Land Use Planning for Sustainable Agricultural Development

BOTSWANA

PROPOSED
AGRICULTURAL LAND USE PLAN
FOR
FORMER FREEHOLD FARMS
25/77 NQ AND 27/77 NQ
NORTH EAST DISTRICT

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B O T S W A N A

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FOR
FORMER FREEHOLD FARMS
25/77 NQ AND 27/77 NQ
NORTH EAST DISTRICT

by

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This field document is one of a series of reports prepared during the course of the project identified on the title page. The conclusions and recommendations in the report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

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

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EXECUTIVE SUMMARY

1. Construction of the Lower Shashe Dam, which is planned to commence in 1997, and flooding of the associated reservoir area will encroach on the grazing area, arable land and village plots of Matopi village, which is located in North East District, close to the confluence of the Shashe and Ramokgwebane Rivers.

2. Farms 25/77 NQ and 27/77 NQ were purchased by the Government from the freeholder in 1990 with the objective of compensating Matopi villagers for the loss of land incurred by flooding the reservoir. The farms comprise a total area of 8,148 ha. Most of this area had been managed as a commercial ranch, but a small area (130 ha gross) had been developed for sprinkler irrigation.

3. The area covered by the farms has a semi arid climate with a mean annual rainfall of 431 mm, and an annual coefficient of variation of 46%. The landform is a plain which is dissected and rolling in the west, and dominantly gently undulating in the east, and the most favourable soils, which are moderately deep chromic Luvisols, occur mainly in the east central part of the farm. Soils in the west are shallow and gravelly, with frequent rock outcrops.

4. Eight land units (LUs) are identified and mapped on the basis of soil, topographic characteristics and flood risk. LU 1, with an area of 702 ha, is suitable for arable cropping. Approximately 60% of the irrigated block falls within this unit. LUs 2a and 2b, together accounting for 2,179 ha, have shallower soils, which make it more suited to controlled grazing of cattle or small stock, while 2ask and 2alp (2,809 ha) are underlain by shallow regosols and leptosols which limit grazing to a lower intensity than on 2a and 2b. The relatively steep, rocky terrain of LU 3 (1,005 ha), with a high erosion risk, is only suitable for very limited dry season grazing. The two valley LUs, V1 and V2 (1,453 ha), are generally suitable for arable or horticultural development, but have a slight flood risk. LUs 1, V1 and V2 are also suitable for livestock grazing.

5. The settlers comprise 41 households of diverse ethnic origins, who currently subsist on a mixture of livestock raising, arable farming and drought relief, with the latter probably being the major source of income for most families. Livestock numbers are difficult to estimate as sources are contradictory. However maximum estimates of stock moving to the new settlement would be approximately 1,300 cattle, 1,400 goats, 100 sheep and 100 donkeys.

6. Levels of technical ability and motivation of the Matopi farmers are generally low, and agricultural extension support has been weak, largely due to the competing demands of drought relief and other administrative matters.

7. Simulation of potential rainfed crop yields using the *CYSLAMB* land evaluation model indicates that sorghum is a more suitable staple cereal crop than maize. However, due mainly to the low and unreliable rainfall, the dependable sorghum yield (calculated as the yield exceeded in 75% of years), under an assumed 'improved traditional' management system, is only barely sufficient to cover standard production costs. Under this yield projection an area of 4 ha of sorghum would be required to satisfy the subsistence calorie requirements of an average household.

8. The land use plan recommends allocation of land to fulfill settlers' needs for residential settlement, subsistence, grazing for animals, some form of agricultural cash income, and fuelwood. Selection of a given option must depend not only upon its technical feasibility but also upon the management abilities and support services available to the

implementors. All the options given are technically feasible but an improved level of extension support will be required to improve crop and livestock husbandry and to develop the horticultural and woodlot components.

9.   We recommend that each household is allocated a 10 ha plot for rainfed arable cultivation. Five hectares would be cultivated in any one year and the remainder either fallowed or planted to fodder crops on a rotational basis. The total area available for rainfed cropping is 586 ha. Allowing for allocations to 41 households and 5% losses due to infrastructure, 147 ha would be available for future expansion.

10.   Sorghum is the most suitable cereal crop for the rainfed arable areas and should be the staple, with smaller areas planted to beans, cowpeas, melons and other subsidiary crops. Farmers should plough early, using oxen or donkeys, and should aim to plant at least half of their cultivated field at the first climatically determined planting opportunity after 20th November. Planting should be in rows in order to obtain an even density and to facilitate weeding, which should be carried out in a timely manner. The arable area should be enclosed within a drift fence.

11.   Given the need for capital investment in rehabilitating the irrigation infrastructure, and the limited state of knowledge of the farmers in irrigated farming, it is recommended that the irrigated block is taken out on a commercial lease agreement, either with the Botswana Development Corporation or with a private investor. Revenue would accrue to the Tati Land Board from this agreement and the commercial farm should provide a source of wage labour for the village.

12.   From comparative studies of three options for managing the cattle herd, the recommended projection involves fencing into paddocks and control of stocking rates according to estimated rangeland production. Continuation of the present system of uncontrolled grazing, while favourable economically, is unsustainable due to rangeland degradation as a result of overstocking. The recommended option (system 2) involves fencing into paddocks, and stocking at rates determined by the estimated carrying capacity of the land units. Cattle and smallstock should preferably be run together to improve efficiency of range utilization. This option has an estimated net present value of Pula 213,144 at a discount rate of 15%, and has a financial internal rate of return of 31%. Estimated annual income per family would be Pula 1319.

13.   Two alternative new settlement sites are identified, each with a gross area of 50 ha. One site is located close to the Ramokgwebana River and has advantages of proximity to a potential horticultural area and a potential woodlot area on the river alluvium. The other site has better road access and is closer to the rainfed arable area. A residential plot size of 900 m^2 is recommended by the Land Board.

14.   The present settlement site has a fuelwood shortage due to continued removal of stocks from the surrounding bush. While the proposed settlement site has adequate firewood to satisfy immediate needs, a fuelwood lot should be developed to ensure a sustainable supply. A site of 30 ha on LU V2 has been identified and should be planted with *Eucalyptus camaldulensis* at the rate of 3 ha/year. The first 3 ha plot will become available for harvest after 10 years, with an estimated yield of 60 m^3.

1. INTRODUCTION

Farms 25/77 NQ and 27/77NQ, located in North East District, were acquired by the Government from the freeholder, Mr Blackbeard in 1990. The purchase followed the recommendations of the consultants appointed to conduct the feasibility study of the Lower Shashe dam (SMEC, 1990), and had the objective of providing compensatory land for Matopi villagers who need to be relocated before flooding of the reservoir.

During the latter part of 1990, the Tati Land Board proposed compensating Matopi residents by relocating them within the bounds of farms 25/77 and 27/77NQ. As a portion of the farm had been developed for irrigated agriculture, however, the Ministry of Agriculture was concerned that this resource should not be wasted, and that any potential for expansion of the irrigated area be investigated prior to land allocation. A study was therefore initiated in late 1990 by the Ministry of Agriculture to evaluate the farm for alternative land use options including resettlement of Matopi people. This study concluded that the potential for expanding the present irrigated area was limited.

Since this study, however, no follow up has been made by the responsible land authorities, despite the interest in resettlement of Matopi residents shown in sessions of the District Land Use Planning Unit (DLUPU) and in the newspapers. The Regional Agricultural Officer for Francistown requested that the present land use plan be drawn up to enable further progress in the resettlement programme and the agricultural development of the area.

The land use plan is based on assessing the suitability of the land occurring on the farms for a number of uses with special reference to the needs of the resettled Matopi villagers. The report is structured so that the physical environment of the farms is first described, followed by the socio-economic conditions of the target group. Land evaluation is then carried out for relevant crop and livestock based production systems, and a spatial plan shows the areas of the farm recommended for settlement, irrigated cropping, rainfed cropping, and livestock production.

2. PHYSICAL ENVIRONMENT

2.1 Location

The farm is situated south of Matsiloje village between the Ramokgwebana and Tati rivers north of their confluence. The area of the farm under study is about 8148 ha. It is bordered to the east by the Ramokgwebana river, to the south by the Tati river, to the north by freehold farm [26/77 NQ], and to the east by freehold farm 23/77 NQ [figure 1]. The latter farm is also owned by Mr Blackbeard and its purchase is also currently under consideration. The farms under study can be reached by proceeding from Francistown along Francistown-Matsiloje road up to Matsiloje, turning right into Matopi road running along the levee of the Ramokgwebana river and continuing for about 23 km (see Map 1).

The study area falls within Tonota Agricultural District and Matsiloje Extension area.

2.2 Climate

The climate of the study area is semi-arid with rainfall occurring in the summer months of October to April. Summer months are hot while winter months are dry but cool during the nights.

There is no weather station or official rain gauge within the study area. Climatic data is therefore taken from Tonota, which is the nearest rainfall station with a sufficiently long series of records. Synoptic data for Tonota are interpolated from the nearest surrounding synoptic weather stations (Francistown, Plumtree and Mahalapye).

2.2.1 Rainfall

Interannual variations in rainfall are more significant than spatial variation within the area. The probability of rainfall and its distribution during the year has become the most reliable index for agricultural planning and for making decisions on agricultural activities and livestock management.

Monthly and annual rainfall totals from 1959/60 to 1992/93 for Tonota are shown in Table 1. The area receives an average annual rainfall of 431 mm with a coefficient of variation of 46%. The rainy season starts in October or November, reaches its maximum in December - January and ends in March or April. Dry spells of several weeks are common during the rainy summer.

2.2.2 Air Temperature Humidity and Wind Speed

Average synoptic data for Tonota are shown in Table 2. The average maximum temperature varies between 23.1 and 31.5°C during the warmest months of October, November and December. The average minimum temperature varies between 4.8 and 19.0°C and the low temperatures were recorded during the months of May, June, July and August. Light frost may occur during the night, but temperatures rise to above 23 degrees by midday.

Map 1

Location of Farms 25/77 NQ and 27/77 NQ
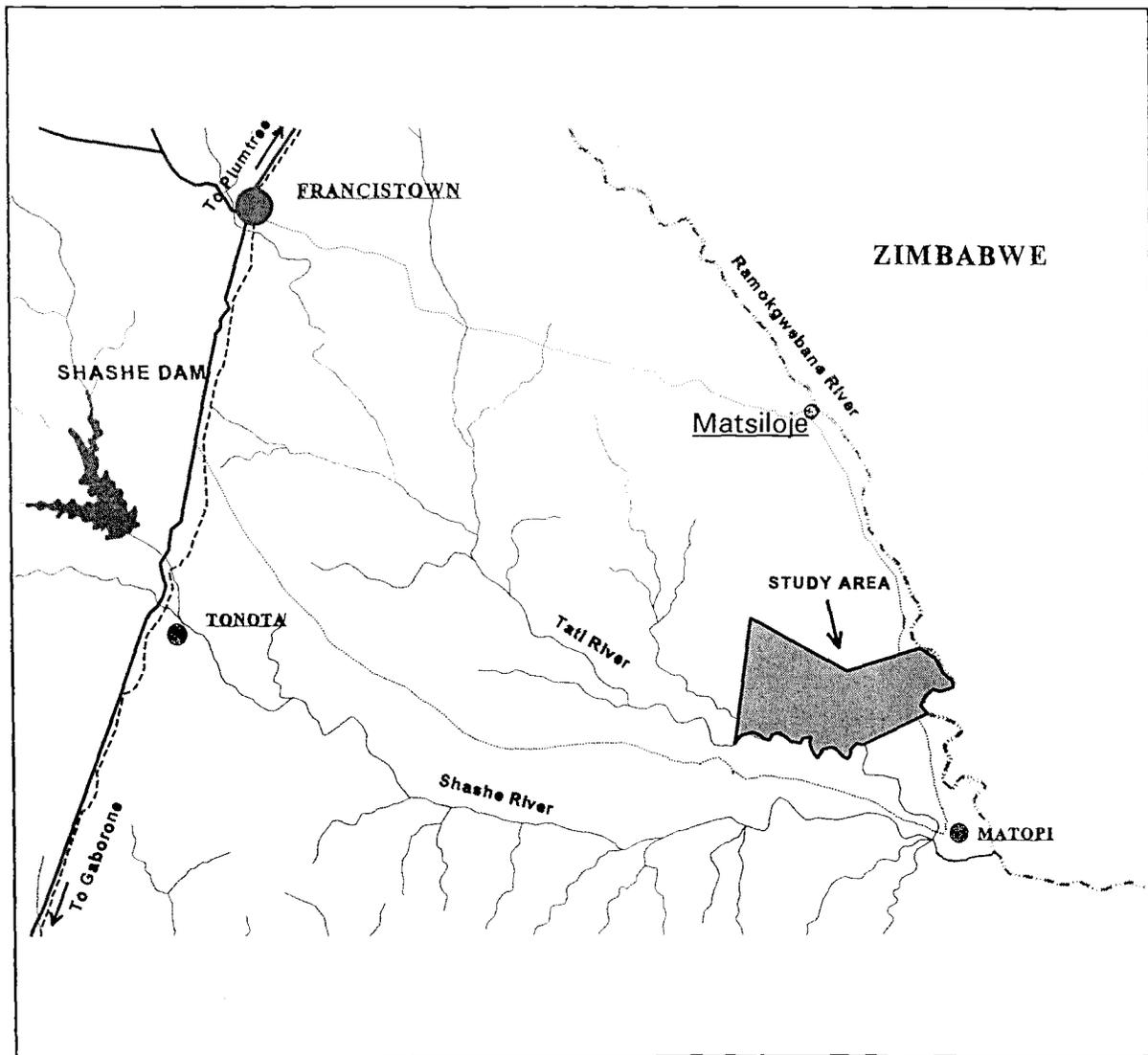
Table 1

Monthly and Annual Rainfall at Tonota 27°28'E; 21°27'S; 940m

(mm)

Year	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	Annual
59/60			0	2	32	84	10	112	58	9	7	0	316
60/61	0	2	3	4	47	72	12	143	93	36	0	2	411
61/62	0	0	16	1	28	39	241	23	12	44	0	0	402
62/63	0	0	17	0	203	33	139	61	0	86	0	29	569
63/64	2	0	0	15	24	109	67	22	0	3	0	0	240
64/65	0	0	0	4	56	58	89	0	0	0	0	0	206
65/66	0	0	0	0	33	4	35	204	24	0	0	0	300
66/67	0	0	0	0	40	126	149	96	0	60	0	0	471
67/68	0	0	0	0	23	11	75	59	9	65	33	0	274
68/69	0	0	0	0	31	60	99	205	160	20	5	0	580
69/70	0	0	57	37	97	44	0	56	10	16	0	21	338
70/71	0	0	0	5	19	94	130	9	1	33	0	0	290
71/72	0	0	17	45	106	41	300	13	56	13	3	0	594
72/73	0	0	0	35	19	32	44	9	42	15	10	1	207
73/74	0	0	7	23	100	102	235	88	35	34	4	0	628
74/75	0	0	68	0	150	65	336	155	108	63	14	1	960
75/76	0	0	0	0	11	124	82	128	137	16	61	1	562
76/77	0	0	0	33	104	83	79	140	175	1	0	0	617
77/78	0	3	19	42	124	227	60	90	9	49	2	0	823
78/79	0	0	0	62	42	30	52	247	33	17	0	0	484
79/80	0	0	0	29	69	25	102	242	4	17	0	0	491
80/81	0	2	7	17	110	75	269	203	30	10	2	0	722
81/82	0	0	0	49	101	69	34	4	0	48	1	0	306
82/83	0	0	0	81	71	56	48	12	50	4	0	4	328
83/84	0	2	0	15	44	42	16	31	94	0	0	2	246
84/85	no data												
85/86	1	0	0	57	0	19	10	40	31	94	0	0	251
86/87	0	0	0	33	33	44	32	11	0	0	0	0	153
87/88	no data												
88/89	no data												
89/90	no data												
90/91	0	0	0	9	13	74	108	179	0	0	0	0	383
91/92	0	0	0	0	0	38	178	76	53	0	0	0	345
Mean	0	0	7	21	60	65	105	92	42	26	5	2	431
c.o.v	350	247	227	111	82	69	88	85	119	105	260	308	46

Note: Annual figures may not always correspond exactly to the sum of monthly figures due to rounding.

Table 2

Average Monthly Synoptic data for Tonota 27°28′E; 21°27′S; 940m

Month	Temperature (°C)				Relative Humidity (%)		Sunshine (hrs/day)	Wind (km/hr)	PET (mm)	Frost days (days/month)	
	Mean max.	Mean min.	Extreme max.	Extreme min.	08.00	14.00				Air	Ground
July	22.7	5.4	29.9	-3.9	66	29	9.6	4.9	98	3	12
August	24.9	8.1	34.8	-3.7	57	26	9.8	5.7	127	1	4
September	29.2	12.6	36.6	2.1	50	27	9.5	7.2	162	0	0
October	30.9	16.1	39.6	4.7	54	32	8.9	7.9	188	0	0
November	30.5	16.9	40.0	5.3	59	41	8.0	6.9	182	0	0
December	29.8	18.2	38.5	9.4	67	45	7.6	6.3	181	0	0
January	30.1	18.5	39.8	10.5	68	48	7.8	5.9	180	0	0
February	29.1	18.0	37.7	10.7	73	51	8.0	5.8	161	0	0
March	28.8	16.6	38.0	5.7	71	47	8.1	5.7	155	0	0
April	27.2	13.5	34.8	4.4	71	41	8.5	4.9	128	0	0
May	25.1	8.9	33.1	-0.6	68	33	9.3	4.4	107	0	3
June	22.5	5.8	30.3	-3.9	65	35	8.9	4.5	89	4	12

The average relative humidity within the area does not vary much but the humidity in the mornings (50-73%) is normally higher than during the afternoons (26-51%). The wind velocities range from 4.4 to 7.9 km/hr. The seasonal winds that occur during the periods of September, October and November can cause considerable damage to shallow rooted trees and to those having brittle stems and branches.

2.2.3   Evapotranspiration

The monthly Penman evapotranspiration varies from 89 mm to 188 mm with the lowest values recorded in the months of June and July and the highest values in October.

2.3   Geology and landform

The area is situated on the Hardveld and is underlain by Precambrian rocks of the Basement Complex, which mainly comprise gneisses and arkose. A belt of ultramafic schists and amphibolites is associated with the rolling - hilly topography in the south of the farm.

The landform of the study area consists dominantly of gently undulating to undulating plains and valleys of low relief. The topography of the north-eastern portion of the study area is nearly level to gently undulating while the north-western portion is confined to an undulating to rolling type of landform. The shallow valley system within the farm mostly originates from the north and the drainage lines slope towards the south. The degree of dissection increases towards the Tati River, and the topography becomes rolling in the south-central and south-western parts of the farm, with small hills and and hummocks occurring locally.

2.4   Soils

2.4.1   Previous studies

The soils of the area have been previously mapped at the scale of 1:250,000 at a reconnaissance level under the Soil Mapping and Advisory Service project of the Land Utilization Division of the Ministry of Agriculture (Radcliffe, Venema, and De Wit, 1990).

2.4.2   Detailed reconnaissance soil survey

As the available soil map (scale 1:250,000) does not provide the details required for establishing a land unit map, a detailed reconnaissance soil map of the study area was prepared by the Agricultural Land use Planner. The map is based on the interpretation of aerial photographs, scale 1:50,000 and flown in 1988. Limited field checks were carried out which led to the identification of an area of soils suitable for arable farming. This area was then surveyed in more detail in order to establish the boundaries with the less suitable land units. The classification was made according to the FAO-Unesco Soil Map of the World Revised Legend (FAO, 1990). Four soil units, namely Chromic Luvisols, Calcic Luvisols, Eutric Regosols and Eutric Leptosols, have been recognized within the study area and are discussed below.

Chromic Luvisols

Chromic Luvisols are the dominant soils in the eastern half of the study area. These well drained, shallow to moderately deep, medium textured soils are developed on basic igneous and metamorphic rocks. The surface horizon is dark reddish brown in colour and mostly has a coarse loamy to fine loamy texture.

The texture of the subsurface horizon is fine loamy and shows some tendency to become heavier with increasing depth. Cation exchange capacity is around 10 - 20 meq per 100 g soils.

The base saturation is high and the soil reaction is slightly acid. The surface and subsurface horizons have low organic carbon content. The exchangeable potassium is high in the surface horizon and moderate in the subsurface horizon.

The Chromic Luvisols occur as the skeletic phase, with an effective depth of between 0.5 and 1.0 m, and as the lithic phase, with effective depths of between 0.3 and 0.5 m. These depth classes are used in the definition of land units.

Eutric Regosols, lithic phase, and Leptosols

These soils are dominant in the western half of the farm. Regosols are well to somewhat excessively drained and shallow (lithic phase with effective depths of between 0.3 and 0.5m), while Leptosols are normally very shallow (< 0.3 m deep). The surface horizon is reddish brown and the texture ranges from sandy loams to sandy clay loams.

Calcic Luvisols

A very small area of these soils is found at the confluences of higher order streams of the area, joining the two major rivers of the Ramokgwebana and Tati. The soils are slightly acid to neutral in reaction. The cation exchange capacity ranges from 10 to 20% meq per 100g soil while base saturation is high in the subsoil. The organic carbon content is low, in both surface and sub surface horizons (0.3%). The available

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phosphorus is low but the exchangeable potassium is high. The secondary $CaCO_3$ rich subsurface horizon can prevent root penetration of deep rooted crops if the land is irrigated.

2.4.3   Soil Survey of Irrigation Block

In addition to the detailed reconnaissance soil survey of the study area a medium intensity soil survey was carried out of the 130 ha fenced area. Part of the fenced area was previously irrigated and the aim of this survey was to determine the extent of deep irrigable soils within the fenced area. Preliminary boundaries were plotted from aiphoto interpretation. The reliability of these interpreted boundaries and their relationship to soil distribution was checked, corrected and confirmed by detailed field observations and check bores. The average density of field observations was one per seven ha.

