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AGRICULTURAL RESEARCH RESOURCE ASSESSMENT
IN THE SADCC COUNTRIES

VOLUME II
COUNTRY REPORT: BOTSWANA

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PREFACE

AGRICULTURAL RESEARCH RESOURCE ASSESSMENT

IN THE SADCC COUNTRIES

This document has been prepared by DEVRES, Inc. in cooperation with the Consultative Technical Committee for Agricultural Research (CTCAR) of the Southern African Development Coordination Conference (SADCC) in accordance with the terms of a contract with the US Agency for International Development.

The national agricultural research resource assessments which provide the necessary background information for this document were conducted by national agricultural research scientists from SADCC countries¹ under the guidance of DEVRES in consultation with the CTCAR. Financial support was provided by the US Agency for International Development (under Contract No. AFR-0435-C-00-2084-00 and Project No. 698-0435 entitled Strengthening African Agricultural Research) on behalf of the member countries of the Cooperation for Development in Africa (CDA).

Discussions concerning this country report were held with the country report authors, responsible officials in the ministries of agriculture, rural development and plan, as well as specialists from international organisations, bilateral donors, and universities. On two occasions, drafts of this final report were examined by SADCC's Consultative Technical Committee for Agricultural Research (CTCAR). Suggestions by its members were incorporated into the report.

The results of the assessment are contained in the following reports:

Volume I - Regional Analysis, Strategy, Programmes and
Summaries of Country Reports

Volume II - Country Reports:²

Botswana
Lesotho
Malawi
Mozambique³
Swaziland
Tanzania³
Zambia
Zimbabwe

These reports are available in English and in microfiche or printed form at a cost determined by document size at the address below. The Regional Analysis and Strategy and the Mozambique country report are also available in Portuguese in the same forms.

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¹SADCC member countries are Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe. Angola, however, did not participate in this study.

²Each country is printed separately.

³Italy provided technical advisors for the preparation of the Tanzania national report and France provided an advisor to help in the preparation of the Mozambique country report.

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LIST OF ACRONYMS AND ABBREVIATIONS

AID	Agency for International Development (United States)
ALDEP	Arable Lands Development Programme
APRU	Animal Production Research Unit
ARPC	Arable Research Practices Committee
ARPU	Arable Research Programme Unit
ARRA	Agricultural Research Resource Assessment
BAC	Botswana Agricultural College
BAMB	Botswana Agricultural Marketing Board
BMC	Botswana Meat Commission
BSc	Bachelor of Science degree
CDA	Cooperation for Development in Africa
CRSP	Collaborative Research Support Project
CTCAR	Consultative Technical Committee for Agricultural Research
DAFS	Department of Agricultural Field Services
DAH	Department of Animal Health
DAR	Department of Agricultural Research
DVS	Director of Veterinary Services
EEC	European Economic Community
EFSAIP	Evaluation of Farming Systems and Agricultural Implements Project
FAO	Food and Agriculture Organization of the United Nations
FSRP	Farming Systems Research Programme
FTE	Full time equivalent
GDP	Gross Domestic Product
GNP	Gross National Product
GOB	Government of Botswana
GTZ	Agency for Technical Cooperation (Germany)
IBRD	International Bank for Reconstruction and Development
IFAD	International Fund for Agricultural Development
IFPP	Integrated Farming Pilot Project
ILCA	International Livestock Centre for Africa
INTSORMIL	International Sorghum and Millet Project
MOA	Ministry of Agriculture
MSc	Master of Science degree
P	Pula
PhD	Doctor of Philosophy degree

POLI	Physical Quality of Life Index
PVO	Principal Veterinary Officer
RFTC	Rural Farmer Training Centre
SACCAR	Southern African Centre for Cooperation in Agricultural Research
SADCC	Southern African Development Coordination Conference
SAREC	Swedish Agency for Research Cooperation with Developing Countries
SIDA	Swedish International Development Agency
TGLP	Tribal Grazing Land Policy
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
US	United States
USAID	United States Agency for International Development

CURRENCY EQUIVALENTS
(December 31, 1983)

Currency unit = Pula (P)

