1K (Zimbabwe), Ustic Quartzipsamments (Soil Taxonomy) and Luvic or Ferralic Arenosols (FAO/UNESCO/ISRIC);

(iv) Imperfectly drained, medium- or coarse-grained sands or loamy sands over light grey, sometimes mottled or calcareous, usually sodic, medium- or coarse-grained sandy loams or sandy clay loams with severely restricted permeability. Some of these soils have very high levels of exchangeable sodium but may not have the structural requirements of a natric B horizon. They classify as 8N or 8h (Zimbabwe) and, assuming a natric B horizon is present, Aquic or Arenic Natrustalfs (Soil Taxonomy) and Stagnic or Haplic Solonetz (FAO/UNESCO/ISRIC).

Natural vegetation The vegetation correlates well with the broad soil types and their drainage status. On the mantle of reworked Kalahari Sand, a few slightly elevated sites may support a woodland containing *Baikiaea plurijuga*. These sites are surrounded by a more typical low, disturbed mixed woodland without *Baikiaea*. The boundary between these two woodland types is usually sharp, scalloped and may be related to fire damage. Much of the apparantly fire-modified woodland comprises *Terminalia sericea* and *Combretum collinum*, which may be co-dominant, associated with *C. fragrans, Commiphora* spp., *Baphia massaiensis, Bauhinia petersiana, Acacia erioloba, Lonchocarpus nelsii* and *Boscia albitrunca*. Mopane may be present, particularly in the drier west, but is never a dominant constituent on the deep sands.

The soils derived from Karoo sediments characteristically support an open, low *Combretum collinum* woodland containing only a few other species including *Peltophorum africanum, Ziziphus mucronata, Colophospermum mopane, Combretum hereroense, Acacia ataxacantha*. The local farmers consider *C. collinum*, if dominant, to be an indicator of poor soils. In places the woodland is transitional to a wooded grassland, indicating severely restricted subsoil drainage and the presence of a perched watertable.

Most of the non-pan depression sites are under mopane woodland or bushland and indicate water-receiving sites with a slowly permeable, moderately clay rich subsoil which may be sodic. The pans are seasonally flooded grasslands.

Land use The unit is sparsely populated and less than 15% of the area shows evidence of arable disturbance, mainly in arable blocks allocated during a past settlement programme, probably during the 1960s. During this same period, part of the unit occupied a portion of the Tjolotjo Experiment Station, a sub-station of the Matopos Research Station, and work was undertaken on livestock production, veld research and crop trials on the Kalahari Sand soils. Cijima Dam, south of Dhlamini, was designed to receive water from the Nata River, some 40 km distant, partly by canal which crosses the Nata-Gwabazabuya watershed.

Land capability The capability of the unit is similar to that of Land Unit K3. Water-receiving sites have the highest capability with the exception of the pans and some of the Karoo soils which are excessively wet. The most fertile soils are those with calcrete at moderate depth and some of the sodic soils.

Irrigability Prospects for irrigation based on dam-supplied water are poor. The viability of small schemes based on groundwater abstraction warrants investigation. The Nyamandhlovu aquifer, in Upper Karoo sediments, is an important source of borehole water for irrigation east of Tjolotjo and may extend into the communal land (Agricultural Development Authority, 1973). Other aquifers, associated with the Kalahari pipe sandstone, have been located along the line of rail between Sawmills and Dete (MacDonald, 1970). Most of the soils currently cultivated are suitable for irrigation with the exception of some of the strongly sodic soils.

Erosion The erosion hazard is low and there is little evidence of water- or wind-induced loss of soil under present conditions. The depression soils under mopane are prone to surface crusting.

Development potential The unit has a low agricultural potential similar to that of Land Unit K3.

Typical Profile Description Land Unit KM2 – deep sand supporting *Baikiaea plurijuga*.

Profile number:	68-GG-90 described on 26 February 1990. Auger boring.
Location:	By Pumula Mission, Tjolotjo CL, Nyamandhlovu District. Map reference NJ 1035.
Site:	Within "island" of well-grown woodland having a sharp boundary with surrounding low, sparse probably fire-damaged woodland. Almost flat, possibly slightly elevated. Loose surface sand.
Vegetation/land use:	*Baikiaea plurijuga* woodland, slightly disturbed by wood cutting. 70% herbaceous ground cover. Woody species include *Bauhinia petersiana, Croton gratissimus, Vangueria infausta, Combretum apiculatum, Acacia* sp. and *Ricinodendron rautanenii*.
Parent material:	Reworked Kalahari Sand. The high proportion of coarse sand is unusual and may derive from an incorporation of Karoo sediment.
Erosion:	Not evident.
Land capability:	Class MIVf.

Profile irrigable value:	4.
Soil classification:	1K (Zimbabwe) Ustic Quartzipsamment (Soil Taxonomy) Ferralic Arenosol (FAO/UNESCO/ISRIC)
0-16 cm	Brown (10YR 4/3m) medium sand; moist.
16-137 cm	Strong brown (7.5YR 5/6m) coarse sand; moist.
137-200 cm	Strong brown (7.5YR 5/6m) coarse sand; moist.

ANALYSIS PROFILE 68-GG-90

Depth (cm)	0-16	16-137	137-200
Lab No.	Y2458	Y2459	Y2460
DM %	99.7	99.6	99.6
Texture	mS	cS	cS
Clay %	2	3	3
Silt %	2	1	1
Fine Sand %	39	41	39
Medium Sand %	33	30	30
Coarse Sand %	23	25	28
pH ($CaC1_2$)	4.3	4.4	4.6
Carbonates %	0	0	0
EX Ca (me %)	2.0	1.9	0.3
EX Mg (me %)	0.3	0.1	0.6
EX Na (me %)	0.00	0.00	0.03
EX K (me %)	0.05	0.03	0.05
TEB (me %)	1.3	2.0	1.0
CEC (me %)	1.3	3.1	1.8
Base Sat %	100	65	54
E/C	60.7	97.7	54.0
S/C	60.7	63.5	29.3
ESP	0.0	0.0	1.4
EKP	3.6	1.0	2.9
Free Fe	0.17	0.15	0.19

Typical Profile Description Land Unit KM2 – petrocalcic soil

Profile number:	64-GG-90 described on 25 February 1990. Profile exposure
Location:	18 km north west of Tjolotjo, near Mkubazi, Tjolotjo CL, Nyamandhlovu District. Map reference NJ 7230.
Site:	Quarry where calcrete is being extracted for road surfacing. Surrounding area almost flat.
Vegetation/land use:	Mixed woodland, mopane probably dominant, with *Acacia nilotica, Lonchocarpus capassa* and *Combretum hereroense.*
Parent material:	Possibly reworked Karoo sediments. The origin of the calcrete is obscure but may be related to the presence of basalt at depth.
Erosion:	No evidence of accelerated erosion recorded.
Land capability:	Class MII.
Profile irrigable value:	2.
Soil classification:	4M (Zimbabwe) Petrocalcic Paleustalf (Soil Taxonomy) Petric Calcisol (FAO/UNESCO/ISRIC)
0-11 cm	Very dark grey (10YR 3/1m) medium sandy loam; weak coarse subangular blocky structure; moist; clear smooth boundary to:
11-30 cm	Dark yellowish brown (10YR 3/4m) medium sandy loam; very weak medium subangular blocky structure; moist; gradual smooth boundary to:
30-75/80 cm	Dark yellowish brown (10YR 4/4m) coarse sandy loam; very weak medium subangular blocky structure; few 2-3 mm quartz gravel; moist; clear wavy boundary to:
75/80-93 cm	Dark yellowish brown (10YR 4/4m) and very dark greyish brown (10YR 3/2m) coarse sandy clay loam; very weak coarse subangular blocky structure; calcareous; moist; abrupt smooth boundary to:
93-300 cm +	Cemented calcium carbonate forming a petrocalcic horizon.

ANALYSIS PROFILE 64-GG-90

Depth (cm)	0-11	11-30	30-80	80-93	93-300
Lab No.	Y2439	Y2440	Y2441	Y2442	Y2443
DM %	98.0	97.5	97.0	95.9	93.7
Texture	mSaL	mSaL	cSaL	cSaCL	cSaL
Clay %	12	16	17	20	18
Silt %	4	3	3	5	9
Fine Sand %	39	38	29	31	25
Medium Sand %	30	27	26	24	21
Coarse Sand %	16	16	25	20	27
pH ($CaC1_2$)	6.0	6.0	5.4	7.6	8.0
Carbonates %	0	0	0	0	0
EX Ca (me %)	17.6	5.6	10.3	33.3	159.6
EX Mg (me %)	1.9	1.1	2.5	3.6	7.6
EX Na (me %)	0.12	0.03	0.06	0.05	0.07
EX K (me %)	0.16	0.03	0.06	0.13	0.07
TEB (me %)	19.0	6.2	13.0	23.7	24.0
CEC (me %)	19.0	6.2	15.5	23.7	24.0
Base Sat %	100	100	84	100	100
E/C	160.5	39.2	89.6	118.7	133.7
S/C	160.5	39.2	74.9	118.7	133.7
ESP	0.7	0.4	0.4	0.2	0.3
EKP	0.8	0.4	0.4	0.6	0.3
Free Fe	0.61	0.42	0.55	0.29	0.29

Typical Profile Description Land Unit KM2 – Karoo sediment derived soil with deep slowly permeable sodic horizon

Profile number:	51-GG-90 described on 20 February 1990. Auger boring.
Location:	8 km northeast of the Ntufu bridge crossing the Amanzamnyama River, Tjolotjo CL, Nyamandhlovu District. Map reference NH 8679.
Site:	Plateau, almost flat, <2% slope. Weak surface crust.
Vegetation/land use:	Natural or derived wooded grassland. Good herbaceous growth with 90% ground cover. Common low *Acacia* spp. regrowth. Occasional *Peltophorum africanum, Euclea divinorum, Terminalia sericea,* small *Colophospermum mopane, Albizia amara, Cassine matabelica, Bridelia mollis* and *Lonchocarpus capassa.* By fenced field of mixed maize and sorghum. Other fields predominantly pearl millet. Shallow well nearby, said to retain water throughout the year and used for irrigating onions and tomatoes.
Parent material:	Karoo sandstone.
Erosion:	Not evident.
Land capability:	Class MIVw. Perched watertable at 110 cm below surface.
Profile irrigable value:	4.
Soil classification:	5M (Zimbabwe) Aquic Quartzipsamment (Soil Taxonomy) Gleyic Arenosol (FAO/UNESCO/ISRIC)
0-33 cm	Dark brown (10YR 3/3m) medium loamy sand; moist.
33-84 cm	Yellowish brown (10YR 5/4m) medium loamy sand; common medium strong brown mottles and few, 1-2 cm moderately hard, strong brown, round nodules with black manganese centres; moist becoming very moist.
84-140 cm	Very pale brown (10YR 7/3m) coarse loamy sand; common medium and coarse strong brown mottles; wet.
140-200 cm	Light grey (10YR 7/2m) medium sandy loam; common medium and coarse strong brown to red mottles and soft nodules; wet becoming moist indicating a reduction in permeability.

ANALYSIS PROFILE 51-GG-90

Depth (cm)	0-33	33-84	84-140	140-200
Lab No.	Y2390	Y2391	Y2392	Y2393
DM %	99.5	99.5	99.3	98.5
Texture	mLS	cLS	fLS	mSaL
Clay %	6	7	7	19
Silt %	3	3	1	4

Fine Sand %	38	34	55	37
Medium Sand %	31	32	19	32
Coarse Sand %	23	24	17	8
Gravel %	0	0	3	5
pH ($CaC1_2$)	6.3	5.8	5.6	6.2
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	28.3	3.3	3.2	3.9
EX Mg (me %)	3.9	0.7	1.1	2.0
EX Na (me %)	0.09	0.09	0.19	1.01
EX K (me %)	0.28	0.39	0.04	0.02
TEB (me %)	19.5	3.2	2.9	4.9
CEC (me %)	19.5	3.2	2.9	4.9
Base Sat %	100	100	100	100
E/C	313.2	48.5	15.1	69.9
S/C	313.2	48.5	15.1	69.9
ESP	0.5	2.9	6.4	20.5
EKP	1.5	12.1	1.4	0.5
Free Fe	0.33	0.62	0.46	0.45

Typical Profile Description Land Unit KM2 – sodic soil in linear depression

Profile number: 67-GG-90 described on 26 February 1990. Auger boring.

Location: 7 km northeast of Pumula Mission, Tjolotjo CL, Nyamandhlovu District. Map reference NJ 1637.

Site: Lower slope near indistinct drainage line, slope less than 2%. Thin loose coarse reddish sand layer over moderately hard crust.

Vegetation/land use: Cultivation in this area is restricted to the linear drainage-way and associated lower slopes. The natural vegetation is a low mopane woodland with common *Combretum apiculatum*. There are few other species including *Peltophorum africanum, Elephantorrhiza goetzei, Commiphora* spp. and *Aloe* spp. The site is fallow with mopane regrowth to 50 cm height. The herbaceous cover has been burnt off.

