Land Resource Study

5 The Northern State Lands, Botswana

Land Resources Division/Directorate of Overseas Surveys

CORRECTIONS. LAND RESOURCE STUDY NO. 5

Page 49, fifth paragraph, lines 4 and 5, *for* lense *read* lens

Page 106, in the table, after P ppm *for* NaCH *read* NaOH

Page 124, first line *for* phenolthiazine *read* phenothiazine

Throughout the text and maps the current spelling Serondellas (a place name) should be understood for the variants Serondella and Serondela

The Northern State Lands, Botswana

Ministry of Overseas Development

The Northern State Lands, Botswana

by

A. Blair Rains and A.D. McKay

Land Resource Study No. 5

Land Resources Division, Directorate of Overseas Surveys,
Tolworth, Surrey, England

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THE LAND RESOURCES DIVISION

OF THE DIRECTORATE OF OVERSEAS SURVEYS

The Directorate of Overseas Surveys, part of the Ministry of Overseas Development, assists developing countries in the fields of land survey, air photography, mapping and the investigation of land resources.

The Land Resources Division assesses land resources, and makes recommendations on the use of these resources for the development of agriculture, livestock husbandry and forestry; it also gives advice on related subjects to overseas governments and organisations, makes scientific personnel available for appointment abroad and provides lectures and training courses in the basic techniques of resource appraisal.

The Division endeavours to work in close co-operation with government departments, research institutes, universities and international organisations concerned with land resource assessment and development planning.

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PART 1. INTRODUCTION

PREFACE

This report is published with the permission of the Botswana Government but the views and opinions are those of the authors and do not necessarily represent those of the Government.

Since the draft copy of the report was submitted to the Botswana Government in March 1967 there have been changes affecting the Northern State Lands. The export of live cattle from Ngamiland to Zambia via Kazengula has ceased and cattle are now taken to the Lobatsi abattoir via Francistown. The Chobe Game Reserve Boundary has been modified; the new boundary is shown on the Current Land Use map. Timber will not be extracted from within the Reserve.

ACKNOWLEDGEMENTS

Many individuals gave generously of their time in providing information and we gratefully acknowledge all the help given by members of the public and by government officials including the following:

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ABSTRACT

An investigation of the land resources of the Northern State Lands, Botswana, with a view to developing the cattle industry while conserving the game population, is described.

The appraisal of resources is based on a survey of the physical environment, with special emphasis on the vegetation. An ecological survey was made of an area of 25 000 mi^2 (64 750 km^2); it consisted of a vegetation pattern analysis of air photographs and ground traverses covering 3 200 m (5 150 km).

Sixteen vegetation communities are described and their distribution is shown on 1:500 000 scale map. Data on the soils and analyses of the herbage from certain areas are presented.

The factors affecting the suitability of the land for ranching are discussed. Three areas selected for controlled development are described, but because of low carrying-capacity (1 adult equivalent to 25 acres/10 hectares) the economic returns are likely to be small. In six other areas development will depend on the availability of potable non-mineralised groundwater in sufficient quantity; economic considerations may limit the development of these areas.

The abundance of game animals throughout the area is noted and their potential contribution to the economy is considered in terms of safari hunting, tourism, and game cropping.

RÉSUMÉ

On a etudié les resources naturelles des Northern State Lands, Botswana, dans l'intention de développer l'industrie bovine tout en conservant la population du gibier.

L'évaluation des resources est basée sur un examen du milieu physique, avec une emphase spéciale sur la végétation. On a fait une étude écologique d'une superficie de 25 000 mi^2 (64 750 km^2), en analysant des photographies aériennes et en faisant des traverses sur le terrain.

Seize populations végétales sont décrites et leur distribution est indiquée sur une carte a l'échelle 1:500 000. Les données sur les sols et l'analyse de l'herbage sont presentés pour certaines régions.

On examine les facteurs qui influent sur l'aptitude des terres pour l'élevage bovin. Trois régions choisies pour un développement controlé sont décrites, mais à cause de leur basse capacité de charge (25 ac (10 ha) par bête), le rendement économique sera limité. Dans six autres régions, la mise en valeur des terres dépendra de la quantité d'eau potable et non-mineralisée disponible; des considérations économiques pourraient limiter le développement de ces régions.

La région est giboyeuse. La contribution potentielle du gibier à l'économie est considérée en fonction du safari, du tourisme et de la production de la viande.

DESCRIPTORS FOR CO-ORDINATE INDEXING

Botswana/land resource assessment/vegetation survey/grassland/savannah-woodland/desert/geology/climate/water resource assessment/underground water/lithosol/gleysol/fluvisol/vertisol/ermosol/acrisol/ferralsol/halosol/fauna/tsetse fly/land use/forestry/agriculture/livestock/beef-cattle/game/meat industry/tourism/sociology/economics/development.

SUMMARY OF RECOMMENDATIONS

General Recommendations

The object of the survey was to assess land resources in relation to the development of the cattle industry. The assessment has shown that this development will depend on certain innovations in social and economic policy which must be indicated here - although they are strictly speaking outside the terms of reference laid down for the survey.

Botswana has very limited land resources which can be easily abused and even destroyed. To preserve these resources it is important not to postpone decisions on the more fundamental issues raised by the recommendations, which are summarised below.

1. It is recommended that a Natural Resources Committee should be established as a counterpart to the Economic Planning Unit. Ecological considerations of many of the country's problems are no less important than their economic aspects.

2. It is recommended that the development of an integrated system of crop and animal husbandry should be encouraged in every way practicable. The traditional zonation into 'lands' and 'cattle posts' is inimical to sound agriculture.

3. Measures must be introduced to ensure stock limitation in tribal areas, on privately owned farms and in any areas of the State Lands which may be used for cattle production.

4. It is recommended that greater resources are provided for research in grassland and animal husbandry and for the training and instruction of stock owners in improved animal husbandry practice.

5. It is recommended that the Government should expand the Game Department even if it is not possible to implement fully the recommendations of the Kinloch Report (1966).

6. The Game Department should be made responsible for:

   (a) The issue of licences and the control of all hunting.

   (b) The management of game reserves.

   (c) The investigation of animal migrations, animal population dynamics and game cropping.

7. It is recommended that there should be financial support for a tourist industry. There will be little incentive for private investment without official encouragement which includes some financial backing by government or by quasi-official organisations.

Recommendations for the Development of the Northern State Lands

1. It is proposed that livestock development be commenced in Areas A, B, and C (see Recommended Land Use Map P. 75) which are situated to the north and east of the fenced blocks of the Nata Ranch. The Government must decide the form of development, but whatever the form of development, it must not be regarded as an immediate or even early source of revenue. Only modest returns can be expected from any sound system of farming.

2. It is recommended that the Geological Survey Department be asked to advise on the water resources of Areas D, E, F, and G. The opportunities for ranching in these areas will depend on the availability of water.

3. It is strongly urged that Area H lying to the north-east of Rakops be closed to grazing by cattle. The presence of both game and cattle in this area is clearly unsatisfactory. It is possible that this area could be considered for cattle grazing, but such a development would depend on the provision of adequate supplies of potable water.

4. The agricultural value of the vertisols, particularly the better drained sites around Panda-ma-Tenga and on the Kakulwane Plain should be investigated.

5. It is strongly recommended that three additional areas should be established for the protection of game animals. The areas are:

   (a) The Nyaia Pan and a corridor to the Botletle River.

   (b) A corridor between the south-western corner of the Chobe Game Reserve and the Moremi Wildlife Reserve.

   (c) An extension from the Chobe Game Reserve into the Kakulwane Plain.

6. Whatever the outcome of the discussion on the future of the Masubia enclave, it is recommended that hunting should be restricted to the eastern part of the enclave.

7. It is suggested that the area south of Kanyu be used for organised hunting but should not continue as a safari hunting concession.

BOTSWANA

SCALE

Miles 10 0 50 100 150 Miles

ANGOLA

CAPRIVI STRIP

REPUBLIC OF ZAMBIA

SOUTH WEST AFRICA

SOUTHERN RHODESIA

TRANSVAAL

REPUBLIC OF SOUTH AFRICA

CAPE PROVINCE

Zambesi River

Kazungula

Kasane

Kachikau

Mohembo

Shakawe

Chobe or Linyanti R.

Savuti Channel

Kwando R.

Okavango River

Sepopa

TSODILO HILLS

Nxau Nxau

Gomare

OKAVANGO SWAMPS

Chief's Island

Mababe Depression

GOHA HILLS

CHOBE DISTRICT

Panda ma Tenga

Tsotsoroga

SHINAMBA HILLS

NORTHERN STATE LANDS

Nokaneng

AHA MOUNTAINS

BATAWANA

KOANAKA HILLS

Tsau

Thamalakane R.

Maun

Naragha Valley

Ngabe R.

Chanokha Drift

Bushman Pits

Kanyu

Odiakwe

Nata

Nata R.

Matiemgwe

Totome R.

Bokalaka

Totome

Bushman Mine

Plumtree to Bulawayo

Schitwa

L. Ngami

KGWEBE HILLS

MAKGABANA HILLS

SHULABOMPE HILLS

Kabaganyane

Makalamabedi

Boteletle R.

Ntwetwe

MAKARIKARI

Sua

Dukwe

Mosetse

Matungu

Phudulooga

Ramaquabane

Tsessebe

TATI CONCESSION

MABELE-A-PUDI HILLS

Rakops

L. Dow

Tswantsha

Lothiekane

Francistown

Shashi

Tonoto

Tati R.

Ramaquabane R.

Foley

Mookane

BAMANGWATO

Majanti

Magogaphate

Seruli

Madinare

Macloutsie R.

Bobonong

Macloutsie

Shashi R.

Tuli

Dimaphuti

Mamakubo

Sefhope

Tuni R.

TOUTSWE HILL

Dikabi

Serowe

Swaneng

PIKWE HILLS

Morapule

Palapye

Tsetsejwe

Baines Drift

Naka La Phala

Bikukunuru

Lotsani R.

Moeng

BLOCK

Shoshong

Sefare

Martin's Drift

Mahalapye

Limpopo River

TULI

Mahibitswane

Bonwapitse

Palla Road

Dead Mule

Lephepe

Mamabule

Debeeti

Ngware

Lethiakeng

BAKGATLA

Schoongezicht

Molepolole

Semarule

Pilane

Mochudi

Kopong

Notwani River

Marico R.

Thamaga

Kolobeng

Khale

GABERONES

BATLOKWA

GABERONES BLOCK

Magalasepe

Moshupa

Tshukutswane

Manyana

Ramoutsa

BAMALETE

Moshaneng

Kanye

Ootsi

Diphawana

KGWATGWE HILL

Matapana

LOBATSI

LOBATSI BLOCK

Pitsane

BAROLONG

Ramathlabama

Pitsani Molopo

Mabule

to Pretoria and Johannesburg

MAFEKING

to Vryburg and Kimberley

Mokopong

Werda

Mospdebe Laagte

Bray

Molopo R.

Knapdaar

Tsabong

Noossp R.

Bokspits

KGALAGADI DISTRICT

KALAHARI DESERT

STATE LANDS

Xade Pan

Tswane

Okwa

Takachu

Lone Tree

Kuli

Manyane

Ukwi

Kang

Lehututu

Tshane

Morwamosu

Kukong

BANGWAKETSE

Keng

Oki

Kakia

BAKWENA

Dutlhe

Mamono

Makunda

Kalkfontein

Buitsivango or Hanehal

GHANZI FARMS

Ghanzi

Groot Laagte

20° 21° 22° 23° 24° 25° 26° 27° 28° 29°

18° 19° 20° 21° 22° 23° 24° 25° 26°

International boundary

Tribal Area boundary

Northern State Lands boundary

D.O.S.(Misc.)448
Based on Provisional Mineral Map of the Bechuanaland Protectorate 1962.
Additional information supplied by the Office of Her Majesty's Commissioner, Bechuanaland Protectorate, 1965.

Agents for the sale of this map are:- Edward Stanford Ltd., 12/14, Long Acre, London, WC2. Price 1/- net.
Copies can also be obtained from the Surveyor-General, Office of the Surveyor-General, Republic of Botswana, Price 10 Cents

Drawn and photographed by the Directorate of Overseas Surveys
Printed for D.O.S. by S.P.C., R.E.
5500/2/67/1914/SPC

PART 2. THE PROJECT

ORIGIN OF THE PROJECT

The survey described in this report was originally requested by Sir Peter Fawcus, C.M.G., O.B.E., formerly Queen's Commissioner in the Protectorate of Bechuanaland, as part of the long-term development of the country. This request was made through the Ministry of Overseas Development to the Directorate of Overseas Surveys, whose Land Resources Division had already undertaken in 1963 a reconnaissance investigation into the land use prospects of Northern Bechuanaland, including the area under consideration in this report.

The terms of reference were as follows:

> 'To conduct an investigational survey and report on the possibility of opening up areas in the Northern Crown Lands* for the development of the cattle industry, bearing in mind the desirability of conserving game in areas where game can be sustained, for the purpose of tourism and for the processing and marketing of game meat, without endangering the cattle industry.'

The need to open up new areas for grazing had become a matter of urgency because of the prolonged and severe drought in Botswana, which has focused attention on both the immediate and long-term problems of the livestock industry.

TEAM COMPOSITION

It was intended that the team should have consisted of two local officers, namely a veterinarian and the pasture agronomist, together with an ecologist of the Land Resources Division who was to be responsible for writing the report. In addition the advice and assistance of the F.A.O. wild-life ecologist working in the area were to be available to the team. Unfortunately it was not possible for a veterinary officer to participate in the survey. The team consisted of A. D. McKay/, Pasture Agronomist, Department of Agriculture, and A. Blair Rains of the Land Resources Division, Directorate of Overseas Surveys; they were accompanied by G. Child** wild-life ecologist of the National Museum, Bulawayo, on secondment to F.A.O. to investigate game in Botswana, who made an invaluable contribution to the survey. A. D. McKay was responsible for the logistics necessary for the field work.

* Subsequently the Northern State Lands.

/ Present address, E.A.A.F.R.O., Nairobi, Kenya.

** Present address, Game Department, Ministry of Commerce and Industry, Gaberones.

PROCEDURE

The programme of work was as follows:

January 1966	Collection of background data
February - April 1966	Field survey of vegetation, and discussions with local technical and administrative officers
May - June 1966	Preparation of draft report
July - September 1966	Detailed mapping

During the preparatory work the relevant maps, aerial photographs and reports were studied. A vegetation pattern analysis was made of 1:40 000 vertical panchromatic air photographs and 1:125 000 air photograph mosaics. In conjunction with their 'Land Use Prospects of Northern Bechuanaland', Langdale-Brown and Spooner (1963) produced a vegetation map which was used during the field work. Visits were paid to the Herbarium of the Royal Botanic Gardens at Kew, in order to become familiar with some of the commoner plants.

The survey was carried out between 20 February and 21 April when it was possible to identify herbaceous species and when travelling was relatively easy. Both before and after the field work, time was spent in Gaberones, Lobatsi, Mafeking and Mahalapye in discussions with Government officials.

The transport consisted initially of a 5-ton Bedford lorry and one Land Rover and later of a 5-ton four-wheel-drive Bedford lorry and two Land Rovers.

As far as possible all the motorable tracks were traversed, even when this involved retracing our tracks; within the State Lands the total distance travelled was 3 200 mi (5 150 km).

PART 3. THE ENVIRONMENT

PHYSICAL ASPECTS

LOCATION

The Northern State Lands, formerly the Northern Crown Lands, lie between the Okavango swamps to the west and the Rhodesian border to the east, and occupy an area of 24 969 mi^2 (64 669.5 km^2). The Chobe River forms the northern boundary, while to the south they are bounded by the Botletle River, the western arm of the Makarikari Pan, the Nata River and the Maitengwe River; the western boundary is the line of longitude (24° 53' east) which runs northwards from Makalamabedi. Within the State Lands there is the small Bamangwato Territory of which Gweta is the centre; this is a detached portion of the main Bamangwato territory.

GEOLOGY

The Northern State Lands are part of a large internal drainage basin formed of Pre-Karroo and Karroo system rocks infilled by a vast accumulation of mainly unconsolidated sedimentary materials of Post-Karroo period. The Karroo system rocks are in the eastern part of the State Lands and the estimated boundary of the system runs from north to south through the approximate median of the area (Green, 1966).

Outcrop basalt rocks of the Karroo system occur at Panda-ma-Tenga, near Kasane, along the Ngwezumba valley, and near Ngoma; in some places these basalt rocks are associated with outcrops of limestone. The Shinamba hills and the Goha and Gubatsa Hills are isolated exposures of pre-Karroo System rocks; there is however, considerable uncertainty about the age of these rocks and of the related Ghanzi Beds and Kwebe Porphyry Series. The problem of assigning these formations to a system is discussed by Boocock and van Straten (1963).

The southern and eastern margins of this large basin are fairly clearly defined by outcrop rocks of the Karroo System; the northern margin is not clearly defined, but is generally considered to be constituted by the basalt outcrops at Panda-ma-Tenga and elsewhere.

The sedimentary materials overlying this basin include sands of Kalahari type, pan sediments, calcrete and silcrete. Sands of Kalahari type have been carried by wind and by water into the basin at varying times during the Tertiary and subsequent period; some material may have been derived from the underlying rocks of the Stormberg series.

Tectonic and climatic changes have affected the sedimentation in the drainage basin. Some of the sedimentary materials as a result of sub-aerial exposure have become silicified and calcified; within the basin of a more extensive earlier lake around the present Makarikari Depression outcrops of calcrete and silcrete are common. Pan sediments include siliceous muds which constitute the floor of many of the Makarikari Pans.

TOPOGRAPHY

The area is mainly flat or gently undulating at a general elevation of 3 000 ft (914 m) above sea level. There are two main depressions namely the Mababe in the west, and the Makarikari in the south. In the north the land slopes down approximately 300 ft (91 m) to the flood plains of the Chobe River; a scarp, steep in places, forms part of this slope. There are a number of dry valleys and poorly developed drainage lines and also a small number of streams and rivers, but these flow infrequently and only in years of exceptional rainfall.

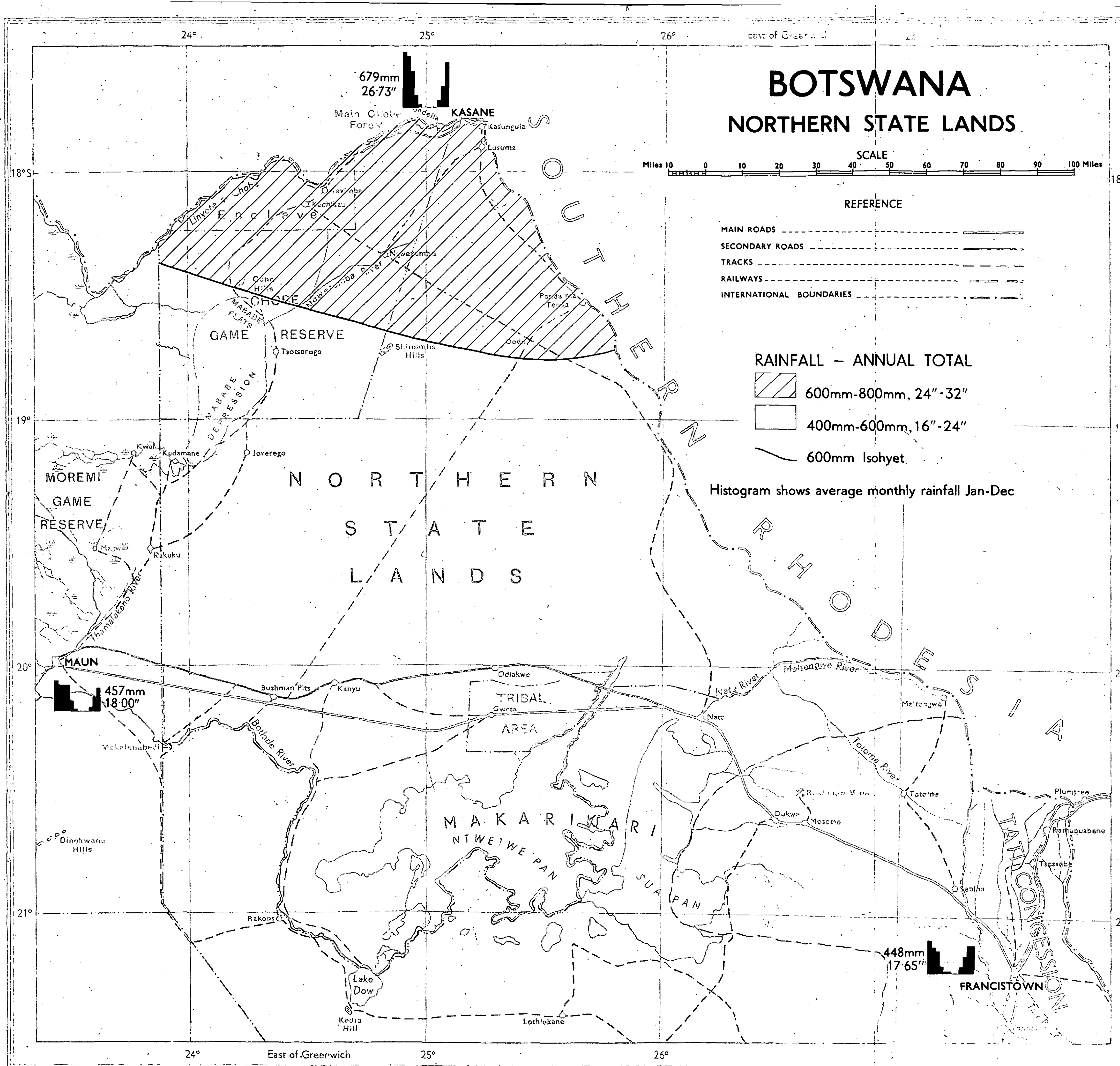
The comparative flatness is broken by a small number of low hills and isolated sand ridges and in several areas by linear or crescent-shaped dunes. The highest hills are the Goha north of the Mababe Depression which rise more than 500 ft (152 m) above the surrounding land; west of the Mababe Depression there is the Magwikwe sand ridge rising to approximately 200 ft (61 m) above the general level of the veld. Other low hills are the Gubatsa in the Mababe Depression and the Shinamba approximately 50 mi (80.5 km) west of Panda-ma-Tenga.

The Mababe Depression is roughly elliptical with a north-south length of 50 mi (80.5 km) and an east-west width of 25 mi (40.2 km). The northern boundary and southern part of the eastern boundary of the depression are clearly defined scarps while the Magwikwe Ridge represents the western boundary. It is believed that the now dry Savuti Channel once diverted the water of the Chobe River into the depression. Today, in years of unusually high rainfall, the depression is partially flooded by water from the Mochaba River in the south-west and by the Ngwezumba River in the north-east; the Mochaba River is part of the network of channels which form the Okavango delta.

Both the Chobe and the Okavango Rivers rise in the highlands of Angola where the former is named the Cuando River. The Chobe River which joins the Zambesi River at Kazungula is perennial and is an important source of water for large numbers of game animals. The Okavango River fans out anastomosing into the channels which form the Okavango swamps from which most of the water is lost by evaporation, although a considerable quantity flows down the Thamalakane River and into the Botletle River which carries water during the dry-season months of June to September.

The Makarikari Depression consists of the eastern Sua or Nata pan and the western Ntwetwe pan and is the main focus of drainage in the south. It is fed principally by the Nata River which with its tributaries rises in Southern Rhodesia and empties its water into the Sua Pan which is linked with the Ntwetwe Pan in the south.

Throughout the area there are many depressions which contain water for short periods during the wet season; a small number of these depressions are a source of surface water throughout the year. Although all depressions are called 'pans' it would seem desirable to restrict the use of this term and only apply it to those depressions which are clearly of aeolian origin.



D.O.S. (Misc) 449a

Drawn and photographed by the Directorate of Overseas Surveys, 1966

This map accompanies a report entitled 'A Land Use Survey of the Northern State Lands, Botswana' by the Land Resources Division, Directorate of Overseas Surveys, 1967.

CLIMATE

The climate of the Northern State Lands is sub-tropical with distinct winter and summer seasons. Most of the rain falls during the summer months from mid-October to mid-April. Temperatures are lower during the dry winter months and air frosts may occur.

Meteorological data for the Northern State Land are fragmentary. Kasane has a third order weather station; rainfall figures are available for Panda-ma-Tenga and Gweta and also for a number of other centres near Kasane.

Kasane is not climatically typical of the greater part of these State Lands, being in a region of higher rainfall.

The data for Francistown to the south-east and for Maun to the west of the area are particularly valuable in view of the scarcity of information.

Rainfall

The average monthly and annual rainfall is shown for Francistown, Gweta, Kasane, Maun and Panda-ma-Tenga in Table 1 and the mean number of rain days for Francistown, Kasane and Maun in Table 2.

The three southern stations Francistown, Gweta and Maun have an annual rainfall of between 17 and 18 in (431.8 and 457.2 mm), with a similar pattern of distribution.

Kasane with nearly 27 in (685.8 mm) is considerably higher, although the pattern of distribution throughout the year is very similar to that at the other three centres.

There are very great variations from both the monthly and the yearly rainfall averages. The total rainfall for any one year may vary from approximately half to nearly double the average, and monthly variations are even more extreme than the yearly fluctuations. Years of less than average rainfall are more frequent than years of more than average rainfall. There is evidence that the rainfall is often sporadic and there can be striking variations between adjacent localities in the same year. These fluctuations in the pattern of rainfall raise many problems and require very careful investigation when the introduction of crops new to an area is being considered. The Agricultural Department have undertaken such a detailed investigation (Weare, 1966) of the rainfall pattern at 14 centres throughout Botswana in connection with an expansion in the cultivation of cotton.

Wind

During the wet season, wind direction is very changeable and often veers round between morning and afternoon, but winds tend to be north-easterly; during the winter winds are generally easterly.

Temperature

The monthly means of daily maxima and of daily minima for Francistown, Kasane and Maun are shown in Table 3.

Temperatures are highest in October and November and lowest in June and July. Ground frosts occur in relatively low-lying areas and are more common in the south than in the north where winter temperatures are higher.

TABLE 1 Average monthly and annual rainfall at five stations, in inches and mm

Month	Francistown 893/883	Gweta 979/462	Kasane 1219/259	Maun 1020/749	Panda-ma-Tenga 1119/332
	1922-50 (29 years)	1960-65 (6 years)	1921-65 (45 years)	1923-65 (43 years)	1962-65 (4 years)
	in (mm)	in (mm)	in (mm)	in (mm)	in (mm)
Jan.	4.17 (106)	3.94 (100)	6.68 (170)	4.11 (195)	3.70 (94)
Feb.	3.11 (79)	2.52 (64)	6.41 (163)	3.75 (95)	4.02 (102)
Mar.	2.80 (71)	2.44 (62)	4.04 (103)	3.17 (81)	1.02 (26)
Apr.	0.71 (18)	1.50 (38)	1.18 (30)	0.98 (25)	1.18 (30)
May	0.16 (4)	0.51 (13)	0.22 (6)	0.20 (5)	0.01 (0.2)
June	0.12 (3)	0.01 (0.3)	0.03 (1)	0.02 (0.5)	0.00 (0)
July	0.00 (0)	0.01 (0.3)	0.00 (0)	0.00 (0)	0.00 (0)
Aug.	0.04 (1)	0.00 (0)	0.00 (0.1)	0.00 (0)	0.00 (0)
Sept.	0.04 (1)	0.04 (1)	0.10 (3)	0.04 (1)	0.00 (0)
Oct.	0.87 (22)	0.47 (12)	0.67 (17)	0.65 (16)	0.16 (4)
Nov.	2.20 (56)	2.44 (62)	2.89 (73)	1.70 (43)	3.74 (95)
Dec.	3.43 (87)	4.06 (103)	5.72 (145)	3.19 (81)	7.44 (189)
Annual Av.	17.64 (448)	19.25 (489)	27.84 (707)	17.80 (452)	21.57 (548)
Max.	32.82 (834)	34.17 (868)	54.3 (1 379)	28.23 (717)*	30.83 (783)
Min.	9.69 (246)	8.54 (217)	14.83 (377)	11.18 (284)*	12.36 (314)

* Period 1931-50.