US\$ 1.00 = P 1.156

P 1 = US\$ 0.865

P 1 = 100 thebe

WEIGHTS AND MEASURES

1 hectare (ha) = 10,000 m²
= 2.471 acres

1 acre = 0.405 ha

1 kilogram (kg) = 2.204 pounds

1 metric ton (MT) = 1,000 kg
2,204 pounds

1 kilometer (km) = 0.621 miles

1 square kilometer (km²) = 100 ha

1 mile = 1.609 km

1 liter = 1.066 quarts

1 quart = 0.9464 liters

GOVERNMENT OF BOTSWANA FISCAL YEAR

July 1 to June 30

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EXECUTIVE SUMMARY

A. Background

1. Country description and economic overview

Botswana is a landlocked country, with a population of 940,000 people which is growing at the rate of 4.6 percent per annum. The climate is subtropical; annual rainfall ranges from 250 mm in the southeast to 650 mm in the northeast and is quite erratic. Surface water is very scarce, and groundwater sources are, therefore, very important. Botswana is a democracy with a President and a unicameral legislature, the National Assembly. There is also a Special House of Chiefs that advises on legislation affecting tribal matters.

The Gross Domestic Product (GDP) of Botswana in 1980-81 was US\$ 780 million, 26 percent of which came from mining and 12 percent from agriculture. This reflected a change over the seven-year period from 1973-74, when agriculture provided 34 percent of GDP and mining only 9 percent. Real average growth rate in GDP between 1973-74 and 1980-81 was 10 percent per annum. Through processing of beef for export, agriculture is an important contributor to the manufacturing sector.

The majority of Botswana's urban and rural people are either unemployed or underemployed. The problem is compounded by the fact that the number of workers migrating to South Africa has decreased by one-half since 1976. In addition, the labour force is growing at the rate of 3 percent annually. Wage-earners comprised 17 percent of the total labour force and received approximately 37 percent of the GDP in 1979-80; in the same period, the rural population which is primarily engaged in agriculture, and which constituted 80 percent of the people, received only 12 percent of the GDP. Most people in the agricultural sector are underemployed even though they combine agriculture with off-farm activities. Earnings differ significantly between citizens and non-citizens, being much higher for the latter.

2. Agriculture in Botswana

Botswana's climate is semiarid with cold, dry winters and generally wet summers. Rainfall is low and erratic, and distribution varies greatly between and within areas and seasons. Rapid and extreme temperature changes and the risk of frost also affect agriculture adversely. The climate in the east is more favorable for agriculture, as are the soils and, hence, this is the more heavily populated part of the country.

Only 5 percent of the land is suitable for cultivation; most of the arable soils are sandy and deficient in phosphorus. Between 60 and 70 percent of the country is covered by Kalahari sands which are partially responsible for rapid evapotranspiration that adversely

affects agricultural productivity. Organic matter levels in the soils are also low.

Under the Tribal Grazing Land Policy, about 12 percent of Botswana's land is zoned commercial and is used for cattle ranching. Both crop and livestock production occurs on the 30 percent of the land which is designated communal and the 5 percent that is freehold. About 25 percent of the land is still unzoned, with the intention that it can be used for commercial ranching if needed.

There are three basic crop production systems in Botswana: communal or traditional, commercial/freehold and government. In 1980, traditional farmers engaged in subsistence production accounted for 85 percent of food grain output, while commercial farms contributed only 15 percent. Yields of both food and non-food cash crops were higher in the commercial sector by a factor of two or more to one than in the subsistence sector. Yields obtained on government research station experimental plots were higher than those of the traditional and commercial sectors. However, experiment station results have seldom been evaluated on farmers' fields to determine their applicability.

The difference in yields can be explained by small farmers' reliance upon traditional practices whereas commercial and experimental production is heavily dependent upon use of modern inputs such as fertiliser and hybrid seeds. The Arable Land Development Programme (ALDEP) is designed to assist small farmers adopt modern practices by offering subsidies to buy draughtpower, farm implements, etc. The technical limits for traditional and commercial farm yields have not yet been achieved, and moderate improvements would contribute greatly to national food production.