Parent material: Probably Karoo sediment with some Kalahari Sand contributions.

Erosion: Slight sheet erosion.

Land capability: Class MIII.

Profile irrigable value: 3.

Soil classification: 8h (Zimbabwe)
Arenic Natrustalf (Soil Taxonomy)
Haplic Solonetz (FAO/UNESCO/ISRIC)
or if natric B is absent:
Arenic Haplustalf (Soil Taxonomy)
Calcic Luvisol, saline and sodic phase (FAO/UNESCO/ISRIC)

0-11 cm: Brown to dark brown (10YR 4/3m) medium sand; slightly moist.

11-27 cm: Brown (10YR 5/3m) coarse loamy sand; slightly moist.

27-79 cm: Light brownish grey (10YR 6/2m) calcareous coarse loamy sand;

79-135 cm: Light grey (2.5Y 7/2m) calcareous coarse sandy loam; slightly moist.

135-200 cm: Light grey (2.5Y 7/2m) calcareous coarse loamy sand; dry.

ANALYSIS PROFILE 67-GG-90

Depth (cm)	0-11	11-27	27-79	79-135	135-200
Lab No.	Y2453	Y2454	Y2455	Y2456	Y2457
DM %	99.3	98.3	97.9	97.0	97.0
Texture	mS	cLS	cLS	cSaL	cLS
Clay %	3	8	10	13	6
Silt %	1	1	1	2	4
Fine Sand %	46	39	38	36	40
Medium Sand %	31	28	28	27	27
Coarse Sand %	19	24	23	21	23
Gravel %	0	0	3	0	3
pH ($CaC1_2$)	5.6	8.0	8.7	8.9	9.0
Carbonates %	0	0	0	0	0
EX Ca (me %)	1.5	3.5	8.9	6.0	9.4
EX Mg (me %)	0.9	2.4	2.7	2.9	2.7
EX Na (me %)	0.22	2.29	5.12	7.64	2.26
EX K (me %)	0.16	0.57	0.55	0.32	0.21

TEB (me %)	2.8	7.5	11.3	12.4	13.2
CEC (me %)	4.1	7.5	11.3	12.4	13.2
Base Sat %	68	100	100	100	100
E/C	140.8	95.7	112.8	95.6	232.0
S/C	95.7	95.7	112.8	95.6	232.0
ESP	5.4	30.8	45.3	61.6	17.1
EKP	3.8	7.7	4.8	2.6	1.6
Free Fe	0.07	0.06	0.07	0.05	0.21

LAND UNIT KMU1

General description This unit, with similarities to the adjoining Land Unit KM2, has been identified because of a high proportion of large pans which appear to form part of a fossil or deranged drainage system. This type of landscape in western Zimbabwe has been described by Goudie and Thomas (1985). East of Dhlamini, the pans may have at one time connected with the Gwabazabuya and Somesetshe Rivers. In the southwest of Tjolotjo CL, the pans are components of a complex coalescence of drainage lines linking the Nata and Gwabazabuya Rivers, extending into the Hwange National Park as the Dzivanini Mud Flats and Botswana as the Dukwe Maitengwe Flats (Venema and De Wit, 1990). The unit occurs in Natural Region IV, Agroclimatic Zone 5 and has an area of 2 180 km^2.

Geology The geology is not well known. The unit appears to be underlain by Karoo rocks capped by recently reworked aeolian sands and alluvium. It appears probable that some of the clay-based pans have developed on Karoo basalt.

Soils The main soil types are similar to those described in Land Unit KM2 but with a higher proportion of soils with varying degrees of poor drainage. In addition, the pan soils include poorly to imperfectly drained, moderately deep to deep, dark grey sodic sandy clay to clay vertisols or clayey soils with vertic properties. They are classified as 3S (Zimbabwe), Typic Pellusterts or Vertic Ochraqualfs (Soil Taxonomy) and Eutric Vertisols or Vertic Luvisols (FAO/UNESCO/ISRIC).

Natural vegetation The pans comprise seasonally wet or flooded grassland. These may be fringed by an almost pure 6-10 m high mopane woodland. On sandier rises the mopane may be co-dominant with *Acacia* in a mixed low, open woodland including *A. nigrescens, A. nilotica, A. nebrownii, Albizia harveyi, A. anthelmintica* and *Ricinodendron rautanenii.*

Land use The unit is sparsely populated and is little affected by cultivation. There is evidence of schemes to provide watering points for livestock, the largest being at Gariya Dam which was designed to receive water by canal from the Nata River.

Land capability The unit is an association of Classes MIII, MIVw and V.

Irrigability The soils are of restricted suitability according to the conventional assessment of Thompson and Purves (1979). However, for traditional irrigation methods which ameliorate drainage and fertility constraints, most of the soils are suitable.

Erosion Many of the soils under mopane, fringing the edges of pans and other depressions, are prone to crusting which may result in runoff and slight sheet and rill erosion, especially on surfaces damaged by human and livestock movement. This does not appear to be a serious problem and may have an advantage in increasing flow into pans which are used as water reservoirs.

Development potential The agricultural potential is very low. In the southwest, the unit forms a natural extension of Hwange National Park.

Typical Profile Description Land Unit KMU1 – large pan

Profile number:	85-GG-90 described on 2 March 1990. Auger boring.
Location:	Mbuhulu Pan on the outskirts of Dhlamini, Tjolotjo CL, Nyamandhlovu District. Map reference NJ 4243.
Site:	Central part of pan. Flat but with microtopography of broad hollows and mounds. Surface slightly cracked with a thin mulch of fine granules over strong coarse angular blocks.
Vegetation/land use:	Well-grazed short grass, 70% of surface bare on mounds but hollows moist and with 100% grass cover. Many domestic animals grazing in pan.
Parent material:	Spoil from deep cistern at edge of pan contains calcrete fragments, agates and well-rounded gravel. The presence of agates may indicate that the pan soil is derived from basalt.
Erosion:	Some sand incorporated in the topsoil may be of depositional origin.
Land capability:	Class V.
Profile irrigable value:	4.
Soil classification:	3S (Zimbabwe) Typic Pellustert (Soil Taxonomy) Eutric Vertisol (FAO/UNESCO/ISRIC)
0-18 cm	Dark grey (10YR 4/1m) sandy clay; dry.
18-45 cm	Dark grey (N 4/m) clay; moist.
45-125 cm	Grey (10YR 5/1m) clay; few, moderately hard carbonate nodules; moist.
125 cm +	Too hard to auger.

ANALYSIS PROFILE 85-GG-90

Depth (cm)	0-18	18-45	45-125
Lab No.	Y2523	Y2524	Y2525
DM %	90.7	90.8	88.3
Texture	C	cSaC	C
Clay %	58	50	66
Silt %	4	3	3
Fine Sand %	19	22	19
Medium Sand %	10	13	7
Coarse Sand %	8	12	5
Gravel %	0	7	0
pH ($CaCl_2$)	7.5	8.1	8.8
Carbonates %	2.2	0.0	0.0
EX Ca (me %)	88.3	55.8	46.6
EX Mg (me %)	13.5	11.6	13.1
EX Na (me %)	5.04	12.21	27.35
EX K (me %)	1.68	1.61	1.22
TEB (me %)	50.0	53.0	55.5
CEC (me %)	50.0	53.0	55.5
Base Sat %	100	100	100
E/C	86.2	106.2	84.3
S/C	86.2	106.2	84.3
ESP	10.1	23.0	49.3
EKP	3.4	3.0	2.2
Free Fe	0.29	0.22	0.25

Group D – Land units on argillaceous sedimentary rocks

LAND UNIT D1

General description This unit occurs in the northern part of Mukumbura CL, between the Mukumbura and Hoya Rivers, in Centenary District and is part of the Mid Zambezi Valley region. The altitude range is 350-400 m above sea level. It comprises an almost flat plain with wide (1-2 km) drainage spacing and gentle, convex interfluve slopes (<2%). Information on the unit is very limited as it was mostly inaccessible by road at the time of survey. There are similarities in landform and soils to Land Unit D2 and it may be appropriate after a more detailed assessment to amalgamate it with this unit. It has been described by Hawkins Associates (1982). The unit occurs in Natural Region IV, Agroclimatic Zone 4 and has an area of 435 km^2.

Geology The underlying rocks are probably Upper Jurassic to Cretaceous siltstones (Kadzi Beds). There may be a partial cover of old alluvium. In the geological interpretation by Broderick (1987), the interfluve crests are shown mantled by Jesse Sands of the Kalahari-type.

Soils The limited information available suggests that the soils are either vertisols or clay soils with vertic properties. The soils sampled at the edge of the unit were imperfectly to moderately well-drained, dark brown to dark grey fine-grained sandy clay or clay vertisols. They are calcareous, deeply cracked when dry and locally sodic. They classify as 3S (Zimbabwe), Entic Pellusterts or Vertic Ustropepts (Soil Taxonomy) and Eutric Vertisols or Vertic Cambisols (FAO/UNESCO/ISRIC).

Natural vegetation Timberlake and Mapaure (1992) describe the vegetation as mainly *Colophospermum mopane – Terminalia stuhlmannii* woodland at a height of 8-12 m. Associated species include *Terminalia prunioides, Kirkia acuminata, Ximenia americana, Erythroxylum zambesiacum, Acacia nilotica* and *A. nigrescens.*

Land use The edge of the unit near Musengezi is cultivated. Otherwise, the unit does not appear to be used.

Land capability The unit is probably an association of Class MII, MIII, MIV and MIVw land.

Irrigability The unit is probably an association of Class B and Class C suitability.

Erosion Accelerated erosion is not likely to be a problem under the relatively undisturbed woodland.

Development potential Local farmers claim that, with adequate rainfall, the soils are productive and are particularly suited to white sorghum and cotton. Hawkins Associates (1982) note that the unit provides palatable and nutritious grazing, mainly short, fine *Eragrostis* and *Aristida* species and propose part of the area as suitable for designation as a National Park.

Typical Profile Description Land Unit D1

Profile number:	96-GG-86 described on 3 December 1986. Auger boring.
Location:	Road junction 3 kilometres southeast of Musengezi school, Muzarabani CL, Centenary District. Map reference UT 0016.
Site:	Almost flat, 1-2% slope. Few patches of surface stones. Several deep cracks and holes which have opened up after rain.
Vegetation/land use:	Short fallow, adjacent to disturbed mopane woodland with minor *Acacia* spp.
Parent material:	Possibly old alluvium.
Erosion:	No evidence of soil loss recorded.
Land capability:	Class MII.
Profile irrigable value:	borderline 2-3.
Soil classification:	3B (Zimbabwe) Entic Pellustert (Soil Taxonomy) Eutric Vertisol (FAO/UNESCO/ISRIC)
0-16 cm	Black (10YR 2/1m), clay.
16-36 cm	Dark grey (5Y 4/1m), fine sandy clay.
36-78 cm	Dark grey (5Y 4/1m), fine sandy clay.
78-113 cm+	Dark grey (5Y 4/1m), fine sandy clay.

ANALYSIS PROFILE 96-GG-86

Depth (cm)	0-15	20-35	50-65	90-105
Lab No.	V2105	V2106	V2107	V2108
DM %	92.9	92.8	93.5	93.1
Texture	C	fSaC	fSaC	fSaC

Gravel %	0	0	0	0
Coarse Sand %	2	2	4	3
Medium Sand %	5	6	7	6
Fine Sand %	32	38	38	37
Silt %	16	11	12	10
Clay %	45	43	39	45
pH ($CaC1_2$)	6.8	7.0	7.1	7.2
pH (water)	0	0	7.8	7.9
Carbonates %	0.0	0.1	0.2	0.6
EX Ca (me %)	34.0	36.9	37.2	53.0
Water sol. Ca (me %)	0	0	0.1	0.1
EX Mg (me %)	11.5	12.4	13.5	15.0
Water sol. Mg (me %)	0	0	0	0
EX Na (me %)	0.13	2.37	4.28	4.30
Water sol. Na (me %)	0	0	0.29	0.32
EX K (me %)	1.72	1.51	0.86	0.73
Water sol. K (me %)	0	0	0.1	0
TEB (me %)	47.4	53.2	55.8	73.0
CEC (me %)	42.6	39.1	36.6	42.2
Base Sat %	100	100	100	100
E/C	95.1	91.6	93.4	94.4
S/C	95.1	91.6	93.4	94.4
ESP	0.3	6.1	10.9	9.4
EKP	4.0	3.9	2.3	1.7

LAND UNIT D2

General description This unit occurs in the Upper Zambezi Valley region where it forms a basin drained by the Sanyati, Ume and Sengwa Rivers. Part of the Pliocene erosion surface, it forms an irregular pediplain mainly almost flat to gently undulating but with local areas of marked dissection (Lister, 1987). It is extensive throughout the northern half of Gokwe CL and extends into Sanyati CL. The altitude range is 650-900 m above sea level. This unit occurs in Natural Regions IV and V, Agroclimatic Zones 3 and 4 and has an area of 3 000 km^2.