The final soil map (Map 3) is reproduced at a scale of 1:10,000. Soil types are converted to Land Units and the map is presented in Section 4.3 (p.23), where land suitability for irrigation is discussed.

Moderately deep Chromic Luvisols are the dominant soil in the irrigation block, although shallower Chromic Luvisols (skeletic and lithic phases), Calcic Luvisols, and Leptosols are also represented.

2.5   Land Cover and Present Land Use

2.5.1   Vegetation

There is a direct relationship between soil, topography and the vegetation type throughout the area. Nearly level and deep well drained land carries vegetation which includes a variety of relatively tall, single stemmed trees. Undulating and moderately deep to shallow land carries mixed vegetation which includes medium height trees with multiple stems. Low catenary sequences with imperfectly drained land usually carries shrubs, often of uniform height and consists of a limited number of species.

Seven main vegetation types were identified in the whole area in the SMEC (1990) report. Three of these occur as major vegetation types in the farm area (Sebego, 1990, Range Ecology Section, Ministry of Agriculture) and are briefly described below.

Riparian Woodland

Dense woodland along the Tati river consisting mainly of an overstorey of *Combretum erythrophyllum, C. hereroense, Acacia karoo, A. tortilis, A. erioloba, Ziziphus mucronata,* and an understorey of *Euclea undulata, Diospyros lycioides, Grewia flavescens, G. flava, Maytenus senegalensis, M. heterophylla* and *Dichrostachys cinerea.* The herbaceous layer on farm is characterised by excellent forage species such as *Panicum maximum, Urochloa trichopus, Brachiaria deflexa* and *Dactyloctenium aegyptium* whilst in similar sites in the vicinity of Tati village the annual species of *Urochloa trichopus and Brachiaria deflexa* occur.

A less dense riparian woodland along the smaller streams feeding the Tati river was recorded as being dominated by *Combretum hereroense, Peltophorum africanum, Ziziphus mucronata, Rhus pyroides, Bolusanthus speciosus, Acacia fleckii, A. tortilis* and *Terminalia sericea*

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Acacia Woodland

This vegetation type is found along the banks of all the river systems in the area away from the actual riparian woodland. Three subassociations were recognised dominated by *Acacia mellifera, A. tortilis* and *A. erubescens/Combretum apiculatum* respectively Other tree/shrub species recorded are, *Combretum hereroense, Lonchocarpus carpassa, Boscia albitrunca*, and *Ziziphus mucronata*. The understorey vegetation is composed of *Diospyros lycioides, Grewia bicolor, G. subspathulata, G flavescens* and regenerating tree species. The grasses of the herbaceous layer are mainly *Eragrostis trichophora, E. biflora, Urochloa trichopus, Brachiaria deflexa* and *Aristida congesta*.

Mopane woodland

Colophospermum mopane is the dominant species throughout the area. It is found in either pure stands or as a co-dominant with *Acacia nigrescens, Combretum apiculatum*, or *Commiphora pyracanthoides* on the valley slopes of the rolling to hilly landform system of the study area.

Other tree species found here include, *Combretum molle, Acacia fleckii* and *Terminalia prunoides*. Shrubs are mostly *Dichrostachys cinerea, Ximenia americana, Grewia flava* and *G. bicolor*. The herbaceous layer is poor and contains *Ryncheletrum repens, Schmidtia pappophoroides, Aristida congesta* and *Eragrostis rigidior*.

2.5.2   Land Use

A large portion of the farms was utilized for livestock grazing and approximately 130 ha has been developed for irrigation. Both were well managed by Mr Roy Blackbeard prior to acquisition by the Government. From the acquisition, ownership of the farms was vested in the Tati Land Board, and since then no development or any resettlement has been made. At present the farm is neglected and appears to be a refuge for stray cattle. No crop farming is currently taking place in the farm area.

2.6   Water Resources

2.6.1 Sandbed aquifers

Sandbed aquifers of Ramokgwebana and Tati are considered to be the most reliable and easily exploitable water source available in the area. However, the quantity of water harvested from these sources during dry spells is highly dependent on the hydro-geomorphology of their catchments as well as the shape of the longitudinal section of the river channel.

Sandbed Aquifer of Ramokgwebana River

The Ramokgwebane river has a large catchment area of 312 km². The river carries a large amount of runoff water along the river channel during heavy rains. Recharge rate of the sandbed aquifer is rapid during the rainy season [November to January] but the amount of water stored in the river bed which could be extracted during the rest of the period of the year depends on the amount of sand deposited over the river bed. Observations indicate that sand depths of between 3m and 4m occur on average in a river channel of some 150m wide.

Any large scale constructions to improve the yield, such as recharge dams, require bilateral negotiations before initiation, as the Ramokgwebana river delineates the border

between Botswana and Zimbabwe. Previous local experiences have indicated problems in sharing common water bodies across this international boundary.

Access to this source along the Botswana embankment is provided by stiles over the fence at irregular intervals.

Sandbed aquifer of Tati river

Possible water extraction from the Tati river sandbed aquifer is relatively low in comparison to the Ramokgwebana river sandbed aquifer. Significant water shortages were experienced when the irrigated portion of the Blackbeard farm was in full operation [personal communication, Mrs Blackbeard].

With the completion of the proposed Lower Shashe Dam, the reservoir water will retreat along the Tati river and reach closer to the irrigable part of the study area. The administration of the reservoir falls under the Water Utility Corporation and the utilization of the reservoir water will become uneconomical for large scale irrigated agriculture [12,000 Pula/ha, SMEC, 1990].

2.6.2   Present Water Use

Eleven Government stockwatering points with an electrically driven (Mono) suction pumps and storage tanks have been installed around Matselagabedi, Matsiloje and Matopi area by the Department of Animal Health and Production. Water is pumped into storage tanks (approximately 50 m^3 capacity) inside the cordon fence and released into watering troughs. Consumption at one such installation is estimated at 10 m^3 day by the pump operator.

Since pumps were installed, no water shortages were experienced except in one location which is close to Matsiloje during the dry season, according to pump operators and farmers.

A number of wells are found along the river in the area which are used to irrigate small scale horticultural plots. Estimated water use for irrigated horticulture at one such installation is 1.4 m^3/hour [Mr Siku, personal communication].

2.7   Land Units

Well defined land units and a land unit map are the essential physical basis for land evaluation and the selection of alternative land uses. In the present study, land units (LUs) have been defined from taxonomic characteristics of the soils and from properties such as surface rockiness, soil depth, gravel content, and slopes. A detailed reconnaissance soil survey was carried out to accurately map the boundaries between land units.
Measurable land characteristics such as soil physical and chemical properties, and terrain features can be combined into land qualities for the purposes of land evaluation. Land qualities include such factors as moisture availability for arable crops during the major growing season [summer], nutrient availability, and resistance to erosion. Land evaluation considers the optimum land quality requirements for a particular land utilization type.

Table 3 shows the major characteristics of each LU, and Map 2 shows their distribution in the study area as well as the existing fencing layout.

Map 2

Land Units

(see overleaf)

Map 2
Land units
with existing fences

N
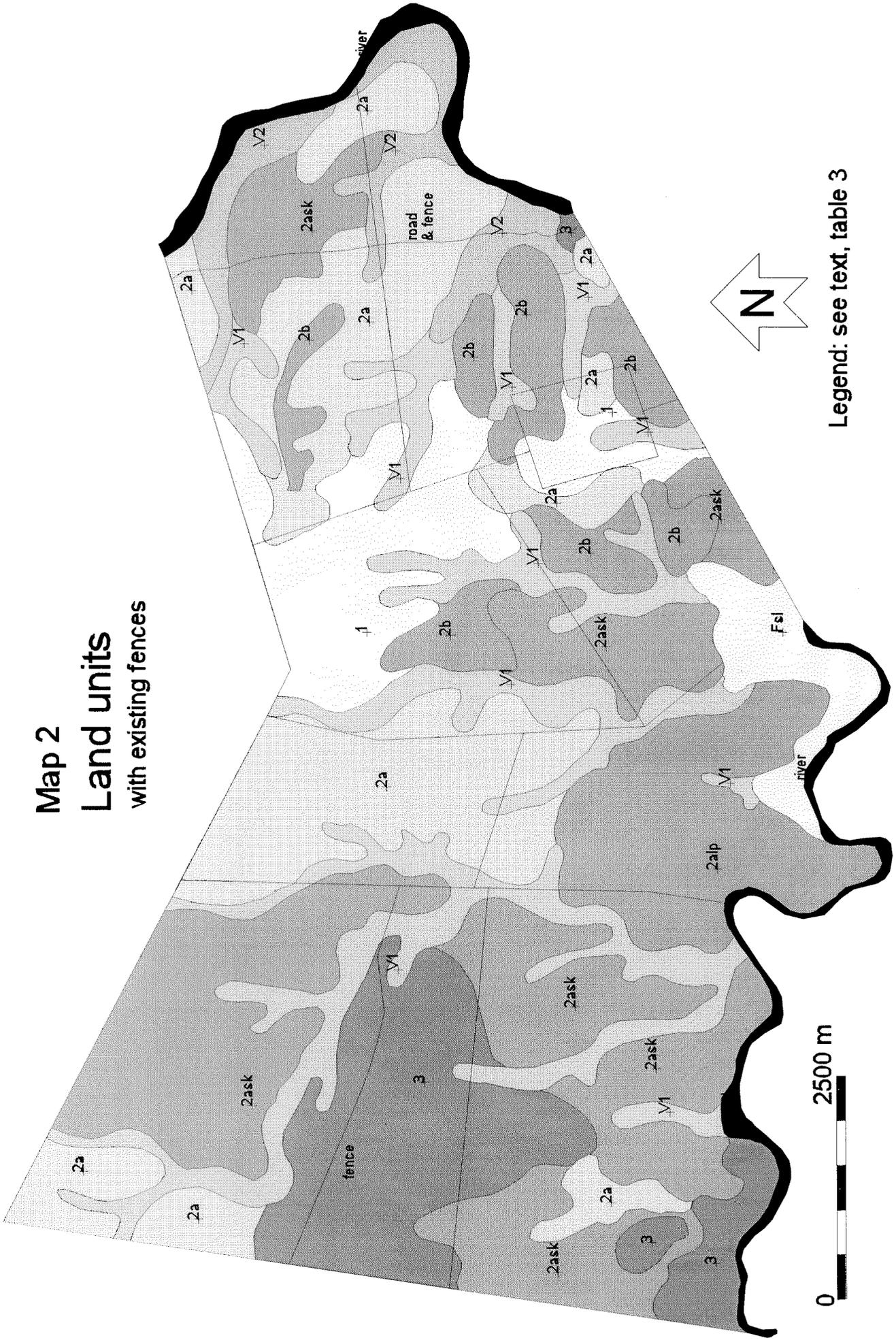
Legend: see text, table 3

2500 m

0

Table 3

Land Units

Land Unit	Landform	Dominant slopes (%)	Soils								Estimated AWHC (mm/m)	Available P (ppm)##	Area (ha)
			FAO Legend#	SLB Class	Effective depth (m)	Drainage Class	Dominant Texture	Gravel					
								Surface	Subsoil				
1.	Flat- Undulating Plain	0-3	LVxsk	G2c	0.75-1.0	Well	sandy clay loam	nil	few	110	3	702
2a.	Undulating Plain	3-8	LVxsk	G2c	0.5-0.75	Well	sandy clay loam	few	many	65	8	1,584
2ask	Undulating Plain	3-8	RGeli, LVxli	G1c, B1	0.3-0.5	Somewhat excessive	sandy loam	many	abundant	25	8	2,151
2alp	Undulating Plain	3-8	LPe	G1c	<0.3	Somewhat excessive	sandy loam	many	n.a	20	8	658
2b	Rolling Plain	8-15	LVxsk	G2c	0.3-0.75	Well	sand clay loam	few	many	50	8	595
3.	Rolling Plain	8-15	LPe	G1c	<0.3	Somewhat excessive	sandy loam	many	n.a	20	8	1,005
V1	Shallow valleys	1-3	LVx	G2c	>0.75	Moderately well	sandy clay loam	nil	nil	130	8	1,124
V2	Valleys, slight flood risk	0-1	LVk	A9	>1.0	Moderately well - Imperfect	clay loam	nil	nil	150	8	329
Fsl	Area to be flooded at full supply level (fsl) of the future Lower Shashe Dam											206

Note# LVx: Chromic Luvisol, LVk: Calcic Luvisol, RGe: Eutric Regosol, LPe: Eutric Leptosol
sk: skeletic phase, li: lithic phase

Note## No soil analysis available. Average values of P content in relevant soil types in north eastern Botswana are taken from Radcliffe *et al* (1990). In the absence of fertilizer, values on the potentially arable unit (1) are assumed to equilibrate at a lower level after several years of cropping.

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3.   SOCIO-ECONOMIC CONDITIONS OF PROSPECTIVE SETTLERS

3.1   Population

The population of Matopi is diverse, having come from Matsiloje and its environs which stretched up to the Zimbabwean border. The majority are Kalanga-speaking and others are Khurutshe, Rolong, Ngwato or Khoesan in origin.

The indicated population of the Matopi area is summarised in Table 4. Estimates are based on 1981 Census data, field surveys conducted by SMEC team and the 1991 Census published by the Central Statistics Office.

Table 4

Matopi Population Estimates

Source	Households	Population
1981 Census	41	177
SMEC, 1988	50	246
1991 Census	41	223

Note.   The determination of the 1988 population estimates is based on the homestead count which was multiplied by the average number of people found occupying dwellings in the area at the time of the 1981 Census.

The area to be resettled is more than sufficient for this number of people with all their livestock. However, conversations with the headman indicate that they wish to bring in other related peoples with their animals. Providing a strict control is established this would be acceptable since it would enable a viable financial unit to be formed providing the incomers were carefully screened with regard to livestock and resources. It would certainly be preferable to settle people of a common background in the same area.

3.2   Socio-economic status of farmers

Matopi villagers could be considered as Remote Area Dwellers in terms of welfare received from the government. In 1987 virtually 75% of villagers were involved to some degree or another in drought relief (SMEC, 1990). This has been of assistance but has been insufficient to lift them above the poverty line. Few of the family members are employed in Selebi -Phikwe or Francistown, and not any in local mines. The Khoesan household normally comprises large families who are in a weak position. The tradition found among this community is the grown-up children with their offspring sometimes continuing to live with their parents. Relatively few find employment outside their communities. Children of the able families receive their education at Matsiloje Community Junior Secondary School.

The principle means of livelihood of Matopi villagers is animal husbandry. Agriculture under semi-arid conditions in Matopi, like in the rest of the North-East region is a high risk activity. Both arable farming and livestock rearing are affected by the unreliable weather conditions.

The current level of motivation within the village is low and they will need to be stimulated through extension in forestry, horticulture, arable and livestock if the more attractive options outlined in this document are to be selected. Without such extension it is felt better to follow a lower level option. However, there appears to be a will to provide labour for tree planting and maintenance, an interest in horticultural and fruit tree cultivation and a knowledge of cattle management and the production of soured milk.

3.3 Present farming systems/practices

Cropping within the old Matopi settlement is characterised by low input, low management crop systems, mainly based on sorghum with smaller amounts of maize, millet, sweet reed and watermelon.

Discussions with the headman reveal a base resource of draught power, mainly consisting of donkeys, which would enable early planting. However, the lands which they have cultivated are not of the highest quality and extension support has been weak because the Agricultural Demonstrator (AD), who supervises a large area, has been involved with the Drought Relief Programme in areas away from Matopi. If the 'improved traditional' crop production systems described in Section 4.2 (p. 19) are to be achieved there is a need for significantly improved extension support.

The Matopi area was originally established as a cattle post and the cattle workers and their dependents formed the basis of todays settlement. Many cattle have died in the past two or three years and, at present, only a few of the cattle grazing the area are owned by the Matopi people, In fact, the present cattle holdings (March 1994) as estimated by the headman are around 100 head with some 930 small stock and around 100 donkeys, whilst the Agricultural Demonstrator for the area estimates them to be 132 head of cattle and similar numbers of small stock and donkeys. This high level of small stock and donkeys, other people's livestock and past drought years, has led to an extremely sparse level of vegetation cover over the whole grazing area which, in conjunction with the slopes, has resulted in erosion.

The communal area has been grazed in the past by cattle from Matopi, Mabete and Marmun Hill cattle posts plus some encroachment by cattle south of the River Shashe. The Matopi people are not happy about such encroachment. SMEC (1988) quotes figures of 1700 livestock units (LSUs) for the area however this includes cattle from the Central District. Livestock statistics from the Animal Health and Production Department, Francistown, for 1992 and 1993 show such differences that they are hard to reconcile. (Tables 5 and 6). This may reflect the confusion caused by mafisa and ownership.

Cattle numbers at Polometsi, south of the Shashe river, in 1988, were given in the SMEC (1990) report, as 504. Crush figures for 1993 are 149 cattle, 328 goats, 39 sheep and 20 donkeys.

Table 5

Livestock Statistics of Matopi and surrounding areas 1992

Village/ Cattlepost	Cattle Crush	Livestock	Types		
		Cattle	Goats	Sheep	Donkeys
Matopi	Matopi	270	352	7	24
Mabete	Mabete	297	127	11	23
Patayan matebele	Marmun Hills	341	451	18	13
Morotole	Morotole	272	204	22	23
TOTAL		1,180	1,134	58	83

Table 6

Livestock Statistics of Matopi and surrounding areas 1993

Village/ Cattlepost	Cattle Crush	Livestock	Types		
		Cattle	Goats	Sheep	Donkeys
Matopi	Matopi	208	903	26	94
Mabete	Mabete	96	167	42	2
Patayan matebele	Marmun Hills	38	439	12	15
Morotole	Morotole	N/A	N/A	N/A	N/A
TOTAL		342	1,509	80	111

A conservative (high) estimate of the total stock using the area can be based on the 1992 livestock statistics figure plus the 1993 Polometsi figure which would give a total of 1,329 cattle, equivalent to 930 LSUs using a 0.7 conversion factor, 1,462 goats, equivalent to 292 LSUs using a conversion factor of 0.2, 97 sheep, equivalent to 19 LSUs using a conversion factor of 0.2 and 103 donkeys eqivalent to 72 LSUs again using a conversion of 0.7. Total LSUs utilising the previous communal area before inundation would therefore be in the region of 1,313. The previous grazing area was 4,370 ha and, at this stocking level, it is not difficult to understand why the rangeland in the area is degraded and also the rise in small stock numbers which are able to survive where cattle cannot, browsing their way to the second stage of degradation.

The traditional grazing system used in the past, when there has been an adequacy of cattle, has been as follows:

Grazing by cattle is confined to the defined grazing area during the cropping season and is basically unsupervised, animals graze/browse around water points during this season when forage is plentiful and return toward the kraals in the evening. Cows are shut in at night and milked in the morning. Small amounts of milk that are not required for consumption are soured and later sold. Small stock remain within the village area and are herded fairly carefully. Cattle and small stock are herded on to arable wastes once harvest is complete after which uncontrolled, unsupervised grazing is the norm until the next cropping season.

Some owners of larger cattle herds feed salt and bonemeal as supplements and some maintenance licks over the hardest three months of the dry season but this is exceptional. Small stock are seldom, if ever, supplemented.

Owners of boreholes and privileged friends/relations water their stock at the borehole without payment. Non borehole owners water at small wells until these dry at which time they pay borehole owners for the use of the water. Charges are dependent on herd size.

3.4   Institutions

The Matopi communal lands and grazing areas fall under the jurisdiction of the Tati Land Board, which has its headquarters in Francistown. The Land Board, which comprises Government officials and elected representatives of the community, has the executive authority for allocating land to individuals for arable farming or other uses. The District Land Use Planning Unit provides technical advice to the Land Board on matters of land allocation.

The area is serviced by the Regional Agricultural Office in Francistown and the District Agricultural Office in Tonota. Specialist officers dealing with crop production, horticulture, irrigation, soil conservation and range ecology are based in the RAO office. A forestry project funded by the European Union is supplying 3 forest extension staff based at the Francistown RAO and proposals have been made to government to expand the service through the creation of a number of Forestry Extension Agent posts.

Matopi is located in Matsiloje agricultural extension area and the Agricultural Demonstrator is based in Matsiloje. Due largely to the demands on the AD of administering drought relief, agricultural extension provided to Matopi has been weak.

The Department of Animal Health and Production (DAHP) have a major regional office in Francistown. DAHP is responsible for providing extension in all aspects of livestock husbandry and health through veterinary assistants (VAs). There is a VA responsible for servicing the Matopi area. Technical officers concerned with ranch extension and smallstock are based in Francistown.

The service provides an excellent veterinary input but is understaffed (and loaded with administrative matters) with VAs often having more than the approved 13 crushes to service. Although the intention is to have VAs available within their areas for the majority of the time for extension purposes, the reality is that due to the Regional exigencies, many are away on vaccination programmes for long stretches of time.

Correct utilization and conservation of natural resources, including soils, rangeland and water, is theoretically controlled by the Agricultural Resources Board, which is represented at the District level by the District Conservation Committee (DCC). The DCC comprises Government officials and elected representatives, and the secretary is normally the Land Use Officer, although this post is currently vacant in the Francistown RAO. The Agricultural Resources Conservation Act of 1974 is the statutory instrument available to the DCC to control improper use of land. However, the

provisions of this act are rarely applied to such issues as overstocking and related rangeland degradation.

At the village level, Matopi has a village development committee, but local institutions are otherwise poorly developed.

3.5 Infrastructure

Matopi is a relatively neglected settlement which does not yet have official village status. In the early 1980s the people in the area were encouraged to consolidate their holdings around a single settlement and some basic services were established. This was mainly to enable assistance under the drought relief programme to be channelled more effectively. Matopi is served by a mobile health shop and a children's non formal education group. The nearest schools are in Matsiloje, and the nearest major centres are Tonota and Francistown. These settlements are linked to Matopi via tracks, which sometimes become impassable during heavy rains.