The differences in productivity between the commercial, traditional and government livestock production systems are not as great as in crop production. However, commercial farmers and government research stations use better husbandry methods: disease and parasite control measures, better grazing systems, feed supplements and regular water supplies. The traditional sector owned 84 percent of the cattle in Botswana in 1980.

The marketing of all livestock in Botswana is in the hands of the Botswana Meat Commission which also exports beef--a major export earner after diamonds. Food crop marketing is the responsibility of the Botswana Agricultural Marketing Board, which has agencies and branches throughout the country. Credit is available through the National Development Bank, mostly for the livestock sector in which cattle can be used as collateral and there is greater potential for cash returns through exports.

Labour shortages during critical periods due to male migration to urban areas and the RSA is a serious constraint to agricultural production. Another problem is that, though women head about one-

third of all farm households, they have the least access to basic resources such as draughtpower, equipment, land and cattle.

Improving Botswana's food production will require dramatic improvements in the traditional sector which produces 85 percent of food grain, including 93 percent of sorghum, 76 percent of maize and almost all the millet, beans and pulses. Average yields of food crops in this sector are among the lowest in Africa. Prospects for improvement depend on the ability of the research institutions to fashion adaptable production, storage and marketing technologies for the traditional sector.

B. Agricultural Institutions

1. Research

The Department of Agricultural Research (DAR), which is a division of the Ministry of Agriculture (MOA), has the task of developing and testing appropriate technology that will enable small farmers to increase food and livestock production. DAR headquarters are at Sebele near Gaborone, with substations at Mahalapye, Goodhope and Maun. There are also 18 beef cattle ranches and two communal grazing areas for research in animal production and range programmes.

The research programmes in breeding and breed evaluation, animal nutrition, range and pasture management, range monitoring and dairy production are conducted by the Animal Production Research Unit (APRU). Range monitoring is a cooperative effort among the Division of Land Utilisation and the Department of Agricultural Field Services, which gather the data, and the APRU of the DAR, which analyse it. Dairy development is a fairly recent activity, designed to improve smallholder milk production by making available a package of recommended practices.

The Arable Research Programme consists of variety trials on major cereals, conducted at five different ecological and climatic locations, and dryland crop production research. There are also USAID-funded farming systems projects principally in the eastern part of the country, and collaborative research on cowpea, sorghum and millet production. Smaller research projects are on legume-cereal rotations and fertiliser improvement.

The personnel of the DAR include 46 professionals and 15 administrators, of which the Director, the heads of divisions and projects and over one-half of the total professional and administrative staff are expatriates. There are very few nationals in the fields of agricultural engineering and veterinary science. Although it is desirable for reasons of continuity to increase the number of nationals on the staff, this has been difficult because of the scarcity of trained Botswana. Plans to augment the national staff are slow to implement because of the lack of in-country training facilities and the long time it takes to train people abroad.

The DAR's research facilities include seven laboratories, three greenhouses, five administrative offices, three workshops, a seed processing plant, a clinic, a consumer cooperative shop and a primary school. Its equipment holdings include 24 trucks, 30 vehicles, 17 tractors and three micro-computers. The library has 1,000 books, to which it adds 100 new books and 120 journals each year. The DAR also has access to information from several international organisations, as well as inter-library loan arrangements with several countries in and outside Africa.

The Government of Botswana (GOB) provided US\$ 2.58 million for the DAR's operating budget in 1984. Vehicles and machinery are not provided through the operating budget. Donor contributions amounted to US\$ 0.68 million from SIDA, USAID, FAO and the UK.

2. Training

The Botswana Agricultural College (BAC) of the MOA is the main training institution that offers certificate and two-year diploma-level programmes in agriculture and animal health. The programmes' composition is evenly divided between practical work and classroom instruction. Current enrollment in the agriculture diploma course is 20, and enrollment in animal health is 19. The animal health certificate course has 57 students, and the agriculture certificate course has 47 students. The GOB pays all student fees; in return, diploma graduates are expected to work for the government for a minimum of two years and to remit 10 percent of their salaries to it during that period. Certificate graduates are expected to work for the GOB for a minimum of three years.