Geology The main rock type is Madumabisa Mudstone of the Lower Karoo. There are several outliers of Upper Karoo sediments and outcrops of arenaceous members of the Lower Karoo sequence. There can also be superficial deposits of unconsolidated sand probably derived from erosion products of Upper Karoo sediments.

Soils The residual soils derived from mudstone are moderately well- to well-drained, moderately shallow, sandy clay loams to clays over greyish brown sometimes calcareous sandy clays or clays. Many of the soils are chemically sodic but do not have a natric B horizon. In most cases the exchangeable sodium appears to be limited to the mudstone parent material. Some soils show evidence of alluvial origin and have a lower clay content but higher ESPs. Other associated soils, derived from arenaceous deposits, are under jesse bush and show the characteristic properties, in soils supporting this vegetation type, of base depletion and extreme acidity in the subsoil. A few jesse-bush soils are fairly heavy-textured, derived from burnt coal of the Hwange Main Seam (Broderick, 1991). The mudstone soils are classified as 4M or, locally, 8N and a few are borderline 3S (Zimbabwe). They correlate with Ustropepts and Dystropepts (Soil Taxonomy) and Cambisols (FAO/UNESCO/ISRIC).

Natural vegetation The vegetation comprises an extensive area of well-grown *Colophospermum mopane* woodland with few other species. There are also scattered small areas of jesse bush and mixed woodland.

Land use Large parts of the unit are inaccessible by road and appear to be unused. However, much of the land recently cleared for cultivation in Gokwe CL, mainly for cotton and subsistence maize, is in this unit and it is likely to remain a focus for settlement, controlled or otherwise.

Land capability Of the 26 sites described, seven are Class MII, eleven are Class MIII, three are Class MIV and five are Class VI.

Irrigability Topographic constraints are few and many of the soils appear suitable for irrigation. A more detailed survey is required to assess the suitability of particular areas. There are several artesian wells within the unit and this supply deserves investigation as a source of water for domestic and irrigation purposes.

Erosion Soil erosion is not a widespread problem but can be locally severe including areas under relatively undisturbed mopane woodland. Soils with vertic properties on moderate slopes and some of the lower-slope sodic soils are particularly prone to erosion.

Development potential This is an important unit in Gokwe District subject to considerable recent land clearing and settlement. Although mopane woodland is difficult to clear by cutting, it is susceptible to fire and large areas are being rapidly cleared by this means. A more detailed study is required to establish its agricultural potential together with concomitant hazards of use. Cotton is being successfully grown, particularly around Nemangwe.

Typical Profile Description Land Unit D2 – Madumabisa Mudstone

Profile number:	122-GG-88 described on 24 June 1988. Auger boring.
Location:	At junction on the Madziwadzido to Chereya road, Gokwe CL, Gokwe District. Map reference PL 6555.
Site:	Near crest in gently undulating terrain with 1%-3% slopes. Well-structured topsoil of permeable peds, mobile underfoot. Superficially cracked with a few deeper cracks.
Vegetation/land use:	Mopane woodland, trees 12 m high and 10-20 m apart. 90% short dry grass cover. Surrounding mosaic of cultivated land cleared since May 1982 (air photos). Some winter ploughing in progress at time of survey.
Parent material:	Lower Karoo Madumabisa Mudstone.
Erosion:	None evident.
Land capability:	Class MII.
Profile irrigable value:	2.
Soil classification:	4M (Zimbabwe) Vertic Ustropept (Soil Taxonomy) Vertic Cambisol (FAO/UNESCO/ISRIC)
0-15 cm	Dark greyish brown (10YR 4/2m) heavy clay; dry.
15-64 cm	Dark greyish brown (2.5Y 4/2m) heavy clay; few carbonate nodules; slowly permeable; slightly moist.
64-108 cm	Dark greyish brown (2.5Y 4/2m) heavy clay; few carbonate nodules; slowly permeable; slightly moist.
108-130 cm	Greyish brown (2.5Y 5/2m) heavy clay; weathered mudstone; common coarse brownish yellow mottles; slowly permeable; dry.

ANALYSIS PROFILE 122-GG-88

Depth (cm)	0-15	30-45	75-90	110-125
Lab No.	X1886	X1887	X1888	X1889
DM %	91.9	91.3	91.5	92.4
Texture	C	C	C	C
Gravel %	0	12	11	0
Coarse Sand %	3	3	2	10
Medium Sand %	3	2	1	4
Fine Sand %	11	9	7	8
Silt %	19	19	19	22
Clay %	65	67	71	56
pH ($CaCl_2$)	7.4	7.4	7.2	6.2
Carbonates %	0.0	0.0	0.0	0.0
EX Ca (me %)	33.4	34.8	30.8	0.9
EX Mg (me %)	3.7	4.3	3.6	0.7
EX Na (me %)	0.13	0.69	2.47	0.15
EX K (me %)	3.05	0.94	0.96	0.76
TEB (me %)	40.3	41.7	37.9	2.1
CEC (me %)	49.2	48.8	49.7	2.1
Base Sat %	82	86	76	100
E/C	76.0	72.4	70.5	3.8

S/C	62.2	62.0	53.7	3.8
ESP	0.3	3.5	5.0	7.1
EKP	6.2	1.9	1.9	35.4

Typical Profile Description Land Unit D2 – jesse-bush soil on burnt coal

Profile number:	136-GG-88 described on 29 June 1988. Auger boring.
Location:	By veterinary fence, Gokwe CL, Gokwe District. Map reference PL 9463.
Site:	Strongly undulating with common rock outcrops. Site at low point with slightly deeper soil. Patches of light red, hard, crusted, bare soil.
Vegetation/land use:	Thick jesse bush, very prominent on air photos. Sparse grass under a tangle of *Combretum celastroides, C. elaeagnoides, Teclea rogersii, Strophanthus kombe* and emergent *Entandophragma caudatum* and *Diospyros quiloensis.*
Parent material:	Lower Karoo Hwange Main Seam coal which has burnt after exposure.
Erosion:	None evident.
Land capability:	Class MIV.
Profile irrigable value:	4.
Soil classification:	7M (Zimbabwe) Ustoxic Dystropept (Soil Taxonomy) Dystric Cambisol (FAO/UNESCO/ISRIC)
0-15 cm	Yellowish red (5YR 5/6m) medium sandy clay loam.
15-37 cm	Reddish yellow (5YR 6/8m) medium sandy clay.
37-52 cm	Red (2.5YR 4/8m) coarse sandy clay loam; sandstone parent material.
52 cm+	Limit of penetration by auger.

ANALYSIS PROFILE 136-GG-88

Depth (cm)	0-15	15-30	37-52
Lab No.	X1940	X1941	X1942
DM %	98.5	97.8	98.1
Texture	mSaCL	mSaC	cSaCL
Gravel %	0	0	6
Coarse Sand %	9	11	18
Medium Sand %	18	16	14
Fine Sand %	24	19	24
Silt %	15	13	13
Clay %	34	41	30
pH ($CaC1_2$)	4.1	3.9	3.9
Carbonates %	0	0	0
EX Ca (me %)	0.7	0.3	0.1
EX Mg (me %)	0.6	0.3	0.1
EX Na (me %)	0.04	0.04	0.04
EX K (me %)	0.97	0.47	0.51
TEB (me %)	2.3	1.2	0.8
CEC (me %)	4.0	4.3	3.7
Base Sat %	56	28	22
E/C	11.8	10.3	12.4
S/C	6.6	2.8	2.7
ESP	1.0	1.0	1.1
EKP	24.3	11.1	13.7

LAND UNIT D3

General description This unit takes the form of gentle dome-shaped elevations rising above Land Unit D2 in the Upper Zambezi Valley region. The largest example of this unit is known as the Sabara Plain in northwest Gokwe CL and is also found in Busi CL, Binga District. It occurs at about 750 m elevation with slope maximums of 3% to 5%, in Natural Region IV, Agroclimatic Zone 3 and has an area of 660 km^2.

Geology Madumabisa Mudstone of the Lower Karoo underlies this unit, probably the K5e lithological subdivision of the mudstones. It is relatively resistant and contains large septarian nodules of limestone (Bennett *et al.*, 1983).

Soils The soils of this unit are dark grey to very dark greyish brown, moderately deep, moderately well-drained heavy clay vertisols. These merge with the surrounding vertic clay soils under mopane in Land Unit D2. They are similar to the basalt-derived vertisols of Land Unit E7 but are deeper, better drained and calcareous. They classify as 3S (Zimbabwe), Chromusterts and Pellusterts (Soil Taxonomy) and Eutric Vertisols (FAO/UNESCO/ISRIC).

Natural vegetation The area is a grassland consisting of the grasses *Ischaemum afrum, Dichanthium papillosum, Setaria incrassata, Brachiaria eruciformis* and *Sorghastrum* sp. Occasional shrubs include *Colophospermum mopane, Dalbergia melanoxylon* and *Acacia nilotica* (Timberlake *et al.*, 1991).

Land use There are a very few patches of cotton cultivation. It is otherwise unused but appears to be burnt periodically.

Land capability The unit is mainly Class MIII owing to the majority of slopes being greater than 2%.

Irrigability The unit is an association of Class B and Class C land.

Erosion There is no observable damage at present but there is an above-average hazard. Vertisols are susceptible to erosion even on slight slopes.

Development potential The potential is difficult to assess. It is primarily a grazing resource but may have a potential for cotton production.

Typical Profile Description Land Unit D3

Profile number:	120-GG-88 described on 23 June 1988. Auger boring.
Location:	Sabara Plain, 5 km east of the Sengwa-South coal deposits. Gokwe CL, Gokwe District.
Site:	Mid-slope about 4%. Extensive, wide surface cracking. Thin, friable platy surface.
Vegetation/land use:	Grassland, 95% grass cover.
Parent material:	Lower Karoo Madumabisa Mudstone.
Erosion:	None evident.
Land capability:	Class MIII.
Profile irrigable value:	1.
Soil classification:	3S (Zimbabwe) Entic Chromustert (Soil Taxonomy) Eutric Vertisol (FAO/UNESCO/ISRIC)
0-19 cm	Dark greyish brown (2.5Y 4/2m) clay; few <1 cm moderately hard to hard carbonate nodules.
19-67 cm	Dark greyish brown (2.5Y 4/2m) clay; few <1 cm moderately hard to hard carbonate nodules.
67-111 cm	Very dark greyish brown (2.5Y 3/2m) clay; few <1 cm moderately hard to hard carbonate nodules.
111-140 cm+	Light olive grey (5Y 6/2m) clay; common coarse yellowish brown mottling along old root channels.

ANALYSIS PROFILE 120-GG-88

Depth (cm)	0-15	35-50	80-95	115-130
Lab No.	X1878	X1879	X1880	X1881
DM %	91.2	91.1	90.8	99.0
Texture	C	C	C	C
Gravel %	0	1	0	14
Coarse Sand %	2	1	4	8
Medium Sand %	2	1	3	7
Fine Sand %	13	9	11	15
Silt %	21	20	18	22
Clay %	63	69	64	47
pH ($CaCl_2$)	74.4	7.5	7.4	5.2
EX Ca (me %)	35.0	25.4	68.9	40.1
EX Mg (me %)	7.3	4.9	8.4	63.0
EX Na (me %)	0.11	0.61	3.08	4.44

EX K (me %)	2.19	0.92	2.20	0.73
TEB (me %)	44.6	31.8	42.9	27.4
CEC (me %)	53.4	33.7	42.9	27.4
Base Sat %	84	95	100	100
E/C	84.6	49.1	66.7	58.4
S/C	70.8	46.6	66.7	58.4
ESP	0.2	1.8	7.2	16.2
EKP	4.1	2.7	5.1	2.7

Group U – Land units on alluvium

LAND UNIT U1

General description The unit forms a discontinuous zone of bajada-type alluvial fans at the foot of the Zambezi Escarpment in the Mid Zambezi Valley region. The landform is almost flat to gently undulating and is moderately dissected by well-incised drainage lines. The altitude range is 400-700 m above sea level. The unit has been described by Hawkins Associates (1982) in the Mid Zambezi Valley and by Barrett *et al.* (1991) in Chiswiti CL. It occurs in Natural Region IV, Agroclimatic Zone 3 and has an area of 580 km^2.

Geology The unit comprises a deposit of alluvium more or less influenced by colluvium and probably only a few metres thick, overlying calcareous conglomerates, sandstones and siltstones of the Kadzi Beds.

Soils The soils are variable in detail over short distances but usually conform to the general description of well-drained, moderately shallow to deep, fine-grained loamy sands and sandy loams over brown to yellowish red sandy loams and sandy clay loams which are usually calcareous. Depositional characteristics such as stratification are not present probably through the homogenising activities of soil fauna and pedogenic processes. They are classified as 4U or 4C (Zimbabwe), Ustropepts or Haplustalfs (Soil Taxonomy) and Cambisols or Luvisols (FAO/UNESCO/ISRIC).