4.   LAND EVALUATION

4.1   Evaluation of capability for major kinds of land use

In order to focus further, more detailed, evaluation on areas with specific potentials, an initial generalised assessment was carried out of land capability for the major land uses of rainfed arable cropping and livestock grazing of varying intensity. Since the study mainly deals with the land suitability for limited agricultural land uses, the suitability for non-agricultural utilization types other than wildlife is not taken into account.

This assessment was made on the basis of soil depth, surface rockiness, gravel content and slope. Soils deeper than 75 cm are considered as potentially suitable for arable cultivation. Shallow rocky land with rolling terrain is considered as only suitable for limited grazing or wildlife utilization.

Four capability classes are recognized, according to the degree of limitation or hazards, for the arable farming and livestock rearing [including smallstock]. Lands with no limitation or hazards for utilization for successful arable agriculture are placed in Capability Class 1. A tract of land having one moderate limitation which could not be easily corrected for arable farming has been placed in Class 2. 2d is an example where the limitation present is insufficient depth of soil. Land Class 3 can have either one severe limitation or two interacting moderate limitations. Land Class 4 has yet more severe limitations. For example, 4td referes to a land unit which is shallow, steep and rocky, and is only suitable for limited dry season grazing.

Table 7 summarises the generalised capability of land units.

Table 7

Generalised Land Capability of Land Units

Land Unit	Land capability class[#]	Land Area (ha)	Capability (most intensive recommended use)
1.	1	702	Rainfed arable cultivation[##]
2a	2d	1,584	Settlements and controlled grazing
2ask	3d	2,151	Controlled grazing
2alp	3d	658	Controlled grazing
2b	3t	595	Controlled grazing
3.	4td	1,005	Dry season controlled grazing
V1	2f	1,124	Controlled grazing
V2	2w	329	Horticulture, fruit trees, poles and fuelwood production, controlled grazing

Notes   # Subscripts indicate limitations as follows:
         d: soil depth/ available water; t: topography; f: flash flood risk; w: drainage / flood risk

         ## Includes some areas also suitable for irrigated cultivation.

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4.1.1. Recommended Land Use for Land Units

Land Unit 1

Previous experience [personal communication, previous owner] has confirmed that the physical and chemical characteristics of the soils of the LU 1 are adequate for good results when utilized for rainfed agriculture. However, suitable crops are limited due to low and erratic rainfall while water availability limits the extent of irrigation development. Land not required for arable cultivation can be used for grazing.

Land Unit 2a

Whilst LU 2a has the limitation of insufficient soil depth for cropping under low rainfall conditions, the crests of this land unit are nearly level and would thus be suitable for settlement areas since they are also well drained. Areas not settled would be suitable for controlled grazing.

Land Units 2ask, 2alp and 2b

These LUs have slopes of 3 to 15 % and the gravelliness and shallowness of the soils, nutrient deficiencies and droughtiness makes this land not suitable for arable production. The slopes indicate a need for caution with regard to stocking rates since the thin soils are highly erodible. Controlled grazing of livestock is therefore the recommended use.

Land Unit 3

Shallow rocky terrain and a rolling landscape with a high risk of further degradation indicate that this unit is suitable for limited grazing only if this were to be strictly controlled. It is recommended that this area be carefully grazed in the dry season only.

Land Unit V1

These shallow valleys could be used for arable agriculture but are, in reality, unsuitable due to their dendritic nature. In addition, removal of the vegetation and cultivation would result in gully formation and topsoil loss since, owing to their water collection function, flow is concentrated in these areas. Controlled grazing of livestock is therefore the recommended use.

Land Unit V2

This LU is composed mainly of riparian areas where there may be a very occasional risk of short term flooding. One area of 56 ha bounded by the Ramokwebana river on one side and the recommended settlement site (Option 1) on the other is considered to have virtually no risk of flooding. Existing vegetation shows that if flooding has occurred, it has not done so over the past decade. Under exceptional rainfall there is some slight possibility, but this is considered so small as to enable recommendation of the area for horticulture and for fruit tree establishment. In addition, riverine areas adjacent to this horticultural site would be suitable for the establishment of a woodlot of 30 ha. The remainder is suitable for controlled grazing.

4.2　Land Suitability for Rainfed Crop based Production systems

4.2.1　Predicted performance of different production systems on Land Unit 1

Crop based production systems are evaluated on Land Unit 1 using the *Crop Yield Simulation and Land Assessment Model for Botswana (CYSLAMB)*. For an introduction to CYSLAMB and an explanation of the structure of the model see ANNEX 1.

In the present study, CYSLAMB was run for 10 production systems which are classified into Farming System *A*, reflecting current management practices and inputs, and Farming System *B*, reflecting possible improved levels of management. The evaluation runs were carried out on LU 1, which is rated as the most capable for rainfed arable cropping, using the climatic data for Tonota over the 27 year period 1959/60 to 1988/89. The characteristics of the production systems tested are listed in Tables 8 and 9, and the results, expressed as dependable and median yields, are presented in Table 10.

Table 8

Crop based Production systems: Farming System A - traditional

Production System Code	Crop	Variety	Plant density (/ha)	No. planting occasions	Weeding (days after planting)
A1S	Sorghum	Segaolane	10,000	3	60
A1Mz	Maize	Kalahari Early Pearl	10,000	3	60
A1MI	Millet	undetermined	10,000	3	60
A1C	Cowpea	undetermined	10,000	3	60
A1G	Groundnut	undetermined	10,000	3	60

Constant factors:　Produce: grain
Irrigation capacity: 0 mm
Irrigation frequency: 0/dekad
Degree of weed infestation: 80% of maximum
Period when early ploughing can occur: OCT1 - NOV3
Soil moisture requirement for early ploughing: 30 mm
Period when planting can occur: DEC3 - FEB3
Soil moisture requirement for planting: 30 mm
Effective rainfall requirement for planting: 30 mm/dekad.
No fertilizer

Table 9

Crop based Production systems: Farming System B - improved traditional

Production System Code	Crop	Variety	Plant density (/ha)	No. planting occasions	Weeding (days after planting)
B1S	Sorghum	Segaolane	30,000	2	30
B1Mz	Maize	Kalahari Early Pearl	15,000	2	30
B1Ml	Millet	undetermined	30,000	2	30
B1C	Cowpea	undetermined	30,000	2	30
B1G	Groundnut	undetermined	30,000	2	30

Constant factors: Produce: grain
Irrigation capacity: 0 mm
Irrigation frequency: 0/dekad
Degree of weed infestation: 80% of maximum
Period when early ploughing can occur: OCT1-NOV3
Soil moisture requirement for early ploughing: 30 mm
Period when planting can occur: NOV3 - FEB3
Soil moisture requirement for planting: 30 mm
Effective rainfall requirement for planting: 30 mm/dekad.
No fertilizer

Table 10

Results of Crop Yield Simulation for Land Unit 1

Production System	Crop	Management level	Yield (kg/ha holding)	
			Dependable	Median
A1S	Sorghum	traditional	90	650
B1S	Sorghum	improved traditional	400	1160
A1Mz	Maize	traditional	0	450
B1Mz	Maize	improved traditional	120	1060
A1Ml	Millet	traditional	60	430
B1Ml	Millet	improved traditional	280	880
A1C	Cowpea	traditional	30	210
.B1C	Cowpea	improved traditional	150	320
A1G	Groundnut	traditional	180	690
B1G	Groundnut	improved traditional	620	880

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The results in Table 7 demonstrate the unreliability of rainfed cropping in the area, particularly if the existing traditional practices of late planting, poor weed control and low plant densities are followed. Even with the projected improvements of planting at the first two opportunities from 21st November, higher crop densities and better weed control, the dependable yields are still low. The apparently good relative performance of groundnut suggests that it could be planted on a trial basis as a possible cash crop.

Current prices of 0.34 Pula/kg for maize and 0.40 Pula/kg for sorghum imply that yields of 530 kg/ha and 390 kg/ha respectively must be achieved to cover the ALDEP estimated production costs of 163.59 Pula/ha for maize and 142.53 Pula/ha for sorghum[1] (ALDEP, 1991). Even if the improved traditional range of practices is adopted, the dependable yield of maize is considerably below that required to break even. Sorghum is more suited to this environment and, given the improved practices, farmers can expect to break even on production costs in approximately 75% of years. The existing traditional cultivation system can only produce sorghum yields high enough to cover costs in good years. Bearing in mind that projected yields may need to be further adjusted downwards due to incidence of pests and diseases, which are not accounted for in the CYSLAMB model, it is apparent that, without subsidies, settlers cannot afford to depend on rainfed cropping alone for their livelihood.

4.2.1   Erosion Hazard on Cropland

Application of the SLEMSA model (Elwell, 1980) to LU 1, using the rainfall/ erosivity relationship defined by Van der Poel (1980) and assuming a soil erodibility of 2.5 (Radcliffe, 1992) and a slope of 1%, gave an estimated average annual soil loss of 8t/ha/yr under a crop of poor maize or sorghum. As this exceeds the anticipated rate of soil formation in the study area, continuous cultivation is likely to result in a small steady depletion of soil depth. Contour ploughing and denser crop stands should reduce this soil loss and may bring it within tolerable limits.

4.3   Land Evaluation for Irrigation

Under semi-arid climatic conditions large scale irrigated agriculture is highly dependent on the availability of water and the crop water requirement. For the selected crop, soil requirements are similar to those for rainfed arable farming as described in Section 4.1.

4.3.1   Availability of Water

Assuming a uniformly shaped river channel with an average width of 150 m, and a depth of 3.5 m of coarse sand with an approximate specific yield of 15% (Wikner, 1980), the yield at full saturation would be 79 000m³/km. A further reduction of 40% could be expected due to the variation of the sandbed thickness, the sand bed properties, the river bed rockiness, and based on the assumption that the real water level in the sand river are on average some 1 m below full saturation. The sand storage volume in the length of Ramokgwebana river section which is accessible to the irrigable portion [ie some 10 km length] amounts to 47 000 m³/km. Therefore an

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[1]   These yields assume 10% harvest losses.

average quantity of 470 000 m³ of water can be expected from this river section during the year for irrigation.

Previous management experiences of Motloutse river basin have indicated that 17 000 m³ irrigation water would be needed to irrigate one hectare of land. Based on the above projection, a maximum area of 28 ha could be irrigated annually.

4.3.2 Availability of Land

The fenced irrigation block of 130 ha was subjected to a medium intensity soil survey as described in Section 2.4.3 (p.7). The soils are related to land units, and the resulting map is illustrated as Map 3.

LU 1 and, to a lesser extent LU V1, have some potential for irrigated agriculture using a sprinkler based system. These units together amount to 112 ha and occur as a continuous area in the central and western part of the block. LU 1 is preferred over LU V1, due to a greater erosion risk and a possible tendency for carbonate accumulation in the latter unit. As the extent of irrigation is limited by water availability, it should be possible to select the deepest soils on LU 1 for development.

Map 3

Land Units of Irrigation Block
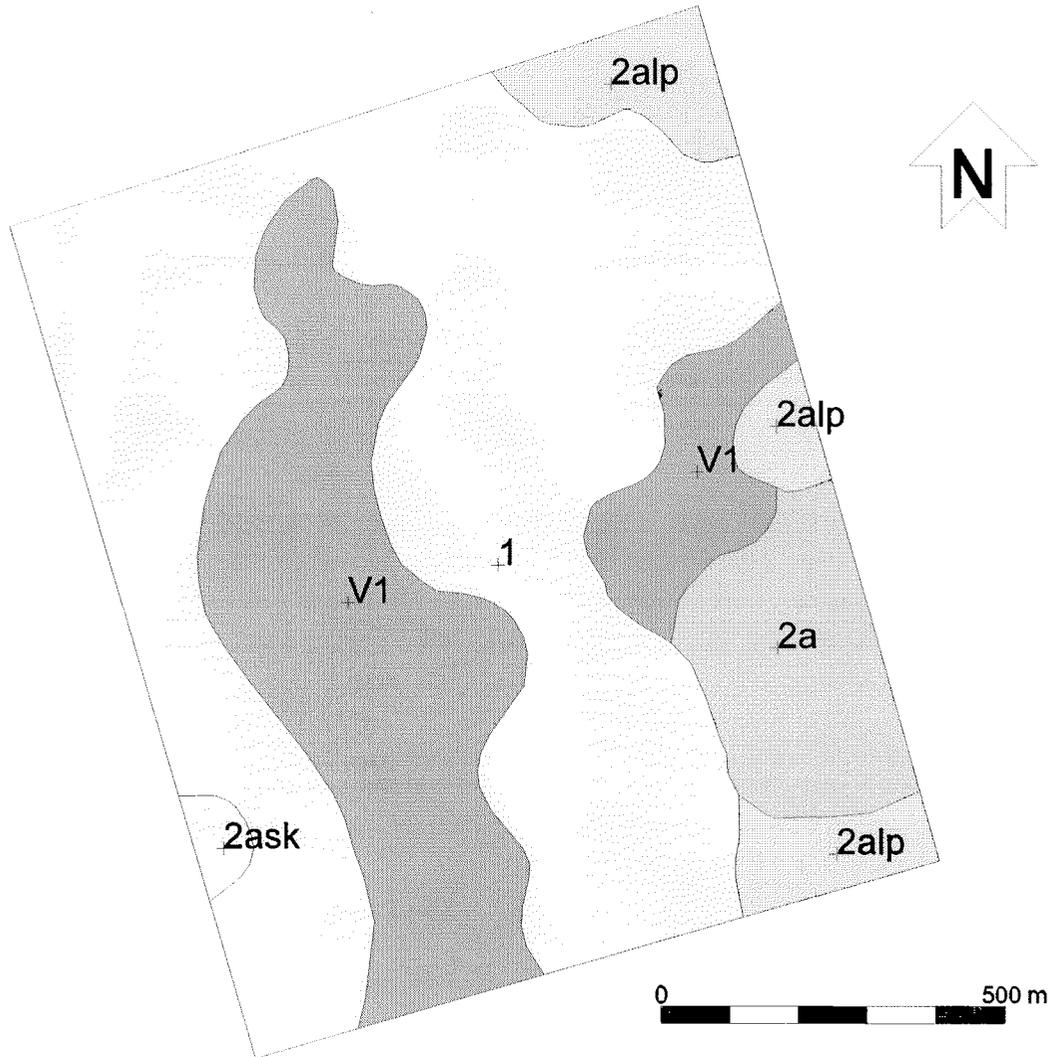
For legend to Land Units, see Table 3 (p.11)

A wide variety of cereals, pulses, oilseeds and subsidiary crops could be grown under supplementary irrigation. Crop choice will largely depend on availability of markets, and, bearing in mind that the irrigation block is recommended for commercial leasing, and is not therefore an integral part of the settlement scheme, a detailed analysis of cropping patterns is not included in the present study.

4.4   Land Evaluation for Livestock Production

As indicated in para 4.1 Land Units 2, 3, V1 and V2 are considered to be suitable for livestock production. Estimates of dry matter production and related carrying capacity are based on field inspections during the 1993/94 rainy season.

Land Unit 2a would yield an average biomass of approximately 900 kg Dry Matter (DM). On a conservative proper use factor (puf) of 50% (take half, leave half) and an expected DM intake (DMI) of 2.5% of empty body weight (11 kg DMI/day) this area could be expected to carry approximately 1 LSU per 10 ha. Although browse production has not been taken into account in calculating the carrying capacity it is felt that this extra forage availability would provide insurance during bad years.

Due to shallower and stony soils, LUs 2alp, 2ask amd 2b would yield an average herbaceous biomass of approximately 600 kg DM. On a conservative puf of 50% (take half, leave half) and an expected DMI of 2.5% of empty body weight (11 kg DMI/day) this area could be expected to carry approximately 1 LSU per 14 ha. Once again it is felt that browse production will provide a buffer against droughty years.

LU 3 is more marginal, and is expected that this land unit would yield an average herbaceous biomass of approximately 400 kg DM. On a conservative puf of 50% (take half, leave half) and an expected DMI of 2.5% of empty body weight (11 kg DMI/day) this area could be expected to carry approximately 1 LSU per 18 ha.

The valley units, V1 and V2 produce a higher level of rangeland biomass and have been estimated to have a carrying capacity of 1 LSU per 7 ha (1,150 kg DM/ha).

If the parts of land unit 1 not required for cropping are grazed, they can be assumed to have a similar dry matter production and carrying capacity to LMU 2a. The arable area actually cropped will yield sufficient stover to give an average carrying capacity of 1 LSU per 7 ha.

4.5   Land Evaluation for Veld Products

The main veld products in this farm are *Grewia* for making local beer, timber for construction purposes and fuelwood, phane and thatching grass.

Grewia flava, though commonly present, is not present in quantities large enough for commercial exploitation.

There is a substantial stand of pure *Colophospermum mopane* in some areas, but very little phane in the farm this year. Our suspicion is that it was over exploited in previous seasons such that

nothing or very little was left to metamorphose. Even though there is no phane this year, the area has the potential to support a substantial amount.

Building and fencing material will be in great demand once people are relocated because most of them cannot afford modern building materials. Therefore it will be necessary to supervise the rate at which trees are cut for this purpose. It would be reasonable to encourage people to use the material cut from those areas recommended for arable farming since they will have to clear these areas in any event.

Fuelwood supplies will be adequate for local use (but not for sale) for a number of years but, dependent upon the siting of the village, will, over time, become scarce in the easily exploited vicinity of the village. For this reason a woodlot has been recommended.

5.   THE LAND USE PLAN

5.1   Spatial Plan

The Land Unit map (Map 2) provides the template for spatial planning of the settlement and associated grazing and arable areas. Land is allocated on the basis of its suitability for the use proposed, and Map 4 labels areas *A* through *E*, which are recommended for specific uses. These areas and their proposed uses are summarised in Table 8.

Table 11

Areas Proposed for Specific Uses

Area Label	Land Units	Proposed Use	Area (ha)
A	1	Rainfed arable cropping	586
Ai	1, 2a, 2ask, 2alp, V1	Irrigated cropping (on LU 1)	130
B	2a	Settlement (alternative 1)#	50*
C	V2	Horticulture and fruit trees	56
D	2a	Settlement (alternative 2)#	50*
E	V2	Woodlot	30
None	2a, 2ask, 2alp, 3, V1, V2	Cattle grazing	7,244

\#   If not used for settlement, the area can be added to the grazing land.
*   Includes area for church, school, clinic, playing fields etc., plus areas for expansion.

Map 4 also shows the proposed fencing layout, the existing road and the proposed spur road, required to achieve the recommended options.

5.2   Rainfed Arable Area

Area A, located on LU 1, which comprises the land recommended for arable cropping, consists of 586 ha. This area should be protected from incursions by livestock by a drift fence, which is indicated on Map 4.

Traditional systems do not generally use all of the available arable area at any one time. It is therefore necessary to allow for some reserve land in deciding the amount for allocation. A total allocation of 10 ha per household is recommended. This assumes a total cultivated area of 5 ha in any one year, and allows a further 5 ha for a fallow. There is therefore an allowance for expansion of cultivated area per family, and perhaps for development of fodder crops, as suggested in livestock option 3 (p. 34). Rotation of the fallow area will help to conserve water and balance nutrient removal by crops, thereby enhancing the sustainability of the farming system.

Map 4

Recommended land use
with proposed fences / paddocks
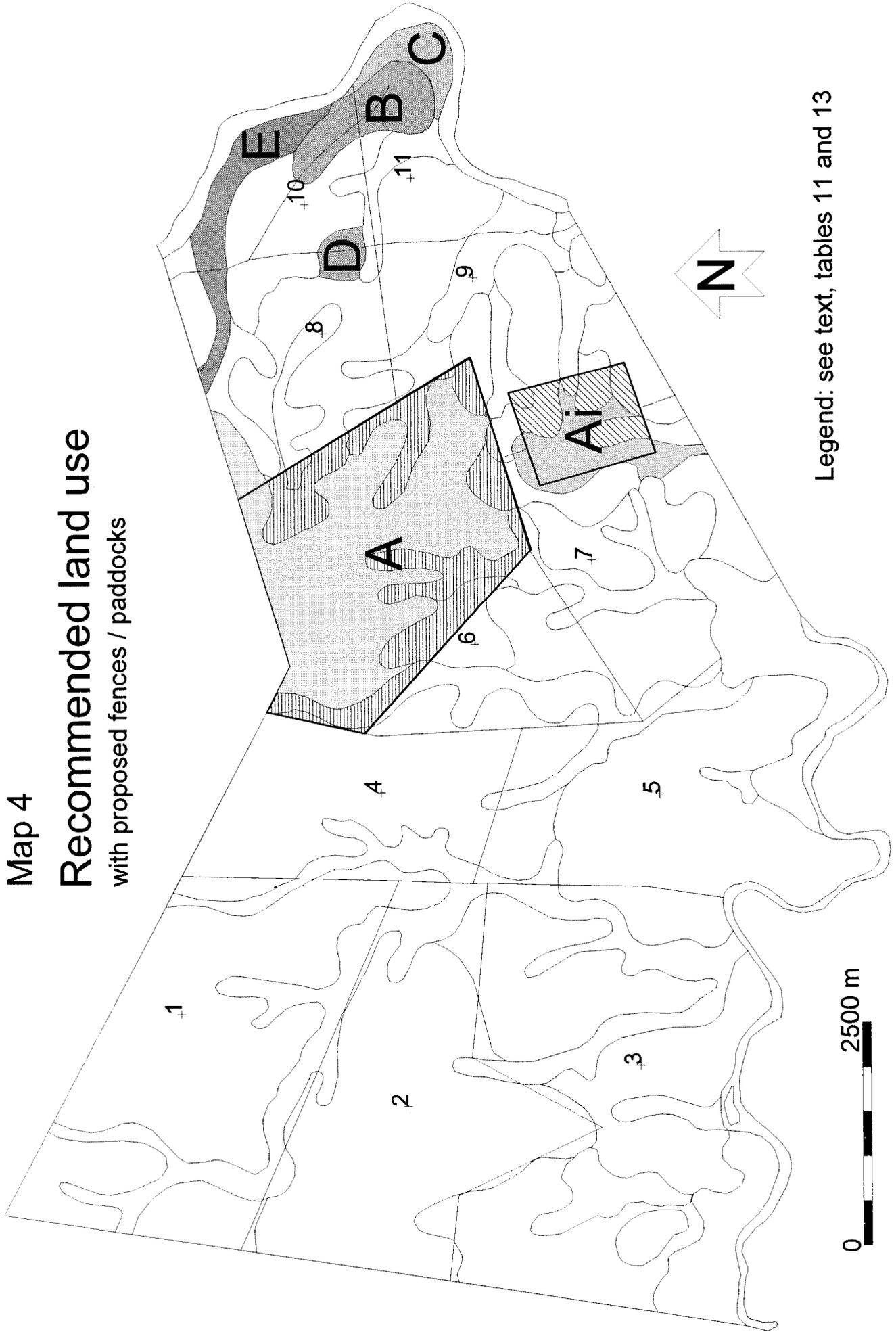
Legend: see text, tables 11 and 13

N

0   2500 m

Allowing a total allocation of 10ha to the current 41 Matopi households, and assuming 5% of **Area A** is taken up by tracks and other infrastructure, 147 ha of **Area A** is available for future expansion of the settlement.