The BAC is headed by a Principal, who is assisted by a Deputy and by Course Directors. Staff positions include 28 professionals with BSc degrees. Ten of these are held by expatriates (two in non-authorized posts) and 18 by nationals. Altogether, the teaching staff numbers 48. At present one staff member is in training abroad for the MSc degree in range management, and five are in BSc training abroad in various fields.

Building facilities include classrooms, administrative and staff offices, laboratories, workshops, a library and a lecture theatre, all of which are in good condition. Major equipment includes an incinerator, a photocopier and vehicles such as buses, trucks, tractors and shop and farm equipment. The library has 9,400 books and adds 1,000 each year. It also receives 20 periodicals and scientific journals. The College has 30 ha of land which are used as demonstration plots and 20 ha for livestock projects shared with the DAR.

The BAC's linkage with the DAR is generally acknowledged as being weak, but it has a good working relationship with the Department of Agricultural Field Services. During each term, students attend demonstrations in surrounding villages and work closely with local extension staff.

All recurrent costs for the BAC are provided by the GOB. This amounted to US\$ 1.1 million for 1984-85. USAID has contributed 92 percent of the capital budget of about US\$ 225,000.

3. Extension

Extension services and some agricultural inputs are provided through the Department of Agricultural Field Services (DAFS), while the Department of Animal Health (DAH) provides field service in animal health. Both are departments of the MOA. Organisationally, the DAFS is divided into six regions which in turn are subdivided into districts. These are headed by graduate and diploma-level staff. Extension areas which encompass 250-300 farm families are headed by certificate-level personnel.

a. Department of Agricultural Field Services

Increased food crop and livestock production are the major programmatic emphases of the extension effort. Research data based on local conditions are already available and have been applied in the relatively small commercial sector, but much remains to be done to disseminate the information to the vast majority of small farmers. The following are some of DAFS' ongoing programmes:

- o The Farming Systems Research Project: Its goal is to improve linkages between research and extension. It does this by promoting collaboration between the DAR and the DAFS to discover means to implement more effective programmes for small farmers;
- o The Arable Lands Development Programme: It is designed to increase production of food crops in the traditional sector by providing recommendations on crop practices, and subsidies and credit to farmers to purchase farm inputs;
- o Under the Tribal Grazing Lands Policy attempts are being made to introduce improved management and grazing techniques in communal areas; and
- o The Information Services Unit produces leaflets on subjects such as livestock diseases and row planting, general fact sheets on livestock and crop topics, and a monthly publication entitled AgriNews. It also produces seven radio programmes per week.

While all of the 41 administrative staff of the DAFS are nationals, 46 percent of the professional staff are expatriates, most of whom serve at headquarters. The major staffing deficiencies are the low ratio of women extension officers and the shortage of agricultural engineers and range ecologists. Staff activities include dissemination of livestock and food crop production information,

agricultural management to encourage farmers to form associations for purposes such as fencing and spraying, and short-term training for farmers at the Training Centres. Since the DAFS does not have any economists or social scientists on its staff, it obtains assistance when needed from the Division of Planning and Statistics of the MOA which employs several economists and rural sociologists.

The DAFS facilities include five Regional Offices, five Rural Farmer Training Centres, ten Demonstration Ranches and 17 district Offices. It also has access to 106 large trucks and 97 four-wheel drive vehicles. Over 95 percent of the DAFS recurrent budget of US\$ 8.3 million is from the GOB and over 90 percent of the capital budget of US\$ 1.2 million is from donors.

b. Department of Animal Health

The DAH is responsible for the diagnosis, control and prevention of livestock diseases through vaccination and the conduct of other health programmes. Field staff are located only at the district level, from which they conduct vaccination campaigns by visiting farming communities; at other times farmers with animal health problems must contact the veterinary staff themselves, which places those in remote areas at a disadvantage. The DAH provides livestock production information to farmers, via Livestock Advisory Centres located all over the country, and plays a vital role in the meat industry through the operation of two abattoirs at Lobatse and Maun. The DAH issues a number of circulars on the prevention and control of livestock diseases and parasites. It is assisted by the DAFS Agricultural Information Section's radio programmes. The DAH does not have field research facilities for diagnostic work, which thus must be done through headquarters; there is no direct communication between laboratory staff and farmers.