Natural vegetation Much of the natural woodland has been cleared throughout the unit. Shade and fruit trees remaining in cultivated or fallow areas include *Cordyla africana, Sclerocarya birrea, Tamarindus indica* and *Ziziphus mauritiana*. Mopane is frequently absent but appears on some interfluve ridges where the Kadzi Beds are exposed or on some of the heavier-textured soils.

Land use This unit incorporates some of the most intensively used land below the Zambezi Escarpment. The proportion of arably disturbed land ranges from approximately 40% in Darwin District to 20% in Guruve District. The main crops are maize, sorghum, pearl millet and cotton with minor groundnuts and sunflower. The unit includes the Agricultural Development Authority's Mzarabani estate which produces, as main crops, irrigated cotton and beans on some 600 ha.

Land capability Most of the described sites are Class MII. There are some local occurrences of stony, dissected Class MIII, MIV or VI land.

Irrigability A high proportion of the unit has deep, fertile, permeable soils and a topography well suited to irrigation. Water supply is the principal constraint to further development.

Erosion Streambank erosion is common resulting from both bank-slope cultivation and occasional high discharges during the wet season. On the interfluves, the effects of erosion are slight. Barrett *et al.* (1991) discuss the wider issue of land degradation in this type of environment.

Development potential The unit has a moderately high rainfall (700-800 mm) and good potential for rainfed cropping. This can be complemented by small-scale irrigation schemes assuming sources of adequate, good

quality water are located. The hydrogeological results obtained by Aquater (1984) indicate that groundwater extraction for irrigation development is feasible over parts of the unit.

Typical Profile Description Land Unit U1

Profile number:	GG 306 described on 23 April 1990. Profile pit – source of data is Barrett *et al.* (1991).
Location:	Near Chipfungwe River, Chiswiti CL, Darwin District. Map reference US 639 994.
Site:	1% – 2% slope on river terrace component of alluvial fan. 490 m above sea level.
Vegetation/land use:	20-year fallow comprising wooded or bushed grassland. Species include *Ziziphus mauritiana, Acacia nilotica, Cassia abbreviata, Lonchocarpus capassa, Combretum elaeagnoides, C. mossambicensis* and *Azanza garckeana.*
Parent material:	Old alluvium.
Erosion:	No significant soil degradation.
Land capability:	Class MII.
Profile irrigable value:	1.
Soil classification:	4U (Zimbabwe) Typic Haplustalf (Soil Taxonomy) Calcic Luvisol (FAO/UNESCO/ISRIC)
0-17 cm	Very dusky red (2.5YR 2.5/2m) and very dark greyish brown (10YR 3/2d), fine loamy sand; weak medium and coarse subangular blocky structure; non sticky, non plastic, soft to slightly hard dry and very friable moist consistency; no cutans observed; non calcareous; common medium pores; termite activity; abundant fine roots; well drained, very permeable to applied water; clear smooth boundary to:
17-40 cm	Dark reddish brown (5YR 3/2m) and reddish brown (5YR 4/4d) fine sandy loam; weak to moderate medium angular and subangular blocky structure; non sticky, non plastic, soft dry and very friable moist consistency; no cutans observed; non calcareous; abundant medium and fine pores; termite activity; abundant fine roots; well drained; very permeable to applied water; clear smooth boundary to:
40-62 cm	Dark reddish brown (5YR 3/2m) and reddish brown (5YR 4/4d), fine sandy loam; weak coarse angular blocky structure; slightly sticky, slightly plastic, slightly hard dry and very friable moist consistency; no cutans observed; fine powdery carbonates on ped faces; abundant medium and fine pores; termite activity; abundant fine roots; well drained, very permeable to applied water; gradual smooth boundary to:
62-105 cm	Dark reddish brown (5YR 3/4m) and reddish brown (5YR 4/4d) fine sandy clay loam; moderate to weak medium angular blocky to prismatic structure; few vertical cracks; slightly sticky, slightly plastic, hard dry and friable moist consistency; few thin patchy cutans on vertical ped faces; fine powdery coatings of carbonates on ped faces; common fine and medium pores; termite activity; common fine, medium and coarse roots; well drained, very permeable to applied water; clear smooth boundary to:
105-150 cm+	Dark brown (7.5YR 4/4m) and brown (7.5YR 5/4d) fine sandy clay loam; weak medium angular blocky to prismatic structure; slightly sticky, slightly plastic, hard dry and friable moist consistency; very few thin patchy cutans on ped faces; 15% irregular carbonate nodules up to 5 mm diameter with coatings of powdery carbonate on ped faces; few medium pores; common to few medium and fine roots; well drained.

REMARKS: No evidence of depositional origin in profile; old alluvium subjected to pedogenic processes. Present river approximately 15 m below level of profile.

ANALYSIS PROFILE GG-306

Depth (cm)	0-17	17-40	40-62	62-105	105-150
Lab No.	9758	9759	9760	9761	9762
pH 1:5 H20	7.6	7.5	8.1	8.3	8.5
pH 1:5 CaC12	6.7	7.2	7.6	7.7	7.8
EX Na	0.1	0.0	0.1	0.1	0.2
EX. K	0.8	0.0	0.4	0.6	0.4
EX. Mg	2.3	2.2	2.4	3.9	6.2
EX Ca	10.7	12.3	33.8	>50	>50
Ca Carbonate	0.0	0.0	1.0	3.5	8.5
TEB	13.9	14.5	36.7	>54.6	>56.8
CEC	12.7	14.7	17.1	20.8	15.8
Base Sat	100	99	100	100	100
Organic C	0.6	0.32	0.28	0.26	0.21
Available P	4	1	1	1	1
CEC/100g Clay	106	105	100	87	79
Stones %	0	0	0	0	0
2000-500µm	2	3	6	7	5
500-250µm	11	9	12	12	11
250-100µm	42	36	27	21	30
100-50µm	20	22	21	16	16
50-20µm	10	12	11	11	10
20-2µm	3	4	6	9	8
<2µm	12	14	17	24	20

LAND UNIT U2

General description This unit comprises the floodplains and terraces of the larger rivers.It is nowhere extensive, but is best represented in the Mid Zambezi Valley and the Sanyati – Sengwa Basin. The landform is almost flat but may be separated into terraces at slightly different elevations showing a micro-topographical variation in level of 1 m amplitude with about 30 m between lows. Most of the drainage channels are well incised but occasional high discharges cause brief periods of flooding on the lower terraces. This unit may occur in all Natural Regions and Agroclimatic Zones and has an area of 3 760 km^2.

Geology This unit comprises old to recent alluvium of varying composition but mainly moderately sandy.

Soils These are usually moderately well- to well-drained, moderately deep to deep, fine-grained sandy loams over dark brown to dark yellowish brown sandy loams or sandy clay loams. They can be calcareous, sodic or have a high clay content with vertic properties but, in general, they are not as variable as might be expected of soils with a depositional origin. They classify as 4U (Zimbabwe), Typic or Fluventic Ustropepts (Soil Taxonomy) and Eutric Cambisols (FAO/UNESCO/ISRIC). A few of the more recent alluvial deposits may be stratified and classify as Aquic Ustifluvents (Soil Taxonomy) and Eutric Fluvisols (FAO/UNESCO/ISRIC).

Natural vegetation In areas unaffected by cultivation the vegetation types range from dense woodland or woodland thicket to wooded grasslands on the more active, less well-drained floodplains. *Faidherbia albida* and *Acacia tortilis* are characteristic trees of the more open woodlands.

Land use The unit is under pressure being a focus of recent clearing for cropping, largely a result of a rapid increase in population, particularly in the Mid Zambezi Valley. At the time of survey, 15% of the unit was estimated to be arably disturbed, although cultivated areas tend to be concentrated near points of road access.

Land capability There are few soil and slope constraints and the majority of sites are classified as MII.

Irrigability There are many small blocks suitable for irrigation, mainly Class B.

Erosion There is a high risk of stream-bank erosion caused by peak flows following large intense rainstorms. To a large extent, this is a natural process but it is exacerbated by the removal of riparian vegetation. There is little evidence of serious erosion at present.

Development potential This unit, having both good soils and a favourable landform, has a high agricultural potential, the more so since it is commonly close to water for domestic purposes and for limited irrigation.

Typical Profile Description Land Unit U2

Profile number:	41-GG-87 described on 17 June 1987. Auger boring.
Location:	South of the Agricultural Development Authority's Mushumbi Pools cotton estate on road to Chitsungo Business Centre, Dande CL, Guruve District. Map reference TT 3202.
Site:	Upper river terrace, almost flat.
Vegetation/land use:	Cotton regrowth in unusually moist soil. Northern edge of large cultivated area. Some low, scattered trees including *Acacia* spp., *Colophospermum mopane* and *Diospyros kirkii*.
Parent material:	Old alluvium. Nearby quarry exposes >3 metres of alluvium becoming coarse and pale with pebble beds at depth.
Erosion:	None evident.
Land capability:	Class MII.
Profile irrigable value:	1.
Soil classification:	4U (Zimbabwe) Typic Ustropept (Soil Taxonomy) Chromic Cambisol (FAO/UNESCO/ISRIC)
0-20 cm	Dark brown (10YR 3/3m) fine sandy loam.
20-58 cm	Brown (7.5YR 4/4m) fine sandy loam.
58-98 cm	Strong brown (7.5YR 5/6m) fine sandy loam.
98-115 cm+	Brownish yellow (10YR 6/6m) fine sandy loam.

ANALYSIS PROFILE 41-GG-87

Depth (cm)	0-15	30-45	65-80	100-115
Lab No.	W0809	W0810	W0811	W0812
DM %	98.4	98.5	97.4	97.5
Texture	fSaL	fSaL	fSaL	fSaL
Gravel %	0	0	0	0
Coarse Sand %	2	3	4	2
Medium Sand %	14	13	15	12
Fine Sand %	64	57	54	55
Silt %	10	12	10	12
Clay %	11	15	17	19
pH ($CaCl_2$)	5.4	5.4	5.8	6.0
Carbonates %	0	0	0	0
EX Ca (me %)	5.4	6.6	8.4	9.7
EX Mg (me %)	3.4	3.9	4.6	4.9
EX Na (me %)	0.04	0.06	0.08	0.10
EX K (me %)	0.22	0.18	0.27	0.27
TEB (me %)	9.1	10.7	13.2	14.9
CEC (me %)	9.3	11.5	13.2	16.7
Base Sat %	98	93	100	90
E/C	82.9	75.8	75.5	85.6
S/C	81.3	70.3	75.5	76.6
ESP	0.4	0.5	0.6	0.6
EKP	2.4	1.6	2.0	1.6

LAND UNIT U3

General description This unit occurs in the northern part of the Mid Zambezi Valley region in Guruve, Centenary and Darwin Districts and has the form of a flat alluvial plain. It occurs adjacent to the alluvial terraces and plains (Land Unit U2) of the present drainage network and appears to represent old depositional areas related to a former drainage system. In places, surface

drainage is poor and small pans are present. The unit occurs in Natural Region IV, Agroclimatic Zone 4 and has an area of 470 km².

Geology Old alluvium with a moderately high clay content partially overlying siltstones and sandstones of the Upper Jurassic Kadzi Beds.

Soils The soils are imperfectly to well-drained, moderately shallow to deep, fine-grained sandy loams to clays over brown or dark brown calcareous fine-grained sandy clay loams to clays often with a hard consistence. Some of the soils are chemically sodic but do not have a natric B horizon. A few of the soils with a high clay content are vertisols. Similar soils in the Shire Valley, Malawi, under mopane are described by Mitchell (1975) who emphasises their compactness. Most of the soils classify as 4U, a few are 8N or 3S (Zimbabwe). According to the international systems they are mainly Typic Ustropepts or Haplustalfs (Soil Taxonomy) and Typic/Calcic Luvisols or Eutric Cambisols (FAO/UNESCO/ISRIC).

Natural vegetation Much of this unit comprises tall mopane woodland where mopane is the dominant, sometimes exclusive, tree. Sparse and stunted mopane occurs under severely restricted drainage conditions around pans or where the topsoil has been stripped by erosion to expose a sodic, relatively impermeable subsoil.

Land use West of Mukumbura and Katarira, in Darwin District, about 20% of the unit is arably disturbed and new settlement appears to be increasing rapidly. North of Muzarabani in Centenary District, the unit has not been cleared to the same extent for cultivation but has been commercially logged in recent years. In Guruve District, about 5% of the unit was arably disturbed at the time of survey. This includes the Mushumbi Pools Project, established by 2nd Brigade on 250 ha cleared from tall mopane woodland in 1983 and partly used for rainfed cropping.

Land capability The majority of sites described are Class MII. A few are downgraded to Class MIVw (seasonal wetness) or Class VIf (sodicity).