TABLE 2 Average monthly number of rain days (≥0.2 mm) and wet days (≥1.0 mm) at three stations*

Month	Francistown		Kasane		Maun	
	1922-50 (29 years)		1922-50 (29 years)		1931-50 (20 years)	
	Rain days	Wet days	Rain days	Wet days	Rain days	Wet days
Jan.	9.1	8.1	n.a.	11.2	11.5	9.7
Feb.	7.9	6.7	n.a.	9.2	10.4	8.9
Mar.	6.1	5.2	n.a.	6.9	8.1	7.3
Apr.	2.5	1.9	n.a.	2.2	3.2	2.6
May	0.9	0.7	n.a.	0.7	0.9	0.7
June	0.4	0.3	n.a.	0.2	0.2	0.1
July	0.1	0.1	n.a.	0.0	0.0	0.0
Aug.	0.1	0.1	n.a.	0.0	0.0	0.0
Sept.	0.6	0.5	n.a.	0.6	0.3	0.1
Oct.	3.0	2.7	n.a.	2.1	2.7	1.9
Nov.	5.6	4.7	n.a.	6.8	6.5	4.9
Dec.	7.9	7.3	n.a.	10.6	9.1	7.3
Annual	44.0	38.3	n.a.	50.5	52.9	43.5

* 1 mm = 0.04 in.

n.a. = not available.

TABLE 3a Monthly means of daily maximum and minimum air temperatures and extremes of air temperatures, at three stations, in °C

Month	Francistown				Kasane				Maun			
	1922-50 (29 years)				1922-50 (29 years)				1931-50 (20 years)			
	Means of:		Extremes:		Means of:		Extremes:		Means of:		Extremes:	
	daily max.	daily min.	highest temp.	lowest temp.	daily max.	daily min.	highest temp.	lowest temp.	daily max.	daily min.	highest temp.	lowest temp.
Jan.	31.0	18.2	40.0	8.9	30.7	18.6	37.8	12.8	32.0	18.9	40.0	8.9
Feb.	30.2	17.8	39.4	8.9	30.8	18.6	37.2	11.1	31.0	18.7	39.4	8.9
Mar.	29.2	16.3	37.8	8.9	30.7	17.7	36.7	10.0	30.9	17.5	38.9	10.0
Apr.	28.5	13.4	35.6	-0.3	30.5	15.9	37.2	6.7	30.5	14.4	37.2	3.3
May	26.0	8.8	34.4	-2.2	28.6	12.1	36.7	2.8	27.9	9.6	35.6	-1.7
June	23.2	4.7	31.1	-4.4	26.2	9.0	31.7	-0.6	24.8	5.7	33.3	-3.9
July	23.6	5.1	31.7	-2.8	26.6	8.4	32.8	0.0	25.1	5.6	32.2	-3.9
Aug.	25.9	7.5	35.0	-2.8	29.0	10.5	35.6	1.7	28.5	8.6	36.1	-4.4
Sept.	29.9	12.2	37.8	-0.6	33.3	15.1	39.4	3.9	32.6	13.0	38.6	-0.6
Oct.	32.3	16.2	40.6	4.9	35.3	18.2	42.2	8.9	35.0	17.6	42.8	6.1
Nov.	31.8	17.8	41.7	6.7	33.6	19.2	40.6	9.4	34.2	18.9	43.3	9.4
Dec.	31.3	18.1	40.6	9.8	31.1	18.5	40.6	11.1	32.5	18.9	42.2	11.1
Annual	28.6	13.0	41.7	-4.4	30.5	15.1	42.2	-0.6	30.5	13.9	43.3	-4.4

TABLE 3b Monthly means of daily maximum and minimum air temperatures and extremes of air temperatures, at three stations, in °F

Month	Francistown				Kasane				Maun			
	1922-50 (29 years)				1922-50 (29 years)				1931-50 (20 years)			
	Means of:		Extremes:		Means of:		Extremes:		Means of:		Extremes:	
	daily max.	daily min.	highest temp.	lowest temp.	daily max.	daily min.	highest temp.	lowest temp.	daily max.	daily min.	highest temp.	lowest temp.
Jan.	87.7	64.8	103.9	48.0	87.2	65.5	100.0	55.0	89.5	66.0	104.0	48.0
Feb.	86.3	64.0	102.8	48.0	87.4	65.5	99.0	52.0	87.7	65.6	102.9	48.0
Mar.	84.5	61.4	100.0	48.0	87.2	63.8	98.0	50.0	87.5	63.5	102.0	50.0
Apr.	83.3	56.6	97.0	31.5	86.9	60.6	98.9	44.0	86.9	57.9	100.7	37.9
May	78.8	47.8	93.9	28.0	83.5	53.8	98.0	37.0	82.2	49.2	96.0	28.4
June	73.7	40.5	88.0	24.1	79.2	48.2	89.0	30.9	76.6	42.2	92.0	25.0
July	74.5	41.2	89.0	27.0	79.8	47.2	91.0	32.0	77.1	42.1	90.0	25.0
Aug.	78.6	45.5	95.0	27.0	84.1	50.9	96.0	35.1	88.3	47.4	97.0	24.1
Sept.	85.8	53.9	100.0	30.9	92.0	59.2	102.9	39.0	90.6	55.4	100.5	30.9
Oct.	90.1	61.2	105.0	40.8	99.5	64.8	108.0	48.0	95.0	63.7	109.0	42.9
Nov.	89.2	64.0	107.0	44.0	92.5	66.6	105.0	48.9	93.5	66.0	110.0	48.8
Dec.	88.3	64.6	105.0	44.6	88.0	65.3	105.0	52.0	90.5	66.0	107.9	52.0
Annual	83.5	55.4	107.0	24.1	86.9	59.2	108.0	30.9	86.9	57.0	110.0	24.1

Relative Humidity

Relative humidity data were available for Francistown, Kasane and Maun although only the last named station had data for 1400h as well as for 0800h. The average relative humidity as a percentage at these three stations is shown in Table 4.

The relative humidity is highest during the second half of the wet season (January - March); for the rest of the year it is low. In the months of August to October it is particularly low.

Calculated values for evapotranspiration for Francistown, Kasane and Maun have been obtained from 'Climatic Tables for the World' by Papadakis (1961) and are shown in Table 5.

Apart from the three months (December - February) of heaviest rainfall at Kasane, the potential evaporation greatly exceeds the rainfall throughout the year at all three stations. The actual annual evaporation in areas with a perennial water deficit is approximately equal to the annual rainfall.

TABLE 4 Average relative humidity as a percentage, at three stations

Month	Francistown	Kasane	Maun	
	1922-50 (29 years)	1922-50 (29 years)	1931-50 (20 years)	
	Local time 0800	Local time 0800	Local time 0800	1400
Jan.	69	73	74	46
Feb.	73	76	74	45
Mar.	74	71	76	45
Apr.	70	67	70	34
May	68	59	69	28
June	70	60	71	27
July	63	59	65	25
Aug.	60	49	56	22
Sept.	55	44	47	19
Oct.	56	44	49	22
Nov.	63	58	57	29
Dec.	65	70	66	37
Annual	65	61	65	32

TABLE 5 Calculated* monthly evapotranspiration for three stations, in inches and mm

Month	Francistown		Kasane		Maun	
	in	(mm)	in	(mm)	in	(mm)
Jan.	5.9	(150)	5.5	(140)	6.3	(160)
Feb.	5.5	(140)	5.5	(140)	5.9	(150)
Mar.	5.5	(140)	5.9	(150)	5.5	(140)
Apr.	5.1	(130)	6.3	(160)	6.3	(160)
May	4.7	(120)	5.9	(150)	5.9	(150)
June	4.3	(110)	5.5	(140)	4.7	(120)
July	4.7	(120)	5.9	(150)	5.5	(140)
Aug.	5.5	(140)	6.7	(170)	6.7	(170)
Sept.	6.7	(170)	8.3	(210)	7.5	(190)
Oct.	7.5	(190)	9.1	(230)	9.5	(240)
Nov.	6.7	(170)	8.3	(210)	8.3	(210)
Dec.	5.9	(150)	5.9	(150)	7.1	(180)
Annual	68.1	(1 730)	78.7	(2 000)	79.1	(2 010)

* Method of calculating

$E = 0.225 (e_{ma} - e_d)$

E = monthly evapotranspiration in inches

e_{ma} = saturation vapour pressure in millibars corresponding to the mean daily maximum temperature

e_d = saturation vapour pressure corresponding to the dew point in millibars (atmospheric water pressure)

Note: although this method probably underestimates evaporation, other more accurate methods require data which are not available.

WATER

For many months of the year surface water is scarce. Rainfall is low, the soils are free draining, and evaporation is high. Although there are large numbers of pools (pans), most of these only contain water for brief periods during the rains and dry up early in the dry season. Similarly many of the streams only flow intermittently and then only during years of above average rainfall. The Chobe River and the Botletle River are the only reliable sources of surface water during the dry season.

It is because of these conditions that development has depended on the availability of groundwater supplies. Boocock and van Straten (1963) have described the groundwater potential of Northern Bechuanaland and have emphasised that throughout much of the basin mineralised and non-potable waters occur at depth. In some places aquifers of potable water occur above this lower saline groundwater, and it is possible to utilise these. Around the Makarikari Depression the water from many of the boreholes is highly mineralised and unusable.

SOILS

The soils over a very large area of the Northern State Lands have developed on the deep sheet of Kalahari type sand. These soils are structureless, mildly acid to neutral in reaction, and of low fertility; they are usually porous and free-draining although relatively impermeable soils occur in topographical depressions.

Etched into this extensive sand sheet are a number of river valleys and two very large shallow depressions namely the Mababe and the Makarikari which in former times were lake sites. In the case of the Makarikari Depression the shore line of the original lake lay well beyond the present limits of the depression. In the north there are the riverine alluvial soils of the Chobe flood plain. In addition to the soils derived from sandy parent material or from riverine or lacustrine alluvial materials there are areas of lithosol derived from basalt and vertisols either of lithomorphic origin or occurring in depressions; these soils are found in the north-east.

As far as possible the units shown on the map 'Provisional Soil Types' were chosen to correspond to the units shown on the Soil Map of Africa (D'Hoore, 1964).

Soil Units	Units on Soil Map of Africa
1. Shallow lithosolic soils derived from basalt	1. Lithosols on rocks rich in ferromagnesian minerals
2. Juvenile soils on recent deposits	2. Juvenile soils on recent deposits
(a) Riverine alluvial soils periodically flooded	(a) Mineral hydromorphic soil
(b) Lacustrine alluvial soils, usually sandy and free-draining sometimes fine-textured and seasonally flooded	(b) Halomorphic soils not differentiated

Soil Units	Units on Soil Map of Africa
3. Vertisols	3. Vertisols
4. Sub-desert sands	4. Brown and reddish-brown soils of arid and semi-arid tropical regions on loose sediments
5. Ferruginous tropical sandy soils on deep sandy parent material	5. Ferruginous tropical soils on sandy parent material; also ferruginous tropical soils with ferrallitic soils on loose sandy sediments
6. Halomorphic soils (a) Salt pan (b) With sub-desert sands on lacustrine deposits often of calcrete; much windblown material (c) With sub-desert sands on riverine alluvium	6. Juvenile soils on recent deposits, lacustrine alluvium mainly halomorphic soils, not differentiated

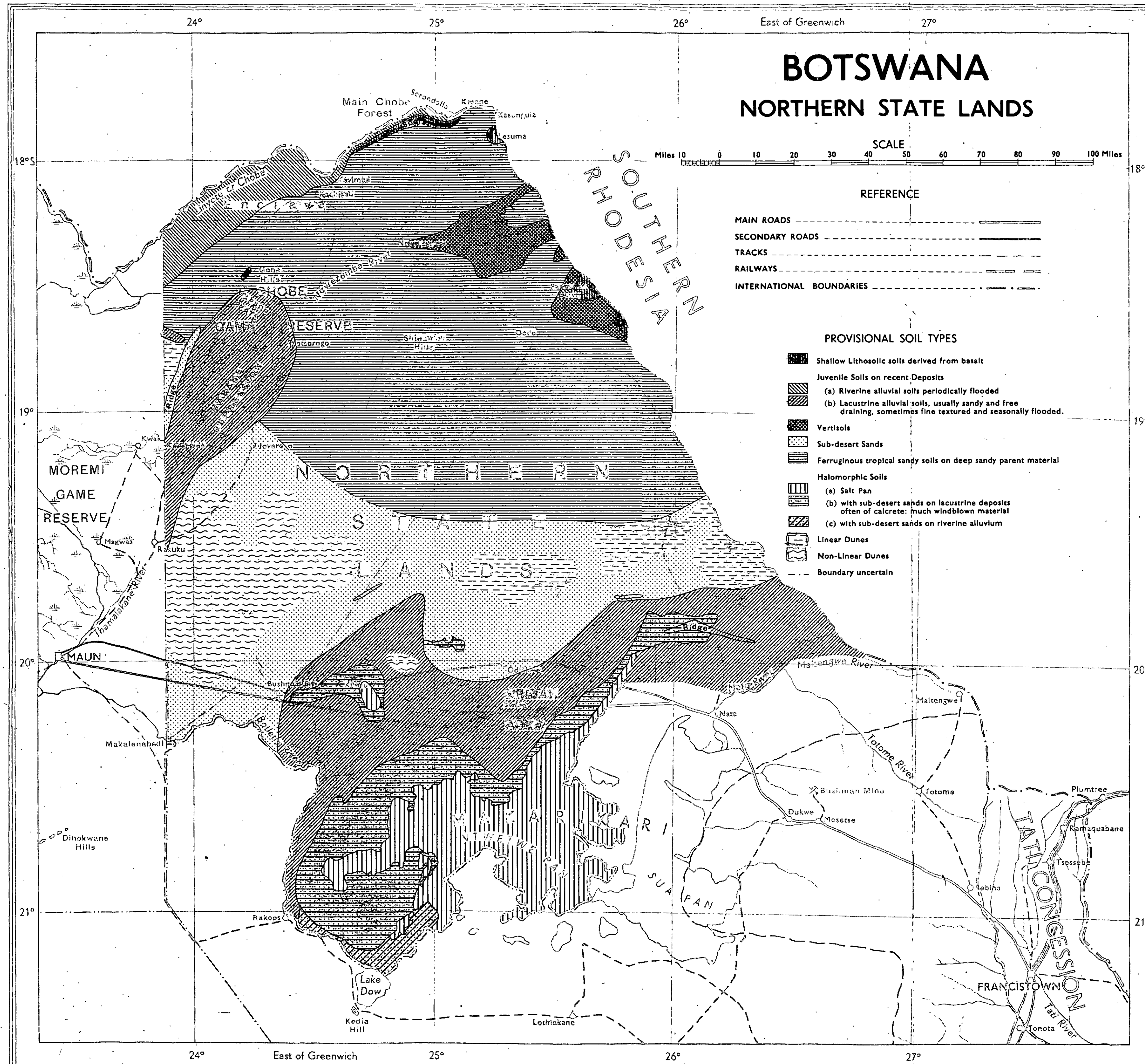
1. Shallow Lithosolic Soils Derived from Basalt

Reddish-brown (5 YR 3/4 moist), loamy soils occur at Panda-ma-Tenga on the ridges; these soils are stony and extremely shallow with rotting rock often less than twelve inches from the surface. Because of their shallowness and slope these soils are not suitable for cultivation. At Panda the vegetation of these ridges provides alternative grazing when other areas are inaccessible. Similar stony brown loams are found overlying the scarp between Kasane and Kavimba.

2. Juvenile Soils on Recent Deposits

(a) Riverine alluvial soils On the Chobe flood plain, which varies in width from a few hundred yards to fifteen miles west of Kachikau, dark grey (10 YR 3/1 dry) alluvial soils occur. As a result of frequent changes in the course of the Chobe River the alluvial deposits have been cut by many channels and sand banks have been thrown up at former bends of the river. The area is subject to seasonal flooding although the level of the floodwater is variable. The dark silty soil when dry is extremely hard, and apart from small lenses of sand at two feet, appeared uniform in colour and texture to a depth of three feet. The unpredictable variations in the level of flooding may have contributed to the decline in the cultivation of the area in the neighbourhood of Kachikau.

Narrow belts of alluvial soil occur along the Botletle River and Nata River. There is cultivation between Makalamebedi and Rakops mainly on the southern and western side of the Botletle. Only small areas are cultivated along the Nata River north of Nata.


BOTSWANA
NORTHERN STATE LANDS
SCALE
Miles 10 0 10 20 30 40 50 60 70 80 90 100 Miles
REFERENCE
MAIN ROADS
SECONDARY ROADS
TRACKS
RAILWAYS
INTERNATIONAL BOUNDARIES
PROVISIONAL SOIL TYPES
Shallow Lithosolic soils derived from basalt
Juvenile Soils on recent Deposits
(a) Riverine alluvial soils periodically flooded
(b) Lacustrine alluvial soils, usually sandy and free draining, sometimes fine textured and seasonally flooded.
Vertisols
Sub-desert Sands
Ferruginous tropical sandy soils on deep sandy parent material
Halomorphic Soils
(a) Salt Pan
(b) with sub-desert sands on lacustrine deposits often of calcrete: much windblown material
(c) with sub-desert sands on riverine alluvium
Linear Dunes
Non-Linear Dunes
Boundary uncertain
East of Greenwich
24°
25°
26°
27°
18°S
19°
20°
21°
SOUTHERN RHODESIA
Main Chobe Forest
Kasane
Kasungula
Lesuma
CHOBE GAME RESERVE
NORTHERN STATE LANDS
MOREMI GAME RESERVE
MAUN
Thamalakane River
Makalamabedi
Rakuku
Magwas
Dinokwane Hills
MAKARIKARI
NTWETWE PAN
SUA PAN
Rakops
Lake Dow
Kedia Hill
Lothlekane
Nata
Maitengwe
Maitengwe River
Totome River
Totome
Bushman Mine
Dukwe
Mosetse
Sebina
Plumtree
Ramaquabane
Tsessebe
TATI CONCESSION
FRANCISTOWN
Tati River
Tonota
Ridge

D.O.S. (Misc) 449f

Drawn and photographed by the Directorate of Overseas Surveys, 1966

This map accompanies a report entitled 'A Land Use Survey of the Northern State Lands, Botswana' by the Land Resources Division, Directorate of Overseas Surveys, 1967

(b) Lacustrine alluvial soils There is evidence of a former more extensive lake to the north of the present Makarikari depression. The soils are mainly free-draining, structureless, greyish brown (10 YR 4/1 moist) sands uniform in colour and texture down the profile.

North of the Sua Pan there is a sandy plain with frequent depressions, pans and drainage lines associated with the Nata River and its tributaries; this plain slopes gradually upwards to the Rhodesia border in the east.

Another area of this description is the Mababe Depression with a northern shore line within two miles of the Goha Hills. The dark grey (7.5 YR 3/0 moist) soils of the south are hard when dry and exhibit some cracking; apart from tiny white flecks (possibly accretions of calcium) at a depth of 22 inches, the soil profile appeared uniform in colour and texture. The soils of the northern part of the Depression are more sandy than those of the south.

3. Vertisols Heavy black (10 YR 2/1 dry) clay soils occur along the drainage lines between the ridges at Panda-ma-Tenga. They are poorly drained but become hard on drying. Fragments of calcrete are common at a depth of two feet and below. These soils, probably of lithomorphic origin, should be fairly fertile; analysis figures reported by Bawden (1965) indicate a moderate level of organic matter but with a fairly wide carbon-nitrogen ratio.

Attempts at mechanised crop production on these soils have not been successful because of the intractable nature of the soil when wet; the selection of the better drained sites combined with an experimental programme designed to investigate mineral deficiencies and crop responses to fertilisers could lead to the development of the area.

North of Panda-ma-Tenga extending westward from the Rhodesian border is the Kakulwane Plain, an extensive area of black soil which is similar to the black soils at Panda-ma-Tenga, although probably not lithomorphic in origin.

4. Sub-desert Sands

These are brown (7.5 YR 5/2 moist) or dark greyish brown (2.5 YR 5/2 moist) soils of arid or semi-arid tropical regions. They are deep porous and structureless. A topographical feature is the occurrence of low dunes or hills and this in turn has a pronounced effect on the vegetation.

5. Ferruginous Tropical Soils

The soils of the most northern part of the State Lands are coarse sands overlying deep or very deep loose sandy parent materials. There may be a fairly distinct surface horizon which varies in thickness. Finer-textured soils occur in the depressions and along drainage lines.

In the north there is an association of ferruginous and ferrallitic soils. On a ridge of coarse sand approximately 100 miles north of Nata there was a grey (10 YR 5/1 moist) horizon of six inches in thickness overlying a brown horizon (10 YR 5/3 moist) of considerable depth. In a nearby depression the surface horizon was eighteen inches thick and dark grey (10 YR 4/1 moist) over a dark greyish brown (10 YR 4/2 moist) horizon. There were fragments of

charcoal resulting from bush fires in the first of these soil profiles and these fragments were also seen at other sites.

6. Halomorphic Soils

(a) Salt pans The Makarikari Depression is a vast expanse of grey-coloured silt and sand, whose surface is sometimes covered by a continuous sheet of water or more often by a large number of pools. The depression has been a focus of internal drainage for a long period of time and the concentration of the dissolved salts introduced by the feeder river has resulted in the formation of a shallow, highly saline groundwater body which underlies most of the area of the depression.

(b) Halomorphic soils associated with sub-desert sands on lacustrine deposits Around the main salt pan area is a zone of soil formed by wind-carried sands mixed with material from the underlying deposits. The soils are greyish brown (10 YR 4/1 moist) or brown (7.5 YR 4/2 moist) and alkaline. Bawden (1965) reports a surface pH 8.2 increasing to pH 8.9 at four feet. Calcrete often occurs near the surface. Woody vegetation is generally absent; the grass cover restricts the movement of soil but in the south where the cover is poor wind-blown sand accumulates where bushes form a windbreak.

(c) Halomorphic soils associated with sub-desert sands on riverine alluvium These soils are similar to the previous group. The presence of scattered shrubs and low trees would indicate less extreme conditions and a higher level of fertility.

VEGETATION

Travelling from north to south through the Northern State Lands the vegetation changes from the open woodlands of the Chobe Forest, to areas with fewer trees but with dense tall shrubs (shrub and tree savanna) sometimes interspersed with patches of open grassland, to savannas with scattered trees and shrubs, to the open treeless grassland around the periphery of the Makarikari salt pans.

This decrease in woody vegetation is accompanied by changes in the composition of the grass cover.

The commoner trees in the northern woodlands are *Baikiaea plurijuga*, *Pterocarpus angolensis*, *Colophospermum mopane*, *Guibourtia coleosperma* and *Burkea africana;* within these woodlands there are frequent open vleis* with coarse grasses which include *Loudetia simplex*, *Heteropogon melanocarpus*, *Andropogon gayanus* and *Aristida spp.*

South of these woodlands low trees or tall shrubs of *Terminalia sericea* and *Burkea africana* are very common especially on the loose sand ridges; in certain areas *Colophospermum mopane* and *Acacia spp.* are the main components of the vegetation.

* An Afrikaans word to describe areas with soils having impeded drainage.

With a further decrease in woody vegetation, the shrub and tree savanna gives way to scattered shrub and infrequent tree savanna with bushes of *Combretum imberbe, C. hereroense, Grewia spp.* and *Acacia spp.* in a grassland of *Schmidtia bulbosa, Aristida uniplumis, Eragrostis rigidior, Urochloa spp.* including *U. trichopus* and *Digitaria spp.*

Trees and shrubs are largely absent from the grasslands which occur around the Makarikari Depression. The common grasses include *Cenchrus ciliaris, Schmidtia bulbosa, Chrysopogon montanus var. tremulus* and *Odyssea paucinervis;* some areas are dominated by one or two of these species.

Vegetation is one of the factors of major importance in this consideration of the development of the area and it is therefore described in greater detail later in the report.

FAUNA

The Northern State Lands are renowned for the variety and numbers of large mammals which elsewhere in Africa have decreased in numbers or disappeared. The undeveloped nature of the country and this variety of animals makes the area attractive to the Safari hunting companies and their clients who are allowed the following trophy animals: elephant *(Loxodonta africana)*, zebra *(Equus burchelli)*, warthog *(Phacochoerus aethiopicus)*, grey duiker *(Sylvicapra grimmia)*, eland *(Taurotragus oryx)*, kudu *(Tragelaphus strepsiceros)*, sitatunga *(Tragelaphus spekei)*, bushbuck *(Tragelaphus scriptus)*, wildebeest *(Connochaetes taurinus)*, tsessebe *(Damaliscus lunatus)*, roan antelope *(Hippotragus equinus)*, sable antelope *(Hippotragus niger)*, gemsbok *(Oryx gazella)*, lechwe *(Kobus leche)*, reedbuck *(Redunca arundinum)*, impala *(Aepyceros melampus)*, springbok *(Antidorcas marsupialis)*, hartebeest *(Alcelaphus buselaphus)*, lion *(Panthera leo)* and leopard *(Panthera pardus)*.

In 1961 the Chobe Game Reserve was established to ensure the preservation of wild life. A variety of animals including elephant, hippopotamus, giraffe, sable, kudu, sitatunga, tsessabe, oribi, bushbuck, reedbuck, puku, lechwe, buffalo, warthog, duiker, steenbuck, baboons and ostrich are to be found in the reserve. During the dry season certain of these animals may be seen in large numbers near the Chobe River within a short drive of Kasane; this is a considerable tourist attraction.

Large numbers of springbok, gemsbok, eland, zebra and wildebeest may frequently be seen in the vicinity of the Nyaia Pan a few miles north of Kanyu; and herds of wildebeest although reduced in size are still common in the Makarikari Depression.

During the year there is considerable movement of animals in search of grazing and water; in the wet season when surface water is widely available animals tend to be dispersed in small groups but during the dry season animals concentrate within reach of permanent water.

TSETSE

The savanna species of tsetse fly *(Glossina morsitans)* which transmits trypanosomiasis in cattle and sleeping sickness in man, is found in the west and north-west of the State Lands. The Okavango Swamps and the Chobe River delta, two contiguous areas, are the principal foci of the distribution of *Glossina morsitans* which under Botswana conditions behaves more like a

riverine than savanna species. This association with water and the very restricted distribution is usually attributed to the low temperatures of the winter months during which period the humidity is also low.

During the last hundred years there have been considerable changes in tsetse fly distribution in Botswana (see map, 'Distribution of Tsetse Fly'.) In the second half of the nineteenth century tsetse fly receded and was confined to a number of small pockets; rinderpest outbreaks which caused the death of large numbers of ungulates depriving the fly of food were believed to have been the major factor in the recession. Stevenson - Hamilton (1912), however, questions this explanation, pointing out that not all game species are affected by rinderpest. Tsetse fly is also reported to have been receding along the Chobe River 10 - 20 years before the rinderpest epidemic. Since 1900 there has been a fairly steady advance of the tsetse fly which today is being contained only by an annual expenditure of R* 200 000/ control measures. While it is probable that tsetse has generally reached its most widespread distribution under present conditions, without control measures eastward movements along the banks of the Chobe River and up the Ngwezumba Valley would still seem possible. Attempts to eradicate tsetse fly in certain areas are unlikely to achieve lasting success at an economic cost, unless the areas will support a reasonable level of farming and there is the opportunity to resettle a sufficiently large number of cultivators.

HUMAN ASPECTS

HISTORY

Bechuanaland was proclaimed a British Protectorate in 1885. A few years later the British Government decided that the administration of the country should become the responsibility of the British South Africa Company, but this proposal was vigorously opposed by Bechuana chiefs, three of whom in 1895 went to London to protest in person. As a result of this opposition it was decided to make the company responsible only for land outside the tribal areas; but this decision was not implemented and the non-tribal areas conceded by the chiefs were declared to be Crown Lands by an Order in Council in 1904. Six years later this proclamation was supplemented by the Bechuanaland Protectorate (Lands) Order in Council which designated the Crown Land including the northern area. With independence on 30 September 1966 the name of the country was changed to Botswana and the Northern Crown Lands became the Northern State Lands.

There remain in the area small numbers belonging to the tribal groups originally present and over the years there have been incursions into the Northern State Lands by people of other tribes.

There were several incursions of Damaras from South West Africa during the Herero wars at the end of the nineteenth century and early in the present century during the German-Damara campaign.

In 1902 Masubia moved to the Chobe District when the Mababe Depression dried up. Their economy is based on fishing and until the loss of their cattle in 1947 they were also pastoralists. The loss is attributed to a combination of diseases which included trypanosomiasis and streptothricosis.