The DAH personnel include 25 veterinarians, of whom 22 are expatriates. There is an urgent need for trained local staff; currently, 159 nationals are in training, but only 11 are studying for degrees in veterinary medicine. The rest are studying for diplomas or certificates in animal health. Another staffing deficiency is the disproportionately small number of women extension agents. Facilities include the central Veterinary Diagnostics Laboratory, the Botswana Vaccine Institute, the Tsetse Fly Laboratory, 27 livestock advisory centres, two abattoirs, and 16 district and regional offices. The DAH's recurrent budget of US\$ 9.8 million is financed almost entirely by the GOB. The capital budget of US\$ 5.8 million is contributed by the GOB (56 percent), CDA (10 percent), and other donors (34 percent).

c. Constraints to Agricultural Production and Production Potential

The overriding constraints to crop and livestock production alike are low and erratic rainfall and a fragile ecology.

1. Food crops

The major food crops produced in Botswana are sorghum and maize, along with small amounts of millet, beans and pulses. Smallholder sorghum yields of 200-225 kg/ha are somewhat less than half those in the commercial sector, while maize yields (170-300 kg/ha) are about one-third less. Aside from rainfall, the primary biological and physical constraints affecting both smallholder and commercial production are: the lack of high-yielding, adaptable, short-season varieties of sorghum, maize and millet; field losses from bird and insect damage; high soil temperatures which affect germination; low phosphate levels and poor mechanical properties of soils; and weeds, especially striga. Smallholders are further constrained by lack of timely access to animal or mechanical power for seed bed preparation, labour shortages at critical times, and poor access to supplies and technology.

Policy constraints include inadequate input provisions and delivery, the inappropriateness of recommended technical packages for low moisture levels, and the inadequacy of marketing services. Smallholders, in particular, are further affected by livestock damage to crops, by the lack of incentives to improve productivity through adoption of improved technological practices and by rural tradition-related constraints of traditional land tenure and land use patterns.

2. Specialty crops (vegetables and fruits)

Vegetable and fruit production are relatively new to Botswana, and very little is produced for home consumption. The economic constraints include the lack of irrigation and of input supply and product marketing systems. Among the physical constraints are the need for water supply, the lack of reliable temperature data and the lack of research on pests and diseases.

3. Livestock and livestock products

Since livestock accounts for about 80 percent of agricultural sector output, the importance of livestock production in Botswana's economy cannot be overstated. Despite the 1975 Tribal Grazing Land Policy, aimed at changing the traditional communal system to one of leaseholds with some communal grazing lands around villages, most lands remain under traditional tenure. Livestock problems in communal grazing areas are much harder to solve than in the commercial sector, because ranges are of poorer quality and are often overstocked. The tenure system is a disincentive to modern management techniques. Other physical constraints to livestock production are drought and range degradation. Although animal diseases such as tsetse fly and foot and mouth disease are present, they are limited to certain cordoned areas and are not as serious as elsewhere in Africa because of the effective veterinary service. The most difficult problem to resolve in terms of increasing production is the issue of

providing equitable access to range and water resources while maintaining the resource base.

D. Staff Assessment of Institutions

The main constraints cited by the agricultural research staff were the need for more trained nationals in senior staff positions, the lack of access to well-maintained laboratory equipment and transport, and the inadequate linkage with extension and animal health staff and programmes.

The training staff emphasised the importance of establishing agency linkages between the DAR and the DAFS with the BAC. They also cited the need for additional teaching and audio-visual materials, access to reliable transport, and improvements in staff qualifications and training.

The extension service staff's major constraint was the access to and service for transport. They also stressed the need for improved linkages between the DAR and the BAC, and for better worker incentives.

E. Conclusions and Recommendations

1. Agricultural institutions

In research, training and extension, an evaluation of current strategies reveals the following:

- o The GOB's emphasis on improved linkage between the research, training and extension agencies of the MOA is becoming operational. To be made even more effective it must be practiced at the administrative, professional and working staff levels;
- o The MOA needs to establish a policy to deal effectively with the maintenance and service of its transport fleet;
- o A strategy is needed to establish better terms and conditions of service for the staff; and
- o There is a need to train, recruit and hire more nationals for professional posts.