Irrigability This unit comprises an association of Irrigability Class B and Class C land. Some of the strongly sodic soils may be unsuitable for conventional irrigation.

Erosion In the less well-drained areas, there is a surface pattern of small, shallow and indistinct drainage lines which give rise, through the action of runoff, to localised scouring of the topsoil. Barrett *et al.* (1991) have observed in Chiswiti CL that soils in this unit under mopane woodland usually show more evidence of erosion than similar soils cleared of mopane and now being cultivated.

Development potential The potential appears moderate to high for dryland and irrigated farming although inadequate drainage and sodicity may be a local limitation. Some of the mopane woodland east of Mushumbi Pools is sufficiently attractive to justify conservation (Timberlake *et al.*, 1991).

Typical Profile Description Land Unit U3

Profile number:	GG 305 described on 23 April 1990. Profile pit - source of data is Barrett *et al.* (1991).
Location:	Near Chiutsi, Chiswiti CL, Darwin District. Map reference US 623 997.
Site:	Alluvial plain, almost flat, 1% slope, wide drainage spacing. 500 m above sea level.
Vegetation/land use:	*Colophospermum mopane* woodland associated with *Acacia nilotica* and *Combretum apiculatum*. There are also scattered trees of *Sclerocarya birrea, Kirkia acuminata* and *Adansonia digitata*. Grass cover at the time of survey was poorly developed. Never cultivated but disturbed by wood cutting and burning.

Parent material:	Old alluvium.
Erosion:	Moderately severe to severe sheet and rill erosion. The adjacent fallow and cultivated fields showed evidence of only very slight to slight erosion.
Land capability:	Class MIII.
Profile irrigable value:	1.
Soil classification:	4U (Zimbabwe) Typic Haplustalf (Soil Taxonomy) Calcic Luvisol (FAO/UNESCO/ISRIC)
0-1 cm	Very dark greyish brown (10YR 3/2m) and brown (10YR 5/3d) fine sand; loose, single grained; abrupt smooth boundary to:
1-4 cm	Very dark greyish brown (10YR 3/2m) and dark brown (7.5YR 3/2d) fine to medium sand; apedal structure; non sticky, non plastic; soft dry and very friable moist consistency; no cutans observed; non calcareous; distinctive high porosity, abundant, fine, medium and coarse pores; very few fine roots; well drained; abrupt smooth transition to:
4-28 cm	Dark reddish brown (5YR 2.5/2m) and dark brown (7.5YR 3/2d) fine sandy loam(+); moderate to strong, medium prismatic, breaking to medium and coarse angular blocky structure; slightly sticky, plastic, hard dry and friable moist consistency; no cutans observed; non calcareous; abundant fine and medium pores; common medium roots; well drained; gradual smooth transition to:
28-66 cm	Dark reddish brown (5YR 3/4m) and reddish brown (5YR 4/4d) fine sandy clay loam; strong coarse prismatic, breaking to coarse angular blocky structure; sticky, plastic, hard to very hard dry and friable moist consistency, continuous thin clay cutans on vertical and horizontal ped faces; non calcareous; abundant fine and medium pores; common medium and fine roots; well drained; smooth gradual transition to:
66-104 cm	Dark brown (7.5YR 4/4m & d) fine sandy clay loam; moderate coarse prismatic, breaking to coarse angular blocky structure; slightly sticky, plastic, very hard dry consistency, few thin patchy cutans on vertical ped faces; very fine calcareous particles; abundant fine and medium pores; common fine and medium roots; well drained; clear smooth transition to:
104-150 cm+	Dark brown (7.5YR 4/4m & d) medium sandy loam; weak coarse and medium prismatic structure; slightly sticky, slightly plastic, soft dry, friable moist consistency; no cutans observed; few irregular hard carbonate concretions and finely divided carbonate; 15% fine gravel and rounded stones; common fine and medium pores; few fine and medium roots; well drained.

REMARKS: Possibly sodic but high porosity throughout indicates absence of dispersed clay. Alluvial origins as evidenced by rounded gravel in last horizon. Mopane roots predominate.

ANALYSIS PROFILE GG-305

Depth (cm)	0-4	4-28	28-66	66-104	104-150
Lab No.	9753	9754	9755	9756	9757
pH 1:5 H_2O	7.1	7.0	7.4	7.4	8.5
pH 1:5 $CaC1_2$	6.5	6.2	6.4	6.7	6.8
EX Na	0.1	0.2	0.3	0.3	0.3
EX. K	0.8	0.2	0.4	0.3	0.3
EX. Mg	1.8	5.4	5.8	6.0	4.2
EX Ca	6.2	11.9	13.9	16.9	41.3
Ca Carbonate	0.0	0.0	0.0	0.0	3.0
TEB	8.9	17.7	20.4	23.5	>46.1
CEC	7.1	17.5	19.4	22.5	15.0
Base Sat	100	100	100	100	100
Organic C	0.37	0.58	0.29	0.18	0.14
Available P	11	1	>0.5	>0.5	>0.5
CEC/100g Clay	118	92	84	102	115
Stones %	0	6	0	0	9

2000-500μm	4	6	8	7	16
500-250μm	18	16	16	17	17
250-100μm	36	27	28	27	30
100-50μm	22	16	13	14	11
50-20μm	11	11	8	8	6
20-2μm	3	5	4	5	7
<2μm	6	19	23	22	13

LAND UNIT U4

General description This unit is restricted to the Middle Save Valley region comprising about half of Musikavanhu Cl and a small part of Ndowoyo CL. The landforms include broad alluvial terraces and plains relating to the depositional history of the Save River as well as a pediment of alluvio-colluvium bordering the footslopes of the hills rising into the Eastern Highlands region. Drainage from the Eastern Highlands to the Save River is hindered by a natural levée and this has created a central drainage system of indistinctly connected pans running parallel to the main river and known as the Dakata or Nyautsa River. This unit occurs in Natural Region V, Agroclimatic Zone 5 and has an area of 430 km^2.

Geology Recent to old alluvium comprises this unit with some colluvial influence in the east.

Soils The alluvium has been the subject of many surveys and assessments from 1947 onwards (Ellis *et al.*, 1953), usually in connection with proposals for irrigation development. The most widespread soils are well-drained, deep, usually coarse-grained sandy loams over calcareous brown to red coarse-grained sandy clay loams and are thought to have a granitic provenance. Some of the levée soils are deep sands, a few may be stratified and most of the depression or pan soils are heavy-textured and sodic. The alluvio-colluvial soils bordering the eastern hills are often stony but have a finer-grained sand fraction. They are classified as 4U or 4C (Zimbabwe), Haplustalfs (Soil Taxonomy) and Luvisols (FAO/UNESCO/ISRIC).

Natural vegetation The natural vegetation, now largely removed, consists of a mosaic of *Colophospermum mopane* woodland alternating with a mixed *Acacia* woodland. *Hyphaene natalensis* occurs on recent alluvium with a high seasonal watertable close to the Save River. Large specimens of *Xanthocercis zambesiaca* are scattered throughout the farmland, providing shade and edible fruit.

Land use A high proportion of the unit, probably exceeding 70%, is arably disturbed.

Land capability The soils under *Acacia* are usually more friable, lighter in texture and more water-receptive than the soils associated with mopane and have a higher capability for dryland cropping.

Irrigability Areas of deep soils without drainage impedence, constituting about 30% of the unit, are Class A. Test pumping of groundwater of high bicarbonate content for irrigation trials at the Chibuwe settlement scheme was initiated in the early 1960s and groundwater use for rice cultivation on sodic soils (Class D) was considered at the same time. The area at Chibuwe under irrigation using water pumped from the Save River is reported as 370 ha (Advisory Committee on African Agricultural Production, 1961a).

Erosion Locally severe sheet and gully erosion is common on the eastern margins of the unit caused by runoff from the flanking hills.

Development potential The unit has a low potential as a dryland farming area owing to the paucity and unreliability of the rainfall. Irrigation provides the

best opportunities although the area competes with a number of others in this region for the supply of water from the Save River. Groundwater development and water harvesting of runoff from the hilly, higher rainfall zone to the east appear to be viable alternatives on a small scale.

Typical Profile Description Land Unit U4 – alluvio-colluvial soil

Profile number:	8-GG-91 described on 7 January 1991. Auger boring.
Location:	By main road, Musikavanhu CL, Chipinge District. Map reference VN 3641.
Site:	Near eastern edge of unit bordering hills rising to Chikore Mission. Almost flat, slope about 1% declining west towards the Save River. Altitude about 430 m above sea level.
Vegetation/land use:	Sorghum, patchy poor stand, wilting. Large cultivated area. Few *Adansonia digitata*.
Parent material:	Old alluvio-colluvium.
Erosion:	None observed.
Land capability:	AGRITEX classification not applicable in Natural Region V.
Profile irrigable value:	2.
Soil classification:	4C (Zimbabwe) Typic Haplustalf (Soil Taxonomy) Chromic Luvisol (FAO/UNESCO/ISRIC)
0-25 cm	Dark brown (7.5YR 3/4m) medium loamy sand; dry.
25-75 cm	Yellowish red (5YR 4/6m) medium sandy loam; slightly moist.
75 cm +	Auger penetration limited by stones.

ANALYSIS PROFILE 8-GG-91

Depth (cm)	0-25	25-75
Lab No.	Z1296	Z1297
DM %	98.6	97.6
Texture	mLS	mSaL
Clay %	3	12
Silt %	10	8
Fine Sand %	47	38
Medium Sand %	26	23
Coarse Sand %	15	18
Gravel %	2	3
pH ($CaCl_2$)	6.7	7.0
Carbonates %	0.0	0.0
EX Ca (me %)	5.4	8.6
EX Mg (me %)	2.0	4.7
EX Na (me %)	0.07	0.11
EX K (me %)	0.96	0.36
TEB (me %)	8.5	13.8
CEC (me %)	10.0	14.6
Base Sat %	85	95
E/C	361.3	122.3
S/C	308.7	115.6
ESP	0.7	0.8
EKP	9.6	2.5
Free Fe	1.69	2.20

Group R – Land units containing more than 50% non-arable land

LAND UNIT RE1

General description This unit extends northwestwards from the Mucheka Wakasunga Beta Range through Magondi and Umfuli CLs in Makonde District to Piriwiri CL in Hurungwe District. Most of the unit forms rolling to hilly terrain of the Middleveld region below 1 100 m but at the lowest elevations, bordering the Mupfure and Sanyati Rivers, it forms the edge of the Sanyati – Sengwa Basin. This unit occurs in Natural Regions III and IV, Agroclimatic Zone 3 and has an area of 1 830 km^2.

Geology The Lomagundi Group in Magondi CL includes quartzites and their arenaceous variants, usually forming ridges, dolomites and various

argillites. These are replaced westwards into Umfuli and Piriwiri CLs by the Piriwiri Group the beds of which are predominantly phyllites and greywacke with a northeasterly strike. Alluvium is a minor constituent throughout the unit.

Soils Most of the soils are shallow or very shallow associated with steep slopes. The deeper soils are mainly confined to valleys and vary according to the nature of the parent material. The soils over dolomite are non-calcareous and acid with red, fine-grained sandy loam subsoils which may contain dolomite boulders. The soils constitute the accumulation of the non-carbonate content of the parent rock. They are highly leached, have a sand or loamy sand topsoil and are of very variable depth, often forming small pockets of deep soil surrounded by a rugged surface, or lapiés, of jagged dolomite. Similar soils have been described in Land Unit MG1.

The quartzite-derived soils are usually extremely or very shallow. Where depth is greater, the soils are remarkably similar to the dolomite profiles owing to the common origin of their sand fraction.

The Umfuli and Piriwiri phyllite and minor greywacke have developed for the most part a very shallow soil cover on fairly steep slopes. There is a scattered distribution of deeper soils on gentler slopes. These are subject to capping or crusting encouraged by the high fine sand and silt contents in the topsoil. Silt content normally exceeds 20% and surface textures are either fine-grained sandy loam, loam, clay loam or silty clay loam. Some of these textures are unusual in Zimbabwean soils.

According to Zimbabwean classification, the soils comprise an association of 2, 5S and 5AE with minor 4U and 5M. The international systems allocate them to Ustropepts and Ustorthents (Soil Taxonomy) and Leptosols, Regosols and Cambisols (FAO/UNESCO/ISRIC).

Natural vegetation Most of the unit is under a *Brachystegia boehmii – Julbernardia globiflora* woodland. Below about 1 000 m elevation *Colophospermum mopane* becomes common often replacing *B. boehmii* on argillaceous rocks. *B. glaucescens* is restricted to rocky hills.

Land use In Magondi CL about 15% of the unit is arably disturbed and about half of this is cultivated in any one year. There appears to be very little scope for expansion. Maize and cotton are important crops and there are many small irrigated gardens at Zumbara based on perennial spring flow. Farther west, the proportion of arably disturbed land decreases and is probably no more than 5% to 10% in Umfuli and Piriwiri CLs. Agriculture in Magondi and Umfuli is reviewed by Gubbins and Prankerd (1983).