If farmers adopt the recommended 'improved traditional' management system outlined in Section 4.2 (p. 19), which implies taking advantage of the first planting opportunity after November 20th, timely weeding, and a plant density of around 30,000 plants /ha, and plant 5 ha to sorghum in 2 planting occasions, they can expect a dependable yield of 400 kg/ ha, equivalent to a total dependable production of 2000 kg.

Assuming there are no losses due to pests or disease, which are factors not modelled in the *CYSLAMB* assessment of potential productivity, the farmers may be expected to cover their costs of production in approximately 75% of years, but rarely to make any significant profit. However, a more realistic scenario may be to assume some additional loss due to pests, particularly birds or insects. If 25% of the potential yield is lost due to these factors, and a further 10% to post harvest losses, the dependable yield would fall to only 260 kg/ha, giving a total production of 1350 kg.

Table 12

Calculation of Subsistence Ratio based on 5 ha sorghum

Parameter	Quantity	Units
Average Household size	5.44	persons
Annual Calorie requirement[#]	4.28	Cals x 10^6
Sorghum Yield (CYSLAMB predicted)	400	kg/ha
Yield adjusted for pests and post harvest losses	260	kg/ha
Yield adjusted for raw product conversion	230	kg/ha
Calorie content of sorghum	3,400	Cals/kg
Total Calorie Yield	0.78	Cals x 10^6
Total Calorie production from 5 ha	3.91	Cals x 10^6
'Subsistence ratio' (Availability/ requirement)	0.91	

Note [#] : Assumes 4.5 'adult equivalents' each with an annual requirement of 0.95 MCals/ year.

In addition to the questionable financial performance of the production system, the total production of sorghum from 5 ha, taking the lower projection which allows for 25% losses by pests and diseases, is barely sufficient to cover the annual subsistence Calorie requirements of an average household in 75% of years. Table 12 shows the basis of this calculation.

5.3　　Irrigation Area

The previously irrigated area comprises 130 ha of fenced land, located on mainly on LUs 1 and V1. This is labelled as **Area Ai** on Map 4, and is treated as a separate block in the land use plan.

The results of land evaluation indicate that shortage of irrigation water is a more serious constraint to irrigation development than shortage of irrigable land (Section 4.3, p. 21). Although 112 ha have soils suitable for irrigation, the maximum net irrigation area to be developed is 28 ha. Seasonal constraints of water availability may limit cropping to one or two crops per year.

Possible options for irrigation development are as follows:

i)　　　　　to lease the block to commercial interests

ii)　　　　to lease the block to the Botswana Development Corporation

iii)　　　　to divide the block into small units, to be leased separately

iv)　　　　for the Ministry of Agriculture to run the farm, either for seed production or as a tree nursery.

v)　　　　to set up a community managed scheme, run by Matopi residents, with the support of the Ministry of Agriculture.

It is recommended that the Land Board leases the block to commercial interests or to BDC (options 1 or 2 above) for the following reasons:

-　　　　　Although some of the irrigation works are still in place, considerable damage has occurred due to neglect over the past three years when the farm was unoccupied.

-　　　　　The knowledge and experience of the villagers in irrigated farming is low. Some villagers, particularly women, had previously worked as labourers on the irrigated plot when the farm was commercially run, but they have little or no experience of how to organize and manage an irrigation scheme.

It follows that if options iii, iv or v were chosen, considerable Government investment would be required to rehabilitate the irrigation works. The marginal availability of water may hinder equitable distribution if option iii is selected, and the Ministry of Agriculture has not expressed interest in option iv. If irrigation was developed as a community managed project (option v), MoA would need to employ a manager to coordinate and run the project, at least in the short to medium term, and to step up the level of extension support to individual farmers. A study of potential markets would be essential to define economic feasibility and to select cropping patterns.

It is considered that the possible social advantages of option v are outweighed by the economic uncertainties and by the additional costs to government. Leasing the plot out to a commercial farmer is a simpler and possibly more viable alternative, provided an interested lessee with experience in irrigated farming can be found. The commercial irrigated farm would then provide a source of employment to villagers, as was the situation under the previous farm ownership. The

revenue from the lease would accrue to the Tati Land Board. The possibility of redirecting some of the benefits to the village could be investigated.

The actual irrigation layout, plot distribution and cropping patterns depend on the option selected. Detailed consideration of cropping patterns and the technical and economic aspects of irrigation is beyond the scope of this report.

5.4   Settlements

The Land Board have identified a prospective settlement site and some plot delineation has already taken place (**Area D**,Map 4). Inspection of the area indicates that there is a second option (**Area B**) which may be preferable from economic and social aspects. The comparative advantages and disadvantages of both options are described below.

Area B is located on a 99 ha block of LU 2a land situated near to the Ramokgwebana river. 50 ha of this should be delineated as the settlement area. For 41 families this would be more than sufficient assuming the homestead area of 900 m² prescribed by the Land Board (Tati Land Board, personal communication). It would also allow for expansion to over 100 families and areas for school, clinic and church facilities. The proximity of the Zimbabwean village of Manehge may be a factor in deciding whether to adopt this site.

Advantages of the site are:

- That it is close to the Ramokgwebana river. Should there be a breakdown in the borehole supply, water is close and can be carried to the village.

    That 56 ha of LU V2 (**Area C**) or part of it, lying between the potential settlement site and the Ramokgwebane, may be used for the production of vegetables and fruit trees. A basic unit of 0.10 ha would produce ample vegetables for a family. Since it is so close to the recommended settlement area crops can be protected against game.

    That, over time, this horticultural enterprise could expand to a small scale cooperative business venture.

    That 30 ha of LU V2 (**Area E**) lying between the potential settlement site and the Ramokgwebana, may be used for the production of poles and fuelwood (woodlot).

Disadvantages are:

    That a spur road, marked on Map 4, from the existing Matsiloje - Matopi track for a distance of 6 km would need to be constructed, at an estimated cost of P150,000 on the crest of the ridge and maintained annually at an estimated P3,600.

    That the settlement site is at a distance of 4km from the lands area.

Area D is within LU 2a and is the area on which the settlement site has already been demarcated. Advantages of this area over that recommended are:

That the existing Matsiloje - Matopi road runs to the site and there would thus be no need to construct a spur road.

That the distance from the lands area is 2.5 km thus reducing the distance by 1.5 km.

Disadvantages are:

It is unlikely that a horticultural enterprise would evolve since the area suitable for this lies 1.5 km from the settlement site in the opposite direction to the lands and little protection could be given to the garden crops against monkeys and warthog or other depredations.

That the establishment of a woodlot is unlikely so far from the centre of use.

5.5 Horticulture

Area C (56 ha), situated on LU V2 in the curve of the Ramokgwebana river, is recommended for horticultural use (vegetables and fruit trees). The suggestion for the horticultural component is that any person wishing to avail themselves of the opportunity to create a vegetable garden be allocated a plot of approximately one tenth of a hectare. This is sufficient to grow vegetables for a family and, if managed properly, will yield sufficient for a small surplus for sale. In the first instance the availability of water carried from the Ramokgwebana will merely extend the wet season allowing the production of fresh vegetables into the dry season. Some of **Area C** can be replanted with fruit trees, but the community needs to be advised so that they are aware of the reasons for tree planting, and the husbandry of both trees and horticultural crops. Once established after 3 or 4 years, the fruit trees will have tapped the subsoil water and will require no further irrigation.

Once some expertise has been acquired it is hoped that, with the encouragement of the Horticultural Officer, hand dug wells on the banks of the Ramokgwebana will be used with a small motorised pump to extend the season still further and lead to the production of a marketable surplus. Formation of a producer co-operative would be the logical next step.

5.6 Woodlot

It is important both from the viewpoint of rangeland conservation and from a social viewpoint that the area close to the settlement is not denuded of vegetation in the quest for firewood, as the Matopi village area has been in the past. Although the existing bush will be adequate for some time, it is apparent that the first areas to be denuded will be close to the settlement area and where the available fuel wood grows most abundantly. This is along the Ramokgwebane river, particularly in the curve of the river (LU V2) where **Area C** and, further upstream, **Area E** have been delineated. The replanting of 30 ha of **Area E** to a woodlot would provide a sustainable source of poles and fuel.

Metro (1955) indicates that *Eucalyptus camaldulensis* tolerates periodic flooding but that it requires a minimum rainfall of approximately 700 mm in summer rainfall areas with a severe dry season. However with subsoil moisture availability, as there would be at the suggested site, this amount

of rainfall could be reduced. *E. camaldulensis* has little tolerance to high pH but near neutral values are anticipated from analysis of similar sites.

A 10 year period will be required before the first harvest can be carried out. The area should then be clear felled, at just above ground level, and the poles carted off the site and stored. Piecemeal felling is not recommended since it damages coppice growth. For this reason it is considered preferable to plant up 3 ha each year for a 10 year period and harvest each area in turn. Coppice growth should be left for two years when the two strongest leaders on each bole should be selected and the remainder discarded.

Production from each 3 ha plot will be of the order of 60 cu metres (approx 60 tonnes) per 10 years which should be sufficient for community use. It is expected that the population (especially the women) will not be difficult to persuade to establish a woodlot since they have had experience now of the increasing difficulty, and distance, of supply of this essential commodity. Discussions with the headman indicate that communal labour could be expected for the establishment of a woodlot.

5.7   Smallstock

The remainder of LUs 2a, 2ask, 2alp, 2b, 3, V1 and V2, totalling 7,244 ha, are considered suitable for livestock production at the stocking rates indicated. Allowance has been made within the cattle planning for sufficient rangeland to adequately support existing smallstock numbers. It is not expected that the smallstock numbers will appreciate overmuch since these are maintained as a source of meat and for immediate cash needs rather than as a commercial enterprise. Despite this, numbers should be monitored and, should they rise appreciably, would need to be controlled.

In addition, the smallstock are predominantly goats which, by preference, are browsers. Whilst this provides a balance with the cattle which are predominantly grazers, the management systems for cattle and smallstock differ to the extent that the smallstock are mainly confined to areas around the village whilst the cattle graze, during the growing season, within the designated grazing areas. This leads to a situation whereby the areas around the village are overutilised by a large number of small stock who effectively kill out all browse up to a height of 1.8 metres, and then are forced to do the same to the herbaceous layer. This can be seen around the Matopi cattle post area. Conversely, if overstocking of the cattle grazing areas is allowed, the cattle will kill out the grass in those areas allowing bush encroachment and the pattern of grass under bush and bare spaces between is established. It is apparent therefore that range would benefit from running the smallstock and cattle together in a number which the range can support without degeneration.

Expected production from the smallstock flock will be around a 68% kidding which was the average birth rate from 1978 - 1988 inclusive (MoA, Farm Management Survey results, 1988). Approximately half the flock would be breeding females which, based on the reported Matopi numbers of 903 head would give an annual production rate of 614 kids. Of these approximately 18% would die leaving a total of 503 kids and culls for consumption over the year. Cull animals would be replaced by young females.

5.8   Cattle

Three possible systems are projected for the cattle enterprise. All are financially viable, and economic indicators as to their performance are given in Table 10, and full calculations of herd projections and monetary flows are given in ANNEX 2. All make allowance for the small stock and

donkey populations reported as belonging to Matopi village community. In basic terms all systems would use the following procedures of generalised management the differences would be in terms of control of grazing.

System 1: Low input/existing management and uncontrolled stocking options

The first projection simulates grazing of the total stock numbers at present using the Matopi cattle post grazing area, i.e. no controls are imposed by either the village authority or the District Conservation Committee and stock numbers are allowed to rise to the level at which they are limited by rangeland primary production. Under this system calvings are lower, mortality higher and equilibrium production occurs with range degradation a natural corollary.

The system is however, the most immediately profitable, returning a Net Present Value (NPV) at 15% of P184,298 including salvage value of the herd. Since the Net Benefit Stream never becomes negative it is not possible to calculate a Financial Internal Rate of Return (IRR) The system also requires negligible inputs and capital resources. Loss of cattle is high, especially in drought years. If no interventions are made this is the system which will be practised since it is unlikely that the community has the necessary resources to support a less environmentally destructive system.

System 2: Medium input/management and controlled stocking option

System two is medium level. It entails control of stock numbers through fencing but does not maximise stocking rates by using the arable area, except for stubble grazing. Investment costs are only slightly lower than under system two but operating costs are considerably lower since there is no preparation of land or input costs for a forage legume. Stocking levels are lower enabling the stock belonging to Matopi vilage plus a further 350 head of cattle to be kept.
The system is straightforward, requires medium level management skills, shows an NPV of P 213,144 at 15% and a financial IRR of 31%.

It is suggested that the fencing layout as depicted in the Proposed Land Use map (Map 4) map be followed. The following stocking rates (Table 13) are considered safe under normal rainfall conditions. For a detailed account of land units per proposed paddock see ANNEX 3.

Table 13

Recommended stocking rates for the proposed paddocking system

Paddock	Area	LSUs	Paddock	Area	LSUs
1	1039 ha	94	2	901 ha	60
3	1329 ha	108	4	522 ha	55
5	711 ha	60	6	319 ha	33
7	513 ha	47	8	494 ha	53
9	460 ha	47	10	280 ha	28
11	292 ha	33	Total	6860 ha	618

System 3: High input/management and controlled stocking option

System three is based on utilisation of the fallowed arable areas by including them as leguminous forage areas in a rotation. Thus each year there would be an area of a drought resistant forage legume such as Siratro (*Macroptilium atropurpurium*) or Townsville Lucerne (*Stylosanthes humilis*) and one of arable cereals. The leguminous forage areas would be cut or lightly grazed by milking cows and weaker animals as a high protein supplement in the driest part of the year. This would encourage the intake of poorer quality roughage from browse and dried grasses. After three years the forage area would be ploughed and used for arable cropping whilst the old arable area would be put down to a forage legume.

Stock numbers would consist of those animals directly associated with Matopi village plus a further 500 head of cattle which could be accomodated within the area. The area would need to be boundary fenced and paddocked at a cost of about P74,000 spread over two years. This would be necessary to protect the arable lands against encroachment by the cattle, to control use of the forage legume and to control encroachment by non-participating stock. In addition the cost of planting each year, one quarter of the arable area, to a forage legume is high; P17,000 on average each year. Costs are shown to rise as an increased area of arable land is opened over time.

Although it is almost certain that there would be an improvement in crop yields from the nitrogen fixation by the forage legume over the three year periods and from the increase in available phosphorus from the single supers applied at planting of the legume, this has not been shown as a benefit since it is difficult to quantify.

The system is complex, requires a high level of management skills, resources and control. Returns from the system improve over a long period and it can support a higher level of stocking on the same area. The major drawbacks are that the profitability levels rise extremely slowly (the first three years show an operating loss) until livestock performance improves to provide an adequate return. In addition the level of investment is high. The Financial IRR is 19%.

An overview of the economic indicators for each system is given in Table 14.

Table 14

Financial Indicators for different Livestock Options

Indicator	System 1: Low input/ existing management, uncontrolled stocking	System 2: Medium input/ medium management, controlled stocking	System 3: High input/ high management, controlled stocking
Net present value @ 15% (Pula)	184298	213144	168424
Financial Internal Rate of Return (%)	Not calculable	31%	19%
Annual Income at full production (Pula)	2002	54094	49341
Income per family (41 families) at stable production (Pula)	49	1319	1203

Within the livestock production area existing fencing is shown on Map 2. The boundary fence is in poor condition and will need replacement. This should be based on shared costs between the resettlement area and Mr. Strauss on the one side, Mr. Blackbeard on the other and a portion exclusively for the resettlement area. Should the second option be chosen for the livestock management system there will be a need to divide the arable area into four more or less equal areas in order to arrange a forage legume/arable 4 year rotation. Costs for appropriate fencing have been included in the projections.

Control of livestock numbers should be vested in the village authority with a supervisory role being adopted by the District Conservation Committee. In order to control stocking rates three requirements will need to be met:
- Firstly that the livestock grazing the area be restricted to those animals owned by the Matopi community and invited participants, whilst livestock owned by other communities graze elsewhere. This would reduce the total pressure on the area to an approximate 398 LSUs, based on the 1993 Department of Animal Health and Production (Francistown) figures, plus a further number as indicated in the annex.
- Secondly that boundary fencing is renewed and maintained to reduce encroachment by neighbouring cattle and that internal fences are modified and maintained in order to control the movement of livestock within the system.
- Thirdly that range condition is reviewed over time and cattle, small stock and donkey numbers adjusted in the light of these findings.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1   Conclusions

The purchase of farms 25/77 NQ and 27/77 NQ provides adequate land to compensate the Matopi villagers for the loss incurred due to construction of the Lower Shashe dam and flooding of the reservoir. A fenced block of 130 ha with irrigation works is also included within the purchased area. The farms are located adjacent to the present communal grazing area of Matopi, and are subject to similar constraints of climate and soils. Suitable areas for settlement, rainfed cropping, livestock grazing and limited fuelwood and horticultural development exist within the farms. Rainfed cropping is very marginal due to drought risk, and cannot serve as the sole means of household livelihood. It is important, therefore, that each household has access to alternative sources of income, such as cattle, smallstock, a horticultural plot or wage labour.

The present settlement comprises 41 households and does not have official village status. Current standards of crop and livestock husbandry are low and the grazing land around the village is severely degraded. Most of the households are heavily dependent on Government drought relief schemes for their survival.

Bearing in mind the generally poor levels of technical ability and motivation of the Matopi farmers, effective extension is important if land use is to improve in a sustainable way on the new settlement area. However, due largely to the competing demands of drought relief and other administrative matters (Section 3.4, p. 15) extension to Matopi village has been weak.

It is against this background of physical and socio-economic constraints, and overstretched extension services that the recommendations which comprise the land use plan are drawn up. Selection of a given option must depend not only upon its technical feasibility but also upon the management abilities and support services available to the implementors. All the options given are technically feasible, however the management abilities of the community are confined to those areas within which they have had past experience, which may be described as basic traditional. In order to be able to extend this experience it is necessary to have improved methods of production demonstrated to them.

6.2   Recommendations

Recommendations are described as sectoral components of a farming system. Livestock grazing, rainfed crop production and settlement are the essential components of the system. Settlers are also offered opportunities for cultivation of small scale horticultural plots, and a communally managed woodlot is recommended for supply of building poles and fuel on a sustainable basis. The irrigation block should be offered for commercial leasing and is thus excised from the land use plan.

Rainfed Arable Cropping

A gross area of 586 ha (**Area A**, Map 4, p 27), located in the north-central part of the farm on LU 1, is identified for rainfed arable cropping. Each household should be allocated a 10 ha plot, on the assumption that 5 ha of this will be cultivated in any one year, and the remainder fallowed on a rotational basis. Sorghum is the most suitable cereal crop and should be the staple, with smaller areas planted to beans, cowpeas, melons and other subsidiary crops. Farmers should plough early, using oxen or donkeys, and should aim to plant at least half of their cultivated field at the first climatically determined planting opportunity after 20th November. Planting should be in rows in order to obtain an even density and to facilitate weeding, which should be carried out in a timely manner. The arable area should be enclosed within a drift fence.

Settlement

Two possible settlement sites are identified. One site (**Area C**, Map 4, p 27) is near the Ramokgwebane river and potential horticultural and woodlot areas. However, a new 6 km access road would need to be constructed to this site. The other site (**Area D**) is closer to the proposed arable area and would not require a new access road, but is further from the proposed horticultural and woodlot sites. The Land Board has prescribed a 30 x 30 m residential plot for each household.

Cattle

It is possible that with sufficient "top-down" interest in the resettlement a sustainable and profitable livestock package could be evolved with the co-operation of the community.

System two (Section 5.8, p 33 and Tables 13, p 34 and 14, p 35) is recommended for cattle since this combines ease of management, is less environmentally damaging, has an extremely good IRR, and has lower resource requirements. This last component is important since it is unlikely that the community has extensive financial resources even to the extent of being able to fund the fencing component. If this is not supplied by government therefore, the likelihood is that the system used will be system 1 with its attendant degradation of the localised natural resources. This is, of course, a form of environmental blackmail, but pragmatically cannot be avoided. It is felt reasonable however that if government supplies fencing in order to conserve the environment of its citizens, those same citizens should undertake to control stock numbers and to manage the environment as sensitively as possible. The control of stock numbers is therefore a priority and the supply of fencing with no attendant controls is a total waste of resources both financial and environmental.