* R = South African Rand
/ Since 1967 spraying has been concentrated on breeding sites and has been effective and less costly

BOTSWANA

NORTHERN STATE LANDS

SCALE

Miles 10 0 10 20 30 40 50 60 70 80 90 100 Miles

REFERENCE

MAIN ROADS

SECONDARY ROADS

TRACKS

RAILWAYS

INTERNATIONAL BOUNDARIES

DISTRIBUTION OF TSETSE FLY
(GLOSSINA MORSITANS)

Fly Infested Areas

24° 25° 26° East of Greenwich 27°

18°S 19° 20° 21°

Main Chobe Forest
Serondella
Kasane
Kasungula
Lesuma
Kazimba
Kachikau
Linyote or Chobe Enclave
Ngwezumba
Ngwezumba River
Gohn Hills
CHOBE GAME RESERVE
Tsotsorogo
Shumaiba Hills
Panda ma Tenga
Dodo
MABABE DEPRESSION
Kwai
Kudamane
Joverego
MOREMI GAME RESERVE
Magwab
Ra'uku
Mahalatane River
NORTHERN STATE LANDS
MAUN
Bushman Pits
Kanye
Odiakwe
TRIBAL AREA
Gweta
Botletle River
Makalanabedi
Dinokwane Hills
MAKARIKARI
NTWETWE PAN
SUA PAN
Rakops
Lake Dow
Kedia Hill
Lothlakane
Nata River
Nata
Maitengwe River
Maitengwe
Totome River
Totome
Dukwe
Moiketo
Plumtree
Ramaquabane
Tsessebe
Sebina
TATI CONCESSION
FRANCISTOWN
Tati River
Tonota
RHODESIA

D.O.S. (Misc) 449b

Drawn and photographed by the Directorate of Overseas Surveys, 1966

This map accompanies a report entitled 'A Land Use Survey of the Northern State Lands, Botswana' by the Land Resources Division, Directorate of Overseas Surveys, 1967

Some of the Batawana settled in Kavimba in 1912 with the Sekgoma who had been banished from Ngamiland some years earlier; later they moved to the Kachikau area. They were primarily pastoralists, but also cultivated cereals.

Utilisation of Resources

Henry (1966a) describes the history of the Chobe Main Forest. Extraction of timber took place between 1935 and 1938 and during a second period from 1944 to 1956. During the first period it is estimated that 1.44 million ft^3 (40 779 m^3) of timber were extracted; the principal species were *Baikiaea plurijuga* 1.3 million ft^3 (36 810 m^3) and *Pterocarpus angolensis* 84 000 ft^3 (2 379 m^3). During the second period 5.26 million ft^3 (148 949 m^3) were removed and this included 3.52 million ft^3 (99 676 m^3) of *B. plurijuga* and 1.04 million ft^3 (29 450 m^3) of *P. angolensis*. The royalties for both periods amounted to R*89 000. In 1948 a Proclamation provided for the creation of Forest Reserves but this proclamation has not been effectively implemented; new legislation is being drafted to replace the 1948 Proclamation.

In 1949 the Commonwealth Development Corporation commenced a large-scale ranching venture and established fenced ranches at Bushmen Pits, Nata, and at Panda-ma-Tenga. After a financially unsuccessful period of eight years, a rapid retrenchment took place, and in 1963 the improvements, namely the boreholes, pumps, fencing and buildings were handed over to the Government in exchange for the freehold of the Molopo Ranch in the most Southerly part of Botswana.

In 1961 the Chobe Game Reserve was established under the First Schedule of the Fauna Conservation Proclamation; its boundaries were subsequently adjusted in 1964 and in 1967.

In 1963 a number of safari companies were given concessions for a three-year period to organise hunting in different areas of the Northern State Lands; controlled hunting is also allowed in certain areas outside the concessions.

POPULATION

The following population figures have been taken from the 1964 Census of Bechuanaland Protectorate.

	Resident population	Area		Population density	
		mi^2	km^2	per mi^2	per km^2
Chobe District	5 101	7 997	20 712	0.64	0.25
Francistown Crown Lands	1 052	5 865	15 190	0.18	0.07

In addition there are resident populations at Bushman Pits (52) and on the north and west bank of the Botletle River; there is also a nomadic population of bushmen.

* R = South African Rand

There are people of the Damara tribe living north of Lake Dow and east of the Botletle River. In the Chobe District there are members of the Masubia, Batawana and Masarwa tribes; the first two of these tribes have already been mentioned; the Masarwa are hunters and there is a growing community at Lesuma.

In a number of places employment opportunities attracted individuals and their dependants, some of whom have remained when work was no longer available, or only available for a small number. The establishment of the sawmills at Serondella resulted in a population of 1 121 in 1946 but this had declined to 12 in 1964. The ranch at Panda-ma-Tenga similarly attracted many Africans from Rhodesia, a few of whom still remain.

The total population resident in the Northern State Lands with express or implied official permission probably exceeds 7 000; the estimated density is 0.28 persons per mi^2 (0.11 persons per km^2).

CURRENT LAND USE

Shooting rights over a large area are leased to a number of safari hunting organisations.

The Chobe Game Reserve 3 800 mi^2 (9 840 km^2) has been set aside for the protection and study of wild life and could become an outstanding attraction for tourists. The northern woodlands have stands of *Baikiaea plurijuga* and *Pterocarpus angolensis* which Henry (1966) estimates could be exploited on the basis of a sustained annual yield of 500 000 ft^3 (14 159 m^3). Of these woodlands 60% are within the Chobe Game Reserve.

The fenced areas at Panda-ma-Tenga and Nata together with the Veterinary Department holding grounds and quarantine camps at Makalamabedi and Odiakwe total 284 000 ac (114 500 ha). At Nata 57 000 ac (22 900 ha) have been leased privately for three years and another area is being used experimentally by the Agricultural Economist with financial assistance from OXFAM to investigate the economics of a small-scale ranch. Other camps are used to regulate the movement of trade cattle and sometimes it is possible to provide agistment for privately owned herds in these camps.

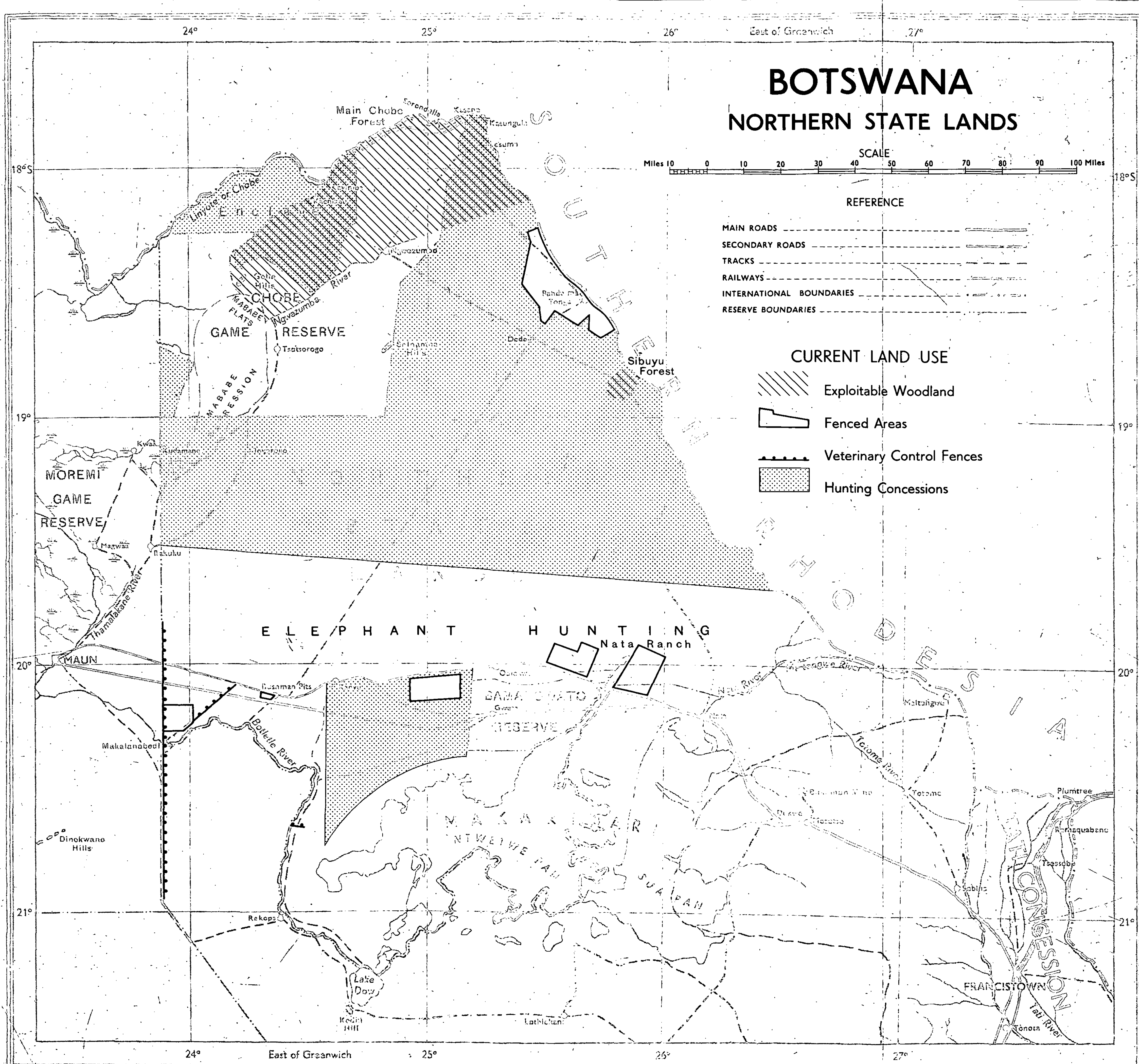
West of the Bamangwato Tribal Territory around Gweta there are areas subject to severe grazing. A private individual who is ranching near Nata hopes to obtain the lease for a unit of land of economic size.

There are a number of very small freehold or leasehold properties at Kasane, Kazungula and Serondela.

The total area of cultivated land is not significant (see map, 'Current Land Use'.)

COMMUNICATIONS

Access to the Northern State Lands is provided by the Francistown to Maun road which has recently been partly re-routed and gravelled and graded to a high standard throughout its length. Access is also possible from Serowe through Rakops.



D.O.S. (Misc) 449c

Drawn and photographed by the Directorate of Overseas Surveys, 1968
Printed for D.O.S. by S.P.C. R.E
This map accompanies a report entitled 'A Land Use Survey of the Northern State Lands, Botswana' by the Land Resources Division, Directorate of Overseas Surveys, 1968

In the north a well maintained road from the railway line at Livingstone, 40 mi (64.6 km) away in Zambia, leads to the ferry across the Zambesi River near Kazungula. From the ferry landing there is a good road for 37 mi (59.5 km) to Kazungula, Kasane, and into the Chobe Game Reserve to a point near Simwanza where it deteriorates into a track which continues to the Ngoma bridge, Kachikau and the Mababe Depression. A good road in Rhodesia provides access to Panda-ma-Tenga and a new road from the Victoria Falls to the Kazungula ferry has been completed. The Ngoma bridge links Botswana and the Caprivi Strip.

North-south roads tend to be either poorly defined tracks difficult to find and follow or easily followed tracks which lead through long stretches of loose sand where the vehicles' speed can be reduced to a walking pace.

Three roads lead northwards from the Francistown-Maun road:

1. From Nata to the Duru (Dodo) Cross Roads, a distance of 137 mi (220.5 km); the track follows part of an older route, the 'Hunters' Road' along the Rhodesia border.

2. From Bushman Pits to the Duru Cross Roads, a distance of 113 mi (181.9 km); it is also possible to join this road from the northern end of the Nyaia Pan.

3. From Maun to Kasane via Tsotsoroga and Kachikau a distance of approximately 250 mi (402.3 km).

From the Duru Cross Roads it is 22 mi (35.4 km) to Panda-ma-Tenga and 48 mi (77.2 km) to the Ngwezumba Bridge, whence roads lead to Kachikau and to Lesuma and Kazungula, a further 50 mi (80.5 km).

In the south a number of tracks lead from the main road to points on the Botletle River including Makalamabedi. From Kanyu and Gweta there are tracks running south and south-west respectively to Khumaga and continuing along the Botletle River to Rakops. There are a large number of airstrips in the North State Lands; not all are adequately maintained and the majority are only suitable for light aircraft. There are longer airstrips at Panda-ma-Tenga and Serondela near Kasane which can take larger aeroplanes such as the Dakota. Maun and Serondela have weekly air connections with Livingstone, with major centres in Botswana and with Johannesburg.

PART 4. SPECIAL FACTORS AFFECTING LAND USE

VEGETATION

Since the middle of the nineteenth century travellers have explored and described features of this and neighbouring areas; it is however often difficult to locate precisely the areas they describe. In recent years a number of surveys and detailed investigations of certain areas have been undertaken. Pole Evans (1948) has described the vegetation in the vicinity of Nata and between Maun and Kazungula. The latter area had been described earlier by Curson (1932). Miller (1939) gives an account of the *Baikiaea plurijuga* woodlands in the Chobe District and Henry (1966 b) has completed a detailed enumeration of the Chobe Main Forest. Seagrief and Drummond (1958) describe the vegetation of the north-east part of the Makarikari Pan. De Beer (1962) has produced a provisional vegetation map of the whole country accompanied by an account of the different vegetation communities. The vegetation of the neighbouring country Rhodesia has been described by Rattray (1961) and by Wild (1965).

Choice of Vegetation Units

Aerial photographs have been used in the present survey and the choice of vegetation units has been based on physiognomic differences which can be distinguished on aerial photographs; at the same time the survey is particularly concerned with the herbaceous vegetation and this cannot be differentiated on the aerial photographs. Consequently the choice of units has been influenced by observations made during the field work and descriptions of the grass cover are also based on these observations. Factors which have been included are floristic composition where this is known or can be determined, the grass cover, the density of shrubs and trees, and topographical features where these affect vegetation.

Many areas are composed of two or more components occurring together in a fairly regular pattern over a large area e.g. alternating belts of open woodland and scattered shrub savanna. It may be desirable to map some of these areas in greater detail later.

Definition of Terms

The terms used in describing the vegetation units are defined below.

Grassland:	land dominated by grass which usually provides a relatively well developed cover; woody species absent, or if present covering less than 2% of the area
Parkland:	open continuous grassland with isolated trees or isolated groups of trees; the tree canopy covering less than 10% of the area
Savanna:	areas of well developed herbaceous cover with woody species present; the ratio of woody species (either trees or shrubs) to herbaceous species determines the type of savanna

Shrub:	woody plants either with multiple stems or branching near the ground that is, at heights of less than 4 ft 3 in (1.3 m); up to 10 ft (3 m) and occasionally to 15 ft (4.6 m) high; the term 'bush' is a synonym. Under certain conditions some tree species resemble shrubs
Semi-desert:	extremely sparse vegetation composed of herbaceous, succulent or woody plants or a combination of these communities
Tree:	woody plants with a single stem (fire and other damage may result in coppicing or multiple stems) taller than 15 ft (4.6 m). Immature specimens will be smaller
Tree savanna:	grassland with scattered trees; tree canopy covering less than 40% of the area and often less than 20%; shrub understorey normally absent apart from young plants of the tree species
Woodland:	predominantly woody vegetation; herbaceous vegetation variable, sometimes very sparse or even absent; an understorey of shrubs of species other than the tree species may be present
Closed woodland:	crowns of the trees continuous or nearly continuous; tree canopy covering more than 70% of the area
Open woodland:	crowns of the trees loose and barely touching; tree canopy covering 40-70% of the area

Vegetation Units

The vegetation of the Northern State Lands is described in terms of six major vegetation units with subdivisions as shown. (See map 'Vegetation', in folder.)

1. Halophytic herbaceous semi-desert of the Makarikari Pan fringes
2. Edaphic Grasslands
   - (a) Halophytic grassland around the Makarikari Depression
   - (b) Impeded drainage or vlei grasslands
   - (c) Floodplain grasslands
3. Parkland
4. Savanna
   - (a) Scattered shrub/infrequent tree savanna
   - (b) Shrub/tree savanna

(c) Dense shrub savanna

(d) Tree savanna

5. Woodland

(a) Closed woodland

(b) Open or savanna woodland

6. Mosaics

(a) Woodland with shrub savanna or with grassland

(b) Shrub/tree savanna with scattered shrub savanna or with grassland

1. Halophytic Herbaceous Semi-Desert of the Makarikari Pan Fringes

Around the pools which form the Makarikari Pan slightly raised ground and hummocks carry a very sparse cover. Only a small number of species are adapted to the conditions of extreme salinity and flooding; among this small number are succulent *Suaeda fructicosa* and the grasses *Sporobolus iocladus*, *S. spicatus* and *Odyssea paucinervis*. Because of flooding these areas are largely inaccessible except for a period of a few weeks in the year; the amount of vegetation is negligible.

2. Edaphic Grasslands

Soils subject to periodic flooding, with impeded drainage or with a seasonally high watertable, are often unfavourable to the development of woody vegetation.

(a) Halophytic grassland around the Makarikari Depression Extensive grassland (Plate 1) occurs on the slightly higher ground away from the sparse vegetation of the pan fringes. In addition to the seasonally high watertable the soils are often both saline and alkaline. Trees and shrubs are absent although there may be scattered or fringing groups of *Hyphaene* sp. and *Acacia giraffae*, and on raised hummocks stands of *Albizia antunesiana*, *Terminalia prunioides* and *Acacia* spp. Among the grasses are *Cenchrus ciliaris*, *Panicum coloratum*, *Schmidtia bulbosa*, *Cymbopogon* sp. *Eragrostis superba*, *E. rigidior*, *E. barbinodis*, *E. echinochloidea*, *Aristida uniplumis*, *A. pilgeri*, *Triraphis fleckii*, *Chrysopogon montanus* var. *termulus* and *Odyssea paucinervis*. Some areas are dominated by one or two of these species. Near Rakops *Solanum incanum* is widespread. The low grey shrub *Catophractes alexandri* and the grasses *Enneapogon scoparius* and *E. cenchroides* occur together on limestone outcrops in this grassland, and these areas are of little or no value. A large area north-east of Rakops has been reduced to a very sparse cover of the hard-leafed rhizomatous grass *Odyssea paucinervis*.

(b) Impeded drainage and vlei grasslands All the grasslands in this category occur in the more northerly districts of the State Lands, where throughout the northern woodlands there are open vleis which are sometimes extensive. On the fifty-eight vleis *Loudetia simplex*, *Andropogon* spp., *Digitaria milanjiana*, *Hyperthelia dissoluta*, *Aristida meridionalis*, *Schizachyrium sanguineum* and *S. jeffreysii* sp. are common; in some areas there are scattered bushes of *Colophospermum mopane* and there may also be bushes of *Combretum hereroense* and

Bauhinia macrantha. The vertisols at Panda-ma-Tenga (Plate 2) and those forming the Kakulwane plain represent an extreme type of poorly drained soils and carry tall stands of *Ischaemum brachyatherum*, *Rottboellia exaltata*, *Andropogon gayanus* var. *squamulatus*, *Heteropogon melanocarpus*, *Setaria sphacelata*, *Hyparrhenia filipendula*, *Loudetia simplex*, *Dichanthium papillosum*, *Urochloa bolbodes* and *Crinipes gynoglossa.*

(c) **Floodplain grasslands** Seasonally flooded grasslands occur along the Chobe River (Floodplain Grassland A, see map: 'Vegetation'); also in small areas west of the Magwikwe Ridge and in part of the Mababe Depression (Floodplain Grassland B). On the firm alluvial soils which are periodically flooded by the Chobe Rover in the vicinity of Kachikau there are impressive stands of *Chloris gayana* and *Setaria sphacelata* as well as mixtures of these species together with *Andropogon eucomis*, *Digitaria milanjiana*, *Sorghastrum friesii*, *Hemarthria altissima* and *Cymbopogon* sp.; nearer the river in this area there are tall stands of *Sorghum verticilliflorum* and *Sesbania sesban.* On the flood plain near Kasane where the soils are less compact there are areas of finer grasses including *Eragrostis lappula* var. *divaricata*, *Paspalum* sp. and *Cynodon dactylon.* The development of these finer grasses is probably the result of grazing by game animals and earlier by cattle, and may also be the result of burning.

Beds of *Cyperus papyrus*, *Phragmites mauritianus* and *Vetiveria nigritana* stretch many miles between streams and backwaters choked with the water fern *Salvinia auriculata.*

Along the margins of the tributaries of the River Kwai where there is close grazing the principal grasses are *Cynodon dactylon*, *Paspalidium geminatum*, *Urochloa* sp. and *Eragrostis* spp.

Although the Mababe Depression (Plate 3) may once have been largely treeless only very small areas can be described as grassland today. Immediately south of the Goha Hills is an area of grassland composed of mainly coarse species including *Diheteropogon amplectans*, *Hyperthelia dissoluta*, *Schizachyrium jeffreysii*, *Andropogon shirensis*, *Loudetia simplex*, *Elymandra grallata*, *Cymbopogon* sp. and *Aristida meridionalis;* there are scattered bushes of *Colophospermum mopane*, *Bauhinia macrantha* and *Combretum hereroense.*

On the finer-textured soils in the centre of the depression there are small areas of grassland. As a result of close grazing the grasses are mainly low-growing and include *Cynodon dactylon*, *Cenchrus ciliaris*, *Urochloa* sp., *Chloris virgata* and *Bothriochloa* sp.; in nearby areas there are tall stands of *Sorghum verticilliflorum;* legumes including *Sesbania sesban* are common. The depression is fringed by trees of *Colophospermum mopane*, *Lonchocarpus capassa*, *Combretum imberbe*, *Acacia giraffae* and *A. tortilis;* scattered bushes of *Acacia* spp. and *Combretum imberbe* also occur in the grassland.

3. Parkland

The Nyaia Pan, north of Kanyu is an example of parkland. Scattered groups of *Terminalia prunioides* trees and stunted shrub-like trees of *Acacia tortilis* occur in a tightly grazed grassland composed of *Cenchrus ciliaris*, *Bothriochloa radicans*, *Panicum repens*, *Tragus* sp. and *Cymbopogon* sp. Another area of this type is found within the small annexe to the main Bamangwato tribal area south of Gweta (Plate 4) where overgrazing has reduced the grass to *Tragus* sp. and *Aristida junciformis* and the trees include *Sterculia africana*, *Commiphora glandulosa* and *Adansonia digitata.*

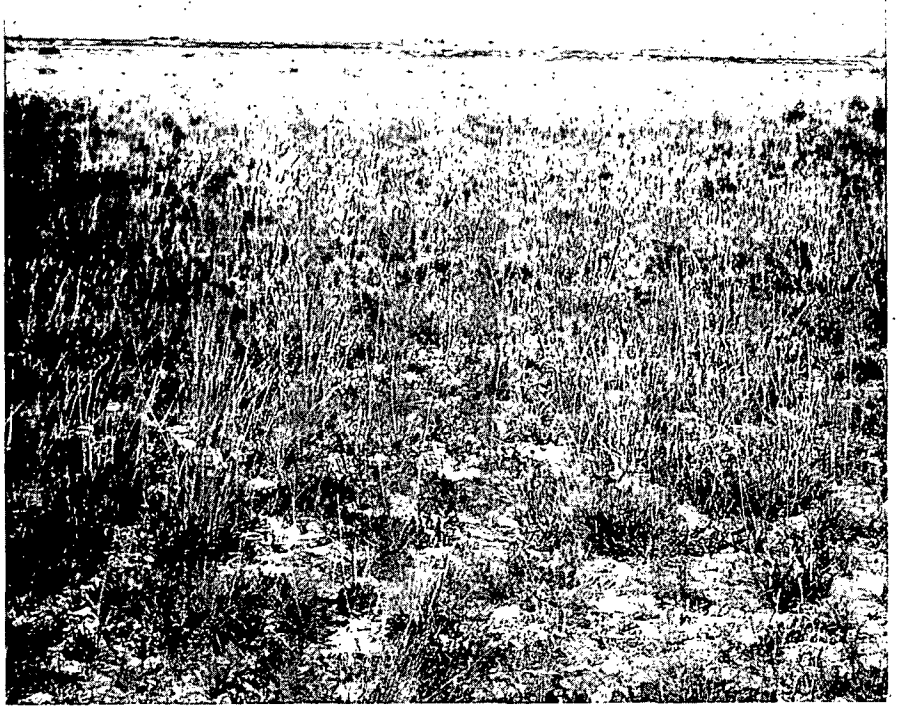


PLATE 1 Edaphic grasslands. Extensive halophytic grassland *(Schmidtia - Aristida - Chrysopogon)* grassland around the Makarikari Depression. This type of grassland tends to be seriously deficient in phosphate and trace elements: 20 mi east of Khumaga

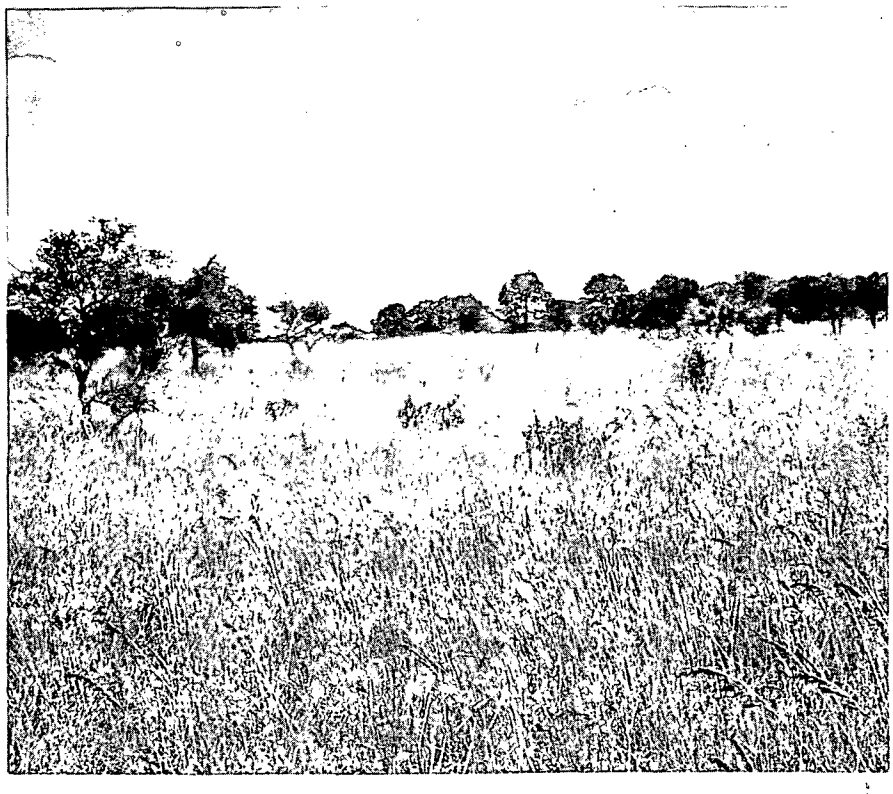


PLATE 2 Edaphic grasslands. A tongue of impeded drainage (vlei) grassland surrounded by shrub/tree savanna on shallow basalt soil : Panda-ma-Tenga

PLATE 3 Edaphic grasslands. Floodplain grassland *(Aristida - Andropogon - Schizachyrium)* : Mababe plains 2 mi south of the Goha Hills

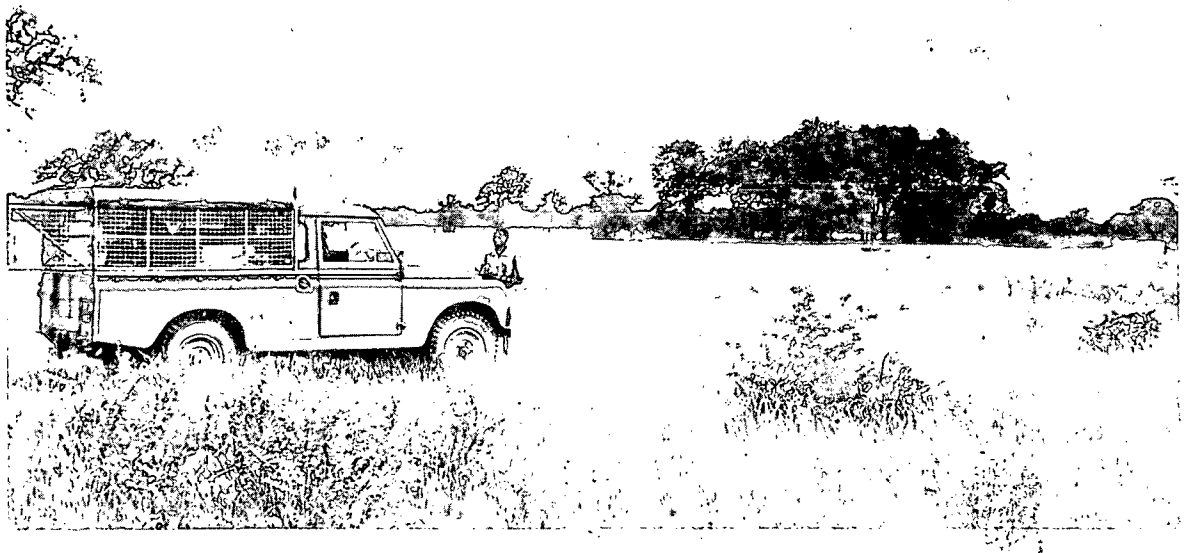


PLATE 4 Parkland. *Aristida - Tragus* grassland with groups of *Sterculia* trees : south of Gweta

The areas of parkland and tree savanna are frequently found in close proximity to the edaphic grasslands, occurring where the soil conditions are less extreme.