In the food crop sector, the farming systems project provides a basis for strengthening linkages at all levels. More emphasis is needed on appropriately-adapted research packages for small farmers. Other production constraints, such as lack of access to farm power, labour shortages, losses from birds and pests, and lack of weed control, have not been adequately addressed as yet.

In the fruit and vegetable specialty crop sector, there is a need to carefully evaluate the potential for smallholder participation before developing a strategy for its further development.

2. Agricultural productivity

Despite a lengthy record of research and an extensive data base in livestock production in Botswana, insufficient knowledge about rural traditions and access to rangelands and water rights are serious impediments to the formulation of sound policies and strategies. What is needed is a greater focus on the traditional sub-sector, the establishment of a long-term methodology to accurately determine the carrying capacity of the resource base, and continued efforts to implement and adapt the Tribal Grazing Land Policy to smallholder needs.

I. INTRODUCTION

A. Background

This Agricultural Research Resource Assessment (ARRA) was conducted from July 1983 through August 1984 in the following countries of the Southern African Development Coordination Conference (SADCC): Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe. The ARRA was initiated as a result of discussions between the SADCC Consultative Technical Committee for Agricultural Research (CTCAR) and representatives of the Cooperation for Development in Africa (CDA). The CDA is an informal association of donors including Belgium, Canada, France, Italy, West Germany, the United Kingdom and the United States.

The inventory and assessment were carried out within the framework of the high priority accorded by the CDA to developing and strengthening agricultural research capability in Africa. The United States, assisted by other CDA donors, was assigned the specific responsibility for coordinating the development of CDA-supported agricultural research programmes in the Southern African and Sahelian regions. The ARRA inventory reports were financed by the United States Agency for International Development (AID) for CDA, and were carried out with the full collaboration and support of SADCC through the CTCAR. DEVRES, Inc., a U.S. private consulting firm based in Washington, DC, was engaged by AID to implement the ARRA together with senior agricultural research personnel from the SADCC countries and to prepare a SADCC regional report. Two other CDA donor countries, Italy and France, also provided technical experts and other assistance for some of the SADCC countries' reports.

The CDA members recognise that the African nations have established Africa-wide and regional institutions, such as SADCC, and that the heads of African states have given unanimous support to the Organization of African Unity's Lagos Plan of Action which emphasises the development of a strong capability to increase agricultural productivity. The donors have, therefore, joined with the African countries and their regional organisations--SADCC in Southern Africa and the Institute du Sahel in the Sahel--to develop country-specific and regional analyses of existing resources and of the medium- to long-term needs and opportunities in agricultural research that will lead to increased agricultural productivity.

The World Bank, in its 1983 report entitled Sub-Saharan Africa: Progress Report on Development Prospects and Programs, reiterated its emphasis on the high priority which governments and donors should give to agricultural research. More specifically the report noted:

Even within the present state of technical knowledge, improved incentives and marketing arrangements would permit very large increases in agricultural output. However, for the longer term, increased output will depend on the development of effective technical packages, pest and disease control and developments in animal husbandry. . .In a situation of budgetary stringency and of immediate crisis, expenditure on research having a possible, but uncertain, payoff ten years or more in the future is frequently seen as dispensable. This danger is increased when research programmes are manifestly weak and unfocussed. It is, therefore, essential that these programmes be formulated and implemented in ways which will enable them to contribute more effectively to the process of development. . .¹

The ARRA reports, and the recommended research priorities, programmes, and projects within them, are set in a 20 to 25 year time-frame. This long-term perspective permitted the flexibility to make recommendations which are more carefully adapted to the needs of agricultural research. Individual country research staff in charge of country reports, assisted by technical experts provided through the CDA have endeavoured to be sensitive and responsive to the severe budgetary constraints in SADCC countries. The reports confirm that, even when a high priority is given to research, the SADCC country governments initially will not be able to meet all of the recurrent costs of certain research projects. Donors, therefore, will need to provide for some of these costs.