It is not envisaged that the community will immediately appreciate the advantages of stock controls and woodlots. Unless there is a possibility of regular livestock and forestry extension to convince the community of the need for these components and backup from the Tribal Authority, neither will occur. If it is decided that extension personnel are not available or that neither the Tribal Authority nor the District Conservation committee are able to control stock numbers then the recommendation must be that the system to be adopted should be system 1 with no fencing supplied by

government. If this is the unavoidable choice then it must also be accepted that the cost will be, over time, considerable environmental degradation.

Woodlot

A strip of alluvial land alongside the Ramokgwebane River is identified as a woodlot site (**Area E**, Map 4, p 27). This woodlot is required to provide a sustainable supply of poles and fuelwood, and to prevent the denudation of natural trees, such as has occurred in the vicinity of the present settlement. 30 ha should be planted to *Eucalyptus camaldulensis* at the rate of 3 ha per year. After a 10 year establishment period, each 3 ha plot should be clear felled. Coppice growth can be harvested after a further 2 year period.

Horticulture

The alluvial area within the meander of the Ramokgwebane River (**Area C**, Map 4, p 27), close to the **Area B** settlement site, is assigned for small scale horticultural development. Fruit trees and fresh vegetables can be grown, initially for home consumption. 0.1 ha plots will be allocated to interested households.

Smallstock

Numbers of small stock should be kept constant relative to the present flock. This would supply a regular offtake of around 500 animals for home consumption or sale. Rather than using the present system of grazing smallstock near the village, cattle and smallstock should preferably be run together for a more effective utilization of the range.

Irrigation Block

The 130 ha fenced block containing the irrigation infrastructure should be let on a commercial lease. The revenue from the lease would accrue to the Tati Land Board, and the commercial irrigated farm should provide a possible source of wage employment for the settlement.

REFERENCES

Arable Lands Development Programme (ALDEP), 1991. Final Report of Agronomist. Ministry of Agriculture, Gaborone.

Elwell, H.A., 1980. A soil loss estimation technique for southern Africa. Proceedings 'Conservation '80', Silsoe, Beds., U.K.

FAO, 1990. Soil Map of the World. Revised Legend. World Soil Resources Report 60 (Reprinted). FAO/UNESCO/ISRIC. Rome, Italy.

Metro, A. 1955. Forestry and Forests Products Studies no 11. FAO, Rome, Italy.

Radcliffe, D.J. 1992. An approach to the assessment of sheet erosion hazard on cropland in Botswana. FAO/ Govt. of Botswana Project TCP/BOT/0053 *Land Resource Assessment for Agricultural Land Use Planning* Field Document 4, Ministry of Agriculture, Gaborone.

Radcliffe, D.J., Venema. J. and De Wit, P.V. 1990. Soils of North Eastern Botswana. UNDP/ FAO/ Government of Botswana Project BOT/85/011 *Soil Mapping and Advisory Services*. Field Document 17. Ministry of Agriculture, Gaborone.

Snowy Mountains Engineering Corporation (SMEC), 1990. Feasibility/ Preliminary Design Study, Lower Shashe Dam. Summary report and Environmental Impact Study. Min. Mineral Resources and Water Affairs, Gaborone.

Van der Poel, P. 1980. *Rainfall erosivity and its use for soil loss estimation*. Soil Conservation Section, Ministry of Agriculture, Gaborone.

Wikner, T. 1980. Sand Rivers of Botswana: A reconnaissance of the major sand rivers. Department of water Affairs, Gaborone. Vol. 1, 40pp.

ANNEX 1:

INTRODUCTION TO THE

CROP YIELD SIMULATION
AND
LAND ASSESSMENT MODEL FOR BOTSWANA
(CYSLAMB)

INTRODUCTION TO CYSLAMB

The structure of CYSLAMB is illustrated in Figure 1. The characteristics of the selected land units (effective rainfall and synoptic meteorological data, soil and weed characteristics) and production systems (crop characteristics, target plant densities and management practices) are read from separate databases. Using this input data, CYSLAMB then simulates crop biomass production and yield for every year required by the run.
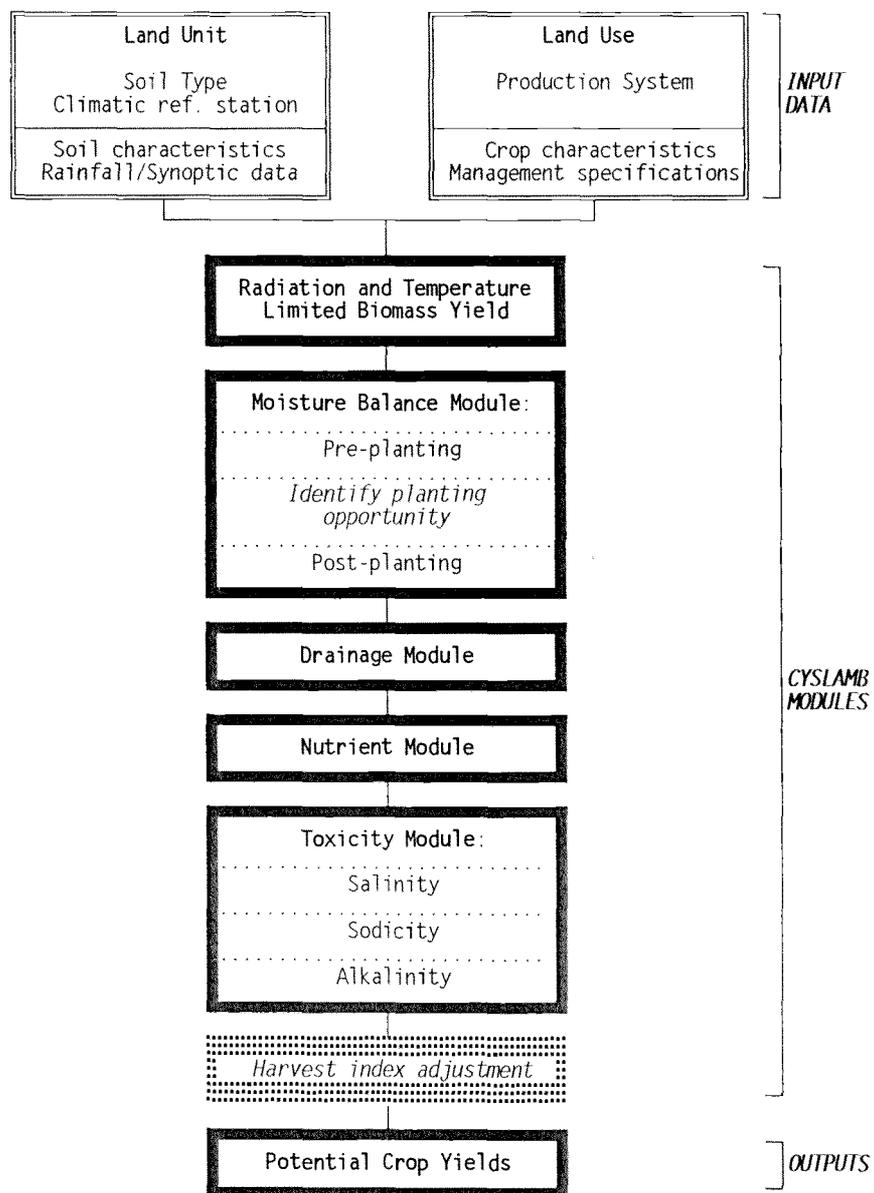
Figure 1: CYSLAMB Structure

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CYSLAMB first calculates what would be the maximum possible biomass yield for the crop under the specified management conditions if there are no constraints due to soils or rainfall. This theoretical maximum yield is determined by solar radiation and temperature. The model then sets up a moisture balance from the first dekad 10 day period) of each hydrological year (1st - 10th September is normally chosen in Botswana), taking into account incident effective rainfall, bare soil evaporation or weed evapotranspiration and water losses due to percolation or run-off. Criteria for the definition of a planting opportunity are defined based on effective incident rainfall and stored soil moisture. When these criteria are met, the crop/soil water balance is then simulated through the crop growth cycle, and periods of moisture stress are accounted for in the calculation of the moisture limited biomass yield. The moisture limited yield is then adjusted to take account of the effects of drainage conditions, nutrient supply and toxicities. The biomass yield is converted to the yield of economic product by the harvest index.

The resulting yields reflect the production on the specified soil type under the climatic conditions prevailing in that particular year. If the model is run over a number of years the outputs can be analysed statistically to give estimates of the yield exceeded at stated levels of probability and the risks of crop failure. Dependable yields (surpassed in 75% of years) and median yields (surpassed in 50% of years), give useful indices on which to base land suitability.

ANNEX 2:

HERD PROJECTIONS AND MONETARY FLOWS
FOR THREE CATTLE ENTERPRISE SYSTEMS

SYSTEM 1:

LOW INPUT/EXISTING MANAGEMENT

AND UNCONTROLLED STOCKING OPTION

Botswana Ministry of Agriculture
Department of Crop Production and Forestry
Land Utilisation Division

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
Low Input/Existing Management and Uncontrolled Stocking Option
Herd Projection

Date: 13-Aug-95

Parameter	Value
Length of Growing Season	120 days
Total Grazable Area	7115 ha
New Pasture Utilisation	100% (in first year of production)
LSU (Livestock Unit)	500 kg
Residual herd value	P'000s 152 units 850
Maximum number of breeding cows	No limit
Minimum size purchased fattener herd	20 head
Maximum size purchased fattener herd	0.0 head
Market price of milk/litre	0.9 Pula
Market price of sour milk/litre	3.5 Pula
Reduction Factor, Fresh to Sour	0.3

STOCKING DATA

(Values shown are TLU / LSU per year. Hectare columns in the original show the land-unit hectares under "Total ha".)

	Carrying capacity ha/LSU	Total ha	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10 on
LU 2a	10	1543	159	157	155	154	154	154	154	154	154	154
LU 2 alp, 2 ask, 2b	14	2997	214	214	214	214	214	214	214	214	214	214
LU 1, V1, V2	7	1388	198	198	198	198	198	198	198	198	198	198
LU 3	18	932	52	52	52	52	52	52	52	52	52	52
Arable Wastes LU 1	7	255	29	32	35	36	36	36	36	36	36	36
Rotational Forage	4	0	0	0	0	0	0	0	0	0	0	0
Total ha		7115										
Total LS U's available			652	653	654	654	654	654	654	654	654	654
Less requirement for smallstock			312	312	312	312	312	312	312	312	312	312
Less requirement for donkeys			72	72	72	72	72	72	72	72	72	72
LSUs available for cattle			268	269	270	270	270	270	270	270	270	270
Area developed as a %			78	78	78	78	78	78	78	78	78	78
Overall carrying capacity			11	11	11	11	11	11	11	11	11	11

TECHNICAL COEFFICIENTS

	Existing	Year 1–15	Year 16	Year 17	Year 18	Year 19	Year 20
Calving %	33	33	38	43	43	43	43
Mortality rate(%) – Adults	10	10	9	8	8	8	8
– Calves	15	15	14	13	13	13	13
– Purch. Fatteners	5	5	5	5	5	5	5
Milk Offtake – litres/cow/day		2	2	2	2	2	2
– lactation (days)		100	100	100	100	100	100

MANAGEMENT FACTORS

	Existing	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7 – Year 20
Culling % – Bulls	10	10	10	10	10	10	10	10
– Breeding cows	5	5	7	8	10	13	13	13
– Heifers	5	5	5	7	8	9	10	10
Bull joining rate (Cows/Bull)	20	20	20	20	20	20	20	20
Age at Bulling – Heifers	2	2	2	2	2	2	2	2
Age at sale Bulls/Steers (years)	4	4	4	4	4	4	4	4
Age at sale Cull heifers (years)	3	3	3	3	3	3	3	3
Age at sale Breeding heifers (years)	3	3	3	3	3	3	3	3

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HERD COMPOSITION & BUILD UP	LSU	Value (Pula)	Existing Stock	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
1. Breeding cows	0.9	700																	
On hand at beginning of year			565	544	526	500	465	424	388	356	326	299	274	250	229	210	193	176	163
Less culls carried 9 months			28	27	37	50	60	55	50	46	42	39	36	33	30	27	25	23	21
Plus purchases			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plus replacement heifers			67	67	67	67	66	62	58	52	48	44	40	37	34	31	28	26	25
Total breeding cows			604	584	556	517	471	431	396	362	332	304	278	254	233	214	196	179	167
Less deaths			60	58	56	52	47	43	40	36	33	30	28	25	23	21	20	16	13
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			544	526	500	465	424	388	356	326	299	274	250	229	210	193	176	163	154
Average LSUs for year			517	482	462	434	400	365	335	307	281	258	236	216	198	181	166	153	143
2. Breeding bulls	1.1	800																	
On han Milk Sales		600	30	27	26	25	23	22	20	18	16	15	13	13	12	11	10	9	8
Less culls			3	3	3	3	2	2	2	2	2	2	1	1	1	1	1	1	1
Plus purchases			2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plus replacements			1	5	5	4	3	2	2	2	3	2	2	1	1	1	1	1	1
Total breeding bulls			30	29	28	26	24	22	20	18	17	15	14	13	12	11	10	9	8
Less deaths			3	3	3	3	2	2	2	2	2	2	1	1	1	1	0	0	0
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	8	7
On hand at end of year			27	26	25	23	22	20	18	16	15	13	13	12	11	10	8	8	8
Average LSUs for year			31	29	28	26	25	23	21	19	17	15	14	13	12	10	9		
3. Heifer calves	0.2	100																	
Born during year			98	98	95	91	84	77	70	65	59	54	49	45	41	38	35	32	33
Less deaths			15	15	14	14	13	12	11	10	9	8	7	7	6	6	5	4	4
On hand at end of year			83	83	81	77	71	65	59	55	50	46	42	38	35	32	30	28	29
Average LSUs for year			20	20	20	19	18	16	15	14	12	11	10	9	9	8	7	7	7
4. Bull calves	0.2	100																	
Born during year			98	98	95	90	84	76	70	64	59	54	50	45	42	38	35	32	34
Less deaths			15	15	14	14	13	11	11	10	9	8	8	7	6	6	5	4	4
On hand at end of year			83	83	81	76	71	65	59	54	50	46	42	38	36	32	30	28	30
Average LSUs for year			20	20	20	19	18	16	15	13	12	11	10	9	9	8	7	7	7
5. Heifers 1–2 years	0.5	300																	
On hand at beginning of year			83	83	83	81	77	71	65	59	55	50	46	42	38	35	32	30	28
Less deaths			8	8	8	8	8	7	7	6	6	5	5	4	4	4	3	3	2
On hand at end of year			75	75	75	73	69	64	58	53	49	45	41	38	34	31	29	27	26
Average LSUs for year			36	36	36	35	33	30	28	25	23	21	20	18	16	15	14	13	12
6. Steers 1–2 years	0.5	300																	
On hand at beginning of year			83	83	83	81	76	71	65	59	54	50	46	42	38	36	32	30	28
Less deaths			8	8	8	8	7	7	7	6	5	5	5	4	4	4	3	3	2
On hand at end of year			75	75	75	73	68	64	58	53	49	45	41	38	34	32	29	27	26
Average LSUs for year			36	36	36	35	32	30	28	25	23	21	20	18	16	15	14	13	12
7. Heifers 2–3 years	0.7	400																	
On hand at beginning of year			75	75	75	75	73	69	64	58	53	49	45	41	38	34	31	29	27
Less deaths			8	8	8	8	7	7	6	6	5	5	5	4	4	3	3	3	2
Replacements to breeding herd			67	67	67	67	66	62	58	52	48	44	40	37	34	31	28	26	25
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			25	25	25	25	25	23	22	20	18	17	15	14	13	11	10	10	9
8. Steers 2–3 years	0.7	350																	
On hand at beginning of year			75	75	75	75	73	68	64	58	53	49	45	41	38	34	32	29	27
Less deaths			8	8	8	8	7	7	6	6	5	5	5	4	4	3	3	3	2
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			67	67	67	67	66	61	58	52	48	44	40	37	34	31	29	26	25
Average LSUs for year			48	48	48	48	47	43	41	37	34	31	29	26	24	22	21	19	18

HERD COMPOSITION & BUILD UP

	LSU	Value (Pula)	Existing Stock	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
9. Heifers 3–4 years	0.9	700																	
On hand at beginning of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less culls sold start of year	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less deaths			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacements to breeding herd			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less sales as breeders			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10. Steers 3–4 years	0.9	400																	
On hand at beginning of year			67	67	67	67	67	66	61	58	52	48	44	40	37	34	31	29	26
Less deaths			7	7	7	7	7	7	6	6	5	5	4	4	4	3	3	3	2
Less replacements to breeding bulls			5	5	5	4	3	2	2	2	3	2	2	1	1	1	1	1	1
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			55	55	55	56	57	57	53	50	44	41	38	35	32	30	27	25	23
Average LSUs for year			55	55	55	55	56	55	51	49	43	40	37	34	31	29	26	24	22
11. Steers 4–5 years	1.1	450																	
On hand at beginning of year			55	55	55	55	56	57	57	53	50	44	41	38	35	32	30	27	25
Less deaths			6	6	6	6	6	6	6	5	5	4	4	4	4	3	3	2	2
Less sales			49	49	49	49	50	51	51	48	45	40	37	34	31	29	27	25	23
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			30	30	30	30	31	31	31	29	28	24	23	21	19	18	17	15	14
12. Steers 5–6 years	1.1	500																	
On hand at beginning of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less deaths			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. Steers 6–7 years	1.1	500																	
On hand at beginning of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less deaths			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11. Cull cows (carried 9 months)	0.7	400																	
Culled at start of year			27	27	37	50	60	55	50	46	42	39	36	33	30	27	25	23	21
Less deaths			2	2	3	4	5	4	4	3	3	3	3	2	2	2	2	2	1
Less sales			25	25	34	46	55	51	46	43	39	36	33	31	28	25	23	21	20
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			9	9	13	17	20	19	17	16	14	13	12	11	10	9	9	8	7
TOTAL RANCH BRED LSUs				760	743	713	674	620	573	525	477	438	403	369	339	310	284	263	245
Surplus LSUs				−492	−474	−443	−404	−350	−303	−255	−207	−168	−133	−99	−69	−40	−14	7	25
Purchased fatteners grazed 6 months	1			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total LSUs				760	743	713	674	620	573	525	477	438	403	369	339	310	284	263	245
DEATHS																			
Purchased Steers/bulls				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Breeding Cows				58	56	52	47	43	40	36	33	30	28	25	23	21	20	16	13
Breeding Bulls				3	3	3	2	2	2	2	2	2	2	1	1	1	1	1	1
Heifer calves				15	14	14	13	12	11	10	9	8	7	7	6	6	5	4	4
Bull Calves				15	14	14	13	12	11	10	9	8	7	7	6	6	5	4	4
Heifers 1–2				8	8	8	8	7	7	6	6	5	5	4	4	4	3	3	2
Steers/bulls 1–2				8	8	8	8	7	7	6	6	5	5	4	4	4	3	3	2
Heifers 2–3				8	8	8	7	7	6	6	5	5	5	4	4	3	3	3	2
Steers/bulls 2–3				7	7	7	7	7	6	6	5	5	5	4	4	3	3	3	2
Heifers 3–4				7	7	7	7	7	6	6	5	5	4	4	4	3	3	3	2
Steers/bulls 3–4				6	6	6	6	6	6	6	5	5	4	4	4	3	3	2	2
Steers/bulls 4–5				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steers/bulls 5–6				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steers/bulls 6–7				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cull cows				2	3	4	5	4	4	3	3	3	3	2	2	2	2	2	1
Total Deaths				138.0	135.0	132.0	123	113.0	106.0	96	87.0	80	75.0	66.0	62.0	56.0	51.0	44.0	35.0

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CATTLE SALES (Pula '000s)

Item	Value/Head	Y1 No	Y1 Value	Y2 No	Y2 Value	Y3 No	Y3 Value	Y4 No	Y4 Value	Y5 No	Y5 Value	Y6 No	Y6 Value	Y7 No	Y7 Value	Y8 No	Y8 Value	Y9 No	Y9 Value	Y10 No	Y10 Value
Breeding Cows	700	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0
Breeding Bulls	800	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0
Cull Cows	400	25	10,000	34	13,600	46.0	18,400	55.0	22,000	51.0	20,400	46	18,400	43	17,200	39.0	15,600	36.0	14,400	33.0	13,200
Cull Bulls	600	3	1,800	3	1,800	3.0	1,800	2.0	1,200	2.0	1,200	2	1,200	2	1,200	2.0	1,200	2.0	1,200	1.0	600
Cull Heifers	400	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0
Surplus Heifers RWB	700	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0
Ranch Steers 2+ yrs	350	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0
Ranch Steers 3+ yrs	400	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0
Ranch Steers 4+ yrs	450	49	22,050	49	22,050	49.0	22,050	50.0	22,500	51.0	22,950	51	22,950	48	21,600	45.0	20,250	40.0	18,000	37.0	16,650
Ranch Steers 5+ yrs	500	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0
Ranch Steers 6+ yrs	500	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0
Total Ranch Bred Sales		77	33,850	86	37,450	98.0	42,250	107.0	45,700	104.0	44,550	99	42,550	93	40,000	86.0	37,050	78.0	33,600	71.0	30,450
Purchased Fatteners	750	0	0	0	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0.0	0	0.0	0	0.0	0
Total Cattle Sales		77	33,850	86	37,450	98	42,250	107	45,700	104	44,550	99	42,550	93	40,000	86	37,050	78	33,600	71	30,450