Land capability An AGRITEX land capability estimate for Magondi CL is 20% arable (Classes I to IV), 10% Class VI and 70% Class VII. The Robinson Commission (1961/62) estimated 8% of this CL as arable on the basis of similar criteria. In Umfuli and Piriwiri CLs the proportion of arable land is estimated as 10% to 15% of the unit.

Irrigability There are a few opportunities for small-scale developments using water from perennial springs or the Mupfure and Sanyati Rivers. Parts of the narrow alluvial terraces bordering the Washanje and Mupfure Rivers are suitable for irrigation.

Erosion The erosion hazard is very high. There is widespread evidence of severe sheet erosion even in areas under lightly disturbed woodland. This appears to be directly related to the prevalence of steep slopes and the tendancy of the silty soils to cap and seal thereby increasing the probability of surface runoff.

Development potential There is very limited arable potential. Grazing resources are moderate. ARDA (1982) has proposed a project to encourage controlled exploitation of natural woodland on non-arable land, for use mainly in the adjacent wood-deficient areas of Chirau and Zwimba. However, timber extraction should be accompanied by comprehensive conservation measures to protect the highly erodible soils in this unit.

Typical Profile Description Land Unit RE1 – soil derived from slaty phyllite

Profile number:	302-GG-88 described on 27 October 1987. Auger boring.
Location:	Umfuli CL. Map reference QL 8750.
Site:	6% convex slope but 10% short slopes in nearby valley head. 30%-50% stone cover of quartz and phyllite/slate in places; first auger hole restricted at 10 cm by stones. Mid-slope.
Vegetation/land use:	Maize during 1986-87 season. Common coppicing *Julbernardia globiflora*. Other trees include *Brachystegia boehmii, B. spiciformis, Acacia karoo* and *Diospyros* sp.
Parent material:	Piriwiri Group slaty phyllite with quartz inclusions.
Erosion:	Moderate rill and severe sheet erosion. Surface 85% bare.
Land capability:	Class MIV.
Profile irrigable value:	2.
Soil classification:	5S (Zimbabwe) Typic Ustropept (Soil Taxonomy) Chromic Cambisol (FAO/UNESCO/ISRIC)
0-11 cm	Brown to dark brown (7.5YR 4/4m), fine sandy loam.
11-58 cm	Yellowish red (5YR 5/6m), clay loam.
58 cm +	Many stones.

ANALYSIS PROFILE 302-GG-88

Depth (cm)	0-11	25-40
Lab No.	W2814	W2815
DM %	98.9	98.8
Texture	fSaL	CL
Gravel %	0	0
Coarse Sand %	2	8
Medium Sand %	8	8
Fine Sand %	44	24
Silt %	30	30
Clay %	15	30
pH ($CaC1_2$)	5.2	4.5
Carbonates %	0	0
EX Ca (me %)	2.2	0.9
EX Mg (me %)	1.8	2.9
EX Na (me %)	0.02	0.06
EX K (me %)	0.08	1.22
TEB (me %)	4.1	5.1
CEC (me %)	4.8	6.3
Base Sat %	86	80
E/C	31.5	21.4
S/C	27.0	21.4
ESP	0.4	1.0
EKP	1.7	19.2

LAND UNIT RE2

General description This unit occurs in the Southeast Lowveld region and comprises a slightly dissected, almost flat to undulating basalt plain. It is best developed in Machuchuta, Maramani and Masera CLs in Beitbridge District where the unit has been called the "Critical Basalt" area (Advisory Committee on African Agricultural Production, 1961b). It is an area that combines a particularly arid climate, Agroclimatic Zone 6, with very poor, stony, shallow soils. It is found in Natural Region V, Agroclimatic Zone 6 and has an area of 3 070 km^2.

Geology Upper Karoo basalt forms the geology of this unit.

Soils The soils are mainly well- to very well-drained, extremely to moderately shallow, dark brown to dark reddish brown, generally calcareous, gravelly clay loams to clays. There are minor occurrences of vertisols similar to Land Unit E8 and a few rocky hills and ridges. Most of the soils are considered to have an aridic soil moisture regime. They are classified as 2, 3B and 4E (Zimbabwe), Torriorthents, Haplargids and Torrerts (Soil Taxonomy) and Leptosols, Regosols, Calcisols and Vertisols (FAO/UNESCO/ISRIC). A typical profile description is not available for this unit.

Natural vegetation The woody cover is a low, open association of *Commiphora* spp., *Combretum apiculatum* and *Colophospermum mopane*. There are a few specimens of *Adansonia digitata* and its grotesque miniature, *Sesamothamnus lugardii*. The grass cover is very poor.

Land use The more favourable areas, usually along drainage lines, are used for sorghum cultivation and some small-scale irrigation is practised by the Shashe River but, overall, the unit is little used for cropping. The unit is primarily a grazing area.

Land capability The more favourable areas, with deeper vertic or alluvial soils in water-receiving areas, are suitable for sorghums and millets grown as subsistence crops. Most of the unit is unsuitable for cropping and is best suited to controlled extensive grazing.

Irrigability The deeper vertic and alluvial soils are well suited to irrigation but these are likely to constitute only about 5% of the unit. Small-scale irrigation from the Shashe River based on weirs and sand-abstraction methods appears to offer the best prospects.

Erosion The soils of the unit show evidence of severe scouring and loss of topsoil caused by sheet erosion but it is not clear from the results of a rapid survey how active this process is and to what extent livestock numbers are implicated.

Development potential The potential is very low, the unit probably having the poorest agricultural prospects amongst those described in this report. In common with the other CLs bordering Botswana and South Africa, many family heads are absent, in employment in the Transvaal or Bulawayo.

LAND UNIT RG1

General description This unit forms part of the Middleveld region between Mberengwa District and Bikita District. The landform comprises a dissected plateau with many prominent granitic rock outcrops of the bornhardt, whaleback and castle koppie types. The pediments separating the outcrops are planar to concave with slopes up to about 12%. The unit occupies high ground with a southeasterly aspect and receives a moderately high, reliable rainfall. It occurs in Natural Regions III and IV, Agroclimatic Zones 3, 4 and 5 and has an area of 1 070 km^2.

Geology The rocks are typically adamellites, granitic intrusions of the Basement Complex.

Soils The soils of the commonly narrow pediments between rock outcrops are well-drained, deep, medium- to coarse-grained loamy sands and sandy loams over, commonly abruptly, yellowish brown to red, medium- to coarse-grained sandy clay loams and sandy clays, rarely clays. They are usually paraferrallitic or orthoferrallitic. Associated soils, commonly in lower-slope positions, are greyish-surfaced medium- to coarse-grained sands over pale brown similar sands or loamy sands. The pediment soils classify as 6G and 7G

(Zimbabwe), Rhodic and Udic Kandiustalfs (Soil Taxonomy) and Haplic Lixisols and Acrisols (FAO/UNESCO/ISRIC).

Natural vegetation This is mainly miombo woodland at its most southerly extension. In particularly moist locations, such as sites receiving runoff from rock surfaces, it includes some forest species typical of the Eastern Highlands region. Bracken is commonly present. Other characteristic trees include *Parinari curatellifolia, Uapaca kirkiana, Erythrina lysistemon* and *Dodonaea viscosa*. There are several localities where *Toona ciliata* and *Jacaranda mimosifolia* have become naturalised.

Land use Most of the pediment slopes are arably disturbed and periodically cultivated. There are a few small plantations of *Eucalyptus* sp.

Land capability Slope is the major constraint. The maximum permissible slope in drier areas is 8% and in moister areas is 12%.

Irrigability The unit consists of an association of Class B land (slopes less than 5%) and Class C land (slopes between 5% and 8%).

Erosion Some of the lower slope profiles show evidence of depositional layering and it seems likely that extensive sheet wash occurs from time to time on the pediment slopes, probably following exceptionally heavy and prolonged rainfall.

Development potential There are opportunities for increasing dryland cropping production through measures to improve soil and moisture conservation. Rainwater harvesting and storage from rock surface runoff is particularly appropriate in this unit.

Typical Profile Description Land Unit RG1 – pediment, upper slope

Profile number:	206-GG-90 described on 2 September 1990. Profile pit.
Location:	6 km east of Mnene, below Mwembe Hill, Mberengwa CL, Mberengwa District. Map reference SN 9917.
Site:	Upper pediment slope, 7% planar slope. 100 m from base of large whaleback granitic rock outcrop. Contour ridging but no longer maintained and now ineffective.
Vegetation/land use:	Previous crop maize. Remnants of miombo woodland including *Brachystegia spiciformis, Julbernardia globiflora, Uapaca kirkiana, Parinari curatellifolia* and *Dodonaea viscosa*. The fern *Pteridium aquilinum* is common.
Parent material:	Granitic drift overlying *in situ* weathered material derived from adamellite.
Erosion:	Severe sheet and moderate rill erosion.
Land capability:	Class III.
Profile irrigable value:	2.
Soil classification:	6G (Zimbabwe) Typic Kandiustalf (Soil Taxonomy) Haplic Lixisol (FAO/UNESCO/ISRIC)
0-17 cm	Brown (7.5YR 4/4m) and light brown (7.5YR 6/4d) medium loamy sand; weak very fine to fine subangular blocky structure; soft, dry; few, angular quartz gravel; common fine and medium roots; clear, wavy boundary to:
17-55 cm	Yellowish red (5YR 5/6m) and reddish yellow (5YR 6/6d) medium sandy loam; very weak very fine to fine subangular blocky structure; slightly hard, dry; few, angular quartz gravel; few fine roots; clear, smooth boundary to:

55-117 cm	Red to yellowish red (4YR 4/8m) and light red to reddish yellow (4YR 6/8d) medium sandy clay; moderate fine and medium angular blocky structure; hard, dry; patchy distinct clay cutans on ped faces and in pores; few angular quartz gravel; few fine roots; gradual smooth boundary to:
117-175 cm	Red to yellowish red (4YR 4/8m) and light red to reddish yellow (4YR 6/8d) medium sandy clay; weak medium angular blocky structure; friable, moist; few fine roots.

Note: 0-55 cm appears to be alluvio-colluvium or "drift" overlying a residual kandic horizon.

ANALYSIS PROFILE 206-GG-90

Depth (cm)	0-15	15-55	55-117	117-175
Lab No.	Y4350	Y4351	Y4352	Y4353
DM %	99.4	99.7	98.2	98.3
Texture	mLS	mSaL	mSaC	mSaC
Clay %	6	11	38	38
Silt %	3	6	3	5
Fine Sand %	46	42	25	30
Medium Sand %	29	28	21	17
Coarse Sand %	16	13	13	10
Gravel %	7	0	8	0
pH ($CaCl_2$)	4.9	4.2	5.6	5.5
Carbonates %	0	0	0	0
EX Ca (me %)	2.0	0.7	2.7	2.9
EX Mg (me %)	0.3	0.1	1.0	1.2
EX Na (me %)	0.02	0.00	0.04	0.02
EX K (me %)	0.31	0.14	0.17	0.07
TEB (me %)	2.6	0.9	3.9	3.6
CEC (me %)	2.6	1.2	3.9	3.6
Base Sat %	100	75	100	100
E/C	42.6	11.0	10.4	9.6
S/C	42.5	8.2	10.4	9.6
ESP	0.7	0.0	1.0	0.6
EKP	11.8	12.0	4.3	1.9
Free Fe	0.65	0.70	1.70	1.80

LAND UNIT RG2

General description This unit completes the links in the chain of northeast trending dissected batholiths described under Land Unit RG1 and is particularly well developed in Chivi and Matobo Districts. The landform is similar to that of unit RG1 but the climate is less humid and the proportion of rock outcrop is higher. The narrow, planar to concave pediments have typical maximum slopes of about 8%. Lightfoot (1981, 1982) describes the natural resources and land use of part of this unit in Kumalo, Matopo and Gulati CLs. The unit occurs in Natural Regions IV and V, Agroclimatic Zones 4 and 5 and has an area of 5 190 km^2.

Geology Intrusive granitic rocks of the Basement Complex form this unit.

Soils Strongly weathered soils of the ferrallitic 6/7G types are very limited in extent, restricted to kloofs and other sites receiving runoff from rock outcrops. The unit shows a toposequence, usually catenary, of soils similar to the association described in Land Unit G9, but with a lower clay content in the upland soil members. On crests and adjacent to koppies, the soils are well-drained, shallow commonly gravelly coarse-grained sands and loamy sands over strong brown to yellowish red coarse-grained sandy loams, in places sandy clay loams. There follows a mid-slope zone which may comprise a moderately deep to deep, pale coarse-grained sand or loamy sand, mottled at depth, or it may include a narrow zone of duplex soils with a slowly permeable subsoil, a perched watertable and, in places, dry season seepage. The bottomlands, which may be vleis, have poorly drained coarse-grained sands and loamy sands abruptly overlying a very hard sandy loam to sandy clay which may be calcareous and sodic. These relationships and the classification of the soils are outlined in Table 27.