4. Savanna

(a) Scattered shrub/infrequent tree savanna Although there are areas of this physiognomic type within the Mababe Depression, by far the largest area occurs on the sandy free-draining lacustrine soils of the earlier more extensive Makarikari Lake. The largest area stretches from Odiakwe to Bushman Pits with a second large area sweeping round to the west and north of the old Wenela all-season road which skirts the northern arm of the Makarikari Pan. In this type of vegetation trees are infrequent or absent and the bushes are widely scattered with a well developed grass cover (Plate 5). Fire is probably an important factor in maintaining the balance between shrubs and grass. Shrub and shrub-like tree species include *Grewia flava, Grewia flavescens, Combretum hereroense, C. imberbe* and *Acacia* spp.; *Terminalia sericea* is sometimes common and may be locally dominant especially on sandy ridges where the shrub growth tends to be denser and the grass cover correspondingly poorer. Occasionally occurring trees include *Hyphaene* sp., *Acacia giraffae, Combretum imberbe* and *Peltophorum africanum.* Common grasses are *Schmidtia bulbosa, Aristida uniplumis, Eragrostis rigidior, Digitaria eriantha, D. milanjiana* and *Urochloa trichopus;* locally common are *Anthephora pubescens, Aristida congesta, A. meridionalis, Setaria sphacelata, Cymbopogon* sp. and *Andropogon gayanus* var. *squamulatus.*

(b) Shrub/tree savanna Although this type of savanna is predominantly herbaceous, the woody components occur more frequently than in type (a). Only rarely will the distribution of the woody species be uniform throughout the area, and many areas form a mosaic of units grading into each other. Where the pattern of units is sufficiently distinct, the area is described under 'Mosaics'. The greatest development of this type of vegetation occurs between the grasslands and scattered shrub of the south and the open woodlands of the north. In many areas the growth of woody plants is greater on the sandy ridges.

Throughout this area and also in the northern woodland community the poisonous plant *Dichapetalum cymosum* occurs on sandy ridges. This plant has an extensive woody underground system from which new leaves are put out in September or October. (A description of its toxic properties is given on p. 68.)

Of a number of shrubs which occur frequently, *Terminalia sericea* is very common; others include *Grewia flavescens, G. retinervis, G. flava, Bauhinia macrantha, Commiphora africana, C. mossambicensis, Rhus tenuinervis, Dichrostachys cinerea, Combretum* spp. incl. *C. apiculatum, Baphia obovata, Colophospermum mopane* and *Boscia obovata.* Commonly occurring trees are *Burkea africana, Pterocarpus angolensis, Terminalia sericea, Lonchocarpus nelsii, Acacia giraffae* and *Croton gratissimus.* Low-growing plants of many of the tree species occur in the shrub storey, often showing coppice development as the result of damage. Among the grasses are *Urochloa trichopus, Aristida scabrivalvis, Eragrostis rigidior, E. pallens, Schmidtia bulbosa, Digitaria milanjiana, D. perrottetii, Panicum maximum, Sporobolus panicoides, Andropogon shirensis* and in disturbed areas *Megaloprotachne albescens, Pogonarthra squarrosa, Perotis patens, Dactyloctenium giganteum* and *Rhynchelytrum repens* are common.

Scattered shrub/tree savanna is also found on the shallow soils overlying the basalt ridges at Panda-ma-Tenga (Plate 2) and in the Lesuma Valley. Trees include *Kirkia acuminata, Combretum apiculatum* and an occasional *Baikiaea plurijuga.* Among the shrubs are *Terminalia randii, T. sericea, Grewia flavescens, Combretum hereroense, Colophospermum mopane, Rhus* sp. and *Commiphora* sp. The grass cover consists mainly of *Schmidtia bulbosa, Heteropogon contortus, Aristida* sp., *Andropogon gayanus* var. *squamulatus, A. schinzii, Digitaria* sp., *Sehima ischaemoides, Loudetia flavida,* and *Andropogon fastigatus (Diectomis fastigata).*

(c) **Dense shrub savanna** Thicket-like vegetation occurs around watering places including stream approaches and along stock routes. It occurs along the Botletle River, along stretches of the Nata River and is particularly dense in certain places along the stock route from Bushman Pits. Its development must be attributed to the disappearance of the grass through overgrazing and trampling, and this in turn both reduces competition and eliminates any control of woody growth by fire. The woody species which develop often include *Dichrostachys cinerea, Terminalia sericea* and *Acacia* spp. such as *A. ataxacantha* and *A. luederitzii* which often form thorny impenetrable thickets.

(d) **Tree savanna** The grass cover is usually continuous and fairly well developed, while the trees are scattered throughout the area and are not in isolated groups as in parkland. In areas which are seasonally flooded the trees are often confined to raised ground and in aerial photographs may have a clumped appearance. Few trees appear able to withstand prolonged inundations. Regularly flooded areas of tree savanna occur along the Chobe River, between the Nata and Maitengwe Rivers and in areas south of Kudamane.

Within the northern woodlands there are many areas of tree savanna which are sometimes composed of relatively pure stands of *Colophospermum mopane* and of *Combretum hereroense.*

On the higher sites of the Chobe River floodplain with moderately firm soils trees of *Lonchocarpus capassa, Kigelia pinnata, Syzygium guineense* subsp. *barotsense* and *Garcinia livingstonei* are found.

West of Kavimba where the floodplain is cut by channels the trees are confined to the higher ground; *Terminalia sericea* develops as a coloniser of sand banks and on clay soils *Acacia* spp. including *A. albida, A nigrescens, A. tortilis, A. xanthophloea* are common.

Between the Nata and Maitengwe Rivers there are tall trees of *Colophospermum mopane* with *Acacia albida* and *A. nigrescens* along the sides of the streams, and in places they form a well developed riparian woodland.

South of Kudamane, *Acacia nigrescens* and *A. giraffae,* together with *Colophospermum mopane,* are most common.

There are areas of tree savanna between Nata and Damdamoga. Trees include *Combretum imberbe, Sclerocarya caffra, Kirkia acuminata,* and *Commiphora* spp.

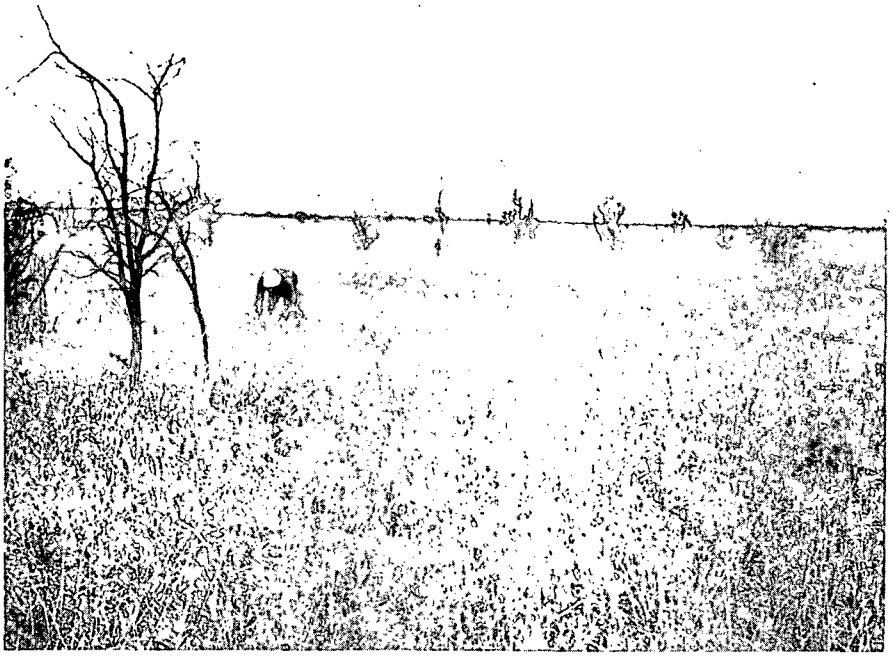


PLATE 5 Savanna. Scattered shrub/infrequent tree savanna. The bushes, mainly *Terminalia sericea* and *Combretum* spp., have been damaged by fire in the previous season; 17 mi west of Odiakwe

PLATE 6 Closed woodland. A waterhole with occasional trees of *Lonchocarpus capassa* and *Combretum imberbe* in closed *Colophospermum mopane* woodland: Tsotosoroga 'Pan' 3 mi east of the Mababe Depression

PLATE 7 Open woodland. *Burkea - Guibourtea - Dialium* woodland : between Ngezumba Bridge and Kazengula

PLATE 8 Open woodland. *Pterocarpus - Ricinodendron* woodland : 45 mi south-west of the Duru Crossroads

5. Woodland

(a) Closed woodland Closed woodland where the crowns of the trees form a continuous or nearly continuous canopy and cover more than 70% of the ground is rarely found. There is a narrow belt of closed *Colophospermum mopane* woodland (Plate 6) to the east of the Mababe Depression and there are other small pockets of this type of woodland which is characterised by having bare or nearly bare ground beneath the trees.

Riparian woodlands and woodlands fringing pans and depressions are usually extremely narrow belts and among the commoner trees are *Acacia giraffae, A. nigrescens, A. albida, Combretum imberbe, Lonchocarpus capassa* and *Colophospermum mopane.* In the woodland along the Chobe River there are a number of typical forest grasses including *Oplismenus burmanii* and *Cymbosetaria sagittifolia.*

(b) Open woodland The Chobe Forest represents open or savanna woodland within which there are areas of vlei grassland; these vlei grasslands have already been described. The reason for not describing these communities under Mosaic is because of the absence of any recognizable pattern in their distribution. In the maps accompanying the Enumeration Report on the Chobe Forest, Henry (1966 b) shows the position of many of these vleis.

The woodland (Plates 7 and 8) has a well developed shrub storey; the herbaceous cover is variable and consists of forbs as well as grasses. The main tree species are *Baikiaea plurijuga, Pterocarpus angolensis, Colophospermum mopane, Terminalia sericea, Burkea africana, Erythrophleum africanum,* and *Kirkia acuminata* together with *Ricinodendron rautanenii, Guibourtia coleosperma, Dialium engleranum* and *Amblygonocarpus andongensis.* *Colophospermum mopane* is sometimes dominant. These species also occur in the shrub layer in addition to *Bauhinia macrantha, Baphia obovata, Popowia obovata, Combretum eleaegnoides, Ochna pulchra, Commiphora mossambicensis, Diplorhynchus condylocarpon* and *Grewia flavescens.* Among the grasses are *Aristida stipitata, Digitaria* spp., *Enteropogon* spp., *Heteropogon melanocarpus, Loudetia simplex, Schmidtia bulbosa, Perotis patens, Panicum maximum, Schizachyrium sanguineum, S. inclusum, Pogonarthra squarrosa, Megaloprotachne albescens* and *Eragrostis* spp. These grasses make their greatest growth in glades and places where the tree canopy is open.

6. Mosaics

(a) Woodland with shrub savanna or with grassland There are two typical forms of this vegetation.

Acacia-Terminalia type. North of Makalamabedi is an area of irregularly shaped dunes and depressions. The depressions are more open than the ridges which are covered in dense shrub. In the depressions the soils are finer and there are pockets of *Acacia* woodland, the species being mainly *A. giraffae, A. mellifera,* and *A. erubescens. Terminalia sericea* is an important component of the tall shrub on the ridges and this is more dense in the north than in the south of the area.

Colophospermum mopane type. East of the previous *Acacia-Terminalia* complex is an area composed of units of poorly developed *Colophospermum mopane* woodland and stretches of scattered shrub savanna in which the shrubs are *Colophospermum mopane, Dichrostachys cinerea, Grewia* spp., *Combretum* spp. and *Terminalia sericea.*

In this scattered shrub savanna the grasses include *Cenchrus ciliaris*, *Urochloa* sp., *Aristida* spp., *Digitaria milanjiana*, *Anthephora pubescens*, *Eragrostis rigidior* and *Enteropogon rupestris*.

(b) Shrub/tree savanna with scattered shrub savanna or with grassland Between the mainly open areas of the south and the savanna woodlands of the north there is a broad belt of mosaic-like vegetation consisting of units of shrub/tree savanna which sometimes includes small units of woodland and units of scattered shrub savanna or grassland. In many areas the shrub/tree savanna occurs on the ridges with the shrub savanna or grassland in depressions between the ridges. This type of vegetation pattern is characteristic of a large part of this transitional zone, although the juxtaposition of the units is more obvious in some areas than in others. Among the commonly occurring tree species are *Burkea africana*, *Terminalia sericea*, *Ricinodendron rautanenii*, *Combretum apiculatum* and *Baikiaea plurijuga*. Locally common are *Acacia* spp. including *A. uncinata (A. gillettiae) A.giraffae* and *A. fleckii*, *Boscia albitrunca*, *Lonchocarpus nelsii* and *Combretum zeyheri*. Among the shrubs are *Grewia* spp., *Dichrostachys cinerea*, *Bauhinia macrantha*, *Combretum* spp. Throughout this area in the shrub/tree savanna the poisonous plant *Dichapetalum cymosum* occurs on sandy ridges. The grass cover is variable both in density and composition; common grasses are *Digitaria milanjiana*, *Eragrostis rigidior*, *Schmidtia bulbosa*, *Brachiaria nigropedata*, *Urochloa trichopus*, *Aristida* spp. including *A. scabrivalvis*.

WATER

Water Resources and their Exploitation

Throughout Botswana the expansion of the livestock industry has to a very large extent depended on the exploitation of underground water by means of boreholes. Any development of the Northern State Lands for ranching will depend on water being available in the selected areas. During the dry season surface water is only available in the Chobe River, the Botletle river and a small number of deep waterholes, with seeps.

In some areas of the Northern State Lands the yields from boreholes have been poor, or the water has been mineralised and non-potable; in the case of certain successful boreholes there is serious anxiety about their recharge. The provision of water in this way is costly both in capital and in recurrent expenditure. The Geological Survey Department is responsible for the siting, the drilling and if necessary the casing of the boreholes. The Water Branch is responsible for the subsequent installation of pumps and engines either by direct labour or on contract. There are in addition a small number of private companies drilling independently.

In Eastern Botswana there is a programme to provide additional water supplies in the 'lands' (arable) areas by the construction of small dams. The Agricultural Department is responsible for this programme which could make an important contribution to the development of an integrated system of crop and animal husbandry.

The Veterinary Department has proposed the opening for cattle of the Hainaveld area south-west of Makalamabedi (outside the Northern State Lands) by pumping water from the Botletle River through a system of pipes to a number of suitably spaced watering points. A new site within the Northern State Lands adjacent to the Makalamabedi Quarantine Camp has been suggested for a pilot project.

The estimated capital cost of each watering point is R2 700; the cost of watering stock in this way is comparable with the cost of borehole water and the economic soundness of the scheme must be considered most carefully. A charge for the water of 30 cents per head per year which has been suggested for the Hainaveld scheme does not seem sufficient to meet the recurrent expenditure and is certainly not realistic, particularly if it is compared with the cost of water from a privately owned borehole.

The development of cheap water storage tanks or haffirs would be advantageous; it would avoid concentrating stock around boreholes; mechanical equipment would be eliminated; there would be less danger of overgrazing an area in a year of little rain because the tank would not be replenished. It would be necessary to provide a storage capacity of 7 yd^3 (5.3 m^3) per adult-equivalent.

The Geological Survey Department has investigated the groundwater supply of certain areas of the Northern State Lands. In some areas it is either not possible to find water, or the quality of the water renders it unsuitable. Within the influence of the Makarikari Depression shallow lenses of potable water are often underlain by highly mineralised water.

The recharge of groundwater is of considerable importance and van Straten (1955) has described the conditions for recharge in areas with a cover of Kalahari type sand. In areas where the sand cover is thicker than 20 feet and laterally persistent all the annual rainfall will be lost in evapotranspiration and no recharge can occur; in areas of shallow sand over outcrop rocks, e.g. calcrete or silcrete, recharge of groundwater is possible.

At Panda-ma-Tenga and Nata there are large numbers of successful boreholes. At Panda very large aquifers occur in the basalt-limestone formation. Between Panda and Bushman Pits there are successful boreholes along the stock route although the recharge is probably poor. At Bushman Pits there is a lense of potable water and another very large lense occurs in the Odiakwe-Gweta area. Apart from these areas an east-west line of boreholes along the originally proposed route of the new road yielded mineralised water (see map: 'Groundwater').

Around the Makarikari fresh water is obtained from wells in areas of exposed calcrete and silcrete; the supply of water in these wells depends on the extent of the catchment area and the rainfall distribution; these supplies are usually small and often fail or become unusable.

Of a series of boreholes drilled in the Mababe Depression a number yielded mineralised water and the others were unsuccessful because of the presence of fine sand which clogged the pumps.

The exploitation of groundwater appears to have often been on an *ad hoc* basis; little attention has been given to questions of 'carrying capacity' of the surrounding area and the ability to ensure stock limitations. Making water available so that livestock can be kept in an area on a year-round basis, where previously there was only restricted seasonal grazing by wild ungulates, introduces into the ecosystem an entirely new factor with far-reaching consequences. In the experience of one member of the team, the provision of water in communally-held semi-arid grazing land has invariably resulted in a serious deterioration of the vegetation of the surrounding area in a relatively short time.

The Geological Survey Department are responsible for the siting of boreholes intended for watering stock, but the suitability of an area for grazing must be decided by the Pasture Research Section of the Department of Agriculture, and until experimental results become available or experience over a lengthy period (at least 10 years) proves to the contrary, a cautious approach to stocking levels must be accepted. The practice of deciding the development of an area without seeking the advice of a Pasture Agronomist cannot be too strongly deplored.

Water Quality

The potability of water is affected both by the level of total dissolved solids and by the relative amounts of the constituents. Domestic livestock and game can become accustomed to water containing greater concentrations of salts than can be tolerated by man.

The principal constituents of mineralised groundwater in Botswana are, carbonates, bicarbonates, sulphates, chlorides and fluorides of magnesium, calcium and sodium. The levels of magnesium, sulphate and fluoride are of special significance and a water may be non-potable even though the level of total dissolved solids is not excessively high. More than 2 parts per million (p.p.m.) of fluorine may, in waters containing high levels of sodium carbonate and sodium bicarbonate, constitute a hazard to human health. A high concentration of magnesium sulphate adversely affects potability but concentrations of sodium chloride can be tolerated.

Boocock and van Straten (1963) have classified the groundwater of Botswana on the basis of its chemical composition into three groups which appear to represent different environmental and recharge conditions. In terms of total dissolved solids they cite Robinove *et al* (1958) as a useful basis for describing the potability of the groundwaters of the central Kalahari:

Class	T.D.S. (mg per litre)
Fresh	0 - 1 000
Weakly saline	1 000 - 3 000
Saline	3 000 - 10 000
Highly saline	10 000 - 35 000
Briny	more than 35 000

They suggest that the limits of potability for human comsumption are normally at the end of the weakly saline range although in certain places waters classified as 'saline' are used. The limits for stock are at the end of the 'saline' range but 'highly saline' groundwaters may be used seasonally. Underwood (1966) suggests that waters containing 10 000 mg total dissolved solids per litre are not harmful provided the proportion of divalent cations and anions, notably magnesium sulphate and carbonate, is low.

The composition of two samples of groundwater from the Nata Ranch area analysed by the Geological Survey Department is as follows:

BOTSWANA

NORTHERN STATE LANDS

SCALE

Miles 10 0 10 20 30 40 50 60 70 80 90 100 Miles

REFERENCE

MAIN ROADS

SECONDARY ROADS

TRACKS

RAILWAYS

INTERNATIONAL BOUNDARIES

GROUND WATER

- Wells
- Boreholes, Fresh Water
- ,, Salt (non-potable) Water

(Based on information supplied by the Geological Survey Dept.)

24° 25° 26° East of Greenwich 27°

18°S 19° 20° 21°

Main Chobe Forest
Serondella
Kasane
Kasungula
Lesuma
Linyote or Chobe Enclave
Kavimba
Kachikau
Ngwezumba River
Ngwetumba
Goha Hills
CHOBE GAME RESERVE
MABABE FLATS
Tsotsorogo
Shinamba Hills
Dodo
Panda ma Tenna
MABABE DEPRESSION
Kwai
Kudamane
Joverego
MOREMI GAME RESERVE
Magwaa
Rakuku
Thamalakane River
NORTHERN STATE LANDS
SOUTHERN RHODESIA
MAUN
Odiakwe
TRIBAL AREA
Bushman Pits
Kanyu
Gweta
Nata River
Maltengwe River
Nata
Maltengwe
Makalanabedi
Boteti River
Totome River
Busliman Mine
Totome
Dukwe
Mosetse
Plumtree
Ramaquabane
TATI CONCESSION
Tsessebe
Sebina
Dinokwane Hills
MAKARIKARI
NTWETWE PAN
SUA PAN
Rakops
Lake Dow
Kedia Hill
Lothlekane
FRANCISTOWN
Tonota
Tati River

D.O.S. (Misc) 449e

Drawn and photographed by the Directorate of Overseas Surveys, 1966

This map accompanies a report entitled 'A Land Use Survey of the Northern State Lands, Botswana' by the Land Resources Division, Directorate of Overseas Surveys, 1967

TABLE 6. Composition of two samples of groundwater from the Nata Ranch area, in mg per litre

	Sample A	Sample B
Anions		
CO_3^{--}	-	-
HCO_3^{-}	764	827
Cl^{-}	1 562	3 832
SO_4^{--}	103	27
F^{-}	5	4
Total	2 434	4 690
Cations		
K^{+}	20	370
Na^{+}	1 280	1 950
Ca^{++}	21	160
Mg^{++}	22	240
Total	1 343	2 722
Total ions	3 777	7 412

The first sample was potable although it spoiled the taste of tea for some people; cattle had become accustomed to the second sample, but it was necessary to cart water for the herdsmen and their families.

Water Requirements of Stock

French (1956) discusses the factors affecting the water requirements of different types and classes of cattle. There are differences between the European breeds and 'zebu' breeds and other factors include maturity, size and class as well as the season and the frequency of watering. When there is adequate grazing, daily watering of cattle gives better liveweight gains than does less frequent watering; with less frequent watering the total intake of water is less and Payne (1963) has shown that, when inadequate forage is available, water deprivation is likely to be advantageous to the animal as long as it is not too prolonged. Conversely scarce fodder could be rationed by depriving the cattle of water. It is obviously very important to control access to water supplies when fodder is scarce. Daily access to water is essential for suckling cows and young stock.

Ideally animals should not have to walk more than two miles to and from water: an area of 1 mi radius is 2 000 ac (800 ha) and cannot safely carry more than 100 head of stock. Animals should certainly not walk more than a total distance of 5 or 6 mi (8 or 10 km) a day for water. Thus if we allow for a radius of 2½ mi (4 km) and a grazing area of 12 500 ac (5 059 ha), then with a carrying capacity of 1 animal per 30 ac or 12 ha, the number at each borehole should not exceed 400 adult equivalents or a 500 head herd; because it is

normally impossible to ensure that the more distant areas are fully grazed, lower figures than these may be recommended. Watering should be limited to every second day if it is necessary for steers and dry cows to walk more than 5 or 6 mi.

In personal observations in Northern Nigeria 750 lb (340 kg) White Fulani (Zebu) steers with constant access to water drank 40 lb (18.1 l) per head per day during the dry season; similar results with Zebu cattle under comparable conditions have been recorded in East Africa.

Cost of Borehole Water

Apart from private boreholes the capital cost of borehole development has been a Government responsibility with financial assistance, prior to Independence, from Colonial Development and Welfare funds. After drilling and installing the pumping equipment the boreholes have been handed over to the tribal authorities who are responsible for their maintenance and control. The charges levied by the tribal authorities for the water supplied to cattle-owners have never represented the cost of the water and because of this, and other factors, the real costs of livestock production have not always been appreciated.

The recently introduced Borehole Repayment Scheme is intended to encourage the individual ownership of and financial responsibility for new boreholes. Even in this scheme, there is an element of subsidy, not only in the actual costs of drilling and if necessary of casing but also in that the cost of unsuccessful or low-yielding boreholes (that is, yielding less than 200 gal or 909 l per hour) is borne by Government.

The cost of a new borehole varies according to the depth of the groundwater and the need for casing. As far as possible boreholes are spaced at 5 mi (8 km) intervals and this provides within a 2½ mi (4 km) radius an area for grazing of 12 500 ac (5 059 ha). The carrying-capacity of different areas will vary and stocking rates must not just be based on average years but must allow for seasons of low rainfall when the growth of herbage is poor.

Recent figures supplied by the Agricultural Department show that the average capital cost of a fully equipped borehole is R*3 000 and it is estimated that the annual recurrent maintenance and running costs are unlikely to be less than R250. Repayments of a R3 000 loan at 8% rate of interest over five years are R750 a year. The cost of water during each of the first five years is R1 000 and this amount will not be appreciably affected by the number of cattle being watered. If the carrying-capacity is low, each borehole will serve fewer animals, the offtake will be smaller and the chances of economic success will be correspondingly poorer. It has been suggested that water from high-yielding boreholes could be piped to other watering points, but unfortunately the capital cost of the necessary piping is unlikely to be less than the capital cost of additional boreholes.

*R = South African Rand

FORESTRY

The areas with exploitable timber in the Northern State Lands have been described by Henry (1966a and 1966b) in his Enumeration Reports on the Main Chobe Forest and the Sibuyu Forest. The principal economic tree species are *Baikiaea plurijuga* and *Pterocarpus angolensis*. These are found on areas of deep loose sand in a number of different plant associations.

The main Chobe Forest Block comprises some 2 000 mi^2 (5 179 km^2), 60% of which lies within the Chobe Game Reserve. The main area of *Baikiaea plurijuga* woodland occupies a belt varying in width between 9 mi (14.5 km) and 15 mi (24.1 km); it is bounded at its north-eastern extremity by the northern edge of the sand ridge which rises from the Chobe River floodplain, and it extends from the Rhodesian border to the Goha Hills. (See maps: 'Current Land Use' and 'Vegetation').

The Sibuyu Forest is an area of 240 mi^2 (621.6 km^2) adjoining the Rhodesian border between 18°45'S and 18°54'S. Because of damage to the trees from frequent fires Henry considers the Sibuyu Forest to be a wasting asset and recommends the immediate extraction over a four-year period of 2 000 000 ft^3 (56 634 m^3) overbark of logs.

Within the Main Chobe Forest Block areas totalling 371 mi^2 (960.9 km^2) have been exploited or partially exploited. The systematic extraction of timber ceased in 1954, although Henry estimates that an annual yield of 500 000 ft^3 (14 158 m^3) overbark of timber could be obtained during the next 24-year period. There may subsequently be a need to limit cutting periodically, depending on the rate of regrowth.

Henry discusses the possible adverse effects of tree felling and extraction in the Chobe Game Reserve; he recognised that some disturbance of game is inevitable, but suggests ways in which this can be minimised and the attractions of the area for tourism preserved.

If Henry's proposals were implemented only 5 trees per acre would be removed in a felling cycle of 40 years, and extraction from some blocks could be restricted to the wet season when animals were dispersed and tourists were few. Tourist routes would be avoided when extracting and transporting sawn timber. The saw mill and the accommodation for employees would inevitably create some local disturbance and this must be accepted. The risks of poaching by employees may easily be exaggerated and cases could be summarily dealt with. (There would be little incentive for this type of illegal activity if a regular supply of cheap game meat were available.)

The direct benefits from exploiting these woodlands cannot be great; royalties are likely to be absorbed in expenditure on a Forestry Department, adequate for the task of supervising felling and extraction, but it is suggested that the provision of employment and the accompanying development of the area would be sufficient to justify the exploitation of the woodlands.

Although extraction of timber from the Sibuyu Forest does not conflict with other interests, a concession for this small area alone is unlikely to be attractive. In the case of the Main Chobe Forest the restrictions on felling which Henry recommends in order to preserve the amenities of the Game Reserve may, together with the limited yield, deter timber-felling companies. The possibility of this happening should be investigated.

We endorse Henry's conclusion that multiple land use is possible and is most likely to be successfully implemented by a single authority or under the control of a single Ministry.