MILK PRODUCTION & SALES

Item	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	Yr10	Yr11	Yr12	Yr13	Yr14	Yr15	Yr16	Yr17	Yr18	Yr19	Yr20	Yr21
Milk Produced ('000 Litres)	37,960	36,140	33,605	30,615	28,015	25,740	23,530	21,580	19,760	18,070	16,510	15,145	13,910	12,740	11,635	12,525	12,525	12,525	12,525	12,525	12,525
Home consumption ('000 Litres)	18,980	18,070	16,803	15,308	14,008	12,870	11,765	10,790	9,880	9,035	8,255	7,573	6,955	6,370	5,818	6,263	6,263	6,263	6,263	6,263	6,263
Milk Sales ('000 Pula)	16,323	15,540	14,450	13,164	12,046	11,068	10,118	9,279	8,497	7,770	7,099	6,512	5,981	5,478	5,003	5,386	5,386	5,386	5,386	5,386	5,386
Sour Milk Sales ('000 Pula)	21,922	20,871	19,407	17,680	16,179	14,865	13,589	12,462	11,411	10,435	9,535	8,746	8,033	7,357	6,719	7,233	7,233	7,233	7,233	7,233	7,233
Total Value of Fresh Milk Prodn	32,646	31,080	28,900	26,329	24,093	22,136	20,236	18,559	16,994	15,540	14,199	13,025	11,963	10,956	10,006	10,772	10,772	10,772	10,772	10,772	10,772

PURCHASES (Pula '000s)

Item	Value/Head	Y1 No	Y1 Value	Y2 No	Y2 Value	Y3 No	Y3 Value	Y4 No	Y4 Value	Y5 No	Y5 Value	Y6 No	Y6 Value	Y7 No	Y7 Value	Y8 No	Y8 Value	Y9 No	Y9 Value	Y10 No	Y10 Value
Breeding Cows	750	0	0	0	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0.0	0	0.0	0	0.0	0
Breeding Bulls	1000	0	0	0	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0.0	0	0.0	0	0.0	0
Fattening Steers	300	0	0	0	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0.0	0	0.0	0	0.0	0
Total Purchases		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NET INCOME (Pula '000s)

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
55,772	58,321	61,657	63,380	60,729	57,415	53,589	49,512	45,011	40,885	37,835	34,496	31,683	29,307	26,969	26,183	26,183	26,183	26,183	26,183	26,183

Existing Stock

Cattle	1329
Goats	1462
Sheep	97
Donkeys	103

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
Low Input/Existing Management and Uncontrolled Stocking Option
Investment Costs

INVESTMENT COSTS	units	value (Pula)	Year 1 units	value	Year 2 units	value	Year 3 units	value	Year 4 units	value	Year 5 units	value	Total units	value
1 Fencing														
Holding Kraal	each	600.0	0	0.0		0.0		0.0		0.0		0.0	0	0.0
*1 Boundary Fencing	km	1502.6	0	0.0		0.0		0.0		0.0		0.0	0	0.0
*2 Internal Fencing	km	1427.9	19	27130.8		0.0		0.0		0.0		0.0	19	27130.8
				0.0		0.0		0.0		0.0		0.0	0	0.0
				0.0		0.0		0.0		0.0		0.0	0	0.0
Sub-total				27130.8		0.0		0.0		0.0		0.0		27130.8
2 Equipment														
Knapsack sprayer	each	185.9	2	371.8		0.0		0.0		0.0		0.0	2	371.8
Dehorning Iron	each	20.0	2	40.0		0.0		0.0		0.0		0.0	2	40.0
Burdizzo	each	159.3	1	159.3		0.0		0.0		0.0		0.0	1	159.3
Syringe	each	28.4	2	56.8		0.0		0.0		0.0		0.0	2	56.8
Spares	set	10.0	2	20.0		0.0		0.0		0.0		0.0	2	20.0
Sub-total				647.9		0.0		0.0		0.0		0.0		647.9
3 Herd Build-up														
In-calf breeding cows	each	750.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Breeding bulls	each	1000.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Fattening bullocks	each	300.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Sub-total				0.0		0.0		0.0		0.0		0.0		0.0
Total				27778.7		0.0		0.0		0.0		0.0		27778.7
Physical Contingency		5.00%		1388.9		0.0		0.0		0.0		0.0		1388.9
Total Investment Costs				29167.6		0.0		0.0		0.0		0.0		29167.6

1* Fencing Costs per Km

The boundary fence to the properties totals approximately 26 km. Most of is in poor condition and requires renovation. 7.5 km of this fence is shared with Mr. Strauss whilst a further 8.5 km is shared with Mr. Blackbeard's other property where renovation is on-going. Since no control would be implemented it is assumed that there would be no reason to renovate the boundary fence

Boundary

Item	Presentation	Length (m)	Cost/Unit	Required per 1000m	Total Cost
High Tensile Wire	Roll	2240	158.9	2.2	354.6
Anchor Wire	Roll	846	99.0	0.1	8.8
Binding Wire	Roll	2015	120.9	0.2	19.8
					0.0
		Distance (m)			0.0
					0.0
Strainers	Each	2.7m X 100 x 125 mm	396	51.0	7.5	382.4
Standards	Each	2.1m x 75 x 100 mm	15	6.0	60.0	357.0
Droppers	Each	1.4 x .3 mm	3	1.1	300.0	330.0
		Total Materials				1452.6
		Labour @ 5 man days/km, P10/man day				50.0

2* Internal

1502.6

Existing internal fences total approximately 45 km and most of this is in fair condition. This divides the properties into 9 paddocks. Since arable land is to be opened up there will be a need to fence this out and to remove the fence which at present divides the arable area. This will entail the construction of 9 km of new internal fence. It is un-likely that the materials will be reusable. Total new internal fencing will therefore be:

	Km
Fencing out of arable area (three sides)	9.0
Fencing out of Land Unit 4	0.0
Fencing out of Settlement and Forestry	10.0
Division of arable land 3 x 2.5	0.0
Total	19.0
Existing fencing minus fence moved	0.0
Total for maintenance	19.0

Item	Presentation	Length (m)	Cost/Unit	Required per 1000m	Total Cost
High Tensile Wire	Roll	2240	158.9	1.8	283.7
Anchor Wire	Roll	846	99.0	0.1	8.8
Binding Wire	Roll	2015	120.9	0.1	16.0
					0.0
		Distance (m)			0.0
					0.0
Strainers	Each	2.7m X 100 x 125 mm	396	51.0	7.5	382.4
Standards	Each	2.1m x 75 x 100 mm	15	6.0	60.0	357.0
Droppers	Each	1.4 x .3 mm	3	1.1	300.0	330.0
		Total Materials				1377.9
		Labour @ 5 man days/km, P10/man day				50.0

1427.9

Botswana Ministry of Agriculture
Department of Crop Production and Forestry
Land Utilisation Division

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
Low Input/Existing Management and Uncontrolled Stocking Option
Sales and Operating Expenditure

SALES

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Arable Sales	33850	37450	42250	45700	44550	42550	40000	37050	33600	30450
Cattle Sales	38245	36411	33857	30845	28225	25933	23706	21742	19908	18206
Milk Sales										
Total Sales	72095	73861	76107	76545	72775	68483	63706	58792	53508	48656

OPERATING EXPENDITURE

1 Salaries & Wages

	Cost p.a.	Year 1 Units	Year 1 Cost	Year 2 Units	Year 2 Cost	Year 3 Units	Year 3 Cost	Year 4 Units	Year 4 Cost	Year 5 Units	Year 5 Cost	Year 6 Units	Year 6 Cost	Year 7 Units	Year 7 Cost	Year 8 Units	Year 8 Cost	Year 9 Units	Year 9 Cost	Year 10 Units	Year 10 Cost
1* Milker/Labourer	1000	15	15000	15	15000.0	14.0	14000.0	13	13000.0	12.0	12000	11.0	11000	11.0	11000.0	10.0	10000.0	9.0	9000.0	8.0	8000.0
Sub-total			15000		15000.0		14000.0		13000.0		12000		11000		11000.0		10000.0		9000.0		8000.0

3 Maintenance

		Year 1 Units	Year 1 Cost	Year 2 Units	Year 2 Cost	Year 3 Units	Year 3 Cost	Year 4 Units	Year 4 Cost	Year 5 Units	Year 5 Cost	Year 6 Units	Year 6 Cost	Year 7 Units	Year 7 Cost	Year 8 Units	Year 8 Cost	Year 9 Units	Year 9 Cost	Year 10 Units	Year 10 Cost
Fencing 10.00%		19	2713	19	2713	19.0	2713	19	2713	19.0	2713	19.0	2713	19.0	2713	19.0	2713	19.0	2713	19.0	2713
Sub-total			2713		2713		2713		2713		2713		2713		2713		2713		2713		2713

4 Veterinary Health & Materials

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
2* Vaccines lump sum young stock	1.1	279	273	262	245	224	205	188	173	158	145
3* Drugs lump/LSU	2.8	76	74	71	67	62	57	53	48	44	40
4* Dip Wash lump/LSU	0.1	760	743	713	674	620	573	525	477	438	403
6* Semen (50% cows)	4	292	278	259	236	216	198	181	166	152	139
Sub-total		1728	1659	1559	1436	1315	1208	1105	1013	927	850

5 Supplementary Feeds

		Year 1 Units	Year 1 Cost	Year 2 Units	Year 2 Cost	Year 3 Units	Year 3 Cost	Year 4 Units	Year 4 Cost	Year 5 Units	Year 5 Cost	Year 6 Units	Year 6 Cost	Year 7 Units	Year 7 Cost	Year 8 Units	Year 8 Cost	Year 9 Units	Year 9 Cost	Year 10 Units	Year 10 Cost
5* Mineral supplements and maintenance	14.4	760	10914	743	10669	713.0	10239	674	9679	620.0	8903	573.0	8228	525.0	7539	477.0	6850	438.0	6290	403.0	5787
Sub-total			10914		10669		10239		9679		8903		8228		7539		6850		6290		5787

6 Costs of Forage Production

			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cultivations	ha	110	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0.0
Stratro	ha	50	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0.0
Single Supers	ha	40	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0.0
Sowing	ha	20	0	0	0.0	0.0	0	0	0.0	0.0	0.0	0.0
Sub–total			0	0	0	0	0	0	0	0	0	0

7 Sales Costs

			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Transport	head	80	77	86	98	107	104	99	93	86	78	71
			6160	6880	7840	8560	8320	7920	7440	6880	6240	5680
			0	0	0	0	0	0	0	0	0	0
Sub–total			6160	6880	7840	8560	8320	7920	7440	6880	6240	5680
Total			36514	36922	36351	35387	33251	31069	29797	27456	25170	23030
Physical Contingency	5.00%		1826	1846	1818	1769	1663	1553	1490	1373	1259	1151
Total Operating Costs			38340	38768	38169	37157	34913	32623	31287	28829	26429	24181
Net Income			33755	35093	37938	39388	37862	35860	32419	29963	27079	24474

1* Assumes one labourer per 50 LSU based on actual figures from farmers

2* Vaccines

	Cost/dose
Calf paratyphoid	0.3
Lumpy Skin	0.5
Enterotoxaemia	0.0
Pasteurella	0.4
Total	1.1

An assumption is made that these vaccines are given to immature stock only

3* Drugs

Terramycin	2.1
Suphamezathin	0.7
Total	2.8

An assumption is made that treatment is required in only 10% of the cattle

4* Dip Wash   administered with Knapsack sprayer –   Whilst correctly the cost would be P1/LSU per week. In reality the spraying is reduced in both concentration and frequency to a cost of approximately P1/LSU per month. This is felt to be too low and a cost of P0.5/LSU per week has been used.

5* Minerals

Cattle Maintenance Lick (50 kg)	24.5
Salt (50 kg)	7.9
Bonemeal (50 kg)	39.5
Total	71.8

10 kg of salt and bonemeal per head per year, 10 kg of maintenance lick over the dry season

6* Semen   50% of owners of cows assumed to have their cattle served by AI with bulls running with cows as insurance.

Cost per insemination = P 8
Number of inseminations per cow = 2

Botswana Ministry of Agriculture
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Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
Low Input/Existing Management and Uncontrolled Stocking Option
Cash Flow

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
Cash Inflows																					
Sales	72095	73861	76107	76545	72775	68483	63706	58792	53508	48656	37835	34496	31683	29307	26969	26183	26183	26183	26183	26183	26183
Total Inflow	72095	73861	76107	76545	72775	68483	63706	58792	53508	48656	37835	34496	31683	29307	26969	26183	26183	26183	26183	26183	26183
Cash Outflows																					
Investment	29168	0	0	0	0																
Operating Expenditure	38340	38768	38169	37157	34913	32623	31287	28829	26429	24181	24181	24181	24181	24181	24181	24181	24181	24181	24181	24181	24181
Total outflow	67508	38768	38169	37157	34913	32623	31287	28829	26429	24181	24181	24181	24181	24181	24181	24181	24181	24181	24181	24181	24181
Net Benefit Stream	4587	35093	37938	39388	37862	35860	32419	29963	27079	24474	13653	10315	7502	5126	2788	2002	2002	2002	2002	2002	154852
NPV at 15.00% 184298																					
IRR ERR																					
Net Income per family	112	856	925	961	923	875	791	731	660	597	333	252	183	125	68	49	49	49	49	49	3777
Based on 41 families																					

ANNEX 2:

HERD PROJECTIONS AND MONETARY FLOWS
FOR THREE CATTLE ENTERPRISE SYSTEMS

SYSTEM 2:

MEDIUM INPUT/MANAGEMENT

AND CONTROLLED STOCKING OPTION

Botswana Ministry of Agriculture
Department of Crop Production and Forestry
Land Utilisation Division

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
Medium Input/Management and Controlled Stocking Option
Herd Projection

Date: 13-Aug-95

Parameter	Value
Length of Growing Season	120 days
Total Grazable Area	7115.0 ha
New Pasture Utilisation	100.00% (in first year of production)
LSU (Livestock Unit)	500 kg
Residual herd value	P'000s 240 / units 800
Maximum number of breeding cows	193 head
Minimum size purchased fattener herd	20 head
Maximum size purchased fattener herd	0 head
Market price of milk/litre	0.9 Pula
Market price of sour milk/litre	3.5 Pula
Reduction Factor, Fresh to Sour	0.3

STOCKING DATA

Each year is shown as Hectare (H) and T.L.U.

Item	Carrying capacity ha/LSU	Total ha	Y1 H	Y1 TLU	Y2 H	Y2 TLU	Y3 H	Y3 TLU	Y4 H	Y4 TLU	Y5 H	Y5 TLU	Y6 H	Y6 TLU	Y7 H	Y7 TLU	Y8 H	Y8 TLU	Y9 H	Y9 TLU	Y10 on H	Y10 on TLU
LU 2a Total ha	10	1543	1593	159	1573	157	1553	155	1543	155	1543	154	1543	154	1543	154	1543	154	1543	154	1543	154
LU 2 alp,2 ask,2b Total ha	14	2997	2997	214	0	214	0	214	0	214	0	214	0	214	0	214	0	214	0	214	0	214
LU 1, V1, V2 Total ha	7	1388	1388	198	0	198	0	198	0	198	0	198	0	198	0	198	0	198	0	198	0	198
LU 3 Total ha	18	932	932	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52
Arable Wastes LU 1 Total ha	7	255	205	29	20	29	20	32	10	35	0	36	0	36	0	36	0	36	0	36	0	36
Rotational Forage Total ha	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total ha		7115																				

Item	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10 on
Total L S U's available	652	652	653	654	654	654	654	654	654	654
Less requirement for smallstock	186	186	186	186	186	186	186	186	186	186
Less requirement for donkeys	66	66	66	66	66	66	66	66	66	66
LSUs available for cattle	400	400	401	402	402	402	402	402	402	402
Area developed as a %	78	78	78	78	78	78	78	78	78	78
Overall carrying capacity	11	11	11	11	11	11	11	11	11	11

TECHNICAL COEFFICIENTS

Item	Existing	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20
Calving %	33	33	50	60	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Mortality rate(%) – Adults	10	9	8	8	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
– Calves	15	12	10	8	7	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
– Purch. Fatteners	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Milk Offtake – litres/cow/day		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
– lactation (days)		100	120	120	130	140	140	150	150	150	150	150	150	150	150	150	150	150	150	150	150

MANAGEMENT FACTORS

Item	Existing	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20
Culling % – Bulls		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
– Breeding cows		5	7	10	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
– Heifers		5	5	5	7	8	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Bull joining rate (Cows/Bull)		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Age at Bulling – Heifers		2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Age at sale Bulls/Steers (years)		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Age at sale Cull heifers (years)		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Age at sale Breeding heifers (years)		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Herd composition and build-up table (values in Pula; LSU = Livestock Units).

HERD COMPOSITION & BUILD UP	LSU	Value (Pula)	Existing Stock	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
1. Breeding cows	0.9	700																	
On hand at beginning of year			242	227	223	190	189	198	183	183	183	183	183	183	183	183	183	183	183
Less culls carried 9 months			12	11	16	19	25	26	24	24	24	24	24	24	24	24	24	24	24
Plus purchases			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plus replacement heifers			20	29	0	28	44	21	34	34	34	34	34	34	34	34	34	34	34
Total breeding cows			250	245	207	199	208	193	193	193	193	193	193	193	193	193	193	193	193
Less deaths			23	22	17	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			227	223	190	189	198	183	183	183	183	183	183	183	183	183	183	183	183
Average LSUs for year			215	203	186	171	174	171	165	165	165	165	165	165	165	165	165	165	165
2. Breeding bulls	1.1	800 / 500																	
On hand at beginning of year			13	12	11	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Less culls			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Plus purchases			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plus replacements			1	1	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total breeding bulls			13	12	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Less deaths			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			12	11	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Average LSUs for year			14	13	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10
3. Heifer calves	0.2	100																	
Born during year			41	41	61	62	64	68	62	63	62	63	62	63	62	63	62	63	62
Less deaths			6	5	6	5	4	4	4	4	4	4	4	4	4	4	4	4	4
On hand at end of year			35	36	55	57	60	64	58	59	58	59	58	59	58	59	58	59	58
Average LSUs for year			9	9	13	13	14	15	14	14	14	14	14	14	14	14	14	14	14
4. Bull calves	0.2	100																	
Born during year			40	40	62	62	65	67	63	63	62	63	62	63	62	63	62	63	63
Less deaths			6	5	6	5	5	4	4	4	4	4	4	4	4	4	4	4	4
On hand at end of year			34	35	56	57	60	63	59	59	58	59	58	59	58	59	58	59	59
Average LSUs for year			8	8	13	13	14	15	14	14	14	14	14	14	14	14	14	14	14
5. Heifers 1–2 years	0.5	300																	
On hand at beginning of year			35	35	36	55	57	60	64	59	58	59	58	59	58	59	58	59	59
Less deaths			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
On hand at end of year			32	32	33	52	54	57	61	56	55	56	55	56	55	56	55	56	56
Average LSUs for year			15	15	16	24	25	26	28	26	25	26	25	26	25	26	25	26	26
6. Steers 1–2 years	0.5	300																	
On hand at beginning of year			34	34	35	56	57	60	63	59	58	58	58	58	59	59	58	59	58
Less deaths			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
On hand at end of year			31	31	32	53	54	57	60	56	55	55	55	55	56	56	55	56	56
Average LSUs for year			15	15	15	25	25	26	28	26	25	25	25	25	26	26	25	26	26
7. Heifers 2–3 years	0.7	400																	
On hand at beginning of year			32	32	32	33	52	54	57	61	60	55	56	55	56	55	56	55	56	55
Less deaths			3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
Replacements to breeding herd			20	29	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			9	0	0	31	49	51	54	58	57	52	53	52	53	52	53	52	53
Average LSUs for year			14	11	11	22	34	35	37	40	39	36	37	36	37	36	37	36	37
8. Steers 2–3 years	0.7	350																	
On hand at beginning of year			31	31	31	32	53	54	57	60	56	55	56	55	56	55	56	55	56
Less deaths			3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			28	28	29	30	50	51	54	57	53	52	53	52	53	52	53	52	53
Average LSUs for year			20	20	20	21	35	35	37	39	37	36	37	36	37	36	37	36	37

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HERD COMPOSITION & BUILD UP	LSU	Value (Pula)	Existing Stock	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
9. Heifers 3–4 years	0.9	700																	
On hand at beginning of year			9	9	0	0	31	49	51	54	58	52	53	52	53	52	53	52	53
Less culls sold start of year	0	400	0	0	0	0	2	3	4	5	6	5	5	5	5	5	5	5	5
Less deaths			1	1	0	0	1	2	2	2	3	2	2	2	2	2	2	2	2
Replacements to breeding herd			0	0	0	0	28	21	34	34	34	34	34	34	34	34	34	34	34
Less sales as breeders			8	8	0	0	0	23	11	13	15	11	12	11	12	11	12	11	12
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			4	4	0	0	13	21	21	22	23	21	22	21	22	21	22	21	22
10. Steers 3–4 years	0.9	450																	
On hand at beginning of year			28	28	28	29	30	50	51	54	57	53	52	53	52	53	52	53	52
Less deaths			3	3	2	1	2	3	3	3	3	3	3	3	3	3	3	3	3
Less replacements to breeding bulls			1	1	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			24	24	26	26	26	45	46	49	52	48	47	48	47	48	47	48	47
Average LSUs for year			23	23	24	25	25	43	44	46	49	45	45	45	45	45	45	45	45
11. Steers 4–5 years	1.1	600																	
On hand at beginning of year			24	24	24	26	26	26	45	46	49	52	48	47	48	47	48	47	48
Less deaths			2	2	2	1	1	1	2	2	2	3	2	2	2	2	2	2	2
Less sales			22	22	22	25	25	25	43	44	47	49	46	45	46	45	46	45	46
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			13	13	13	14	14	14	25	25	27	29	26	26	26	26	26	26	26
12. Steers 5–6 years	1.1	600																	
On hand at beginning of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less deaths			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. Steers 6–7 years	1.1	600																	
On hand at beginning of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less deaths			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11. Cull cows (carried 9 months)	0.7	400																	
Culled at start of year			11	11	16	19	25	26	24	24	24	24	24	24	24	24	24	24	24
Less deaths			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Less sales			10	10	15	18	24	25	23	23	23	23	23	23	23	23	23	23	23
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			4	4	5	6	9	9	8	8	8	8	8	8	8	8	8	8	8
TOTAL RANCH BRED LSUs			341	325	314	330	378	406	406	409	407	401	402	401	402	401	402	401	402
Surplus LSUs			59	75	87	72	24	−4	−4	−7	−5	1	0	0	0	0	0	0	0
Purchased fatteners grazed 6 months	1			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total LSUs				325	314	330	378	406	406	409	407	401	402	401	402	401	402	401	402
DEATHS																			
Purchased Steers/bulls			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Breeding Cows				22	17	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Breeding Bulls				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Heifer Calves				5	6	5	4	4	4	4	4	4	4	4	4	4	4	4	4
Bull Calves				5	6	5	5	4	4	4	4	4	4	4	4	4	4	4	4
Heifers 1–2				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Steers/bulls 1–2				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Heifers 2–3				3	2	2	3	3	2	3	3	3	3	3	3	3	3	3	3
Steers/bulls 2–3				3	2	0	3	3	2	2	3	2	2	2	2	2	2	2	3
Heifers 3–4				1	1	0	1	1	2	2	3	2	2	2	2	2	2	2	2
Steers/bulls 3–4				3	2	1	2	2	2	2	3	2	2	2	2	2	2	2	2
Steers/bulls 4–5				2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steers/bulls 5–6				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steers/bulls 6–7				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cull cows				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Deaths				52	46	34	37	38	39	39	40	40	39	39	39	39	39	39	39