Table 27 Typical toposequence and classification of the Land Unit RG2 soils

Landscape position	Soil Classification		
	Zimbabwe	Soil Taxonomy	FAO/UNESCO/ISRIC
Crest (rock outcrops)	2	Lithic Ustorthents	Lithic/Umbric Leptosols
Pediment upper slope	5G	Typic Ustropept	Chromic Cambisol
Pediment mid slope (perched vlei)	5G	Arenic/Grossarenic Paleustalfs Aeric Albaqualfs	Albic Arenosols/Lixisols Eutric Planosols
Pediment footslope and valley bottom	8N	Typic Natrustalfs	Haplic/Stagnic Solonetz

Natural vegetation The rock outcrops of the bornhardt and whaleback types are mainly bare apart from a veneer of multi-coloured lichens and a few pockets of black humic sand supporting, for example, the sedge *Coleochloa setifera*. The pediment slopes were under miombo woodland although this is largely replaced by cultivation. In some drier valleys *Acacia* spp. appear to be dominant and mopane may be characteristic of lower slope positions. In sheltered, moist positions in the hills the ecological conditions favour the survival of some evergreen forest elements more typical of the Eastern Highlands region.

Land use Most of the pediment slopes show evidence of arable disturbance. There is a higher population and greater intensity of land use in the Chivi area compared to communal lands in the Matopo Hills where Gulati and Kumalo were created as recently as 1963. Small irrigated gardens are cultivated in areas with accessible groundwater.

Land capability The proportion of arable land, Classes I to IV, in Matopo, Gulati and Kumalo is approximately 20% and the proportion of vlei land (Class V) is, respectively, 4%, 12% and 7% (Lightfoot, 1981).

Irrigability The pediment slopes mainly have a Class C suitability on the basis of soil and slope criteria. Micro-scale irrigation is practiced at many seepage and vlei sites.

Erosion There is locally severe erosion, with sheet erosion on the upper pediment slopes developing into gullies by the drainage lines and vleis. Grazing areas appear to be more seriously affected than cropland.

Development potential The potential is very limited. Moisture conservation, through practices enabling a reduction in runoff and soil loss, is a primary requirement in raising dryland crop yields.

Typical Profile Description Land Unit RG2 – duplex soil on pediment mid-slope

Profile number:	227-GG-90 described on 4 October 1990. Auger boring.
Location:	On Fort Usher to Gwanda road, about 12 km south of Matopo Mission, Matopo CL, Matobo District.
Site:	Pediment mid-slope in valley, 2% slope. Grassland vlei in valley bottom. Hard surface crust.
Vegetation/land use:	Grazing area with common *Julbernardia globiflora* associated with *Parinari curatellifolia* and *Syzygium guineense*.
Parent material:	Probably granitic alluvio-colluvium.
Erosion:	Moderately severe sheet erosion but appears to be stable.
Land capability:	Class MIV.
Profile irrigable value:	4.

Soil classification:	5/6G (Zimbabwe) Aeric Albaqualf (Soil Taxonomy) Eutric Planosol (FAO/UNESCO/ISRIC)
0-20 cm	Dark yellowish brown (10YR 3/4m) coarse sand; dry.
20-35 cm	Brown (10YR 5/3m) coarse sand; slightly moist.
35-80 cm	Brownish yellow (10YR 6/6m) coarse sandy clay; many coarse red mottles and irregular soft concretions; slightly moist.
80-115 cm +	Brownish yellow (10YR 6/8m) coarse sandy clay; few medium red mottles; slightly moist.

ANALYSIS PROFILE 227-GG-90

Depth (cm)	0-20	20-35	35-80	80-115
Lab No.	Z120	Z121	Z122	Z123
DM %	99.8	99.8	98.5	98.3
Texture	cLS	cS	cSaC	cSaC
Clay %	7	4	35	42
Silt %	5	4	6	9
Fine Sand %	15	13	13	16
Medium Sand %	28	26	16	12
Coarse Sand %	46	53	29	22
pH ($CaC1_2$)	4.5	4.5	5.5	4.8
Carbonates %	0	0	0	0
EX Ca (me %)	0.9	0.7	4.7	1.1
EX Mg (me %)	0.3	0.2	0.0	0.4
EX Na (me %)	0.04	0.02	0.02	0.06
EX K (me %)	0.05	0.05	0.10	0.25
TEB (me %)	1.3	0.9	4.8	1.8
CEC (me %)	1.3	1.1	5.6	3.7
Base Sat %	97	88	86	50
E/C	19.3	26.1	15.7	8.8
S/C	18.7	22.9	13.5	4.4
ESP	2.8	2.1	0.4	1.5
EKP	4.2	4.2	1.8	6.8
Free Fe	0.55	0.46	1.78	2.06

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Appendices

APPENDIX 1

Rainfall distribution and crop yields

Introduction

The effect of rainfall amounts and distribution on crop yields has been investigated by analysing the rainfall data for Nyamapanda, in Mudzi Communal Land, (26 years, 1951/52-1976/77), using a crop specific soil water balance model (Frere and Popov, 1979; and Gommes, 1983).

The model is based on the simple relationship between soil moisture, rainfall and evapotranspiration for equal time intervals during the growing season. Using the pentad as the time interval, this can be expressed as:

$$Si = Si - 1 + R - P$$

where Si is the soil moisture at the end of the i th pentad, R is the rainfall during that pentad, Si – 1 is the residual soil moisture from the previous pentad and P is the crop evapotranspiration derived from Penman's PET corrected by the crop coefficient (Kc). Kc is crop specific and varies according to the phenological stage of the crop.

Moisture deficits, that is when Si is negative, are totalled for the length of the crop cycle and compared with the sum of the values of P for each pentad over the same period. The percentage of the total water need met by rainfall can then be calculated. A crop specific yield reduction factor (Doorenbos and Kassam, 1979) is used to convert the moisture deficits at the different phenological phases to an overall percentage reduction in yield.

Results

The crops used in the model are maize, sorghum and millet (mhunga) with 120 day maturation periods. Two soil types are considered: one, moderately shallow, derived from siliceous gneiss, with an available water capacity (AWC) of 50 mm: the other, moderately shallow, derived from mafic gneiss, with an AWC of 100 mm. These soils are considered to be typical of over half of Mudzi District (Land Unit GE1).

Planting is assumed to take place in the pentad following the one during which at least 25 mm of rain was recorded. The main results are shown in Tables A1.1-A1.5.

Table A1.1 Effect of Soil moisture deficit and run-off for maize (50 mm AWC)

Year	PP	Crop rain mm	H_2O Need mm	H_2O Surplus mm	Crop loss due to moisture stress %
51/52	64	839	570	280	0
52/53	63	713	575	232	26
53/54	69	346	545	65	85
54/55	65	437	565	83	67
55/56	67	714	555	307	100
56/57	68	598	551	233	98
57/58	70	656	540	275	30
58/59	65	555	565	124	36
59/60	66	282	560	36	100
60/61	68	603	551	178	28
61/62	63	353	575	27	67
62/63	67	651	555	236	45
63/64	69	459	545	172	83
64/65	68	736	551	369	39
65/66	66	635	560	117	4
66/67	66	627	560	157	26
67/68	73	239	521	39	100
68/69	70	491	540	117	60
69/70	62	484	582	150	63
70/71	63	627	575	140	18
71/72	66	695	560	195	5
72/73	71	301	533	31	100
73/74	64	774	570	230	8
74/75	68	539	551	82	10
75/76	67	674	555	174	34
76/77	72	457	527	101	37

Notes: PP – planting pentad. The numbers refer to five-day periods, 1 to 73, with pentad 1 representing Jan 1-5 and pentad 73 representing Dec 27-31.
Crop rain, the amount of rain measured during the 120-day (24 pentad) crop cycle.
H_2O Need – crop evapotranspiration ET (Crop), under optimal conditions.
H_2O Surplus – rainfall in excess of crop evapotranspiration and soil storage capacity. This is potential runoff (neglecting a small proportion of the surplus which will drain through the soil).

Table A1.2 Effect of soil moisture deficit and runoff for maize (100 mm AWC)

Year	PP	Crop rain mm	H_2O Need mm	H_2O Surplus mm	Crop loss due to moisture stress %
51/52	64	839	570	230	0
52/53	63	713	575	135	16
53/54	69	346	545	15	62
54/55	65	437	565	33	41
55/56	67	714	555	207	76
56/57	68	598	551	139	67
57/58	70	656	540	225	13
58/59	65	555	565	58	23
59/60	66	282	560	0	100
60/61	68	603	551	123	7
61/62	63	353	575	0	62
62/63	67	651	555	136	18
63/64	69	459	545	122	52
64/65	68	736	551	298	13
65/66	66	635	560	62	0
66/67	66	627	560	92	9
67/68	73	239	521	0	100
68/69	70	491	540	67	29
69/70	62	484	582	100	34
70/71	63	627	575	50	0
71/72	66	695	560	145	0
72/73	71	301	533	0	100
73/74	64	774	570	180	8
74/75	68	539	551	32	2
75/76	67	674	555	60	2
76/77	72	457	527	51	16

Notes: PP – planting pentad. The numbers refer to five-day periods, 1 to 73, with pentad 1 representing Jan 1-5 and pentad 73 representing Dec 27-31.
Crop rain, the amount of rain measured during the 120-day (24 pentad) crop cycle.
H_2O Need – crop evapotranspiration ET (Crop), under optimal conditions.
H_2O Surplus – rainfall in excess of crop evapotranspiration and soil storage capacity. This is potential runoff (neglecting a small proportion of the surplus which will drain through the soil).

Table A1.3 Crop water need, potential runoff and yield reduction for sorghum and millet (mhunga) at 50 mm AWC

	Sorghum			Millet		
Year	Water need mm	Water surplus mm	Crop loss due to moisture stress %	Water need mm	Water surplus mm	Crop loss due to moisture stress %
51/52	527	NC	0	485	346	0
52/53	532	–	7	491	279	9
53/54	503	–	38	464	65	31
54/55	522	–	31	481	95	22
55/56	513	–	32	472	352	25
56/57	508	–	36	469	257	23
57/58	498	–	19	460	303	18
58/59	522	–	14	481	155	8
59/60	517	–	46	476	45	44
60/61	508	–	14	469	202	13
61/62	532	–	26	491	43	23
62/63	513	–	13	472	260	10
63/64	503	–	43	464	187	34
64/65	508	–	21	469	387	20
65/66	517	–	0	476	163	0
66/67	517	–	14	476	195	14
67/68	480	–	63	446	42	46
68/69	498	–	23	460	125	17
69/70	539	–	31	497	163	26
70/71	532	–	3	491	160	4
71/72	517	–	4	476	241	0
72/73	492	–	55	456	40	40
73/74	527	–	2	485	277	1
74/75	508	–	7	469	110	3
75/76	513	–	13	472	230	9
76/77	486	–	25	451	130	23

Notes: NC – not calculated.

Table A1.4 Crop water need and yield reduction for sorghum and millet (mhunga) at 100 mm AWC

	Sorghum		Millet	
Year	Water need mm	Crop loss due to moisture stress %	Water need mm	Crop loss due to moisture stress %
51/52	527	0	485	0
52/53	532	3	491	4
53/54	503	27	464	23
54/55	522	15	481	11
55/56	513	24	472	16
56/57	508	21	469	14
57/58	498	10	460	7
58/59	522	4	481	4
59/60	517	46	476	44
60/61	508	4	469	2
61/62	532	21	491	16
62/63	513	3	472	2
63/64	503	28	464	25
64/65	508	10	469	8
65/66	517	0	476	0
66/67	517	5	476	3
67/68	480	53	446	38
68/69	498	8	460	7
69/70	539	19	497	16
70/71	532	0	491	0
71/72	517	0	476	0
72/73	492	47	456	32
73/74	527	2	485	1
74/75	508	0	469	0
75/76	513	0	472	0
76/77	486	13	451	11

Table A1.5 Mean values of crop loss, water need, crop rain and water surplus

Crop (AWC)	Crop loss due to moisture stress % (SD)	Water need mm (SD)	Crop rain % (SD)	Water surplus mm (SD)
Maize (50)	49(34)	555(15)	557(161)	160(92)
Maize (100)	33(34)	555(15)	557(161)	98(81)
Sorghum (50)	22(17)	513(15)	557(161)	NC
Sorghum (100)	14(16)	513(15)	557(161)	NC
Millet (50)	18(14)	473(13)	557(161)	187(102)
Millet (100)	11(12)	473(13)	557(161)	NC

Notes: NC Not calculated
SD Standard deviation

In Table A1.6, F is the estimated probability of occurrence of a rainfall amount less than that shown, ie. the probability that the annual precipitation is less than 786 mm is 0.815 and greater than 786 mm, 0.185.