GAME

Introduction

In attempting to assess the importance and value of game in a nation's economy it is difficult to obtain sufficient information of an objective and reliable kind. There is widespread interest in wild life and game preservationists are enjoying much popular support although sometimes of an uninformed and sentimental kind. Game is one of the country's more important natural assets, the presence of animals in their natural environment has an aesthetic appeal and few people would wish for the disappearance of this wild life. Riney (1963) suggests that Bechuanaland contains the finest herds of plains game in Africa today. Plowright (1963) writing about East African plains game observes: 'The conservation for posterity of this unique and irreplaceable heritage is an objective with which all thinking men would probably agree, but as has been found in similar situations elsewhere, the interests of man and the rest of nature are not always easily reconciled'. In spite of these intangible characteristics it is necessary to attempt an appraisal of the economic value of game.

Game is an economic asset which produces direct and indirect revenue, provides employment and is also a source of meat for local people. On the other hand its preservation requires the expenditure of public money on the maintenace of a game department and, of greater significance, on the continuing costly disease control measures among domestic livestock. This includes the provision of fences, the need for which is partly due to the presence of game.

In addition to the conflict of interests between those concerned with livestock production and those concerned with game, there may also be conflicts over the management of areas where there is both game and exploitable timber.

General

At the present time there is a serious lack of information about the number, movements, food requirements, reproduction rate, diseases and general behaviour of many of the large mammals. Research workers in other countries are investigating certain of these problems, and some of their results will apply in Botswana. Local investigations however, will be needed to answer most of the major questions. A sound game policy must be based on reliable data about numbers and population dynamics (breeding potential, growth rate, death rate and migratory movements) of the different species.

Insufficient is known about the effect of fences on the seasonal migration of game; many species are very mobile even if not strictly migratory. This mobility is associated with the need for water and food, and the extent of any movement is the minimum necessary for the group or herd to obtain its requirements. The construction of fences is known to have an adverse effect on the plains game species; gaps left in fences apparently do little to mitigate this effect and would at the same time defeat the purpose of fencing.

The effect of fences on migratory species is a cause for concern and the construction of further fences should be a matter for consultation after investigating the probable consequences of the fences on wild life.

Because the food requirements of different wild herbivores are so varied, the vegetation of a given area will support a larger mixed animal population than is possible when only two or three species of domestic animal are involved. Similarly certain species are less dependent on water than others, some rarely having to drink, others drinking only infrequently; this is in contrast to the need of cattle for regular watering.

Those who advocate the utilisation of an area by game rather than by cattle usually emphasise that a greater biomass (total weight of all the animals in the area) can be safely supported, that there is no need for the provision of water, that the yield or productivity from game is greater because of different growth rates and rates of maturity, and that game requires neither herding nor veterinary care.

It is generally accepted that under natural conditions each species will, by various homeostatic or self-balancing mechanisms, maintain an optimum population density according to the available resources of the environment. Under adverse climatic conditions, however, unstable animal populations are not uncommon; a rapid eruptive phase may be followed by a spectacular decline or crash in animal numbers. In years of low rainfall dense populations of herbivores can cause a long-lasting deterioration of the vegetation before their numbers begin to decline.

Vegetation frequently deteriorates in the vicinity of water. This damage invariably occurs during the dry season when water is no longer available in shallow pools, and the small groups of animals which have been widely scattered congregate within reach of the deeper waterholes, and within reach of the two rivers the Chobe in the north and Botletle in the south. Much of the damage caused by these concentrations of animals is the result of treading and movement during their daily journey to and from water, as well as by browsing or grazing. This type of deterioration is usually localised, but tends to increase in extent over a period of years.

The charges against game are that in some areas wild animals may compete with cattle for food, serve as a reservoir of disease which they may also transmit, provide a food source for the vectors of disease and in some circumstances even prey on stock.

The Economic Value of Game

The economic or the potential economic value of game can be assessed in terms of safari hunting operations, tourism and game cropping for food or other products.

Safari hunting Organised hunting is a leisure activity for which the demand already exceeds the limited facilities which are likely to decrease still further. Reservations with Safari companies are frequently made three years ahead. The direct revenue which accrues from safari hunting is unlikely to be substantial; indirect revenue could be considerable but is unfortunately difficult to determine.

Direct revenue arises from the rentals paid by the safari companies for their concessions, from the sale of licences and from the duties paid on the export of game trophies by the visitor. Each company has paid a rental of R300 per year for each party that it is permitted to have in its area at any one time. Because of the small number (four) of companies, each of which is allowed two or three parties, revenue from this source is of little or no significance.

A number of different game licences are available and their cost is related to the value of the animals which they include. The package licence costs are R500 and in 1965-6 the sale of this type of licence realised R56 130. The total revenue from all licences, including those purchased by residents in this period, was R72 786 (at the present time Africans do not require a licence other than a firearms licence in order to hunt in the tribal areas). While this revenue relates to the whole country, much of it could be credited to the Northern State Lands. In the financial year 1962-3 revenue from game licences amounted to R23 000 or 0.7% of the total national revenue and this has increased steadily to the present level which represents 1.36% of the total revenue. The revenue from the export of trophies (including those of the visitors) was R27 000 in 1965-6. The safari operators have a recurrent expenditure on salaries, supplies and services estimated at R200 000 per year; but it must be remembered that most of the supplies are imported, and under the Customs Agreement with the Republic of South Africa Botswana will not obtain any significant revenue from these imports.

Tourism In many countries in recent years tourism has become a major industry, earning much needed foreign currency. The ever-increasing demand for recreational facilities of every description suggests that the tourist will make a growing contribution to the economy of any country which offers unusual attractions and which is prepared to receive him.

The opportunity of seeing and photographing wild animals in their natural surroundings is an attraction which draws people to National Parks and Game Reserves. The opportunities for viewing game in Africa are limited to a relatively small number of Parks, and as a result of international publicity the Reserves in Southern Africa are often fully booked months in advance. In Rhodesia, the Wankie National Park has had a '500%' increase in visitors over 12 years and the value of the tourist industry has increased by 36% in two years to R11.2 million in 1965.

Botswana with its rich fauna, could, with appropriate development obtain a useful source of income from a properly promoted tourist industry. The Chobe Game Reserve is within 1½ hours' drive of the Victoria Falls, a major attraction for most visitors to Africa, and in 1965 attracted 3 000 visitors (5% of the number of visitors to the Victoria Falls) who paid R1 375 for the privilege of entering the Chobe Reserve. This number is surprisingly large in view of both the absence of publicity and the almost complete lack of facilities; as a consequence of this lack there is no inducement for the visitor to stay longer in the country after he has spent a few hours in the Reserve.

Game cropping The utilisation of an area by game requires a properly formulated management policy which may include some form of cropping. Not only is this economically desirable but at the correct level of 'off-take' it should preserve the balance between the habitat and the species which ideally are kept in the eruptive stage. (In the eruptive stage population numbers are increasing under favourable conditions including adequate supplies of food. In nature a rapid upsurge in numbers may be followed by an

equally rapid decline which may have a variety of causes, including increased mortality rate, lower reproduction rate or migration. Fluctuation in numerical size is a pattern common to many species.)

It is necessary to distinguish between game cropping which implies a sustained supply of saleable animal products, and the more drastic culling operations which result in large quantities of meat being available over a period of days or weeks. Locally secured game is an important source of meat for many communities and the annual consumption of game meat in Botswana has been estimated at more than 4 000 tons (4 064 metric tons). It has been suggested that the consumption of game releases an equivalent amount of meat for export, in other words that the game is 'worth' 4 000 tons of exported beef. This is a mistaken view: if the game were not available an equivalent weight of beef for local consumption would not be withdrawn from the valuable export trade. It is possible that a small additional weight of beef would be consumed locally, but the value of this village-slaughtered beef would be far lower than the same weight of abattoir-slaughtered beef for export. Thus the money value of the game in relation to exported meat is low.

Nevertheless the value of game in nutritive terms is high. The nutritive value of game meat is as high as or higher than that of beef, mutton and pork and the percentage of lean meat is higher in wild ungulates than in their domestic counterparts (Talbot *et al.*, 1966).

In order to avoid offending the feelings of potential tourists discretion is necessary when game cropping is practised in tourist areas.

Some of the advantages claimed for game have already been described. There is also their tolerance of trypanosomiasis and thus their ability to utilise country where this disease precludes the introduction of cattle. In spite of the many advantages, the problems of game cropping for fresh meat production in areas remote from markets and in a country where the movement of meat requires strict veterinary supervision would seem almost insurmountable. It is appropriate to quote part of the opening address by Sir Richard Turnbull at the Arusha Wildlife Conference in 1961. 'Although I feel that this is an idea (i.e. game cropping) which should continue to be examined, I see very little hope of it turning out to be a profitable one. Even scientists have their blind spots and I think that in pursuing the idea of a maximum protein yield per acre from game, we may be chasing an illusion. Your protein yield per acre from game may be as high as the sky, but it will be of little use to you unless you can secure it how you want it, when you want it, where you want it and in the quantities you want it; unless you can be certain that the game you crop is of the proper kind, the appropriate age and free from disease, unless the cropping can be done in a manner which is both humane and unlikely to make the game so shy that the area ceases to be of any value as a tourist attaction, and unless the carcasses can be neatly butchered and promptly despatched to market'.

All these points are relevant to the problem of game cropping for fresh meat in the Northern State Lands. In some of the nearer markets, game meat would have to compete with relatively cheap beef (10c per lb or 10c per 0.45 kilogram in Maun). The sale in more distant markets would call for the rigorous inspection and high standards of cleanliness and butchering, and in addition would require elaborate equipment for chilling and transport; any suggestion that its movement constituted a disease hazard would immediately stop the trade. Canning requires elaborate and costly equipment; the small-scale canning of meat products is not feasible since it cannot satisfy the normal stringent food regulations.

'Biltong', air-dried strips of lean meat popular throughout Southern Africa, can be produced from game without complicated equipment, has a high market value and is easily transported; its production requires skilled cutting and drying without artificial heat and is only possible during four or five months of the year. The risk of transmitting foot and mouth disease in properly cured biltong exposed to the light is probably slight.

Properly cured hides and skins have a high market value (a zebra skin is worth R20) and there are many other items which would be saleable as souvenirs after some preparation; these include horns, tails, elephants' feet and karosses ('blankets') made from damaged skins. Game cropping directed to the production of hides, skins and souvenirs would under present-day Botswana conditions seem to have a greater chance of success than putting the emphasis on its value of a source of meat. It should not be difficult to determine market requirements in terms of type, quality and condition of skin, and on this basis organise cropping. It must be expected that fashion trends will cause changes in the requirements and in the values.

LIVESTOCK

General

Smallstock are relatively unimportant in the export trade of Botswana and these discussions about livestock are primarily concerned with cattle. In the 1964 Livestock Census sheep and goats numbered 137 000 and 378 000 respectively compared with 1 347 000 cattle. A limited number of sheep are received at the Lobatsi abattoir and there is a small trade in Karakul pelts in the south.

In normal years cattle together with by-products represent 85% of the total value of Botswana exports. In spite of the importance of this trade only a small part of the livestock industry is adequately organised. Of the national herd, 80% are African-owned in small herds. These herds are frequently grazed a considerable distance from the owner's cultivated lands and these in turn may be some distance from his home in town or village. The result is that frequently the owner has very limited contact with his cattle and there is no opportunity for any integration of animal and crop husbandry. This traditional zonation into home, lands and cattleposts is depriving the country of the undoubted advantages of mixed farming under the present conditions in Botswana.

Most of the cattle are of the Sanga type although the cervico-thoracic hump is often poorly developed; the most important breeds are the Tswana and the Africander (Afrikaner). The Tswana is variable in colour and conformation and often shows evidence of crossing with the Africander which is frequently used in up-grading schemes.

Exports of Cattle

Cattle are exported through the modern abattoir at Lobatsi and before 1968 were also exported on the hoof to Zambia and Rhodesia. Exports of cattle in recent years are shown in Table 7.

TABLE 7. Exports of cattle from Botswana, 1962-6

Destination	1962	1963	1964	1965	1966
Beef carcases					
South Africa	40 925	39 627	34 648	32 940	17 465
Other African markets	18 287	14 486	15 052	17 995	13 813
Overseas (mainly U.K.)	31 122	46 593	59 172	86 624	97 287
Condemned	2 972	2 700	2 886	5 177	3 667
Total slaughtered	93 306	103 406	111 758	142 736	132 232
Live cattle					
Zambia and Rhodesia	18 228	27 348	15 045	19 568	16 422

Because of the drought and the dearth of grazing there was an abnormally high offtake of 162 000 (>12%) in 1965.

The movements of cattle are controlled by the Veterinary Department through permit systems. This same department has erected various disease control fences to assist in limiting the spread of foot-and-mouth disease from one area to another. As a routine measure the abattoir in Lobatsi is closed and exports are suspended at the beginning of an outbreak of foot-and-mouth disease until such time as the extent of the outbreak has been ascertained. Thereafter it is a matter for negotiation with the importing countries regarding the areas from where they will accept cattle while the outbreak continues and the length of the quarantine period after an outbreak has been brought under control.

Animal Husbandry

During recent years the national herd has numbered more than 1 300 000 and the offtake has risen from 69 000 (5.3%) in 1958 to 162 000 (12%) in 1965. This increase in offtake is largely due to the drought conditions over a period of four years, but it may also indicate a change in the African's traditional attitude of regarding cattle as status symbols.

The record offtake of 1965 included a high proportion of female breeding-stock and this trend has continued in 1966; in addition there are reports that large numbers of animals have died from starvation. These losses must inevitably reduce the size of the national herd; it has been suggested that the national herd has been reduced to 900 000 head and as a result the offtake during the next five-year period must be smaller. In order to reduce the number of casualties various emergency measures have been introduced and these include the issue of a special concentrate ration, the movement of stock to areas of adequate grazing and the preparation of a bulk feed by hammer-milling woody shrubs.

The structure of the individual herd is a major factor when 'offtake' is considered. Van Reit Lowe (1963) indicates that in one area (Bamangwato) 72% of owners had less than 50 head of cattle and that the average herd size was 33 head. Of this number a large proportion will be draught oxen, calves and immatures, the remainder will include the breeding herd, animals in poor condition and disposable stock. Under normal circumstances an offtake of two animals (6% of the herd) is all that is possible.

The standards of animal husbandry are low and the problems of extension work have not been given sufficient attention. Elementary principles of management are neglected. Advisory work is less rewarding than similar work among settled farmers; difficulties arise because of the absence of many owners, the poor education of the herdsmen and the great distances between cattle posts.

How to improve the standards of pasture and animal management is one of the most urgent of all the many serious problems facing the leaders of the newly independent Botswana; every medium of mass communication must be used to disseminate the basic principles.

The Animal Husbandry Section of the Agricultural Department has introduced a training scheme to foster the better understanding of the principles of animal husbandry. For the three years since 1963 this scheme has been supported by the 'Freedon from Hunger Campaign', although unfortunately staff shortages have prevented the expansion which had been planned. Further financial support for this vital scheme is being provided under the Technical Assistance Programme.

Livestock Marketing

Disposal of cattle in the past has usually been through European traders, who under veterinary supervision have organised quarantining, trekking and rail transport to the abattoir at Lobatsi or to the northern centres Kazungula and Panda-ma-Tenga prior to sale to Zambia and Rhodesia. If grazing is available immature animals will be held for fattening. African producers are encouraged to send their cattle direct to the abattoir but there has often been a preference for the African or European trader's ready cash. The Veterinary Department regulates the flow to the abattoir by a quota system. An outbreak of foot-and-mouth disease will stop the movement of livestock and stringent regulations concerning the resumption of trade are imposed by the importing countries. Botswana is divided into a number of zones and the movement of cattle between zones is regulated with fences, control posts and quarantine camps. Until recently in remote areas the disposal of surplus stock has only been possible through traders, but the sale of cattle to middlemen has always been severely criticised. The producer has not received a fair return, and the purchase of stock at a flat rate per 100 lb (45.36 kg) does not give the seller any incentive to produce a better animal. On the trader's behalf, however, it must be pointed out that he risks buying unthrifty animals and animals the meat from which may be condemned. Another criticism is that the trader who himself holds animals for fattening is rarely concerned about the deterioration of the veld which results from his activities. Government intervention in trading activities could have a very beneficial effect. In some tribal areas auction sales have been introduced and these enable the owner to obtain a fair price for his stock.

Little progress has been made so far in developing co-operatives or tribal organisations for the marketing of members' cattle. A considerable number of African owners have formed registered groups who supply direct to the abattoir and will employ an agent to represent their interests there.

In 1964, a total of 15 000 head (12% of cattle exports) were sold to Rhodesia and Zambia. However, the export of live cattle is prohibited with effect from 1 January 1968 and Ngamiland cattle will no longer be driven from Bushman Pits to Kazungula or Panda-ma-Tenga, but will move from Makalamabedi to the Lobatsi abattoir through a series of quarantine camps at Odiakwe, Damdamoga and Dukwe and a holding ground at Francistown.

Lack of supplies will dictate the pattern of exports for a period of at least five years; at the end of this period the demand for beef is still likely to be high and world markets may still be favourable for extensively reared beef; but it is possible that there may be a fall in demand if cheaper forms of meat become available, or alternatively production of grain-fed beef may develop with unforeseen rapidity. These are serious considerations and re-emphasise the urgent need to encourage pasture management and good animal husbandry.

PART 5. RECOMMENDATIONS FOR DEVELOPMENT

GENERAL

By its terms of reference this survey is primarily concerned with the need for additional grazing areas, which will be capable of sustained animal production without deterioration of the vegetation and without unnecessarily endangering the preservation of wild life in the State Lands.

The export of livestock products is virtually Botswana's only source of income and this has resulted in the establishment of a very efficient Veterinary Department, the utilisation of groundwater and the construction of a modern abattoir and meat-processing plant. During the development of this industry it would probably be true to say that little thought was given to the consequences of placing so much reliance on cattle in a semi-arid country. The effects of drought are always intensified by overgrazing and in areas of unreliable rainfall there should always be reserve grazing, i.e. understocked areas. The capacity of sandveld to recover is commonly over-estimated because of its appearance soon after rain has fallen. In recent years attention has been drawn to the fact that the country may have already paid too high a price in wasted natural resources, and any development which involves the destruction of a country's natural assets must be viewed with alarm.

Climatically the country is subject to recurring drought years and series of drought years; this hazard must be recognised and the organisation of grain storage and fodder banks would seem to be a priority. Without such provision losses and hardships in a future crisis could be even more severe than those which have recently been experienced.

The present condition of the livestock industry and the grazing areas is a matter for concern; this condition has undoubtedly been seriously aggravated by, but not primarily caused by, the recent prolonged drought. Although digressing from the terms of reference, some discussion of the agricultural background is necessary.

The most intractable problem is the traditional zonation into village 'lands' and cattle posts each of which may be a considerable distance from the others. This deep-rooted pattern precludes any development of mixed farming with its many advantages in this type of environment.

Under the existing system stock cannot be easily supervised and time must be wasted in travelling between the centres. The distance between the 'lands' and the 'cattle posts' frequently precludes the return of manure to the arable areas and the feeding of crop residues to the stock. Crops and stock would both benefit therefore if cattle could be kraaled on or near the cultivated areas, depending on the season. In sandy soils, organic matter derived from cattle manure not only supplies plant nutrients but also improves moisture retention, although the residual value of the manure in the following season is low, owing to rapid oxidation. Bringing the cattle nearer to the crops means that there would be a sustained transfer of fertility from the grazed areas to the smaller cultivated areas and a considerable improvement in crop yields.

The desirability of diversifying the ecomomy by the introduction of irrigation schemes and arable cash crops is recognised but ideally must be made complementary to the development of an integrated system of animal and crop husbandry. The adoption of a conservative system of agriculture will not produce immediate or spectacular results but it should lead to eventual economic soundness and stability. Such a radical change in customs and attitude cannot be accomplished overnight, but requires imaginative thinking by the country's leaders, and a willingness on the part of those directly concerned, the agricultural research worker and the extension officer, to prepare the way in their experimental programme and in discussion with the farming community.

Much of the present Master Stockman programme for improved animal husbandry would be equally applicable to an integrated system of crop and livestock farming; the recommendations for feeding crop residues are only appropriate if some form of integration is adopted.

Many of the grazing areas closest to the arable lands in Eastern Botswana are in need of rehabilitation. This will usually involve destocking and a lengthy resting period; in some places special reclamation measures may be necessary including simple cultivation and the introduction of seed. In many of these areas their subsequent management, if it is to be effective, will require the provision of fencing. The demand for the development of the Northern State Lands is partly a result of this urgent need for alternative grazing but even the temporary overstocking of new areas must be avoided.

Throughout the country, grazing control and stock limitation are essential and ways of enforcing these measures must be devised and implemented. The disease control measures of the Veterinary Department and the development of groundwater and surface water storage must continue, but measures to limit and control stock numbers must have equal priority. Effective implementation of grazing control measures will require the wholehearted co-operation of the administration as well as that of the Veterinary Department, although the responsibility for making recommendations belongs to the Pasture Section of the Agricultural Department. In the same way the programme for improvement in animal husbandry will require the support of all officials who are in contact with stock owners and herdsmen. To enforce the necessary unpopular control measures, including restrictions on numbers and movements of cattle, without losing the confidence of the cattle owners, will require the utmost skill and diplomacy. Recognition of the country's dependence on the livestock industry must be translated into practical measures for its proper development and improvement. The expansion of the national herd into as yet unused land will produce lasting benefit only if there is an acceptance of a clearly defined policy of pasture and animal management and careful control of newly developed areas.

Within the Northern State Lands only limited areas can be recommended for immediate development for grazing. When the large number of factors relating to domestic livestock production have been taken into account the conflict between the interests of the game hunter and those of the cattle producer need not be regarded as irreconcilable.

The absence of an adequate Game Department is a serious obstacle to the proper development, whether for ranching, hunting or forestry, of the Northern State Lands; very often individuals in the Department who are genuinely concerned with the conservation of wild life appear to adopt positions inimical to all forms of development. But until there is a Game Department adequate to command professional respect this unfortunate defensive attitude is likely to continue.

The present resources of the Game Department are totally inadequate for any of its roles and unless it is expanded there is no possibility of this department contributing to the development and economy of the country. It has been suggested that any expansion of the Game Department should be related to the expected revenue from game licences; annual Game Department expenditure is R36 000 which is approximately half the annual revenue from game licences. The expansion of the Game Department, including responsibility for tourist facilities, cannot be shelved indefinitely because of conflicting claims and priorities; when a natural asset is diminishing the time factor is critical.

Kinloch (1965) has provided details of an expanded Game Department and stresses the need for an increase in the numbers of Game Wardens, Game Scouts and ancillary staff. The recruitment on short-term contracts or through voluntary agencies of two or three suitably qualified specialists to investigate some of the urgent biological problems is also essential. It should be possible within a period of three or four years for an expanded and properly organised department to prove its value in the national economy.

Among the urgent tasks of an expanded Department will be the management and development of the Reserves, the control of the issue of game licences, the supervision of organised hunting and the investigation of game cropping. The allocation of manpower for the prevention of poaching will have to be decided locally in the light of experience, but policing duties however necessary must not be regarded as the primary function of the Department. Aspects of these various tasks are discussed in the Report of an Economic Survey Mission (1960) but of their recommendations only the one on the development of safari hunting appears to have been implemented. Priority must be given to the management of the reserves in accordance with a defined policy; the vegetation must be conserved and this may involve the culling of certain species; to ensure that the tourist may see the greatest possible variety of animals, other species may have to be given special protection. Parts of reserves must be managed for the benefit of the tourist; roads must be developed and accommodation must be organised. The tourist must be given all possible assistance and knowledgeable guides must be available if required; guides are essential if visitors are to be allowed to leave their cars and the roads.

With the exception of the least numerous species, the effect of trophy hunting on animal numbers is not likely to be a significant factor, but in spite of this we consider that the Game Department should exercise control over the issue of game licences, and that the safari companies should be required to make regular returns of the animals taken by their clients. Safari parties should at all times be open to inspection by senior Game Department staff, and this should be a condition attached to the granting of concessions in future. Organised hunting often provides a most valuable buffer zone between Game Reserves and land used for farming, and encouragement should be given to this type of zonation.

The prospects of game cropping for fresh meat production are not encouraging, but the possibilities of biltong production should be examined; the risk of transmitting foot-and-mouth disease in properly cured biltong is probably slight but should be investigated with the assistance of the Veterinary Department and the Animal Virus Research Institute in Britain. Apart from meat, properly cured hides and skins have a high market value and there are many other items which would be readily saleable after a little preparation as souvenirs, including horns, tails and elephants' feet, while damaged skins could be used to make karrosses (bed coverings) and other small items.

There is a need in Botswana for an authority (Natural Resources Committee) to whom disagreements on land use may be referred. There may develop a serious conflict of interests concerning the management of certain areas which cannot be resolved, in spite of goodwill, by those directly concerned. There must be flexibility in land use, but changes must be made in the national interest and not simply as the result of pressure from a group or from individuals with a vested interest in some particular form of development.

LIVESTOCK IN THE NORTHERN STATE LANDS

FACTORS AFFECTING DEVELOPMENT

In order to decide the suitability for ranching of the different areas within the Northern State Lands a number of factors must be considered; major factors are fodder resources and water supplies, but of almost equal importance are other factors including the incidence of disease, the presence of the poisonous plant *Dichapetalum cymosum*, the size and shape of suitable areas, the ease of access to the area for both stock and vehicles, and in a few places the current land use. Because of the low level of utilisation the question of current land use can be largely disregarded in the selection of areas suitable for immediate development for livestock. .

In making an appraisal of the fodder resources it has be to remembered that the introduction of the grazing animal will bring about a change in the composition of the vegetation and because this change may be unfavourable some areas which appear eminently suitable for development must be avoided. The converse of this may also be true and certain degraded areas may after suitable rehabilitation be potentially productive.

The existing cattle industry is based on a system of extensive ranching; little provision is made for supplementary feeding and ideally a grazing area must be nutritionally adequate for all classes of stock throughout the year. The natural herbage must be adequate in quantity and must meet the animal's requirements for energy, protein and minerals. Animals frequently obtain valuable minerals and protein by browsing on a variety of bushes and shrubs in addition to grazing; this source of food is particularly valuable during the dry season and in years of low rainfall.

The leaves and fruits of a large number of plants are also eaten by wild animals, and this is the basis for the assertion that most areas are better utilised (support a larger number of animals whose total weight or biomass is greater) by game animals than by one or two species of domesticated livestock which are usually selective in their choice of food. Plants browsed by cattle include *Combretum hereroense*, *C. apiculatum*, species of *Grewia*, the pods and leaves of some *Acacia* species, both fresh and fallen leaves of *Colophospermum mopane*, and the leafy shoots of *Terminalia sericea; Colophospermum mopane* is very valuable although alone it will not provide an adequate diet.

Control of Woody Plants

In spite of its value as browse, dense shrub or tree growth limits the carrying-capacity of an area because the grass cover is poorer and the yields of herbage are lower; it also hinders the supervision of the animals and necessitates scrub control measures. At present burning is the only practical

method of scrub control; however fire is only appropriate for certain types of veld and must then only be used with adequate precautions.

A number of factors have to be considered when using fire to reduce competition from woody species in savanna communities. There has to be sufficient combustible material and in order to accumulate dry herbage the animal must be excluded from the area to be burnt during the whole of the previous growing season. (Under a dense shrub canopy it may be impossible to accumulate sufficient herbage.) Routine burning will have to be postponed whenever there is insufficient material as a result of a poor season and the area intended for burning may itself have to be used for extra grazing. The burning must be delayed until the end of the dry season and precautions must be taken to minimise the effects of earlier accidental fires. Unfortunately deliberate burning and accidental fires during the height of the dry season are common. These fires seriously damage perennial grasses and are relatively less effective in controlling shrub growth.

After burning, grazing must be delayed until late in the growing season or preferably until the dry season.

When a burn is incorporated in the system of veld management, a camp must be closed to grazing for a period of 18 months; if a burn every third year is recommended, two-thirds of the total area will be closed during the rains and one-third during the dry season.

Forage Quality

Grasses vary in both palatability and in their nutritive value at different stages of growth and workers in Southern Africa have introduced the terms 'sweet', 'sour' and 'mixed' to describe grasses and grassland. A sweet grass is one which remains palatable and retains its feeding value after completing its seasonal growth; a sour grass is either unpalatable or its nutritive value declines rapidly during the growing season and is very low in the dry season. A number of grasses are intermediate and their value can be improved by management. Because most pastures are composed of a variety of grasses their value will vary according to the proportions of the components. It is sometimes mistakenly believed that all annuals are sweet and that perennials are sour.