CATTLE SALES (Pula '000s)

	Value/Head	Year 1 No	Year 1 Value	Year 2 No	Year 2 Value	Year 3 No	Year 3 Value	Year 4 No	Year 4 Value	Year 5 No	Year 5 Value	Year 6 No	Year 6 Value	Year 7 No	Year 7 Value	Year 8 No	Year 8 Value	Year 9 No	Year 9 Value	Year 10 No	Year 10 Value
Breeding Cows	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Breeding Bulls	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cull Cows	400	10	4,000	15	6,000	18	7,200	24	9,600	25	10,000	23	9,200	23	9,200	23	9,200	23	9,200	23	9,200
Cull Bulls	500	1	500	1	500	1	500	1	500	1	500	1	500	1	500	1	500	1	500	1	500
Cull Heifers	400	0	0	0	0	0	0	2	800	3	1,200	4	1,600	5	2,000	6	2,400	5	2,000	5	2,000
Surplus Heifers RWB	700	8	5,775	0	0	0	0	0	0	23	16,100	11	7,700	13	9,100	15	10,500	11	7,700	12	8,400
Ranch Steers 2+ yrs	350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranch Steers 3+ yrs	450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranch Steers 4+ yrs	600	22	13,200	22	13,200	25	15,000	25	15,000	25	15,000	43	25,800	44	26,400	47	28,200	49	29,400	46	27,600
Ranch Steers 5+ yrs	600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranch Steers 6+ yrs	600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Ranch Bred Sales		41	23,475	38	19,700	44	22,700	52	25,900	77	42,800	82	44,800	86	47,200	92	50,800	89	48,800	87	47,700
Purchased Fatteners	600	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0	0
Total Cattle Sales		41	23,475	38	19,700	44	22,700	52	25,900	77	42,800	82	44,800	86	47,200	92	50,800	89	48,800	87	47,700

MILK PRODUCTION & SALES

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20
Milk Offtaked ('000 Litres)	15,925	24,840	28,656	35,152	35,126	35,126	37,635	37,635	37,635	37,635	37,635	37,635	37,635	37,635	37,635	37,635	37,635	37,635	37,635	37,635
Home consumption ('000 Litres)	7,963	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Milk Sales ('000 Pula)	6,848	17,062	20,344	25,931	25,908	25,908	28,066	28,066	28,066	28,066	28,066	28,066	28,066	28,066	28,066	28,066	28,066	28,066	28,066	28,066
Sour Milk Sales ('000 Pula)	9,197	22,915	27,323	34,826	34,796	34,796	37,693	37,693	37,693	37,693	37,693	37,693	37,693	37,693	37,693	37,693	37,693	37,693	37,693	37,693
Total Value of Fresh Milk Prodn	13,696	21,362	24,644	30,231	30,208	30,208	32,366	32,366	32,366	32,366	32,366	32,366	32,366	32,366	32,366	32,366	32,366	32,366	32,366	32,366

PURCHASE (Pula '000s)

	Value/Head	Year 1 No	Year 1 Value	Year 2 No	Year 2 Value	Year 3 No	Year 3 Value	Year 4 No	Year 4 Value	Year 5 No	Year 5 Value	Year 6 No	Year 6 Value	Year 7 No	Year 7 Value	Year 8 No	Year 8 Value	Year 9 No	Year 9 Value	Year 10 No	Year 10 Value
Breeding Cows	750	0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0	0
Breeding Bulls	1000	0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0	0
Fattening Steers	300	0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0	0
Total Purchases		0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0	0	0	0

NET INCOME (Pula '000s)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
NET INCOME	32,672	42,615	50,023	60,726	77,596	79,596	84,893	88,493	86,493	85,393	84,093	85,393	84,093	85,393	84,093	85,393	85,393	85,393	85,393	85,393	85,393

Existing Stock
Cattle 270
Goats 903
Sheep 26
Donkeys 94

Suggested extra stocking: 300

Approx LSUs: (270+30)
(270+300)x0.7 = 399

56

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
Medium Input/Management and Controlled Stocking Option
Investment Costs

INVESTMENT COSTS	units	value (Pula)	Year 1 units	value	Year 2 units	value	Year 3 units	value	Year 4 units	value	Year 5 units	value	Total units	value
1.0 Fencing														
Holding Kraal	each	600.0	2	1200.0	2	1200.0		0.0		0.0		0.0	4	2400.0
*1 Boundary Fencing	km	1502.6	18.0	27047.6	25	37566.1		0.0		0.0		0.0	43	64613.7
*2 Internal Fencing	km	1427.9	24	33556.5	24	34270.5		0.0		0.0		0.0	48	67827.0
				0.0		0.0		0.0		0.0		0.0	0	0.0
				0.0		0.0		0.0		0.0		0.0	0	0.0
Sub-total				61804.1		73036.6		0.0		0.0		0.0		134840.7
2.0 Equipment														
Knapsack sprayer	each	185.9	2	371.8		0.0		0.0		0.0		0.0	2	371.8
Dehorning Iron	each	20.0	2	40.0		0.0		0.0		0.0		0.0	2	40.0
Burdizzo	each	159.3	1	159.3		0.0		0.0		0.0		0.0	1	159.3
Syringe	each	28.4	2	56.8		0.0		0.0		0.0		0.0	2	56.8
Spares	set	10.0	2	20.0		0.0		0.0		0.0		0.0	2	20.0
Sub-total				647.9		0.0		0.0		0.0		0.0		647.9
3.0 Herd Build-up														
In-calf breeding cows	each	750.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Breeding bulls	each	1000.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Fattening bullocks	each	300.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Sub-total				0.0		0.0		0.0		0.0		0.0		0.0
Total				62452.0		73036.6		0.0		0.0		0.0		135488.6
Physical Contingency		5.00%		3122.6		3651.8		0.0		0.0		0.0		6774.4
Total Investment Costs				65574.6		76688.4		0.0		0.0		0.0		142263.0

1* Fencing Costs per Km

The boundary fence to the properties totals approximately 26 km. Most of is in poor condition and requires renovation. 7.5 km of this fence is shared with Mr. Strauss whilst a further 8.5 km is shared with Mr. Blackbeard's other property where renovation is on-going. It is assumed that the joint sections would be renovated on a cost sharing basis. There is thus a need for total renovation of 26 - ((7.5 + 8.5)/2) = 18 km.

Boundary

Item	Presentation	Length (m)	Cost/Unit	Required per 1000m	Total Cost
High Tensile Wire	Roll	2240.0	158.9	2.2	354.6
Anchor Wire	Roll	846.0	99.0	0.1	8.8
Binding Wire	Roll	2015.0	120.9	0.2	19.8
					0.0
		Distance (m)			0.0
					0.0
Strainers	Each 2.7m X 100 x 125 mm	396.0	51.0	7.5	382.4
Standards	Each 2.1m x 75 x 100 mm	15.0	6.0	60.0	357.0
Droppers	Each 1.4 x .3 mm	2.5	1.1	300.0	330.0
		Total Materials			1452.6
		Labour @ 5 man days/km, P10/man day			50.0
					1502.6

2* Internal

Existing internal fences total approximately 45 km and most of this is in fair condition. This divides the properties into 9 paddocks. Since arable land is to be opened up there will be a need to fence this out and to remove the fence which at present divides the arable area. This will entail the construction of 9 km of new internal fence. It is un-
-likely that the materials will be reusable. The fence bisecting LMU 3 should also be moved to enable better late season grazing control. Total new internal fencing will therefore be:

		Km
Fencing out of arable area (three sides)		9.0
Fencing out of Land Unit 4		4.5
Fencing out of Settlement and Forestry		10.0
Division of arable land	3 x 2.5	0.0
Total		23.5
Existing fencing minus fence moved		35.0
Total for maintenance		58.5

Item	Presentation	Length (m)	Cost/Unit	Required per 1000m	Total Cost
High Tensile Wire	Roll	2240.0	158.9	1.8	283.7
Anchor Wire	Roll	846.0	99.0	0.1	8.8
Binding Wire	Roll	2015.0	120.9	0.1	16.0
					0.0
		Distance (m)			0.0
					0.0
Strainers	Each 2.7m X 100 x 125 mm	396.0	51.0	7.5	382.4
Standards	Each 2.1m x 75 x 100 mm	15.0	6.0	60.0	357.0
Droppers	Each 1.4 x .3 mm	2.5	1.1	300.0	330.0
		Total Materials			1377.9
		Labour @ 5 man days/km, P10/man day			50.0
					1427.9

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
Medium Input/Management and Controlled Stocking Option
Sales and Operating Expenditure

SALES

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Arable Sales										
Cattle Sales	23475	19700	22700	25900	42800	44800	47200	50800	48800	47700
Milk Sales	9197	22915	27323	34826	34796	34796	37693	37693	37693	37693
Total Sales	32671.7	42615.2	50022.7	60725.6	77595.5	79595.5	84893	88493	86493	85393

OPERATING EXPENDITURE

1 Salaries & Wages (Cost p.a. 1000)

		Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10	
	Cost p.a.	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost
Milker/Labourer (1*)	1000	7	7000	6	6000	7	7000	8	8000	8	8000	8	8000	8	8000	8	8000	8	8000	8	8000
Sub-total			7000		6000		7000		8000		8000		8000		8000		8000		8000		8000

2 Maintenance

		Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10	
		Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost
Fencing	10.00%	58.5	8353	58.5	8353	58.5	8353	58.5	8353	58.5	8353	58.5	8353	59	8353	59	8353	59	8353	59	8353
Sub-total			8353		8353		8353		8353		8353		8353		8353		8353		8353		8353

3 Veterinary Health & Materials

		Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10	
	Cost p.a.	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost
Vaccines (2*) lump sum young stock	1.1	116	129	159	176	179	199	186	206	195	216	189	210	183	203	184	204	183	203	184	204
Drugs (3*) lump/LSU	2.8	33	91	31	88	33	92	38	105	41	113	41	113	41	114	41	114	40	112	40	112
Dip Wash (4*) lump/LSU	0.1	325	16	314	16	330	17	378	19	406	20	406	20	409	20	407	20	401	20	402	20
Semen (6*) (50% cows)	4.0	123	490	104	414	100	398	104	416	97	386	97	386	97	386	97	386	97	386	97	386
Sub-total			726		694		705		747		736		729		724		724		721		722

4 Supplementary Feeds

		Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10	
	Cost p.a.	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost	Units	Cost
Mineral supplements (5*) and maintenance	14.4	325	4667	314	4509	330	4739	378	5428	406	5830	406	5830	409	5873	407	5845	401	5758	402	5773
Sub-total			4667		4509		4739		5428		5830		5830		5873		5845		5758		5773

5 Costs of Forage Production

			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cultivations	ha	110	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratro	ha	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Single Supers	ha	40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sowing	ha	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total			0	0	0	0	0	0	0	0	0	0

6 Sales Costs

			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Transport	head	80	41	38	44	52	77	82	86	92	89	87
			3300	3040	3520	4160	6160	6560	6880	7360	7120	6960
			0	0	0	0	0	0	0	0	0	0
Sub-total			3300	3040	3520	4160	6160	6560	6880	7360	7120	6960
Total			24046	22596	24317	26688	29080	29473	29830	30282	29953	29809
Physical Contingency		5.00%	1202	1130	1216	1334	1454	1474	1492	1514	1498	1490
Total Operating Costs			25248	23726	25533	28023	30534	30947	31322	31796	31450	31299
Net Income			7423	18889	24489	32703	47062	48649	53572	56697	55043	54094

1* Assumes one labourer per 50 LSU based on actual figures from farmers

2* Vaccines

	Cost/dose
Calf paratyphoid	0.3
Lumpy Skin	0.5
Enterotoxaemia	0.0
Pasteurella	0.4
Total	1.1

An assumption is made that these vaccines are given to immature stock only

3* Drugs

Terramycin	2.1
Sulphamezathin	0.7
Total	2.8

An assumption is made that treatment is required in only 10% of the cattle

4* Dip Wash administered with Knapsack sprayer –   Whilst correctly the cost would be P1/LSU per week, in reality the spraying is reduced in both concentration and frequency to a cost of approximately P1/LSU per month. This is felt to be too low and a cost of P0.5/LSU per week has been used.

5* Minerals

Cattle Maintenance Lick (50 kg)	24.5
Salt (50 kg)	7.9
Bonemeal (50 kg)	39.5
Total	71.8

10 kg of salt and bonemeal per head per year, 10 kg of maintenance lick over the dry season

6* Semen

50% of owners of cows assumed to have their cattle served by AI with bulls running with cows as insurance.
Cost per insemination = P 8   Number of inseminations per cow = 2

Botswana Ministry of Agriculture
Department of Crop Production and Forestry
Land Utilisation Division

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
Medium Input/Management and Controlled Stocking Option
Cash Flow

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
Cash Inflows																					
Sales	32672	42615	50023	60726	77596	79596	84893	88493	86493	85393	84093	85393	84093	85393	84093	85393	85393	85393	85393	85393	85393
Total Inflow	32672	42615	50023	60726	77596	79596	84893	88493	86493	85393	84093	85393	84093	85393	84093	85393	85393	85393	85393	85393	85393
Cash Outflows																					
Investment	65575	76688	0	0	0	0															
Operating Expenditure	25248	23726	25533	28023	30534	30947	31322	31796	31450	31299	31299	31299	31299	31299	31299	31299	31299	31299	31299	31299	31299
Total outflow	90823	100414	25533	28023	30534	30947	31322	31796	31450	31299	31299	31299	31299	31299	31299	31299	31299	31299	31299	31299	31299
Net Benefit Stream	-58151	-57799	24489	32703	47062	48649	53572	56697	55043	54094	52794	54094	52794	54094	52794	54094	54094	54094	54094	54094	294894
NPV at 15.00%	213144																				
IRR 31%																					
Net Income per family	-1418	-1410	597	798	1148	1187	1307	1383	1343	1319	1288	1319	1288	1319	1288	1319	1319	1319	1319	1319	7193

ANNEX 2:

HERD PROJECTIONS AND MONETARY FLOWS
FOR THREE CATTLE ENTERPRISE SYSTEMS

SYSTEM 3:

HIGH INPUT/MANAGEMENT

AND CONTROLLED STOCKING OPTION

Botswana Ministry of Agriculture
Department of Crop Production and Forestry
Land Utilisation Division

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
High Input/Management and Controlled Stocking Option
Herd Projection

Date: 13‑Aug‑95

Parameters

Parameter	Value
Length of Growing Season	120 days
Total Grazable Area	7370 ha
New Pasture Utilisation	40% (in first year of production)
LSU (Livestock Unit)	450 kg
Residual herd value	P '000s 245 / units 300
Stabilised Number of Breeding Cows	214 head
Minimum size purchased fattener herd	20 head
Maximum size purchased fattener herd	0 head
Market price of milk/litre	0.9 Pula
Market price of sour milk/litre	3.5 Pula
Reduction Factor, Fresh to Sour	0.3

STOCKING DATA (TLU per year)

Item	Carrying capacity (ha/LSU)	Total ha	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10 on
LU 2a	10	1543	164	162	160	159	159	159	159	159	159	159
LU 2 alp,2 ask,2b	14	2997	214	214	214	214	214	214	214	214	214	214
LU 1, V1, V2	7	1388	79	198	198	198	198	198	198	198	198	198
LU 3	18	932	52	52	52	52	52	52	52	52	52	52
Arable Wastes LU 1	7	255	29	32	35	36	36	36	36	36	36	36
Rotational Forage	4	255	21	53	58	62	64	64	64	64	64	64
(Total ha)		7370										
Total LSU's available			559	711	717	721	723	723	723	723	723	723
Less requirement for smallstock			186	186	186	186	186	186	186	186	186	186
Less requirement for donkeys			66	66	66	66	66	66	66	66	66	66
LSUs available for cattle			307	459	465	469	471	471	471	471	471	471
Area developed as a %			78	78	78	78	78	78	78	78	78	78
Overall carrying capacity			13	10	10	10	10	10	10	10	10	10

(Hectare sub-columns: Year 1 hectares developed/available — LU 2a 1643, LU 2 alp,2 ask,2b 2997, LU 1,V1,V2 1388, LU 3 932, Arable Wastes 205; hectares added in later years for Arable Wastes and Rotational Forage: +20, +20, +10. LU 2a hectares: 1643, 1623, 1603, 1593 … 1593.)

TECHNICAL COEFFICIENTS

	Existing	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20
Calving %	33	33	50	60	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Mortality rate(%) – Adults	10	9	8	8	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
– Calves	15	12	10	8	8	7	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5
– Purch. Fatteners	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Milk Offtake – litres/cow/day																					
– lactation (days)	100	120	120	130	140	140	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150

MANAGEMENT FACTORS

	Existing	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20
Culling % – Bulls	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
– Breeding cows	5	5	7	10	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
– Heifers	5	5	5	8	7	7	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Bull joining rate (Cows/Bull)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Age at Bulling – Heifers	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Age at sale Bulls/Steers (years)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Age at sale Cull heifers (years)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Age at sale Breeding heifers (years)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

HEARD COMPOSITION & BUILD UP

	LSU	Value (Pula)	Existing Stock	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
1. Breeding cows	1.0	700																	
On hand at beginning of year			242	237	233	197	196	206	203	203	203	203	203	203	203	203	203	203	203
Less culls carried 9 months			12	12	16	20	25	27	26	26	26	26	26	26	26	26	26	26	26
Plus purchases			0	0	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plus replacement heifers			31	31	0	29	46	35	37	37	37	37	37	37	37	37	37	37	37
Total breeding cows			261	256	214	206	217	214	214	214	214	214	214	214	214	214	214	214	214
Less deaths			24	23	17	10	11	11	11	11	11	11	11	11	11	11	11	11	11
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			237	233	197	196	206	203	203	203	203	203	203	203	203	203	203	203	203
Average LSUs for year			249	235	215	197	201	205	203	203	203	203	203	203	203	203	203	203	203
2. Breeding bulls	1.2	800 / 500																	
On hand at beginning of year			13	12	12	10	9	10	10	10	10	10	10	10	10	10	10	10	10
Less culls			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Plus purchases			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plus replacements			1	2	0	1	3	2	2	2	2	2	2	2	2	2	2	2	2
Total breeding bulls			13	13	11	10	11	11	11	11	11	11	11	11	11	11	11	11	11
Less deaths			1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			12	12	10	9	10	10	10	10	10	10	10	10	10	10	10	10	10
Average LSUs for year			15	15	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12
3. Heifer calves	0.3	100																	
Born during year			43	43	64	64	67	71	69	70	70	69	69	69	69	69	69	70	69
Less deaths			6	5	6	5	5	4	4	4	4	4	4	4	4	4	4	4	4
On hand at end of year			37	38	58	59	62	67	65	66	65	65	65	65	65	65	65	66	65
Average LSUs for year			10	10	15	15	16	17	17	17	17	17	17	17	17	17	17	17	17
4. Bull calves	0.3	100																	
Born during year			42	42	64	64	67	70	70	70	70	69	70	70	70	70	70	69	70
Less deaths			6	5	6	5	5	4	4	4	4	4	4	4	4	4	4	4	4
On hand at end of year			36	37	58	59	62	66	66	66	66	65	65	66	66	66	66	65	66
Average LSUs for year			10	10	15	15	16	17	17	17	17	17	17	17	17	17	17	17	17
5. Heifers 1–2 years	0.5	300																	
On hand at beginning of year			37	37	38	58	59	62	67	65	65	66	65	65	65	66	66	65	66
Less deaths			3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3
On hand at end of year			34	34	35	55	56	59	64	62	62	63	62	62	62	63	63	62	63
Average LSUs for year			18	18	18	28	29	30	33	32	32	32	32	32	32	32	32	32	32
6. Steers 1–2 years	0.5	300																	
On hand at beginning of year			36	36	37	58	59	62	66	65	66	65	66	66	66	66	65	66	65
Less deaths			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
On hand at end of year			33	33	34	55	56	59	63	62	63	62	63	63	63	63	62	63	62
Average LSUs for year			17	17	18	28	29	30	32	32	32	32	32	32	32	32	32	32	32
7. Heifers 2–3 years	0.7	400																	
On hand at beginning of year			34	34	34	35	55	56	59	64	62	62	63	62	62	62	63	63	62
Less deaths			3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
Replacements to breeding herd			31	31	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			0	0	0	33	52	53	56	61	60	60	59	60	60	59	60	60	59
Average LSUs for year			13	13	13	25	40	41	43	47	46	46	45	46	46	45	46	45	45
8. Steers 2–3 years	0.7	350																	
On hand at beginning of year			33	33	33	34	34	55	56	59	63	63	62	63	63	62	63	62	63
Less deaths			3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			30	30	30	32	52	53	56	60	60	60	59	60	60	59	60	59	60
Average LSUs for year			24	24	25	25	40	41	43	46	46	46	45	46	46	45	46	45	46