Table A1.6 Cumulative distribution of annual precipitation for Nyamapanda (1951/52-1976/77)

Rank m	Rainfall mm	F=m/n+1 (n=26)	Rank m	Rainfall mm	F=m/n+1 (n=26)
1	307.3	0.037	14	678.9	0.519
2	376.5	0.074	15	715.6	0.556
3	389.7	0.111	16	716.2	0.593
4	425.7	0.148	17	720.2	0.630
5	512.3	0.185	18	737.5	0.667
6	551.7	0.222	19	747.0	0.704
7	554.6	0.259	20	759.6	0.741
8	575.1	0.296	21	776.8	0.778
9	581.2	0.333	22	786.0	0.815
10	588.8	0.370	23	805.2	0.852
11	609.3	0.407	24	855.8	0.889
12	660.2	0.444	25	929.7	0.926
13	668.3	0.481	26	995.1	0.963

Discussion

Maize is clearly a risky crop in the Nyamapanda environment. Factors other than rainfall, such as input levels, disease and farming practices will also affect yield, but even if these are optimised poor rainfall distribution will remain the major limiting factor in stabilising maize yields at a reasonable level.

Since only 50% of farmers in Mudzi District buy hybrid maize seed and less than 20% use fertilisers (PTA Consulting Services, 1982), actual yields in the rare season free of moisture stress (crop loss = 0) are likely to be around 2000 kg/ha.

Table A1.7 indicates the relative crop yield reductions resulting from moisture stress. Sorghum and millet (mhunga) are less likely than maize to suffer a severe decrease in yield during drought years.

Table A1.7 Number of years with crop loss greater than 50% (1951/52-1976/77, 26 years)

	AWC = 50 mm (years)	AWC = 100 mm (years)
Maize	11	8
Sorghum	2	1
Millet	None	None

The mean and median date of planting, according to the definition given above, occurs at the beginning of pentad 67, which is 27 November. The standard deviation is 3 pentads. The mean and median of the first rainy pentad is 66 (SD=4). The mean and median for the last rainy pentad is 12, which is 25 February-1 March (SD=4). The length of season, from the date of planting to the end of the last rainy pentad, has a mean value of 95 days (SD=24) and a median value of 100 days.

There is no significant correlation between date of planting and the last rainy pentad (r=0.06). The mean number of rainy pentads between the beginning of October and the end of April is 14 (SD=5). For the 26 years analysed, there is no occurence of a rainy pentad before the start of pentad 62 (2 November) nor after pentad 18 (31 March) which neatly conforms to the accepted notion that the rainy season runs from November to March inclusive.

During the 120 day (24 pentad) crop cycle considered, there is a mean of 11 dry pentads (SD=3) and the average number of consecutive dry pentads within this period is 5, (SD=3). During the reproductive phase of growth lasting about 8 pentads, when the crop is particularly sensitive to moisture stress (high Kc), the average number of dry pentads is 3 (SD=1.7) and is significantly correlated with yield reduction for the three crops (r>0.74).

The water surplus during the crop cycle has been calculated for maize at both AWC levels and for millet at the 50 mm AWC level as shown in Tables 1, 2, 3 and 5. This is the sum, accumulated by pentad, of rainfall amounts that exceed the crop evapotranspiration and soil storage capacity. The water surplus is therefore potential runoff. The mean value of the percentage of rain which is potential runoff varies from 15% under maize, (100 mm AWC), to 31% under millet (50 mm AWC).

This is in fair agreement with the empirical relationship between effective rainfall and runoff used by the Department of Meteorological Services (1981). The relationship assumes that two thirds of the seasonal rainfall over 400 mm is runoff and that no runoff occurs when the seasonal rainfall is less than 400 mm. Rainfall in excess of 1150 mm is all considered as runoff.

The mean value of rainfall during the crop cycle is only marginally greater than the potential requirement of the crop, especially in the case of maize (Table A1.5). This emphasizes the need for practices which promote moisture conservation.

In many areas, it should be possible to improve yield by controlled runoff from rocky areas such as dwalas to supplement the direct rainfall. Otherwise, conventional irrigation from surface water or groundwater sources is required to stabilize yields at a high level.

The rainfall data for Nyamapanda just meet the definition of requirements for Natural Region III. The mean annual rainfall is 655 mm and the average number of rainy pentads per season is 14. It seems likely, therefore, that Natural Region IV is less extensive in the north east of Zimbabwe than is shown on the 1:1 000 000 Natural Regions and Farming Areas map (see Text Map 3).

APPENDIX 2

Outline of the soil classification system of Zimbabwe

Order	Group	Typical soil families
I Amorphic	1. Regosol	1K (deep sands derived from Kalahari and Karoo sediments)
	2. Lithosol	2E (soils less than 25 cm deep, derived from mafic rocks)
II Calcimorphic	3. Vertisol	3B (dark brown to black cracking clays, formed on basalts)
	4. Siallitic	4U (alluvial soils with an active clay fraction)
III Kaolinitic	5. Fersiallitic	5G (coarse grained sandy soils with a mixed clay fraction. Derived from granitic rocks)
		5E (reddish clay soils with a mixed clay fraction. Derived from mafic rocks)
	6. Paraferrallitic	6G (coarse grained sandy soils with an inert clay fraction. Derived from granitic rocks)
	7. Orthoferrallitic	7G (coarse grained sandy soils with a very inert clay fraction. Derived from granitic rocks)
IV Natric	8. Sodic	8n (weakly sodic soils)
		8n (strongly sodic soils)

APPENDIX 3

Land capability and irrigability class definitions

Capability Classes

Class I (or MI) is land with few or no limitations or hazards. With good management it is suitable for long continued cropping with no (or only simple) conservation practices. Soils are deep or moderately deep and naturally well drained with stable structure and good working properties. Slopes are slight and the only limitations are those of maintenance of soil structure and fertility.

Class II (or MII) is land subject to moderate limitations or hazards. It is suitable for cropping with adequate protection measures which may sometimes include special management practices and/or regular ley rotations. Limitations may include one or more of the following: moderate susceptibility to erosion; moderate slopes; moderately shallow soil depth; slightly unfavourable surface physical characteristics; inadequate permeability in the lower root zone or moderate wetness existing as a permanent feature. Such land needs normal moderate conservation practices, the extent of which will depend on the limiting characteristics but will include moderate mechanical and biological methods in varying combinations.

Class III (or MIII) is land subject to severe limitations or risk of damage. It is suitable for cropping only with the application of intensive protection measures and or with special practices which may include long ley rotations with short cropping periods. Limitations may include: moderately steep slopes; high susceptibility to erosion; soils of low moisture-retaining capacity; moderately shallow and shallow soils; intractable texture; inadequate permeability in the lower root zone; unfavourable physical characteristics in the surface soil or moderate wetness. Combinations of intensive measures are required to use the land permanently. These include adequate mechanical protection; soil conserving rotations incorporating grass leys; maintenance of adequate cover while under tillage; drainage and other measures used in combination, depending upon the limitations.

Class IV (or MIV) is land subject to very severe permanent limitations or hazards. It is suitable for intermittent row-cropping only in long ley rotations, or for use under perennial vegetation. Limitations may include: steep slopes; shallow soils, or soils of very low water retaining capacity; high erodibility; unfavourable characteristics in the surface soil; and severe but correctable wetness. The use of this land for row-cropping is limited to once in every four to six years. Complex and intensive protection measures and practices would be required when under cultivation.

Class V comprises watercourses and land subject to severe, permanent wetness limitations which normally preclude cultivation. Vleis and watercourses subject to severe wetness are not usually drained and are best left under permanent vegetation. This class should be cultivated only with very special practices and measures.

Class VI is land which has such severe soil and/or slope limitations that cropping must be excluded, but which is productive under perennial vegetation and then only moderately subject to deterioration. Limitations include very steep slopes; very shallow soils; physical hazards of rock outcrops, unevenness etc. Its use is one of permanent grassland, which with sound methods of veld management can provide good grazing or hay. This land may also be suitable for afforestation, orchard or plantation crops.

Class VII is land which has such severe soil and or slope limitations as to exclude cultivation, and which is limited in its production and highly susceptible

to deterioration. Its limitations are similar to but more severe than those occurring in Class VI, with consequently reduced productivity and increased hazards. It is suitable only for rough grazing, and in some instances for afforestation.

Class VIII is land which has excessive limitations of soil, relief, wetness etc. and is only suitable for wildlife. It includes very steep hills, rocks and sponges.

The "*M*" prefix is applied to all arable classes in areas of low rainfall where the climate becomes too restrictive for normal cash crop production (Natural Region IV and the adjacent parts of Natural Region III).

It should be noted that while Class I, (MI), land could be put to the uses noted for Classes II and III, (MII and MIII) etc., Class VIII land has only the one use. A higher class is capable of the uses noted for those below it, but a lower class is not capable of being put to one of the uses noted for a higher class.

Irrigability Classes

The irrigability classes assigned to mapping units have been based on factors related to land characteristics, such as slope, and soil properties, such as water-holding capacity, permeability and levels of exchangeable sodium percentage.

The irrigability classes are defined as follows:

Class A: Suitable for irrigation without special precautions or practices and capable of sustained productivity.

Class B: Suitable for irrigation with special precautions or practices. Sustained productivity is attainable with good management and maximum efficiency in the use of irrigation water, but risks are greater than with Class A owing to moderate soil and/or topographic limitations, and special care is necessary.

Corrective measures may be recommended according to the nature of the limitations.

Class C: Of very restricted suitability for irrigation; confined to specific types of crops and practices owing to severe soil and/or topographic limitations.

Class D: Unsuitable for normal irrigation.

Class S: Excessively pervious sands of restricted suitability owing to inadequate water-holding capacity, unavoidable high water loss and low inherent fertility.

N.B. It should be noted that these irrigability classes and the criteria used to assess the suitability of soils are intended for normal full-scale irrigation i.e. all-the-year-round irrigation for a rotation of intensively grown crops as distinct from supplementary irrigation of summer crops grown mainly under normal rainfall. For the latter, soil requirements are much less stringent and all that is necessary is an economically productive arable soil. It is also assumed that the water used for irrigation is of good quality.

APPENDIX 4

Glossary of technical terms and abbreviations

Soil Depth:	extremely shallow	< 25 cm
	very shallow	25-40 cm
	shallow	40-50 cm
	moderately shallow	50-100 cm
	moderately deep	100-150 cm
	deep	> 150 cm

Soil texture:	C	Clay
	CL	Clay Loam
	L	Loam
	SiC	Silty Clay
	SiCL	Silty Clay Loam
	Si	Silt
	SaC	Sandy Clay
	SaCL	Sandy Clay Loam
	SaL	Sandy Loam
	LS	Loamy Sand
	S	Sand

Abbreviations used in soil analyses:
E/C – exchange capacity per 100 g clay
S/C – exchangeable bases per 100 g clay
ESP – exchangeable sodium percentage
EKP – exchangeable potassium percentage
DM – dry matter

APPENDIX 5

Analytical Methods

Analytical data refer to the fine earth fraction passing a 2 mm sieve and are expressed on an oven-dry basis.

$$\text{Percentage gravel} = \frac{\text{gravel}}{\text{gravel + soil}} \times 100$$

The methods of analysis employed are outlined below:

Mechanical analysis

Mechanical analysis was carried out by Bouyoucos hydrometer after dispersion with sodium hexametaphosphate reagent; sedimentation times of 5 minutes for silt + clay reading, and 5 hours for clay reading; coarse and medium sand fractions separated by sieving, fine sand calculated by difference.

Particle sizes are:
Coarse sand (cS) 2.0-0.5 mm. Medium sand (mS) 0.5-0.2 mm. Fine sand (fS) 0.2-0.02 mm. Silt 0.02-0.002 mm. Clay less than 0.002 mm.

Determination of pH ($CaCl_2$)

The pH was measured in a 1:5 suspension of soil in 0.01 *M* $CaCl_2$.

Cation exchange capacity

Cation exchange capacity (CEC) in milligram equivalents per cent, was determined by leaching the soil with either *M* ammonium acetate at pH 7 for soils of pH greater than 6.5 or with 0.2 *M* ammonium chloride at approximately field pH for soils of pH less than 6.5. If free carbonates were present the soils were pretreated with 0.5 *M* acetic acid prior to leaching with *M* ammonium acetate. Ammonium ions were displaced by the direct distillation method after washing with 96 per cent ethyl alcohol.

Exchangeable cations

The exchangeable cations were determined in the ammonium leachates and expressed as milligram equivalents per 100 g of soil (me %). Calcium, magnesium and sodium were determined by atomic absorption spectrophotometry and potassium by emission spectrophotometry; total exchangeable bases (TEB) were taken as the sum of exchangeable cations. Exchangeable sodium percentage (ESP) is the exchangeable sodium (after correction for sodium in the saturation extract) as a percentage of TEB. The percentage base saturation (BS %) is the TEB as a percentage of CEC.

Free iron (Fe_2O_3)

Free iron was determined by dithionite reduction followed by atomic absorption detection of iron.

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