B. Methodology

This study was carried out with the full participation of African professional agricultural researchers and agriculturalists. It was agreed that such participation was of central importance for all phases of the activity--the design of the questionnaires, the data collection process, the analysis, the assessments of research programmes and direction, the actual preparation of the country reports, and the development and review of a regional agricultural research strategy. DEVRES provided a group of technical experts who had wide African and other international experience to assist the country researchers, to contribute to the analysis of the country reports, and to prepare a SADCC regional report. Italy and France also provided technical experts to assist country researchers in Mozambique and Tanzania, respectively.

The ARRA was initiated with a pilot study performed collaboratively with the SADCC member states of Botswana, Malawi and Swaziland. Following review of this pilot report by both SADCC and CDA members, the ARRA was expanded to include additional SADCC countries: Lesotho, Mozambique, Tanzania, Zambia and Zimbabwe. At the time these countries were added, the pilot country reports were updated and a regional analysis was prepared.

Senior researchers from the SADCC countries were designated as National Coordinators. Each Coordinator provided overall direction and support for the ARRA in her/his country. In turn, each Coordinator nominated researchers to be in charge of completing the questionnaires and preparing the national reports for their respective countries. The Country Researchers also used other experienced researchers for short periods to help complete questionnaires on specific subjects. The scope of the questionnaires included not only the research institutions, but also training institutions and extension institutions which provide links between research professionals and the farmers who are intended to utilise research results.

The expanded ARRA was prepared from July to September 1984 by the Country Researchers in cooperation with the DEVRES staff. A regional report, including summaries of the national reports, was prepared by DEVRES in consultation with the CTCAR members and the Country Researchers. The regional report was based on a regionally-oriented analysis of programmes and national reports, on the answers to the questionnaires, on contacts with international research organisations and national and international donors, and on other available information.

During the course of the ARRA, DEVRES provided assistance in the development of a computerised data bank to process ARRA data and to assist the SADCC countries in meeting their future needs for research which, when combined with other available information, can provide a foundation of practical, useful data that can be continuously updated. The data bank can be a valuable tool for use by those designing programmes and projects in agricultural research. It will remain with the Southern African Centre for Cooperation in Agricultural Research (SACCAR) which will update the data bank, as well as ARRA, in the future.

In preparing recommendations for programmes and projects, the National Coordinators, Country Researchers and DEVRES staff took into account research work already proposed or underway. New ideas were also included in this country report and in the regional report as well. One of the principal objectives of the analysis was to build on existing national research, analyses, conclusions and recommendations in a manner which will strengthen these research activities. A concerted effort was made to place recommendations in a wider context, involving not only the research institutions, but also the training of researchers, the use of research results by the farmers, and the linkages with other SADCC member institutions or other international research institutions.

¹The World Bank, Sub-Saharan Africa: Progress Report on Development Prospects and Programmes (Washington, D.C.: The World Bank, 1983).

II. GENERAL INFORMATION ON BOTSWANA

A. Description of the Country

1. Geography

A landlocked country, Botswana is bounded by the Republic of South Africa on the south and east, by Zambia and Zimbabwe on the north and east, and by Namibia on the north and west. With an area of 582,000 km², Botswana is about the size of Kenya or France. It is generally a flat country with a mean altitude of 1,000 m (3,300 ft).

2. Agro-ecological zones

Botswana may be viewed as consisting of three major ecological zones, each of which has several subsets:

- o The Okavango Delta in the north;
- o The semiarid eastern belt; and
- o The Kalahari (Kgalagadi) Desert in the central and southwest areas. (See Figure 1.)