HEAD COMPOSITION & BUILD UP

	LSU	Value (Pula)	Existing Stock	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
9. Heifers 3–4 years	1.0	700																	
On hand at beginning of year			0	0	0	0	33	52	53	56	61	59	60	59	60	59	60	59	60
Less culls sold start of year	0	400	0	0	0	0	2	4	4	5	6	6	6	6	6	6	6	6	6
Less deaths			0	0	0	0	2	2	2	3	3	3	3	3	3	3	3	3	3
Replacements to breeding herd			0	0	0	0	29	35	37	37	37	37	37	37	37	37	37	37	37
Less sales as breeders			0	0	0	0	0	11	10	11	15	13	14	13	14	13	14	13	14
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			0	0	0	0	16	24	25	26	28	27	27	27	27	27	27	27	27
10. Steers 3–4 years	1.0	450																	
On hand at beginning of year			30	30	30	30	32	52	53	56	60	60	59	60	59	60	59	60	59
Less deaths			3	3	2	2	2	3	3	3	3	2	2	2	2	2	2	3	3
Less replacements to breeding bulls			2	2	1	1	3	2	2	2	2	2	2	2	2	2	2	2	2
Less sales			25	25	28	27	27	47	48	51	55	55	54	55	54	55	54	55	54
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			15	15	15	15	16	26	27	28	30	30	30	30	30	30	30	30	30
11. Steers 4–5 years	1.2	600																	
On hand at beginning of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less deaths			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12. Steers 5–6 years	1.2	600																	
On hand at beginning of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less deaths			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. Steers 6 years+	1.2	600																	
On hand at beginning of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less deaths			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Less sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14. Cull cows (carried 9 months)	0.8	400																	
Culled at start of year			12	12	16	20	25	27	26	26	26	26	26	26	26	26	26	26	26
Less deaths			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Less sales			11	11	15	19	24	26	25	25	25	25	25	25	25	25	25	25	25
On hand at end of year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average LSUs for year			5	5	6	8	9	10	10	10	10	10	10	10	10	10	10	10	10
TOTAL RANCH BRED LSUs				362	352	368	424	453	462	470	472	471	471	471	471	471	471	471	471
Surplus LSUs				-55	107	97	45	18	9	1	-1	0	0	0	0	0	0	0	0
Purchased fatteners grazed 6 months	1																		
Total LSUs				362	352	368	424	453	462	470	472	471	471	471	471	471	471	471	471
DEATHS																			
Purchased Steers/bulls				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Breeding Cows				23	17	10	11	11	11	11	11	11	11	11	11	11	11	11	11
Breeding Bulls				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Heifer calves				5	6	5	5	4	4	4	4	4	4	4	4	4	4	4	4
Bull Calves				5	6	5	5	4	4	4	3	3	3	4	4	4	4	4	4
Heifers 1–2				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Steers/bulls 1–2				3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Heifers 2–3				3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
Steers/bulls 2–3				0	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3
Heifers 3–4				3	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Steers/bulls 3–4				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steers/bulls 4–5				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steers/bulls 5–6				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steers/bulls 6+				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cull cows				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Deaths				50	45	34	39	38	38	39	39	39	39	39	39	39	39	39	39

CATTLE SALES (Pula '000s)

	Value Head	Year 1 No	Year 1 Value	Year 2 No	Year 2 Value	Year 3 No	Year 3 Value	Year 4 No	Year 4 Value	Year 5 No	Year 5 Value	Year 6 No	Year 6 Value	Year 7 No	Year 7 Value	Year 8 No	Year 8 Value	Year 9 No	Year 9 Value	Year 10 No	Year 10 Value
Breeding Cows	700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Breeding Bulls	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cull Cows	400	11	4,400	15	6,000	19	7,600	24	9,600	26	10,400	25	10,000	25	10,000	25	10,000	25	10,000	25	10,000
Cull Bulls	500	1	500	1	500	1	500	1	500	1	500	1	500	1	500	1	500	1	500	1	500
Cull Heifers	400	0	0	0	0	0	0	2	800	4	1,600	4	1,600	5	2,000	6	2,400	6	2,400	6	2,400
Surplus Heifers RWB	700	0	0	0	0	0	0	0	0	11	7,700	10	7,000	11	7,700	15	10,500	13	9,100	14	9,800
Ranch Steers 2+ yrs	350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranch Steers 3+ yrs	450	25	11,250	28	12,600	27	12,150	27	12,150	47	21,150	48	21,600	51	22,950	55	24,750	55	24,750	54	24,300
Ranch Steers 4+ yrs	600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranch Steers 5+ yrs	600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranch Steers 6+ yrs	600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Ranch Bred Sales		37	16,150	44	19,100	47	20,250	54	23,050	89	41,350	88	40,700	93	43,150	102	48,150	100	46,750	100	47,000
Purchased Fatteners	750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Cattle Sales		37	16,150	44	19,100	47	20,250	54	23,050	89	41,350	88	40,700	93	43,150	102	48,150	100	46,750	100	47,000

MILK PRODUCTION & SALES

	Milk Offtaked ('000 Litres)	Home consumption ('000 Litres)	Milk Sales ('000 Pula)	Sour Milk Sales ('000 Pula)	Total Value of Fresh Milk Prodn
Yr 1	16,656	8,328	7,162	9,619	14,324
Yr 2	25,680	5,000	17,785	23,885	22,085
Yr 3	29,664	5,000	21,211	28,487	25,511
Yr 4	36,673	5,000	27,239	36,582	31,539
Yr 5	38,948	5,000	29,195	39,210	33,495
Yr 6	38,948	5,000	29,195	39,210	33,495
Yr 7	41,730	5,000	31,588	42,423	35,888
Yr 8	41,730	5,000	31,588	42,423	35,888
Yr 9	41,730	5,000	31,588	42,423	35,888
Yr 10	41,730	5,000	31,588	42,423	35,888
Yr 11	41,730	5,000	31,588	42,423	35,888
Yr 12	41,730	5,000	31,588	42,423	35,888
Yr 13	41,730	5,000	31,588	42,423	35,888
Yr 14	41,730	5,000	31,588	42,423	35,888
Yr 15	41,730	5,000	31,588	42,423	35,888
Yr 16	41,730	5,000	31,588	42,423	35,888
Yr 17	41,730	5,000	31,588	42,423	35,888
Yr 18	41,730	5,000	31,588	42,423	35,888
Yr 19	41,730	5,000	31,588	42,423	35,888
Yr 20	41,730	5,000	31,588	42,423	35,888

PURCHASE (Pula '000s)

	Value Head	Year 1 No	Year 1 Value
Breeding Cows	750	0	0
Breeding Bulls	1000	0	0
Fattening Steers	300	0	0
Total Purchases		0	0

(All years Year 1–Year 10 = 0)

NET INCOME (Pula '000s)

Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
25,769	42,985	48,737	59,632	80,560	79,910	85,573	90,573	89,173	89,423

Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
89,173	89,173	89,173	89,423	89,173	89,423	89,423	89,423	89,423	89,423	89,423

Existing Stock
Cattle 270
Goats 903
Sheep 26
Donkeys 94

Suggested extra Stocking: 300

Approximate LSU: (270+300) > 399

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Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
High Input/Management and Controlled Stocking Option
Investment Costs

INVESTMENT COSTS	units	value (Pula)	Year 1 units	value	Year 2 units	value	Year 3 units	value	Year 4 units	value	Year 5 units	value	Total units	value
1 Fencing														
Holding Kraal	each	600.0	2	1200.0	2	1200.0		0.0		0.0		0.0	4	2400.0
*1 Boundary Fencing	km	1502.6	18	27047.6		0.0		0.0		0.0		0.0	18	27047.6
Internal Fencing	km	1427.9	31	44266.0		0.0		0.0		0.0		0.0	31	44266.0
				0.0		0.0		0.0		0.0		0.0	0	0.0
				0.0		0.0		0.0		0.0		0.0	0	0.0
Sub-total				72513.6		1200.0		0.0		0.0		0.0		73713.6
2 Equipment														
Knapsack sprayer	each	185.9	2	371.8		0.0		0.0		0.0		0.0	2	371.8
Dehorning iron	each	20.0	2	40.0		0.0		0.0		0.0		0.0	2	40.0
Burdizzo	each	159.3	1	159.3		0.0		0.0		0.0		0.0	1	159.3
Syringe	each	28.4	2	56.8		0.0		0.0		0.0		0.0	2	56.8
Spares	set	10.0	2	20.0		0.0		0.0		0.0		0.0	2	20.0
Sub-total				647.9		0.0		0.0		0.0		0.0		647.9
3 Herd Build-up														
In-calf breeding cows	each	750.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Breeding bulls	each	1000.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Fattening bullocks	each	300.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Sub-total				0.0		0.0		0.0		0.0		0.0		0.0
Total				73161.5		1200.0		0.0		0.0		0.0		74361.5
Physical Contingency		5.00%		3658.1		60.0		0.0		0.0		0.0		3718.1
Total Investment Costs				76819.6		1260.0		0.0		0.0		0.0		78079.6

1* Fencing Costs per Km
The boundary fence to the properties totals approximately 26 km. Most of is in poor condition and requires renovation. 7.5 km of this fence is shared with Mr. Strauss whilst a further 8.5 km is shared with Mr. Blackbeard's other property where renovation is on-going. It is assumed that the joint sections would be renovated on a cost sharing basis. There is thus a need for total renovation of 26 - ((7.5 + 8.5)/2) = 18 km.

Boundary

Item	Presentation		Length (m)	Cost/Unit	Required per 1000m	Total Cost
High Tensile Wire	Roll		2240	158.9	2.2	354.6
Anchor Wire	Roll		846	99.0	0.1	8.8
Binding Wire	Roll		2015	120.9	0.2	19.8
						0.0
			Distance (m)			0.0
						0.0
Strainers	Each	2.7m X 100 x 125 mm	396	51.0	7.5	382.4
Standards	Each	2.1m x 75 x 100 mm	15	6.0	60.0	357.0
Droppers	Each	1.4 x .3 mm	3	1.1	300.0	330.0
			Total Materials			1452.6
			Labour @ 5 man days/km, P10/man day			50.0
						1502.6

2* Internal

Existing internal fences total approximately 45 km and most of this is in fair condition. This divides the properties into 9 paddocks. Since arable land is to be opened up there will be a need to fence this out and to remove the fence which at present divides the arable area. This will entail the construction of 9 km of new internal fence. It is un--likely that the materials will be reusable. The fence bisecting LU 3 should also be moved to enable better late season grazing control. Total new internal fencing will therefore be:

		Km
Fencing out of arable area (three sides)		9.0
Fencing out of Land Unit 4		4.5
Fencing out of Settlement and Forestry		10.0
Division of arable land	3 x 2.5	7.5
Total		31.0
Existing fencing minus fence moved		35.0
Total for maintenance		66.0

Item	Presentation		Length (m)	Cost/Unit	Required per 1000m	Total Cost
High Tensile Wire	Roll		2240	158.9	1.8	283.7
Anchor Wire	Roll		846	99.0	0.1	8.8
Binding Wire	Roll		2015	120.9	0.1	16.0
						0.0
			Distance (m)			0.0
						0.0
Strainers	Each	2.7m X 100 x 125 mm	396	51.0	7.5	382.4
Standards	Each	2.1m x 75 x 100 mm	15	6.0	60.0	357.0
Droppers	Each	1.4 x .3 mm	3	1.1	300.0	330.0
			Total Materials			1377.9
			Labour @ 5 man days/km, P10/man day			50.0
						1427.9

Botswana Ministry of Agriculture
Department of Crop Production and Forestry
Land Utilisation Division

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
High Input/Management and Controlled Stocking Option
Sales and Operating Expenditure

SALES

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Arable Sales										
Cattle Sales	16150	19100	20250	23050	41350	40700	43150	48150	46750	47000
Milk Sales	9619	23885	28487	36582	39210	39210	42423	42423	42423	42423
Total Sales	25769	42985	48737	59632	80560	79910	85573	90573	89173	89423

OPERATING EXPENDITURE

1 Salaries & Wages (Cost p.a.)

	Cost p.a.	Year 1 Units	Year 1 Cost	Year 2 Units	Year 2 Cost	Year 3 Units	Year 3 Cost	Year 4 Units	Year 4 Cost	Year 5 Units	Year 5 Cost	Year 6 Units	Year 6 Cost	Year 7 Cost	Year 8 Units	Year 8 Cost	Year 9 Units	Year 9 Cost	Year 10 Units	Year 10 Cost
1* Milker/Labourer	1000	7	7000	7	7000	7	7000	8	8000	9	9000	9	9000	9000	9	9000	9	9000	9	9000
Sub-total			7000		7000		7000		8000		9000		9000	9000		9000		9000		9000

3 Maintenance

		Year 1 Units	Year 1 Cost	Year 2 Units	Year 2 Cost	Year 3 Units	Year 3 Cost	Year 4 Units	Year 4 Cost	Year 5 Units	Year 5 Cost	Year 6 Units	Year 6 Cost	Year 7 Cost	Year 8 Units	Year 8 Cost	Year 9 Units	Year 9 Cost	Year 10 Units	Year 10 Cost
Fencing 10.00%		66	9424	66	9424	66	9424	66	9424	66	9424	66	9424	9424	66	9424	66	9424	66	9424
Sub-total			9424		9424		9424		9424		9424		9424	9424		9424		9424		9424

4 Veterinary Health & Materials

		Year 1 Units	Year 1 Cost	Year 2 Units	Year 2 Cost	Year 3 Units	Year 3 Cost	Year 4 Units	Year 4 Cost	Year 5 Units	Year 5 Cost	Year 6 Units	Year 6 Cost	Year 7 Cost	Year 8 Units	Year 8 Cost	Year 9 Units	Year 9 Cost	Year 10 Units	Year 10 Cost
2* Vaccines lump sum young stock	1.1	122	135	166	184	186	206	193	214	203	225	206	229	226	205	228	204	226	205	228
3* Drugs lump/LSU	2.8	36	101	35	98	37	103	42	118	45	126	46	129	131	47	132	47	131	47	131
4* Dip Wash lump/LSU	0.1	362	18	352	18	368	18	424	21	453	23	462	23	24	472	24	471	24	471	24
6* Semen (50% cows)	4	128	513	107	428	103	412	109	434	107	428	107	428	428	107	428	107	428	107	428
Sub-total			767		728		740		788		802		809	809		811		809		811

5 Supplementary Feeds

		Year 1 Units	Year 1 Cost	Year 2 Units	Year 2 Cost	Year 3 Units	Year 3 Cost	Year 4 Units	Year 4 Cost	Year 5 Units	Year 5 Cost	Year 6 Units	Year 6 Cost	Year 7 Cost	Year 8 Units	Year 8 Cost	Year 9 Units	Year 9 Cost	Year 10 Units	Year 10 Cost
5* Mineral supplements and maintenance	14.4	362	5198	352	5055	368	5284	424	6089	453	6505	462	6634	6749	472	6778	471	6764	471	6764
Sub-total			5198		5055		5284		6089		6505		6634	6749		6778		6764		6764

6 Costs of Forage Production

	Unit			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cultivations	ha	110	205	22550	2200	2200	23650	2200	2200	23650	2200	2200	23650
Siratro	ha	50	205	10250	1000	1000	10750	1000	1000	10750	1000	1000	10750
Single Supers	ha	40	205	8200	800	800	8600	800	800	8600	800	800	8600
Sowing	ha	20	205	4100	400	400	4300	400	400	4300	400	400	4300
Sub-total				41000	4000	4000	43000	4000	4000	43000	4000	4000	43000

7 Sales Costs

	Unit			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Transport	head	80	37 / 44 / 47 / 54 / 89 / 88 / ... / 102 / 100 / 100	2960 (0)	3520 (0)	3760 (0)	4320	7120	7040 (0)	7440 (0)	8160	8000 (0)	8000 (0)
Sub-total				2960	3520	3760	4320	7120	7040	7440	8160	8000	8000
Total				66350	29727	30208	71621	36852	36907	76423	38173	37997	76998
Physical Contingency		5.00%		3317	1486	1510	3581	1843	1845	3821	1909	1900	3850
Total Operating Costs				69667	31214	31719	75202	38694	38753	80244	40082	39897	80848
Net Income				-43898	11772	17018	-15569	41866	41157	5329	50491	49276	8575

1* Assumes one labourer per 50 LSU based on actual figures from farmers

2* Vaccines

	Cost/dose
Calf paratyphoid	0.3
Lumpy Skin	0.5
Enterotoxaemia	0.0
Pasteurella	0.4
Total	1.1

An assumption is made that these vaccines are given to immature stock only

3* Drugs

Terramycin	2.1
Sulphamezathin	0.7
Total	2.8

An assumption is made that treatment is required in only 10% of the cattle

4* Dip Wash administered with Knapsack sprayer – Whilst correctly the cost would be P1/LSU per week, in reality the spraying is reduced in both concentration and frequency to a cost of approximately P1/LSU per month. This is felt to be too low and a cost of P0.5/LSU per week has been used.

5* Minerals

Cattle Maintenance Lick (50 kg)	24.5
Salt (50 kg)	7.9
Bonemeal (50 kg)	39.5
Total	71.8

10 kg of salt and bonemeal per head per year, 10 kg of maintenance lick over the dry season

6* Semen

50% of owners of cows assumed to have their cattle served by AI with bulls running with cows as insurance.

Cost per insemination = P   8 Number of inseminations per cow = 2

Proposed Agricultural Land Use Plan of Former Freehold Farms Numbers 25/77 NQ and 27/77 NQ, North East District
High Input/Management and Controlled Stocking Option
Cash Flow

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 15	Year 16
Cash Inflows															
Sales	25769	42985	48737	59632	80560	79910	85573	90573	89173	89423	89173	89423	89173	89173	89423
Total inflow	25769	42985	48737	59632	80560	79910	85573	90573	89173	89423	89173	89423	89173	89173	89423
Cash Outflows															
Investment	76820	1260	0	0	0										
Operating Expenditure	69667	31214	31719	75202	38694	38753	80244	40082	39897	80848	40082	39897	80848	39897	80848
Total outflow	146487	32474	31719	75202	38694	38753	80244	40082	39897	80848	40082	39897	80848	39897	80848
Net Benefit Stream	−120718	10512	17018	−15569	41866	41157	5329	50491	49276	8575	49091	49526	8325	49276	8575
NPV at 15.00% 168424															
IRR 19%															
Net Income per family	−2944	256	415	−380	1021	1004	130	1231	1202	209	1197	1208	203	1202	209
Based on 41 families															

ANNEX 3:

INCLUSION OF LAND UNITS

IN RECOMMENDED PADDOCKING SYSTEM

INCLUSION OF LAND UNITS IN RECOMMENDED PADDOCKING SYSTEM

Paddock No	Land Unit	Area	ha/LSU	LSUs	Paddock No	Land Unit	Area	ha/LSU	LSUs
1	1		7	0	7	1	35.0	7	5
	2a	219.5	10	22		2a	49.9	10	5
	2b		14	0		2b	147.3	14	11
	2ask	621.0	14	44		2ask	188.2	14	13
	2alp		14	0		2alp		14	0
	3	2.0	18	0		3		18	0
	V1	196.1	7	28		V1	92.1	7	13
	V2		7	0		V2		7	0
	Total	1,038.6	11	94		Total	512.6	11	47
2	1		7	0	8	1	25.3	7	4
	2a	8.7	10	1		2a	263.7	10	26
	2b		14	0		2b	50.8	14	4
	2ask	69.8	14	5		2ask	43.7	14	3
	2alp		14	0		2alp		14	0
	3	721.0	18	40		3		18	0
	V1	101.4	7	14		V1	79.1	7	11
	V2		7	0		V2	31.5	7	5
	Total	900.9	15	60		Total	494.1	9	53
3	1		7	0	9	1	4.5	7	1
	2a	70.3	10	7		2a	96.1	10	10
	2b		14	0		2b	193.4	14	14
	2ask	773.4	14	55		2ask		14	0
	2alp	87.0	14	6		2alp		14	0
	3	199.6	18	11		3	5.0	18	0
	V1	198.8	7	28		V1	96.2	7	14
	V2		7	0		V2	65.0	7	9
	Total	1,329.0	12	107		Total	460.0	10	48
4	1		7	0	10	1	0.0	7	0
	2a	442.7	10	44		2a	55.8	10	6
	2b		14	0		2b	0.0	14	0
	2ask	15.4	14	1		2ask	134.8	14	10
	2alp		14	0		2alp		14	0
	3		18	0		3		18	0
	V1	63.7	7	9		V1	0.0	7	0
	V2		7	0		V2	89.6	7	13
	Total	521.9	10	54		Total	280.2	10	29
5	1		7	0	11	1	0.0	7	0
	2a	98.8	10	10		2a	166.2	10	17
	2b		14	0		2b	0.0	14	0
	2ask	2.7	14	0		2ask	10.6	14	1
	2alp	523.9	14	37		2alp		14	0
	3		18	0		3	4.1	18	0
	V1	85.9	7	12		V1	0.0	7	0
	V2		7	0		V2	111.0	7	16
	Total	711.4	12	59		Total	292.0	9	34
6	1		7	0	Total	1	64.8	7	9
	2a	71.7	10	7		2a	1,543.4	10	154
	2b	40.1	14	3		2b	431.6	14	31
	2ask	95.0	14	7		2ask	1,954.5	14	140
	2alp		14	0		2alp	610.9	14	44
	3		18	0		3	931.7	18	52
	V1	112.4	7	16		V1	1,025.8	7	147
	V2		7	0		V2	297.1	7	42
	Total	319.2	10	33		Total	6,859.8	11	619