Commonly occuring sweet grasses include the following, many of which are perennials, *Anthephora pubescens*, *Brachiaria nigropedata*, *Cenchrus ciliaris*, *Chloris gayana*, *Digitaria* spp., *Eragrostis rigidior*, *E. superba*, *Panicum maximum*, *P. coloratum* and *Schmidtia bulbosa*. In years of adequate rainfall annual *Urochloa* spp. produce large amounts of valuable food. Prolonged rains or dry-season showers reduce the value of the standing herbage.

Sour grasses include the aromatic genus *Cymbopogon* and tall-growing coarse grasses such as *Andropogon* spp., *Heteropogon melanocarpus*, *Hyparrhenia* spp., *Loudetia simplex*, and *Rottboellia exaltata*. *Eragrostis pallens* and many *Aristida* spp. are unpalatable and the hard *Odyssea paucinervis* also seems to be in this category; *Aristidia uniplumis* is widespread and is important in that it may be utilised to a considerable extent; by skilled management the value of such grasses as *Andropogon gayanus*, *Heteropogon contortus* and *Hyparrhenia* spp. can be enhanced.

Mineral deficiences in the herbage, particularly an inadequate level of phosphorus, are widespread. The chemical analyses of samples from different

areas are given in Appendix I where they are considered in detail. A sample from the open grassland near the northern arm of the Makarikari Pan is seriously deficient in phosphorus, and deficient in copper and cobalt. In this type of grassland woody browse species are absent, and the poor reputation of these grasslands for livestock production, except where the animals have access to other types of vegetation, may be attributed to these mineral deficiencies.

The effective utilisation of many areas will depend on the provision of mineral supplements. In many places bonemeal, after mixing with salt in accordance with the standard recommendation, will be satisfactory, but in certain places it may be necessary to include trace elements in the mixture. To encourage the feeding of bonemeal, it is recommended that it be made available throughout the livestock areas at the lowest possible price by subsidising the cost of production and distribution.

A number of plants at some stage of their development are poisonous to stock. The seeds of some leguminous plants are toxic but are usually avoided by stock. The widely distributed plant *Dichapetalum cymosum* is probably the most serious potential source of stock poisoning in the Northern State Lands and is by itself a factor of some importance. This suffrutescent plant forms colonies on loose sand ridges with a cover of shrubs and trees which include *Ochna pulchra* and *Burkea africana*. It spreads by horizontal subterranean branches and these throw up clusters of low shoots, each of which bears a few leaves (Plates 9 and 10). Fluoroacetic acid is the poisonous principle and levels of 15 milligrams per gram of leaf have been reported. Watt and Breyer-Brandwijk (1962) describe the symptoms of poisoning; stock which are watered after eating the plant die quickly; if water can be withheld for several days stock may recover. Mogg (1930) describes a trial with sheep which indicates that the mature leaves are relatively harmless but that the young leaves appearing in September and sometimes again at the end of the rains are particularly dangerous, and suggests that young leaves developing at the end of the rains may also be toxic.

There are reports that stock kept permanently in an area where this plant occurs learn to avoid it, but this is doubtful and most owners of cattle try to keep animals away from these areas. It has been suggested that kraaled animals which tend to eat indiscriminately when first taken out in the morning are very susceptible to the low-growing green leaves of this plant. The distribution map of *D. cymosum* is in no sense complete but shows the localities where this plant was recorded during the survey and it is probable that the plant occurs throughout the area lying within these widely scattered points.

Water

After considering the vegetation the availability of water is the next factor determining the usefulness of an area of development. In many places, an inadequate, unreliable or highly mineralised supply of water precludes development. Water resources have already been described in detail, page 48.

Tsetse

The presence of tsetse fly with the associated danger of trypanasomiasis precludes livestock development in western areas of the Northern State Lands.

Access

Ease of access even for ranching is an important factor although movement of stock on the hoof reduces the problem. The construction of the new road from Francistown to Maun has improved access to the Northern State Lands although the secondary roads running north and south are, without exception, poor. Livestock development will depend on adequate access and internal roads, and there must be provision for the cost of making the essential motorable tracks.

Between the scattered shrub savanna of the south and the open northern woodlands there are many areas which have moderate or good carrying capacity but are too small or too remote from similar areas to permit worthwhile development.

AREAS SUITABLE FOR RANCHING

For the purpose of this section of the report the Northern State Lands have been divided by an east-west line at the latitude of approximately 19°07'south (see maps: 'Vegetation' and 'Recommended Land Use').

North of this line the herbage of many areas is characterised by the predominance of sour grasses.

To the south of this line the grasslands are composed of more palatable grasses with a higher nutritive value particularly during the winter months, although the density of the woody vegetation prevents the utilisation of much of the area for ranching.

1. Northern Zone

In this higher rainfall zone there are only a few areas of agricultural significance: two of these areas have been developed but have subsequently been abandoned, ranching was attempted at Panda-ma-Tenga between 1949 and 1957 by the Commonwealth Development Corporation, and an area near Kachikau is reputed to have been until recently an important cereal-growing centre.

(a) Around Panda-ma-Tenga and both north and south of this centre there are black clay soils; if the smaller irregular shaped areas of these soils are included the total area is more than 360 mi^2 (94 000 ha). Provided that the better drained sites are chosen and any nutrient deficiencies are remedied, it might be possible to cultivate arable and fodder crops and develop a semi-intensive type of livestock production. It must be a matter for regret that the modest experimental programme with arable crops which was started in the last years of the original ranch at Panda-ma-Tenga was not completed for lack of financial support. The excellent yields of maize and groundnuts which were obtained from experimental plots were unfortunately never obtained on a field scale.

The sour grasslands of these black clay soils and of the many vleis which occur within the northern woodlands are nutritionally inadequate for eight months of the year and because of this they are not suitable for development as holding grounds for finishing animals which are accustomed to the sweeter pastures of the south.

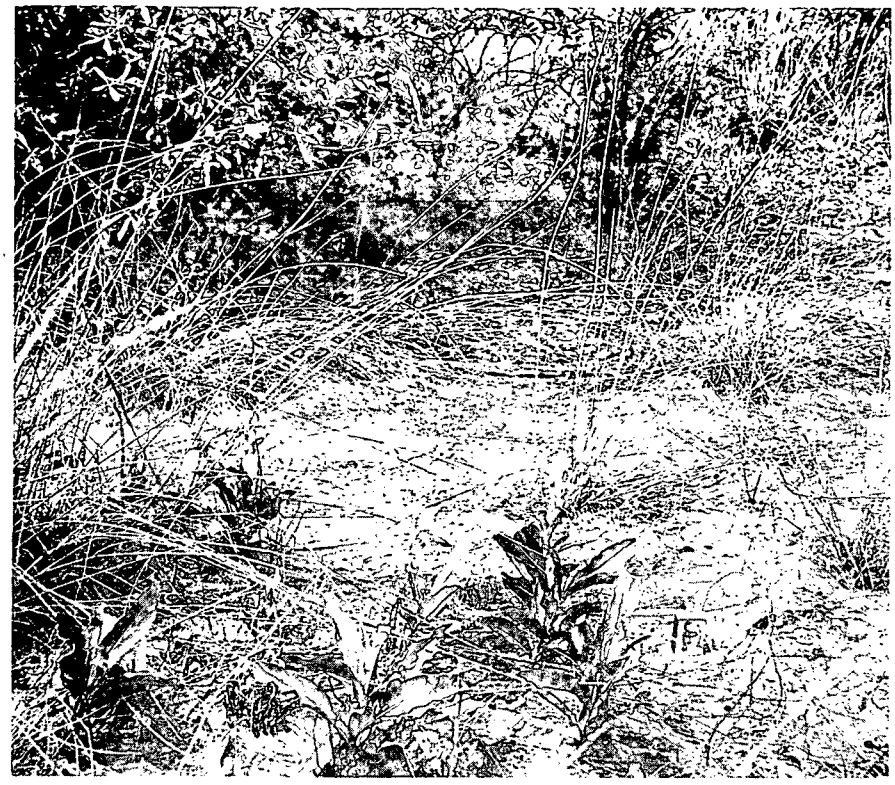


PLATE 9 *Dichapetalum cymosum*. The limited aerial growth can be seen in the foreground

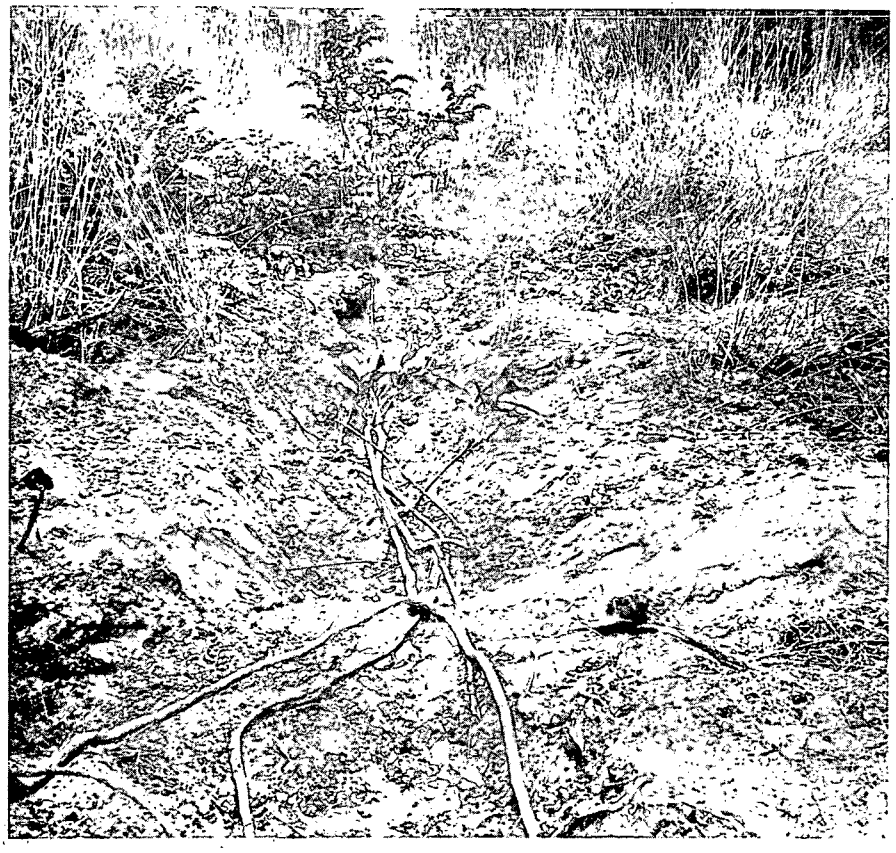


PLATE 10 *Dichapetalum cymosum* growing on the ridge north of the Nata Ranches : excavation to show the extensive underground system

BOTSWANA

NORTHERN STATE LANDS

SCALE

Miles 10 0 10 20 30 40 50 60 70 80 90 100 Miles

REFERENCE

MAIN ROADS

SECONDARY ROADS

TRACKS

RAILWAYS

INTERNATIONAL BOUNDARIES

● *Dichapetalum cymosum* (Mogau)

24° 25° 26° East of Greenwich 27°

18°S

19°

20°

21°

Main Chobe Forest
Serondella
Kasane
Kasungula
Lesuma
Kavimba
Kachikau
Linyote or Chobe Enclave
Ngwetumba
Ngwezumba River
Goha Hills
CHOBE GAME RESERVE
MABABE FLATS
Tsotsorogo
Shinamba Hills
Panda ma Tenga
Dodo
MABABE DEPRESSION
Joverego
Kwai
Kudamane
MOREMI GAME RESERVE
Magwaa
Rakuku
Thamalakane River
NORTHERN STATE LANDS
SOUTHERN RHODESIA
MAUN
Odiakwe
Bushman Pits
Kanyu
TRIBAL AREA
Gweta
Botletle River
Makalanabedi
Nata River
Maitengwe River
Maitengwe
Nata
Totome River
Bushman Mine
Totome
Dukwe
Mosetse
Plumtree
Ramaquabane
Tsessebe
Sebina
TATI CONCESSION
FRANCISTOWN
Tati River
Tonota
MAKARIKARI
NTWETWE PAN
SUA PAN
Dinokwane Hills
Rakops
Lake Dow
Kedia Hill
Lothlekane

D.O.S. (Misc) 449d

Drawn and photographed by the Directorate of Overseas Surveys, 1966

This map accompanies a report entitled 'A Land Use Survey of the Northern State Lands, Botswana' by the Land Resources Division, Directorate of Overseas Surveys, 1967

(b) An area of alluvial soil on the Chobe River floodplain in the neighbourhood of Kachikau village has been described as the 'granary of the north' implying the large-scale production of cereals. It was not possible to obtain information about this earlier development, and today there is only a low level of subsistence farming in the area. The decline in farming is usually attributed to two events and resulted in the migration of adult males to South Africa; the first of these soon after 1947 was a combination of animal diseases including trypanosomiasis and streptothricosis which reduced the cattle population within the enclave from 22 000 to less than 2 000 head and this would include the loss of draught animals; ten years later in 1957 much of the arable land was flooded and this proved a serious discouragement to continuing cultivation.

Today, livestock production is of no consequence in the enclave, which has been encircled by the Chobe Game Reserve since its establishment in 1960, and is in any case continually threatened by trypanosomiasis. The unpredictable level of flooding would seem to rule out the redevelopment of the area for crop production unless it became possible to control the level of the water.

Within the northern zone there are two other areas which have been mentioned as possibly being of agricultural value; these are the Lesuma Valley and the Mababe Depression.

(c) The Lesuma Valley extends into Rhodesia where some areas are under cultivation; the amount of land within Botswana however is too small for extensive agricultural development.

(d) The Mababe Depression might be suitable for crop production although the level of fertility is unlikely to be uniform throughout the area and previous attempts at cultivating crops including groundnuts were not successful. Two obstacles to development are inadequate water supplies and the presence of tsetse fly. There is no reason to recommend any reduction in the size of the Chobe Game Reserve Boundary.

2. Southern Zone

Immediately south of the line dividing the two zones the country is undulating with belts of fairly dense woody vegetation where the grass cover is correspondingly poor; many of these areas occur on sandy ridges and would be extremely sensitive to treading. Regular burning is the only practical method of controlling woody growth but this necessitates long resting periods to accumulate sufficient combustible material for an effective burn. These long resting periods will reduce the overall carrying capacity to about 1:60 ac (1:24 ha) and at these stocking rates the provision of water becomes prohibitively expensive.

Other factors militating against the development of the areas are the presence of *Dichapetalum cymosum* and the movement of game in the eastern part of the area to and from the Wankie National Park in Rhodesia.

In the following description of the potentially valuable ranching areas emphasis is placed on the availability of potable water and of possible mineral deficiencies in the herbage. While it should be possible to rectify mineral deficiencies with suitable licks, inadequate or highly mineralised water will probably preclude the development of certain areas and the value

of including such areas is open to criticism. It must be remembered however that the Geological Survey Department is the authority with the relevant information relating to the groundwater resources of these areas.

Area A This area, north and northeast of the fenced Nata Ranches, consists of approximately 234 mi^2 (60 000 ha) of open grassland. Special mineral supplements are probably necessary. The estimated carrying capacity is 1:20 ac (1:8 ha). Part of this area is within the area known as the Nata Ranch and includes a number of existing boreholes.

Area B Adjacent to Area A, Area B is a *Schmidtia-Urochloa* scattered shrub savanna of 280 mi^2 (72 100 ha); carrying capacity 1:25 ac (1:10 ha).

Area C Lying between Areas A and B and the Nata River System, Area C consists of 340 mi^2 (87 600 ha) of shrub and tree savanna where the trees are mainly confined to the grassy depressions around the waterholes. The carrying capacity of this area will be far from uniform, but it is estimated to be 1:30 ac (1:12 ha) overall. The dense mopane scrub and mopane woodland will determine the limit of development in the east.

Area D Occupying nearly 700 mi^2 (180 600 ha), this area surrounds 80 mi^2 (20 640 ha) of open grassland around the Kudlakam Pan to the east of Kanyu (Area F); a further 300 mi^2 (77 300 ha) would be occupied by the proposed corridor between the Nyaia Pan and the Botletle River. The area includes sand veld and mixed grassland and the density of the shrub is variable although mainly open. The woody vegetation tends to be thickest on the loose sand ridges which occur east of the Kudlakam Pan. The Odeakwe veterinary camp is sited in the eastern part of this area. The most serious obstacle to the development of the area is the lack of adequate and reliable supplies of potable water. Many of the boreholes between Gweta and Bushman Pits have yielded highly mineralised water. It might be feasible to open some areas for grazing by pumping water from the Botletle River, as has been proposed for the development of the Hainaveld. The carrying capacity will vary from 1:25 ac to 1:40 ac (1:10 ha to 1:16 ha) and overall is estimated at 1:30 ac (1:12 ha).

Area E In these 230 mi^2 (59 250 ha), between the Makalamabedi Veterinary Quarantine Camp and the old Maun-Francistown Road, any development will depend on the availability of water; the overall carrying capacity is 1:40 ac (1:16 ha) but will vary according to the density of the scrub. Regular burning will have to be included in the system of management.

Area F The characteristics of this open grassland, occupying 80 mi^2 (20 640 ha) around the Kudlakam Pan, are similar to those of Area A. The lack of water will probably preclude its development; and mineral deficiencies in the pasture are likely to be serious. Estimated carrying capacity 1:25 ac (1:10 ha).

Area G Open grassland extends over approximately 625 mi^2 (161 000 ha) immediately north of the south-western arm of the Makarikari Pan. Near Gweta there are herds of cattle which are watered at wells and at seasonal pools, but elsewhere lack of potable water is the most serious obstacle to the introduction of cattle. Mineral deficiencies are probably serious: carrying capacity is estimated to be 1:25 ac (1:10 ha).

Area H Although this is the southerly continuation of Area G, a large part of the grassland has been reduced to a sparse cover of the rhizomatous grass

BOTSWANA

NORTHERN STATE LANDS

SCALE

Miles 10 0 10 20 30 40 50 60 70 80 90 100 Miles

REFERENCE

MAIN ROADS

SECONDARY ROADS

TRACKS

RAILWAYS

INTERNATIONAL BOUNDARIES

RECOMMENDED LAND USE

Areas to be protected for the conservation of Game.

	Areas suitable for Ranching	Carrying capacity acres per animal unit	Area sq. miles
A	Good potential† Mineral deficiencies	20	234
B	Moderate potential	25	280
C	Moderate potential	30	340
D	Poor - moderate potential:	30	700
E	water may limit development	40	230
F	Moderate potential: Mineral	25	80
G	deficiencies: water probably not available	25	625
H	Immediate Destocking: after recovery period moderate potential: mineral deficiencies: water probably not available	30	650
I	Low potential: *Dichapetalum*	50	970
J	*cymosum* occurs frequently on the ridges (dunes)	50	190

Predominantly sourveld north of this line

Black clay soils (vertisols)

† potential refers to herbage production

Main Chobe Forest
Serondella
Kasane
Kasungula
Lesuma
Kavimba
Kachikau
Linyote or Chobe Enclave
Goha Hills
CHOBE GAME RESERVE
MABABE FLATS
Ngwezumba River
Nata
Pandamatenga
SOUTHERN RHODESIA
Tsotsorogo
Shinamba Hills
Dodo
MABABE DEPRESSION
Kwai
Kuke
Kumane
Jovelega
MOREMI GAME RESERVE
Magwaa
Rakuku
Thamalakane River
NORTHERN STATE LANDS
MAUN
Bushman Pitsane
Odiakwe
TRIBAL AREA
Gweta
Boteti River
Makalanabadi
Dinokwane Hills
MAKARIKARI
NTWETWE PAN
SUA PAN
Rakops
Lake Dow
Redia Hill
Lothlakane
Nata
Motongwe River
Maitengwe
Tutume River
Bushmen Mine
Tutume
Dukwe
Mosetse
Plumtree
Ramaquabane
Tsessebe
Sebina
FRANCISTOWN
TATI CONCESSION
Tati River
Tonota

24° East of Greenwich 25° 26° 27°

18°S 19° 20° 21°

D.O.S. (Misc) 449g

Drawn and photographed by the Directorate of Overseas Surveys, 1967

This map accompanies a report entitled 'A Land Use Survey of the Northern State Lands, Botswana' by the Land Resources Division, Directorate of Overseas Surveys, 1967

Odyssea paucinervis. Occasional plants of other grasses suggest that the cover was once more varied and that the deterioration is probably due to overgrazing. Wildebeest are common but less numerous than formerly.

There are frequent outbreaks of foot-and-mouth disease and the herds of cattle which are kept in the area involve the Veterinary Department in a heavy programme of disease control measures. In this area the presence of both cattle and game is clearly unsatisfactory, but no effective utilisation of the area by either cattle or game is possible until the vegetation has recovered from overgrazing.

After a recovery period, provided that adequate quantities of potable water could be supplied, this area of more than 650 mi^2 (167 000 ha) could be developed as a ranching unit, with if necessary the elimination of the game. If enough water cannot be found, and this seems most likely (the existing herds are watered at shallow wells), then the area could be reserved for game with the introduction of some form of game cropping.

Area I In this area of 970 mi^2 (249 000 ha) of shrub savanna there are alternating belts of fairly dense woody vegetation and more open scattered shrub savanna. The carrying capacity varies according to the density of the shrub cover but is relatively low because of the necessity to include regular burning and is estimated at 1:50 ac (1:20 ha). At this stocking rate the cost of providing water may be a serious obstacle to development.

Area J Shrub savanna occupies 190 mi^2 (44 500 ha). The carrying capacity is estimated at between 1:40 ac (1:16 ha) and 1:50 ac (1:20 ha). The isolation and size of this area and the cost of providing water appear to be major difficulties affecting any development.

The members of the team are aware that others have recommended the development of some of these areas; we do not however believe that sufficient attention has been given to the various factors affecting development. In some cases a safe level of stocking will preclude economic success and in others lack of water will prevent development.

POSSIBLE FORMS OF DEVELOPMENT

A number of different methods of developing the more promising areas of the State Lands have been suggested; the alternatives which are not mutually exclusive are:

1. Leasing of very extensive areas to one of the international meat packing companies who would develop large ranches.

2. Development of large ranches run by individual farmers.

3. Formation of smaller ranches run by African farmers either individually or as a co-operative venture in which a number of separate ranches would be managed as a single unit.

4. Development of holding grounds.

The first of the alternatives has the advantage of developing a large area and provides the maximum opportunity for manipulating the movement of stock according to seasonal variations in the availability of forage.

1 and 2. Extensive and Large Ranches

In the case of the development of large (30 000 - 70 000 ac or 12 100 - 28 300 ha) individually owned ranches, we recommend that suitable areas are leased at nominal rents for a period of five years. During this period the occupant would have to undertake certain clearly specified capital development (boreholes, crushes and fencing); in addition he would be required to conform to a laid-down policy of management. There would have to be competent supervision to ensure compliance with the rules relating to stock limitation and good husbandry practices. Excellent safeguards have been introduced into the terms relating to the sale of land elsewhere but they have not always been enforced. At the end of the five-year period the rent would be assessed, taking into account the improvements to the property and the carrying capacity; and during a second period of fifteen years the tenant should be allowed the option of acquiring the freehold of the property at an agreed valuation.

The terms of the leases must be favourable to sound development, and the taxation policy conducive to the 'ploughing back' of profits. New Zealand and Australia are examples of countries with income tax laws which allow generous concessions on profits which are ploughed back into livestock production; in contrast the taxes of recent years levied on the meat industry in the Argentine and Uruguay have prevented sound livestock development in these countries (McMahon 1966). We would draw attention to a recommendation made by Wedderspoon (1964) in connection with comparable economic problems in Swaziland: 'Capital expenditure on farming may be set off against income in the year in which it is incurred subject to a maximum related turnover. Write-off over five years, with the removal of the turnover limited is recommended'. In recognition of the hardship and inconvenience of residence in isolated areas, consideration should be given to the possibility of introducing residential allowances on personal income tax similar to the concessions enjoyed by persons resident in Northern Territory, Australia.

3. Small Ranches

Running small ranches individually or on a group basis is being currently investigated on part of the fenced area at Nata by the Agricultural Economist of the Agricultural Department with financial assistance from the Oxford Committee for Famine Relief. Participants in schemes of this type are unlikely to be able to provide the capital required and it would be necessary for the Government or a government sponsored agency to make loans available. Hutchison (1965) in a theoretical consideration of the economics of ranching in Tanzania, suggests that even when ranching is a community development without capital charges for cattle and land and without direct charges for herding, the profit margin is likely to be small unless the carrying capacity and productivity can be increased and this will involve extra capital investment and supervisory skill.

In addition to the provision of capital regular supervision and direction in the day-to-day running of the ranches would be essential. Participants must be prepared to accept the discipline and direction which are necessary. In addition there are other sociological problems, particularly the absence of education and medical facilities in isolated areas.

Sufficient attention does not appear to have been given to realistic costings of livestock production. 'Free' water, unpaid herdsmen, subsidised

veterinary treatment, and free communal grazing together conceal the true cost of production: costs which would have to be carried by any enterprise. Appendix 3 indicates some of the costs involved in organised large scale ranching.

4. Holding Grounds

Holding grounds would be similar to the six which are planned by the Department of Agriculture for the tribal reserves. These holding grounds should bring financial benefit to the African farmer who lacks opportunity to fatten his stock and who consequently fails to obtain the higher prices paid for the heavier weights and better grades. Draught animals would also be brought to the centres during the dry season and kept in condition, in readiness for ploughing; the holding grounds would also be used to give stock owners instruction in animal husbandry and this could be their most valuable function. It is intended that the recurrent costs of the holding grounds should be covered by the fees (agistment) charged for grazing and supplementary feeding. The success of this excellent scheme will depend on the standard of management of each holding ground, (particularly important is the early recognition and disposal of unthrifty animals) and on the charges being realistically related to the cost of providing the facilities. At the present time large numbers of breeding stock also require alternative grazing while the denuded areas of Eastern Botswana are allowed to recover; holding grounds in the Northern State Lands could provide some of the grazing required for this purpose.

Choice of Methods

The Botswana Government has to make the choice between these possibilities, but the development of land of low carrying capacity imposes a limitation on the return which can be expected from the invested capital, and careful attention will have to be given to the economic viability of both public and private schemes. There must be adequate profit margins without resort to periods of overstocking and exploitation. The opening up of the State Lands should not be considered an immediate source of revenue either from freehold sales or from leases. Unless there is confidence in the political stability of the country, and this will be affected by developments in neighbouring states, there will be a reluctance on the part of the company or the private investor for long-term projects.

GAME IN THE NORTHERN STATE LANDS

DEVELOPMENT FOR GAME

Many of the general recommendations for additonal activities of an expanded Game Department are of special significance in the Northern State Lands which already has a large Game Reserve and concessions for safari hunting.

The recommendation relating to the protection of game in certain areas is based on the knowledge of one member of the team but is endorsed by the others. It is recommended that there should be three new areas where shooting would be prohibited; the second and third of these are at present within hunting concessions. (See map: 'Recommended Land Use'.)

New Protected Areas

Area 1 The largest of these areas is the Nyaia Pan which affords exceptional opportunities for viewing large numbers of game animals in open parkland. The protected area around the Nyaia Pan should extend in the west to the Panda-ma-Tenga Road to the line of longitude 25°00′ east and from 19°45′ south to latitude 20°00′ south (an alternative southern boundary could be the old Francistown-Maun road). The preservation of game in this area also requires the provision of a wide corridor to allow access to the Botletle River. However the presence of such a corridor may seriously interfere with the eastward movement of trade cattle from Makalamabedi Quarantine Camp and may not be acceptable, in which case the provision of several watering points on the Nyaia Pan should be considered.

Area 2 A corridor ten miles wide between the south-west corner of the Chobe Reserve and the Moremi Wild Life Reserve to allow the movement of game between these two reserves.

Area 3 An area of ten miles by ten miles extending into Kakulwane plain from the eastern boundary of the Chobe Game Reserve; this is one of the few areas where oribi occur.

Other Measures

The western part of the Masubia enclave includes the type of habitat required by lechwe, sitatunga and reedbuck; and for the sake of these three species hunting in this area is to be discouraged. The map 'Current Land Use' shows the new (1967) boundary of the Chobe Game Reserve.

Hunting concessions should not be renewed in areas of potential value for ranching; this affects the concession south of Kanyu. Authorised parties should continue to hunt in the southern part of the Northern State Lands.

Every effort must be made to develop the tourist industry, so that financial returns can be obtained similar to those reaped by many other countries which have developed natural attractions. Botswana cannot afford to neglect this opportunity. Ideally, there should be roads and the provision of accommodation which will enable the visitor to go further afield, to extend his stay and possibly to undertake a tour of several days' duration. It has been suggested that many visitors to the Chobe Reserve would welcome the opportunity of visiting the Moremi Reserve on the eastern edge of the Okavango Swamps, and of seeing an area of open grassland such as the Nyaia Pan provided that this could be undertaken easily. The provision of the necessary amenities would not necessarily involve the expenditure of large sums of public money: elaborate roads are not required, provided that the routes chosen avoid stretches of loose sand and that there is adequate sign-posting and speed control. At certain of the overnight stopping points only simple facilities would be called for. The provision of camps with rondavels with cooking facilities could be a Government activity, while the provision of meals and more elaborate accommodation could be a commercial undertaking, in which case the terms of the lease should ensure that the Government retained effective control. Alternatively, Government-built camps could be leased to commercial caterers, but this would depend on the availability of capital.

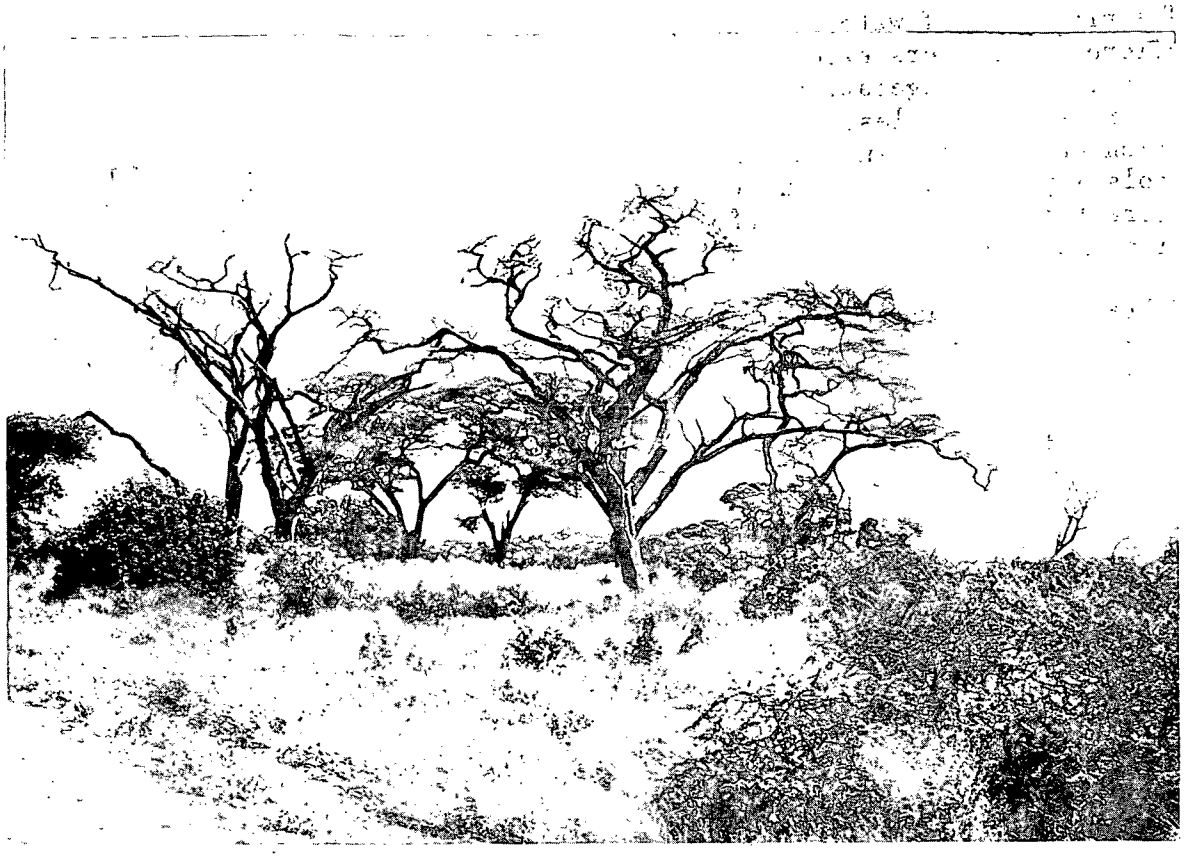


PLATE 11 *Acacia giraffae* ring-barked by elephants : near the Chobe River

PLATE 12 *Lonchocarpus capassa* and *Acacia tortilis* damaged by giraffe : eastern edge of the Mababe Depression

The provision of water at certain points within a reserve is a means of affording visitors exceptional opportunities for seeing game. It is inevitable that the vegetation for some distance from the waters' edge will be destroyed, and unless resources are sufficient to provide a series of pools which can be used in a planned rotation, the destruction around one or two pools may become so extensive that it diminishes rather than enhances the attraction of the area. If pools are developed it has to be in conjunction with the road network.

While most of the tourists visiting Botswana have to stay on the few miles of road which is used by through traffic flagrantly ignoring speed limits, there is little likelihood of any appreciable increase in income from tourism; if an alternative route to the main road through the Chobe Reserve cannot be justified (and this seems unlikely at least by an early date) then some form of restriction should be placed on road users not paying admission to the Reserve.

Another source of income could be a popular version of the safari tour allowing the visitor of modest means to secure one or two of the more abundant trophy species.

There is evidence of excessive animal populations in several areas (Plates 11 and 12) including the northern zone of the Game Reserve along the Chobe River, the eastern fringe of the Mababe Depression and the Nyaia Pan; in all of these areas a reduction in animal numbers is a matter of urgency. It would be an advantage if the culling could be combined with an experimental programme designed to investigate problems of curing, processing and marketing of game products. Financial assistance for this would probably be available from outside organisations or voluntary agencies.

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APPENDIXES 1 - 4

APPENDIX 1. CHEMICAL ANALYSES OF HERBAGE SAMPLES

DISCUSSION

The development and utilisation of an area for livestock production depends on a number of factors, the most important of which are adequate supplies of water and food. Although cattle will supplement their diet by browsing the leaves and young shoots of certain trees and shrubs they are primarily dependent on the herbage for their food requirements. The herbage must meet the animals' requirements in terms of digestible nutrients throughout the year.

When the cover is sparse the animal must spend a disproportionate amount of energy in grazing. In the higher rainfall zone of the Northern State Lands there is often an abundance of fodder, but because of its low nutritive value the animals are unable to obtain from it the food necessary for their maintenance.

Fortunately in many areas of the country the grasses are still comparatively nutritious at the end of the rains when they 'cure', remaining on the ground in the dry season as standing hay; their feeding value is lowered by both a prolonged wet season and by showers. This herbage is frequently deficient in phosphorus which can however, be supplied in supplements such as bonemeal; many of the leaves of the browse species are also a valuable source of this mineral. In certain areas of the Northern State Lands browse plants are absent and mineral deficiencies in the herbage must impose severe limitations on livestock production, unless they are rectified.

In addition to a deficiency of phosphorus, there may be a deficiency of other elements including copper and cobalt in pastures growing on the calcareous alkaline soils which occur around the Makarikari Depression.

It is difficult to define the level at which an element may be described as deficient. The level at which an element becomes deficient is affected by the level of other elements and by the class of stock. In the case of phosphorus the level at which it becomes deficient is affected by the ratio between this element and calcium. A phosphorus level of 0.15% is sufficient for the bare maintenance of mature animals.

Naik (1965) has suggested the following standards for phosphorus, copper and cobalt in herbage:

	Deficient below	Doubtful
Phosphorus	0.10%	0.10 -0.20%
Copper	5 ppm	5 - 8 ppm
Cobalt	0.06 ppm	0.06 - 0.09 ppm

The analyses in Table 1 are discussed on the basis of these probably modest standards.

In relation to the other samples, samples 1 and 2 from Panda-ma-Tenga have high levels of phosphorus and iron but very low levels of sodium. The sodium: potassium ratios are extremely wide. The level of crude protein in these samples is low and could be expected to fall still lower after seeding.

TABLE 1. Chemical analyses of herbage samples

Sample	Yield d.m. lb/ac (kg/ha)	Digest. % **	Sol. carb. %	Crude protein % ⁄	Ash %	Crude fibre %	P %	K %	Ca %	Na %	Mg %	Cu ppm	Co ppm	Mn ppm	Fe ppm
1*	766(859)	60.6	7.7	4.75	10.2	34.8	0.20	1.40	0.34	0.008	0.13	5.5	0.18	22	212
2	695(779)	48.5	5.0	5.25	9.58	36.9	0.20	0.72	0.24	0.004	0.12	4.1	0.14	26	305
3	1 583(1 775)	54.5	3.1	6.25	14.4	36.5	0.05	2.26	0.27	0.11	0.13	2.0	0.03	18	78
4	520(584)	52.7	4.2	7.25	10.2	37.4	0.05	2.26	0.45	0.02	0.32	6.2	0.10	24	82
5	396(444)	58.0	1.8	8.00	8.00	39.6	0.07	1.99	0.30	0.01	0.16	4.4	0.25	28	66
6	695(779)	54.4	5.1	6.38	9.23	38.9	0.06	2.82	0.29	0.01	0.26	5.0	0.06	29	72
7		49.2	5.4	4.50	10.6	37.6	-	-	-	-	-	-	-	-	-
8		45.4	4.9	4.50	7.38	41.6	-	-	-	-	-	-	-	-	-
9		46.3	5.0	4.50	7.42	41.2	-	-	-	-	-	-	-	-	-
10		50.8	4.7	5.88	11.0	37.4	-	-	-	-	-	-	-	-	-
11		46.1	3.4	9.88	12.5	32.2	-	-	-	0.43	-	-	-	-	-

Description

*1. Open 'sourveld' grassland with scattered shrubs and low trees mainly *Combretum imberbe, C. hereroense,* and *Piliostigma thonningii;* grasses incl. *Andropogon gayanus* var. *squamulatus, Setaria sphacelata, Ischaemum brachyatherum;* heavy black clay at Panda-ma-Tenga, 18.3.66.

2. Occasional trees *Combretum imberbe, Colophospermum mopane, Baikiaea plurijuga* and *Sclerocarya caffra;* frequent low shrubs incl. *Grewia* spp. *Combretum hereroense, Commiphora* sp. and *Rhus* sp.; grasses incl. *Schmidtia bulbosa, Heteropogon contortus, Andropogon gayanus, A. schinzii, Loudetia simplex;* stony basalt ridge at Panda-ma-Tenga, 18.3.66.

3. Open grassland with *Cenchrus ciliaris, Panicum coloratum, Schmidtia bulbosa, Eragrostis stapfii;* 31 miles east of Odiakwe. Adjoins northern arm of Makarikari Pan, 23.2.66.

4. Fairly open with widely scattered low shrubs mainly *Terminalia sericea* and *Combretum* spp.; grasses incl. *Digitaria eriantha, Schmidtia bulbosa, Urochloa* sp. *Anthephora pubescens;* 17 miles west of Odiakwe, 7.3.66.

5. Scattered low shrubs *Combretum hereroense* and *C. imberbe;* grasses incl. *Schmidtia bulbosa, Aristida uniplumis, Urochloa trichopus* and *Panicum* sp.; Nata Ranch, Paddock M4, 1.3.66.

6. Frequent trees and shrubs incl. *Acacia giraffae, Terminalia sericea, Grewia flava, Combretum imberbe* and *Bauhinia macrantha.* Grasses incl. *Urochloa trichopus, Dactyloctenium giganteum, Eragrostis rigidior, Schmidtia bulbosa;* 5 miles east of Odiakwe, 2.3.66.

7. *Aristida scabrivalvis;* Nata area, 16.4.66.

8. *Aristida uniplumis;* " " " " "

9. *Eragrostis lehmanniana;* " " " " "

10. *Urochloa trichopus;* near Rakops, 8.4.66.

11. *Odyssea paucinervis;* " " " "

* Soil profiles 1-6 correspond to herbage samples 1-6.

** digestibility *in vitro.*

⁄ N x 6.25.

Sample 3 gave an exceptional high yield of dry matter (1 583 lb per ac or 1 775 kg per ha) but is seriously deficient in copper and cobalt as well as phosphate; these deficiencies would account for the reported poor performance of livestock on this type of grassland unless they have access to other types of vegetation. These deficiencies could be remedied by supplying suitable mineral supplements.

Samples 4, 5 and 6 are all seriously deficient in phosphorus and have wide phosphorus:calcium ratios. The level of copper in these samples is also low. Although these samples represent a better type of savanna in which animals will obtain additional food from browse species it is essential to supply phosphorus and the value of this supplement would probably be enhanced by the addition of copper. The recommended practice is to mix together bonemeal and salt in equal proportions and this would ensure an adequate intake of sodium which is also needed. Sample 4 is from an area which had been burnt during the previous dry season and this has depressed the yield of dry matter. The higher level of crude protein in sample 5 is related to the lower yield of dry matter and may be the result of earlier grazing.

The crude protein level of the individual grasses was the same in samples 7, 8 and 9, three grasses of similar appearance all being stemmy with narrow leaves; the level of crude protein was better in the more leafy *Urochloa* (Sample 10) and this grass is eagerly sought by stock. The exceptionally high crude protein content of *Odyssea* (Sample 11) can be correlated with the sparse aerial growth arising from an extensive rhizomatous network; in the absence of competition from other vegetation it can draw on the total available nitrogen in the soil. This grass also has an exceptionally high level of sodium and crystals of sodium chloride are formed on the leaves.

APPENDIX 2. SOIL ANALYSIS

PROFILES

The distribution of profiles in relation to the units proposed for the provisional soil map is as follows:

Soil Type	Profile
Shallow lithosolic soils derived from basalt	2
Juvenile soils on recent deposits	
(a) riverine alluvial soils	11
(b) lacustrine alluvial soils	4, 5, 8
Vertisols	1
Sub-desert sands	6
Ferruginous tropical sandy soils on deep sandy parent material	9, 10
Halomorphic soils	
(b) with sub-desert sands on lacustrine deposits	3, 7

The profiles 1-6 correspond with the herbage samples 1-6

METHODS OF ANALYSIS

Preparation of Sample

The soil taken from the field is air-dried and hand-ground to pass a 2 mm screen. A subsample is ground in a Morrice mechanical pestle and mortar (agate) to pass a 0.5 mm sieve. The 2 mm sample is used for all determinations except carbon, nitrogen and calcium carbonate equivalent which are made on the 0.5 mm sample.

Mechanical Analysis

The sample is dispersed using sodium hexametaphosphate (Calgon) and sodium hypochlorite. Calcium carbonate is not dissolved. Coarse sand (200μ-2 mm) is retained on a suitable sieve; the fractions <2μ, 2-20μ and 20-50μ are obtained by sedimentation analysis using an hydrometer, (Bouyoucos, 1951). the 50-200μ fraction is calculated by difference, after making allowance for The organic matter present. The fractions separated are:

coarse sand	200μ-2 mm	
fine sand	50μ-200μ	U.S. Soils Bureau silt
	20μ-50μ	
silt	2μ-20μ	
clay	<2μ	

Loss on Ignition

This value is determined using a muffle furnace maintained at 850°C and is corrected for the decomposition of calcium carbonate when this is present.

Calcium Carbonate Equivalent

A calcimeter (Bascomb, 1961) is used to measure the volume of carbon dioxide evolved from the sample on treatment with 1:3 hydrochloric acid. This is calculated to the equivalent amount of calcium carbonate irrespective of whether other carbonates contribute.

Total Nitrogen

A Kjeldahl digestion is followed by steam distillation of an aliquot using a Hoskins apparatus; the distillate is absorbed in boric acid and titrated with 0.01N hydrochloric acid.

pH Measurements

These are made electrometrically in a 1:2.5 suspension of soil (a) in water and (b) in 0.01M calcium chloride (Schofield and Taylor, 1955).

Exchangeable Bases

The soil is leached with neutral normal ammonium acetate. Sodium and potassium in the leachate are determined directly using an EEL flame photometer, while calcium is determined in the same apparatus after the addition of magnesium as release agent (Row, 1963). Magnesium is determined spectrographically using a porous cup technique (Scott and Ure, 1958).

Soluble Salts

These are determined by conductivity measurement on a 1:5 water extract. The results are recalculated in terms of milliequivalents per 100g soil.

Phosphorus

Phosphorus is determined either as ppm phosphorus soluble in 0.5M sodium bicarbonate (Olsen *et al*, 1954) on calcareous soils or as ppm phosphorus soluble in 0.1N sodium hydroxide.

Copper and Cobalt

20g of soil is leached with 2.5% acetic acid (800 ml) and copper and cobalt are determined in the leachate.

PROFILE 1

This soil is found in one of the many depression sites at the Panda-ma-Tenga ranch near the Rhodesian border. The pit in the black clay soil filled with water at 24 in (61 cm).

Horizon	Depth in (cm)	Description
1	0-24 (0-61)	5 Y 4/1 (moist) black plastic; occasional roots

Analysis

Characteristic	Horizon 1
Mechanical analysis	
200μ-2 mm %	n.d.*
50μ-200μ %	n.d.
20μ-50μ %	n.d.
2μ-20μ %	n.d.
<2μ %	n.d.
$CaCO_3$ equivalent %	5.3
Loss on ignition %	7.0
Total N %	0.04
pH in water	8.0
pH in 0.01M $CaCl_2$	7.2
Exch. K meq %	1.56
Exch. Na meq %	0.79
Soluble salts meq %	0.87
P ppm (sol. in 0.5M $NaHCO_3$)	0.75
Cu ppm	0.12
Co ppm	0.65

* Not determined. The mechanical analysis of a soil in the same area is reported by Bawden (1965) as follows:

Horizon	0.6 in (0-15 cm)	6-20 in (15-51 cm)
Coarse sand %	8	3
Fine sand %	0	11
American silt %	21	16
Clay %	66	64

Comment

The nitrogen content of this soil is very low; the potassium content is very high while the phosphorus content is low. Because of the physical character, cultivation presents great difficulties even if the nutrient status can be rectified with fertilisers.

PROFILE 2

This soil occurs on the ridges between the depression sites represented by Profile 1. The depth of soil is less than 11 in (28 cm).

Horizon	Depth in (cm)	Description
1	0-10 (0-25)	5 YR 3/4 (moist) reddish brown loam; rock fragments abundant; roots frequent

Analysis

Characteristic	Horizon 1
Mechanical analysis	
200μ-2 mm %	42
50μ-200μ %	-
20μ-50μ %	31
2μ-20μ %	14
<2μ %	11
$CaCO_3$ equivalent %	Trace
Loss on ignition %	3.3
Total N %	0.05
pH in water	6.8
pH in 0.01M $CaCl_2$	5.8
Exch. K meq %	0.62
Exch. Na meq %	0.15
Soluble salts meq %	0.21
P ppm (sol. in 0.1N NaOH)	<0.2
Cu ppm	1.0
Co ppm	2.3

Comment

Nitrogen and phosphorus are both very low; the level of potassium is moderate.

PROFILE 3

This soil is from the treeless grassland adjacent to the northern arm of the Ntwetwe Pan, (Makarikari) and 31 mi (50 km) east of Odiakwe. At a depth of 18 in (46 cm) there are many large fragments of calcrete.

Horizon	Depth in (cm)	Description
1	0-18 (0-46)	7.5 YR 4/2 (moist); A brown or dark brown sandy soil; roots common in top 6 in (15 cm)
2	18-24 (46-61)	Many large fragments of calcrete

Analysis

Characteristic	Horizon 1	Horizon 2
Mechanical analysis		
200μ-2 mm %	38	22
50μ-200μ %	52	42
20μ-50μ %	2	4
2μ-20μ %	1	14
<2μ %	7	18
$CaCO_3$ equivalent %	Trace	39.1
Loss on ignition %	1.1	0.6
Total N %	0.03	0.03
pH in water	7.5	8.5
pH in 0.01M $CaCl_2$	6.7	7.6
Exch. K meq %	0.29	0.57
Exch. Na meq %	0.09	0.13
Soluble salts meq %	0.14	0.63
P ppm (sol. in 0.5M $NaHCO_3$)	0.72	1.18
Cu ppm	<0.1	-
Co ppm	0.14	-

Comment

This soil is poorly supplied with nitrogen, phosphorus and potassium and in addition the levels of copper and cobalt are also very low.

PROFILE 4

Site 17 mi (27 km) west of Odiakwe.

Horizon	Depth in (cm)	Description
1	0-36 (0-91)	2.5 YR 5/2 (moist) dark greyish brown sandy soil; very uniform in colour and texture apart from some roots in the first 9 inches (23 cm)

Analysis

Characteristic	Horizon 1
Mechanical analysis	
200μ-2 mm %	47
50μ-200μ %	43
20μ-50μ %	2
2μ-20μ %	1
<2μ %	7
$CaCO_3$ equivalent %	-
Loss on ignition %	0.9
Total N %	0.02
pH in water	7.5
pH in 0.01M $CaCl_2$	6.8
Exch. K meq %	0.21
Exch. Na meq %	0.07
Soluble salts meq %	0.16
P ppm (sol. in 0.1N NaOH)	0.2
Cu ppm	<0.1
Co ppm	0.12

Comment

This soil and that of profile 6 are low in cobalt and very low in nitrogen, phosphorus, potassium and copper.

PROFILE 5

Site within the fenced camp M4 on the Nata Ranch.

Horizon	Depth in (cm)	Description
1	0-6 (0-15)	Roots common
2	6-36 (15-91)	Very small fragments of calcrete

Analysis

Characteristic	Horizon 1	Horizon 2
Mechanical analysis		
200μ-2 mm %	41	32
50μ-200μ %	33	46
20μ-50μ %	8	6
2μ-20μ %	8	7
<2μ %	8	8
$CaCO_3$ equivalent %	7.8	13.2
Loss on ignition %	3.0	1.6
Total N %	0.12	0.05
pH in water	8.2	9.2
pH in 0.01M $CaCl_2$	7.4	7.9
Exch. K meq %	0.69	1.41
Exch. Na meq %	0.54	7.34
Soluble salts meq %	0.58	1.41
P ppm (sol. in 0.5M $NaHCO_3$)	1.65	0.75
Cu ppm	<0.1	-
Co ppm	0.22	-

Comment

The soil is very low in copper, and low in cobalt; the subsurface pH and sodium level are probably unfavourable.

PROFILE 6

Site, 5 mi (8 km) east of Odiakwe. Frequent low trees and shrubs.

Horizon	Depth in (cm)	Description
1	0-3 (0-8)	7.5 YR 5/2 (moist) a brown sandy soil; occasional roots
2	3-24 (8-61)	7.5 YR 5/2 (moist) a brown sandy soil

Analysis

Characteristic	Horizon 1	Horizon 2
Mechanical analysis		
200μ-2 mm %	44	47
50μ-200μ %	46	43
20μ-50μ %	1	2
2μ-20μ %	2	1
<2μ %	6	7
$CaCO_3$ equivalent %	-	-
Loss on ignition %	1.1	1.1
Total N %	0.04	0.02
pH in water	6.7	7.1
pH in 0.01M $CaCl_2$	5.6	6.2
Exch. K meq %	0.25	0.19
Exch. Na meq %	0.14	0.11
Soluble salts meq %	0.10	0.14
P ppm (sol. in 0.1N NaOH)	<0.2	<0.2
Cu ppm	<0.1	-
Co ppm	0.16	-

Comment

This soil and that of profile 4 are low in cobalt and very low in nitrogen, phosphorus, potassium and copper.

PROFILE 7

This represents the soil on the sand ridge immediately north of the fenced area of the Nata Ranch.

Horizon	Depth in (cm)	Description
1	0-15 (0-38)	10 YR 4/2 dark greyish brown sandy soil; roots common
2	15-48 (38-122)	10 YR 6/3 pale brown sandy soil

Analysis

Characteristic	Horizon 1	Horizon 2
Mechanical analysis		
200μ-2 mm %	57	58
50μ-200μ %	38	37
20μ-50μ %	2	1
2μ-20μ %	1	2
<2μ %	2	2
$CaCO_3$ equivalent %	-	-
Loss on ignition %	0.6	0.2
Total N %	0.02	0.04
pH in water	6.2	6.5
pH in 0.01M $CaCl_2$	5.0	5.7
Exch. K meq %	0.07	0.03
Exch. Na meq %	0.08	0.02
Soluble salts meq %	0.01	0.01
P ppm (sol. in 0.1N NaOH)	<0.2	<0.2
Cu ppm	<0.1	-
Co ppm	0.04	-

Comment

A poor soil low in all nutrients.

PROFILE 8

This is the soil of the central Mababe Depression. The surface showed considerable cracking. It was difficult to penetrate the dry soil.

Horizon	Depth in (cm)	Description
1	0-12 (0-30)	Both horizons: 7.5 YR 3/0 (moist) dark grey clay; roots *(Sorghum verticilliflorum)* present
2	12-24 (30-61)	Very little indication of a separate horizon; at 22 in (56 cm) tiny white flecks of calcium

Analysis

Characteristic	Horizon 1	Horizon 2
Mechanical analysis		
200μ-2 mm %	2	2
50μ-200μ %	8	5
20μ-50μ %	2	2
2μ-20μ %	16	13
<2μ %	71	76
$CaCO_3$ equivalent %	3.1	Trace
Loss on ignition %	8.4	9.6
Total N %	0.09	0.10
pH in water	7.9	7.2
pH in 0.01M $CaCl_2$	7.2	6.5
Exch. K meq %	1.29	1.73
Exch. Na meq %	0.46	0.31
Soluble salts meq %	0.81	0.67
P ppm (sol. in 0.5M $NaHCO_3$)	2.88	3.09
Cu ppm	<0.1	-
Co ppm	0.23	-

Comment

This soil is very poorly supplied with nitrogen but has a high potassium content. Its physical properties would make cultivation difficult.

PROFILE 9

Profiles 9 and 10 are a few hundred yards apart approximately 103 mi (166 km) north of Nata and 34 mi (55 km) south of the Duru Cross Roads. Profile 9 represents the soil of a well wooded deep sand ridge and Profile 10 is a depression site between successive ridges.

Horizon	Depth in (cm)	Description
1	0-6 (0-15)	10 YR 5/1 (moist) grey sandy soil with many fragments of charcoal
2	6-30 (15-76)	10 YR 5/3 (moist) brown sandy soil

Analysis

Characteristic	Horizon 1	Horizon 2
Mechanical analysis		
200μ-2 mm %	72	70
50μ-200μ %	19	25
20μ-50μ %	1	1
2μ-20μ %	2	2
<2μ %	3	2
$CaCO_3$ equivalent %	-	-
Loss on ignition %	3.2	0.6
Total N %	0.07	0.01
pH in water	4.5	5.4
pH in 0.01M $CaCl_2$	3.8	4.2
Exch. K meq %	0.06	0.03
Exch. Na meq %	0.07	0.04
Cation exch. capacity meq %	7.1	1.6
Soluble salts meq %	0.01	0.01
P ppm (sol. in 0.1N NaOH)	<0.2	0.2
Cu ppm	<0.1	-
Co ppm	0.20	-

Comment

This soil has a poor supply of nutrients. The analysis of profiles 9 and 10 differ mainly in pH level and are otherwise unexpectedly similar.

PROFILE 10

The site is described under Profile 9.

Horizon	Depth in (cm)	Description
1	0-18 (0-46)	10 YR 4/1 (moist) dark grey sandy soil; grass roots common in first 12 inches
2	18-36 (46-91)	10 YR 4/2 (moist) dark greyish brown sandy soil

Analysis

Characteristic	Horizon 1	Horizon 2
Mechanical analysis		
200μ-2 mm %	68	64
50μ-200μ %	19	18
20μ-50μ %	1	2
2μ-20μ %	3	3
<2μ %	8	13
$CaCO_3$ equivalent %	-	Trace
Loss on ignition %	1.3	1.4
Total N %	0.03	0.03
pH in water	6.7	7.1
pH in 0.01M $CaCl_2$	5.9	6.7
Exch. K meq %	0.22	0.23
Exch. Na meq %	0.07	0.04
Cation exch. capacity meq %	7.0	10.3
Soluble salts meq %	0.14	0.54
P ppm (sol. in 0.1N NaCH)	<0.2	<0.2
Cu ppm	<0.1	-
Co ppm	0.16	-

Comment

See the comment on Profile 9.

PROFILE 11

Site 8 mi (12.9) south-west of Kachikau; area subject to flooding from Chobe River. Soil was dry and very hard.

Horizon	Depth in (cm)	Description
1	0-20 (0-51)	10 YR 3/1 (moist) very dark grey soil; grass roots present in first 6 in (15 cm)
2	20-36 (51-91)	10 YR 3/1 (moist); this horizon contained small lenses of sand

Analysis

Characteristic	Horizon 1	Horizon 2
Mechanical analysis		
200μ-2 mm %	34	38
50μ-200μ %	29	24
20μ-50μ %	4	3
2μ-20μ %	14	13
<2μ %	19	22
$CaCO_3$ equivalent %	-	Trace
Loss on ignition %	2.1	1.6
Total N %	0.04	0.03
pH in water	7.1	6.8
pH in 0.01M $CaCl_2$	6.5	5.9
Exch. K meq %	0.20	0.19
Exch. Na meq %	0.05	0.06
Soluble salts meq %	0.31	0.14
P ppm (sol. in 0.1N NaOH)	<0.2	<0.2
Cu ppm	<0.1	-
Co ppm	0.14	-

Comment

This soil is poorly supplied with nutrients.

APPENDIX 3.

ECONOMICS OF LIVESTOCK PRODUCTION IN BOTSWANA

GENERAL

It is difficult to discover the real cost of livestock production in Botswana owing to various concealed subsidies which include free water, subsidised veterinary care, free communal grazing and unpaid herdsmen; part of the cost of veterinary care is met from levies which are raised at the abbatoir. These levies are in addition to the Botswana Meat Commission's handling charges and further complicate the costing of livestock production.

Although the accurate costing of livestock production is difficult, it must be attempted if there is to be any realistic assessment of the cost of and returns from organised livestock development in the Northern State Land or elsewhere in Botswana.

Four possible forms of development are considered in this appendix. The items common to each system are described and the estimates of their cost are explained.

Because of the low carrying capacity the provision of water is one of the more costly factors in livestock production. The significance of carrying capacity and the problem of providing water may be explained by referring to the Borehole Repayment Scheme. This scheme for undeveloped areas in tribal lands is intended to encourage the individual ownership of boreholes spaced at five-mile intervals. Each owner of a borehole accepts a stock limitation of 400 animal units* and has the exclusive rights to the grazing within 2.5 mi (4 km) of his borehole (12 500 ac or 5 058 ha). Clearly the acreage required to support a herd of 500 head (approximately 400 animal units) depends on the carrying capacity of the land which in the Northern State Lands varies from 20 ac (8.1 ha) to 50 acres (20.2 ha) or more per animal unit. The acreages to support a herd of 400 animal units are shown below.

Carrying capacity animal units: acres	Acreage for a herd of 400 animal units
1:20	8 000
1:22½	9 000
1:25	10 000
1:30	12 000
1:37½	15 000
1:40	16 000
1:50	20 000/

* The memorandum of the agreement for the Borehole Repayment Scheme used the term Animal Unit; it is assumed that this is the Standard Animal Unit which is defined as one mature beef cow with or without calf at side. In this report references to carrying capacity relate to this unit which is sometimes termed adult equivalent, e.g. yearlings (6-18 months) equal 0.6 animal units. The standard animal unit should not be confused with the Livestock Unit (F.A.O., 1956) in which system cattle equal 0.8 Livestock Units.

/ The radius of this area is 3.15 mi (5.06 km) and represents the approximate limit of the animals' walking ability which is commensurate with reasonable productivity. Mature stock would graze the more distant areas and be watered every second day, allowing cows and calves to graze nearer to the watering point. In this connection see the notes on the third form of development.

A small part (234 mi^2 or 607 km^2) of the Northern State Lands has a carrying capacity of 1:20 ac (1:8.1 ha) and a further area (985 mi^2 or 2 560 km^2) has a carrying capacity of 1:25 ac (1:10.1 ha); elsewhere the carrying capacity is poorer than this. It may not be possible to develop all the areas of better carrying capacity because the water is highly mineralised. For ease of calculation a carrying capacity of 1 animal unit : 25 ac (1:10.1 ha) has been assumed; a herd of 400 animal units would therefore require 10 000 ac (4 047 ha). The schemes described here (see Tables 1-4) are based on units of 10 000 acres. It should be clearly understood that this is not regarded as a unit of economical size and that the development of areas of lower carrying capacity would give appreciably poorer returns. It is however relatively easy to obtain multiples of 10 000 and it is for this reason that this figure has been adopted.

CAPITAL AND OCCASIONAL COSTS

Water Supply

The cost of providing water is based on the average costs of completed boreholes provided recently under the Borehole Repayment Scheme. The cost includes the charges for drilling and the installation of pump and engine; it is often necessary to case the hole and a water-storage tank is desirable. Costs of drilling and casing have recently been increased, but in that the cost of drilling unsuccessful or low-yielding boreholes is borne by Government there is still an element of subsidy.

The current charges are R3 per foot for drilling and R1.25 per foot for casing. The depth at which water is found will affect the cost of the completed borehole; the national average cost of drilling is R1 000. Drilling costs may be less than the National Average in some areas of the Northern State Lands.

The engine and pump cost R2 000, and although depreciation is not allowed in the analysis there is provision for their replacement during the period of twenty years.

Purchase of Cattle

In commercial development, foundation stock and trade cattle must be purchased at current prices, but in the case of development based on African farmers already owning cattle this expenditure can be disregarded (the defects in costing a scheme in this way are recognised). The recent serious losses of livestock may result in higher prices for breeding stock, but for the purpose of this analysis the following current costs have been used: cows and heifers R40; bulls R80; trade cattle R30. This last figure may be too low in view of the prices paid for weaners.

Fencing

The provision of fencing is essential for organised development and for control of grazing. Without fencing, a minimum of two herdsmen per hundred head of stock are required; with fencing one man is sufficient. The provision of fencing in the third scheme based on family labour, may be criticised but except where it is necessary to find useful employment as

TABLE 1 Scheme 1. A breeding herd (commercial development). Labour costed at R250 per year. Return per unit of 10 000 ac (4 047 ha)

Costs and returns	Year of operation																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capital and occasional costs																				
Borehole and pump	3 000							1 000							1 000					
Purchase of foundation stock, 150 females at R40, 5 males at R80	6 400																			
Purchase of trade cattle at R30	7 500	6 000	3 000																	
Construction of kraal and crush	200																			
Housing for herdsmen	400																			
Fencing 10 miles at R210/mile	2 100																			
Cleaning out borehole											250									
Annual Costs																				
Labour at R250	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Innoculations and supplements	800	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Pumping and maintenance	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Total costs	21 650	8 250	5 250	2 250	2 250	2 250	2 250	3 250	2 250	2 250	2 500	2 250	2 250	2 250	3 250	2 250	2 250	2 250	2 250	2 250
Revenue																				
Sale of good grade beef at R50					1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750	1 750
Sale of old stock at R40					1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Sale of trade cattle at R45		10 800	8 736	4 365																
Total revenue		10 800	8 736	4 365	2 750	2 750	2 750	2 750	2 750	2 750	2 750	2 750	2 750	2 750	2 750	2 750	2 750	2 750	2 750	2 750
Net gain or loss	-21 650	+2 550	+3 486	+2 115	+500	+500	+500	-500	+500	+500	+250	+500	+500	+500	-500	+500	+500	+500	+500	+500

If the project is terminated in the twentieth year the additional revenue in that year is : Sale of livestock 12 550

Value of improvements 2 500

R15 050

TABLE 2 Scheme 2. A flying herd (commercial development). Labour costed at R250 per year. Return per unit of 10 000 ac (4 047 ha)

Costs and returns	Year of operation																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capital and occasional costs																				
Borehole and pump	3 000							1 000							1 000					
Purchase of trade cattle at R30	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000	12 000
Construction of kraal and crush	200																			
Housing for herdsmen	400																			
Fencing 10 miles at R210/mile	2 100																			
Cleaning out borehole											250									
Annual costs																				
Labour 4 at R250	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Innoculations and supplements	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800
Pumping and maintenance	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Total costs	19 750	14 050	14 050	14 050	14 050	14 050	14 050	15 050	14 050	14 050	14 300	14 050	14 050	14 050	15 050	14 050	14 050	14 050	14 050	2 050
Revenue																				
Sale of trade cattle at R45	-	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550	17 550
Net gain or loss	-19 750	+3 500	+3 500	+3 500	+3 500	+3 500	+3 500	+3 500	+2 500	+3 500	+3 500	+3 250	+3 500	+3 500	+3 500	+2 500	+3 500	+3 500	+3 500	+3 500	+15 500

TABLE 3 Scheme 3. Breeding herd from which weaners are sold at 10-12 months (commercial development). Labour costed at R250 per year. Return per unit of 10 000 ac (4 047 ha)

Costs and returns	Year of operation																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capital and occasional costs																				
Borehole and pump, 2 at R300	6 000							2 000							2 000					
Purchase of foundation stock, 320 females at R40, 10 males at R80	13 600																			
Construction of kraal and crush	200																			
Housing for herdsmen	400																			
Fencing 10 miles at R210/mile	2 100																			
Cleaning out borehole											250									
Annual costs																				
Labour 4 at R250	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Innoculations and supplements 330 at R2, 192 at R1	852	852	852	852	852	852	852	852	852	852	852	852	852	852	852	852	852	852	852	852
Pumping and maintenance	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Total costs	24 402	2 102	2 102	2 102	2 102	2 102	2 102	4 102	2 102	2 102	2 352	2 102	2 102	2 102	4 102	2 102	2 102	2 102	2 102	2 102
Revenue																				
Sale of cull females at R40	-	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400
Sale of 93 male weaners at R20	-	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860	1 860
Sale of 51 female weaners at R20	-	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020	1 020
Total revenue	-	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280	4 280
Net gain or loss	-24 402	+2 178	+2 178	+2 178	+2 178	+2 178	+2 178	+178	+2 178	+2 178	+1 928	+2 178	+2 178	+2 178	+178	+2 178	+2 178	+2 178	+2 178	+2 178

If the project is terminated in the twentieth year the additional revenue in that year is : Sale of livestock 13 600

Value of improvements 2 500

16 100

TABLE 4 Scheme 4. A breeding herd (African owned) employing family labour. Return per unit of 10 000 ac (4 047 ha)

Costs and returns	Year of operation																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Capital and occasional costs																				
Borehole and pump	3 000							1 000							1 000					
Purchase of stock	-																			
Purchase of trade cattle	-																			
Construction of kraal and crush	200																			
Housing for herdsmen	-																			
Fencing 10 miles at R160/mile	1 600																			
Cleaning out borehole											250									
Annual costs																				
Labour 4 at R100	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Innoculations and supplements	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000	1 000
Pumping and maintenance	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Total costs	6 450	1 650	1 650	1 650	1 650	1 650	1 650	2 650	1 650	1 650	1 900	1 650	1 650	1 650	2 650	1 650	1 650	1 650	1 650	1 650
Revenue																				
Sale of good grade beef at R50	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500	1 500
Sale of old stock at R40	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200	1 200
Total revenue	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700	2 700
Net gain or loss	-3 750	+1 050	+1 050	+1 050	+1 050	+1 050	+1 050	+50	+1 050	+1 050	+800	+1 050	+ 1 050	+1 050	+50	+1 050	+1 050	+1 050	+1 050	+1 050

herdsmen for a large number of relatives it is considered to constitute a reasonable development cost. The proposed ten miles of fencing is only about half that required for 10 000 acres but is appropriate to this acreage when it forms part of a larger scheme. The cost of a five-strand fence is estimated at R210 per mile, but will vary according to the cost of labour and the relative cost of wooden posts and iron standards. Maintenance of fencing is assumed to be included in the annual cost of labour.

Construction of Kraal and Crush

Without a strong, well constructed crush it is impossible to inspect stock adequately; a kraal is also essential. The estimated cost of these items is R200.

Cleaning the Borehole

It will not be necessary to clean out every borehole but some may become clogged with silt after several years of operation and provision of R250 is allowed during a twenty-year period towards the cost of cleaning.

ANNUAL COSTS

Labour

It is difficult to determine the cost of labour. Members of a herd owner's family and herdsmen in isolated areas are often willing to work for R100 a year in the form of cash and rations, or even less. But in costing the labour charges for large-scale commercial development the national labour rates of R250 per year must be adopted. Although inexpensive labour may be available during the initial stages of development in some areas, additional employment opportunities will increase the cost of labour; skilled dependable workers will probably require an incentive to live in more isolated areas.

Innoculations and Supplements

This includes a contribution towards the cost of innoculations and veterinary care, the provision of simple medication and instruments and the provision of a salt-bonemeal supplement. The last item fed at 2 oz per head per day costs R0.8 (exclusive of the cost of transport) per head per year. It may also be desirable to provide other supplements and in a few areas it will be necessary to control ticks. An overall charge of R2 per head per year for all these items may be too low.

Pumping and Borehole Maintenance

The present cost of the somewhat inadequate borehole maintenance service is estimated at R107 per year. A better service might increase the cost to R244. In the light of this and after the cost of fuel and lubricants for pumping are included a combined charge for pumping and maintenance of R250 per year may be too low.

OTHER CHARGES

In addition to the items which have been enumerated there are other charges. In this analysis, there is no provision for payment of a rent or for the purchase of the freehold. There has been no attempt to estimate the cost of the skilled supervision essential for any form of development; this cost must include not only personal emoluments but also accommodation and transport. The most serious defect in the failure to allow for continuing improvement of the property without which the prospects for increasing the yields and obtaining greater profits are poor.

REVENUE

The revenue from the sale of stock for slaughter is assumed to be at three levels, the sale of an above-average grade of beef, the sale of old stock from the breeding herd and the sale of trade cattle, the net prices of these are assumed to be R50, R40 and R45 respectively. Before current handling charges and levies are deducted it is necessary (at the time of writing) to obtain R60, R48, and R54 per head respectively to obtain the above net prices. These prices should be attainable and payment by owners for veterinary services ought to result in a reduction in some of the levies. It is not the purpose of this analysis to assess long term trends in the price of beef. The relatively high price (R20) for 10-12 month-old weaners is based on the results of recent (1967) sales.

DEVELOPMENT

Scheme 1. Commercial Development with a Breeding Herd

A permanent breeding herd is in certain respects the soundest method of development; it allows up-grading and the production of high quality steers; disease control is facilitated. It has a high requirement of capital and gives a relatively poor return. During the initial years when the herd is still increasing trade cattle are bought in order to utilise the surplus grazing and to provide some income. The introduction of trade cattle is restricted to the first three years.

It is assumed in the calculations that the permanent herd has a calving rate of 60%, that the herd casualties are less than 3% and that the off-take of mature stock is 12% of the herd. While with good management it may be possible to obtain a better calving rate and a higher off-take, this level of off-take is considerably better than the national average in normal years.

Table 1 based on these calculations gives an indication of the expenditure and the revenue in each year of a twenty-year project.

If the project is terminated in the twentieth year there is a large cash flow from the sale of the herd and the realisation of the value of improvements to the property. Improvements may include selective clearing of woody plants, the eradication of harmful weeds and pasture improvement by sod seeding as well as the items which are included in the initial development costs. The value of these improvements is small, although it could have been greater if part of the profits had been devoted to further improvements.

Table 1 shows that apart from the final sale, a very large part of the profit in this scheme occurs in the initial period when trade cattle are bought and fattened. In Scheme 2 the development is based entirely on a herd of trade cattle.

Scheme 2. Commercial Development: Flying Herd of Trade Cattle

In this system there is no permanent breeding herd and it is assumed that there is a continuing supply of immature cattle at moderate prices. The farmer acts as a middleman between the breeder and the operator of the abbatoir. If however, the development of holding grounds makes it possible for African farmers to fatten their own stock, or if there is a large expansion in this type of ranching the price of immature animals will rise because of the increased demand and reduced supply, and the margin of profit will shrink accordingly. Although it is more profitable, the system can only have limited application. It requires skill in the selection of stock, in the control of disease, and in the early disposal of unthrifty animals. This system of fattening cattle reared elsewhere contributes to the national economy by the improvement in weight and grades which result, and the better prices that are obtained for the finished animal.

The expenditure and revenue for the scheme are shown in Table 2, and based on the same development and recurrent costs as shown in Table 1.

Scheme 3. Commercial Development. A Breeding Herd Selling Weaners at 10-12 Months

This system has been suggested because of the high prices which are being currently (1967) paid for weaners (R7.50 per 100 lb or 45.36 kg liveweight) when they are sold in the Barolong. The cost of transporting these animals is relatively low. It is based on a large breeding herd; this will require a greater degree of care and skill in management than in the other systems. Because lactating cows and calves must have daily access to water and cannot be expected to remain productive if they are required to walk more than two miles* to and from the watering point (ideally not more than a mile) a second borehole is included in the development costs. Because it is desirable that all calving should occur within one or two periods of one or two months there will be two herds, each of approximately 96 cows/heifers with calves grazing within easy walking distance of the boreholes and approximately 140 dry cows, replacement heifers and bulls grazing more distant areas. Each year 42 female weaners will be retained as herd replacements and 35 old or barren stock will be sent for slaughter.

The expenditure and revenue for the scheme are shown in Table 3.

Scheme 4. A Breeding Herd - African Owned - Employing Family Labour

In the third system of development it is assumed that an individual or a number of individuals opt to enter some type of communal ranching scheme, that no capital is required for the purchase of stock, and that relatively low-cost family labour is available. Obviously the herd cannot be sold at the end of the twenty years. The current investigation into the economics of small-scale

* 1 mi = 1.6 km.

ranching which is being studied on a fenced area of the Nata Ranch by the Agricultural Economist with financial assistance from Oxfam will be relevant to this type of development.

It is assumed that the herd owner fattens his stock and obtains the better prices for them when they are sold. If for any reason he has to sell immature stock there will be a decline in the gross return, unless he decides to concentrate on the sale of immature stock and thus increases his off-take from 12% to 18%. An increase would require a larger breeding herd which could be justified as the followers are disposed of earlier. A cattle-owning family might decide that the production of weaners as in the previous type of development was more profitable than the production of fat stock.

The assistance of the extension worker is essential if the individual cattle owner is to improve his standards of animal husbandry and achieve success. In a communal ranching scheme success will depend on the quality of the supervision and also on the willingness of the participants to co-operate.

Conclusions

The benefits likely to accrue from any type of development can be considered in terms of the investor, the local African community and the country. The benefit to the country arises both from revenue and from the development of the infrastructure.

At the prevailing rates of interest private development based solely on a breeding herd is not profitable although it may provide a satisfactory way of life, and the values of stock and freehold land may appreciate sufficiently to compensate for the low annual return.

The level of certain charges and the omission of others can be criticised. The cost of labour is a matter for debate. It may be argued that the cost of labour must be related to the alternative employment opportunities, which are few within the country, and that extensive livestock production has the lowest labour requirement of any form of agriculture.

In a similar way any charge for the land must be related to the opportunity for land use.

The return on the capital in Schemes 1, 2 and 3 is approximately 2½%, 17% and 7% respectively. The flying herd (Scheme 2) provides the best return, but the opportunities for this type of development are limited. Both in Scheme 1 and Scheme 3 the margin of profit is too low to meet charges which economists would insist should be deducted from income. This income would not cover interest on invested capital in Scheme 1 and it would not cover interest plus a charge for skilled management in Scheme 3.

The return in the fourth scheme cannot be determined in a similar way because of the absence of any cost for the original stock.

Personal taxes are payable to the local Authorities and to the central Government. Incomes of R100 and R250 per year pay R6 and R12 respectively to the local Authorities. The private owner of 400 head of weaned stock is assumed to enjoy an income of R1 600* (R4 per head of cattle); on the first

* Revenue must exceed the owner's production costs by R1 600 if this income is to be realised.

R660 of this income the tax payable to the local Authority is R48 and the tax payable to central Government on the remainder varies according to the individual's personal circumstances.

Private companies are taxed at 20% on the first R5 000 profits and thereafter at 30%, a rate which is applied to all the profits made by public companies.

The provision of the local Authorities and by Government of various services including communications, medical and educational services is likely to be relatively more costly for a sparsely scattered community than for other communities.

APPENDIX 4. ANIMAL HUSBANDRY

The Agricultural Department have introduced a system of training, which enables the cattle owner to increase his skill in livestock husbandry; this scheme is similar to the Pupil Farmer Scheme and a progressive improvement in his standards of management is required if the cattle owner is to graduate from pupil stockman to master stockman.

Emphasis is placed on simple aspects of breeding, feeding and management, and this excellent scheme deserves the fullest support, but in addition other methods for making known these principles should be considered.

The recently established broadcasting service provides the agricultural extension worker with new facilities for disseminating information. The planning and preparation of the programmes will require imagination, effort and care if the interest and attention of the audience is to be aroused and held.

In addition broadcast advice should be supported by simple lavishly illustrated booklets describing the various techniques and improved methods and like the broadcasts should be produced in the vernacular languages as well as in English. Such booklets could be of value in encouraging adult literacy and they could also be used in the schools. In other developing countries booklets of this kind have proved most effective; attractively produced they are carefully studied and preserved. They can be distributed in a variety of ways; they may be sold at a subsidised price over the counter of the Post Office and by Government officials in contact with cattle owners; they may be given with tax receipts. Imaginative methods of distribution are necessary if such booklets are to be properly appreciated and for this reason the indiscriminate handout should be avoided.

The use of other media of communication including films, film loops, film strips and slides requires elaborate equipment and competent operators. The possibility of establishing a small number of mobile units to promote the interests of several ministries should be considered.

The Pupil Stockman Scheme includes under the headings of breeding, feeding and management all the important aspects of livestock husbandry; there is however, no reference to the increasing incidence of 'measles' or cysts of the tapeworm *Taenia (Taeniarhynchus) saginata* in the muscles of animals sent for slaughter. In 1965 9% of the carcasses inspected at the Lobatsi abattoir were detained because of this infection; a figure of 17% is reported recently (Botswana, Economic Planning Unit, 1966). The tapeworm stage of the parasite develops in the human alimentary canal and its eggs are passed out in the faeces and the contaminated herbage may be ingested by the grazing animal. While it is desirable to eliminate the tapeworm by administering vermifuge, the immediate need is that there should be nation-wide instruction in elementary hygiene.

The Stockman is required to adopt the following practices:

(a) Breeding

1. Have a herd bull or bulls of approved quality.

2. Have no more than one bull to thirty cows.

3. Castrate bull calves not required for breeding before they are twelve months old.

4. Practice the culling of female stock.

5. Only run the bulls with the breeding herd during the periods January to March and August to September.

6. Avoid using bulls which have been bred within the herd, and avoid using any bull for longer than three years.

7. Prevent heifers under two years of age from being served.

(b) Feeding

1. Where the cattle are kraaled at night they must be allowed out to graze at sunrise and not return before sunset.

2. Cattle must have access to water every day.

3. Grazing around watering points should be controlled.

4. Cattle must be fed bone meal and salt in areas where this is found to be necessary.

5. Crop residues should be used for the supplementary feeding of breeding cows and work oxen in the latter part of the winter.

(c) Management

1. The construction of adequate kraal accommodation with, if possible, a water trough and with a well-built crush leading from it.

2. Regular deticking.

3. Deworming twice a year.

4. Cattle inspected and treated regularly for minor injuries.

5. When milking is practised two full quarters left for the calf.

6. To allow calves adequate grazing time and access to water.

7. To ensure the cattle receive necessary inoculations.

8. The regular inspection of his cattle by the stockman himself even when he does not live at the cattle post.

9. The ownership of medicines and necessary equipment.

10. The de-horning of bull calves not intended for use for trophy purposes.

11. All branding to be carried out on the lower leg or the neck so as not to damage the valuable parts of the hide.

OBSERVATIONS AND RECOMMENDATIONS

The Bull Subsidy Scheme was introduced to make bulls of improved quality available to cattle owners at subsidised prices. The Veterinary Department have an Afrikander herd and are building up a Brahman herd; there are also three tribal improvement centres; but in order to meet the considerable demand bulls are purchased from European farmers in the Republic of South Africa and in Botswana. This Scheme, which has been criticised in the past, should continue to be given financial support, but the purchase and issue of bulls must be more strictly supervised and they should only be made available to farmers who have shown the necessary ability in livestock husbandry.

Instruction is given in the use of the Burdizzo Castrator and the cattle owner is expected to purchase his own castrator.

In many herds opportunities for culling female stock are limited and this will be particularly true during the next five years, because of the losses during the recent drought years.

It is an advantage if calving takes place at the beginning of the rains when grass is nutritionally adequate both for the lactating animal and for the calf in the post-weaning period. It is recommended that the bull be re-introduced to the herd during August and September so that cows not in calf at the end of March will be served and long calving intervals will be avoided.

Inbreeding should be avoided by using unrelated bulls. Heifers should not be served unless they have reached approximately three-quarters of their normal adult weight and it is suggested that heifers are not served under two years of age.

It was frequently observed that herds were leaving the kraal late in the morning and returning very early in the afternoon, not only is the overall grazing time curtailed, but particularly valuable grazing periods are lost. Overgrazing was very severe around most of the watering points.

Phosphate deficiency is widespread and the provision of phosphate supplements is essential; bonemeal is readily available and it is usually mixed with salt in equal proportions. It is strongly recommended that the production and distribution of bone meal be subsidised. The export of bone meal from a country as deficient in phosphate as Botswana is a matter for grave concern.

Most African cattle-owning communities appreciate the value of crop residues for stock feeding during the dry season and in many countries bean and groundnut haulms are sold for cash while corn stover is given to the cattle owner in exchange for the manure left by the cattle on the arable land. Both stock and crops benefit from this form of integration.

It is an advantage if stock can have access to water while in the kraal over night. Apart from the advantage of a well-built kraal, a stoutly constructed crush is essential if there is to be adequate inspection and treatment of stock.

Ticks are not usually a serious problem and are controlled by spraying and greasing; a hand spray or stirrup pump is satisfactory.

The younger stock should be given P.T.Z. (phenolthiazine) in the spring and autumn. Worm burdens can be minimised by ensuring that young stock graze on clean land ahead of the main herd but in the absence of fencing this is difficult to implement.

The sale of cream (butter fat) is an important source of income in certain tribal areas. When milking is practised two-quarters of the udder should be milked and stripped; the calf should be allowed two full quarters. Weaning should be carried out at least a month before calving.

The Veterinary Department is responsible for inoculation against anthrax and quarter ill, and in certain areas against botulism, lumpy skin and contagious abortion. It is proposed also to provide protection against calf paratyphoid. No payment is required for this treatment, although part of the cost is met by a levy at slaughter; | while this system avoids burdening veterinary assistants with revenue collection it does not foster a sense of responsibility amongst cattle owners for their stock.

The regular inspection of the animals by the owner is obviously desirable.

De-horning is not widely practised and most owners believe that de-horned animals would be at a disadvantage when neighbouring herds have not been so treated. A general willingness to de-horn would lead to improvement in the quality of hides, which would be in the national interest. The value of hides is also reduced by branding on the rump; it is recommended that branding be done on the neck or lower leg. The poor response to de-horning and correct branding may indicate the desirability of paying a premium for animals that have been treated correctly.

PUBLICATIONS OF THE LAND RESOURCES DIVISION

The Division makes a report on each completed project. The report is published as a *Land Resource Study* or *Technical Bulletin* only with the consent of the government concerned. The abbreviated titles of the reports in the style of the 'World List of Scientific Periodicals' are *Land Resour. Stud.* and *Tech. Bull. Land Resour. Div. Dir. Overseas Surv.*

BAWDEN, M. G. and LANGDALE-BROWN, I.	1961	An aerial photographic reconnaissance of the present and possible land use in the Bamenda Area, Southern Cameroons.*
BAWDEN, M. G. and STOBBS, A. R.	1963	The land resources of Eastern Bechuanaland.
LANGDALE-BROWN, I. and SPOONER, R. J.	1963	The land use prospects of Northern Bechuanaland.
BAWDEN, M. G. (Ed.)	1965	Some soils of Northern Bechuanaland with a description of the main vegetation zones.

LAND RESOURCE STUDIES

SPOONER, R. J. and JENKIN, R. N.	1966	The development of the Lower Mgeta River Area of the United Republic of Tanzania. *Land Resource Study* No. 1.
BAWDEN, M. G. and TULEY, P.	1966	The land resources of Southern Sardauna and Southern Adamawa Provinces, Northern Nigeria. *Land Resource Study* No. 2.
BAWDEN, M. G. and CARROLL, D. M.	1968	The land resources of Lesotho. *Land Resource Study* No. 3.
JENKIN, R. N. and FOALE, M. A.	1968	An investigation of the coconut-growing potential of Christmas Island. Volume 1, The environment and the plantations. Volume 2, Appendixes. *Land Resource Study* No. 4.
BLAIR RAINS, A. and McKAY, A. D.	1968	The Northern State Lands, Botswana. *Land Resource Study* No. 5.

TECHNICAL BULLETINS

CARROLL, D. M. and BASCOMB, C. L.	1967	Notes on the soils of Lesotho. *Technical Bulletin* No. 1.
PIGGOTT, C. J.	1968	A soil survey of Seychelles. *Technical Bulletin* No. 2.

* Out of print.

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