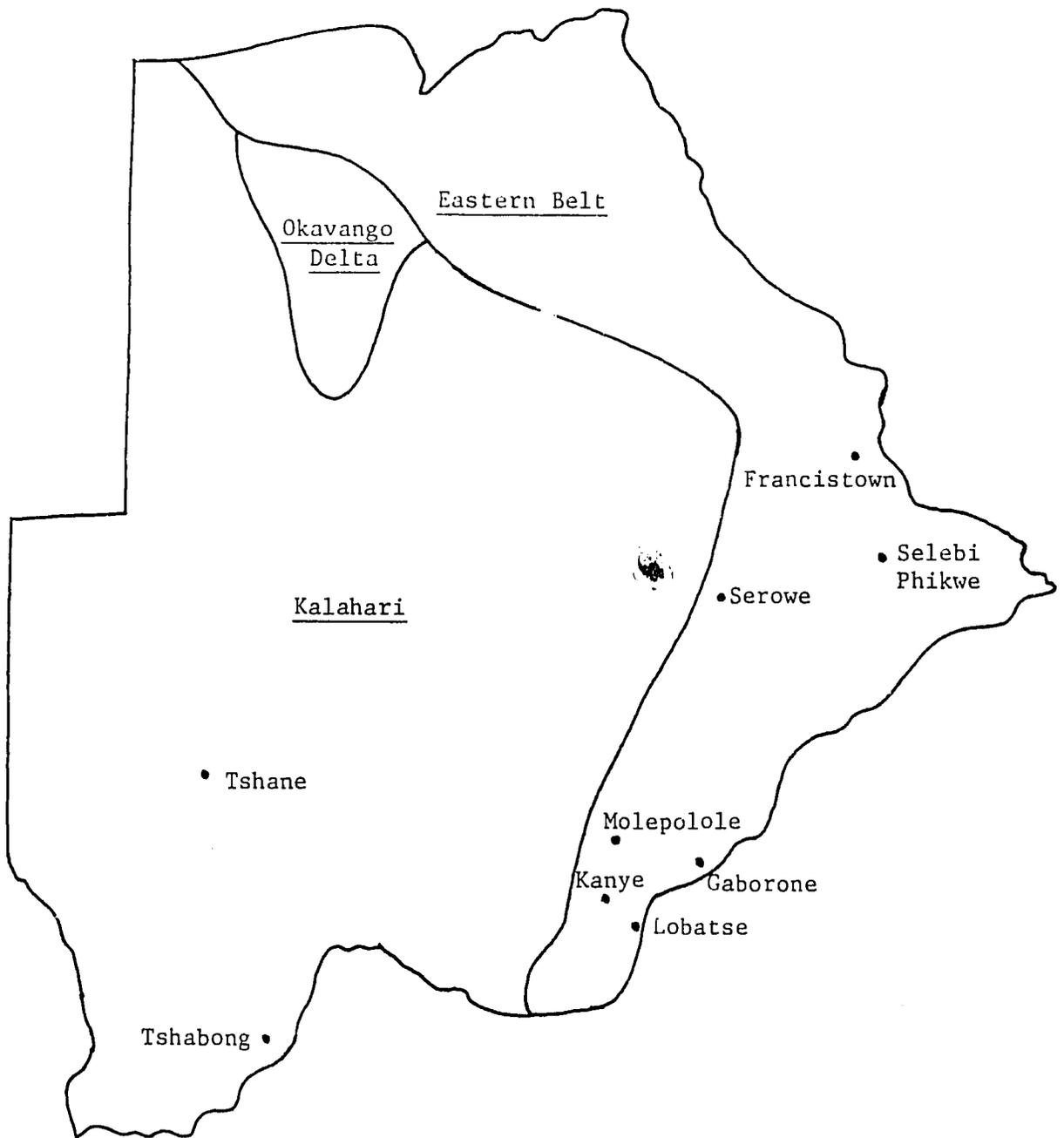
Most of the population and arable land are located in the eastern section of the country, in the semiarid rainfall zone of from 400 to 600 mm per year. The north and north central zones, while having more abundant though seasonal moisture, are troubled by trypanosomiasis and are natural habitats for tsetse-resistant wildlife.

While most of the Kalahari Desert is not arable or suitable for grazing, there are pockets of productive rangeland and, in some areas, large-scale cattle or sheep operations.

3. Natural environment

Only about 5 percent of Botswana's land is estimated to be suitable for farming. Most of Botswana's arable soils are sandy and deficient in phosphorus. Drainage is not a problem, due to the high sand content of most soils. The most arable soils are located in the eastern part of the country. Except for isolated areas in the Chobe, the Okavango Delta, around Serowe and in the southeastern parts of the country where relatively clay-rich soils can be found, between 60 and 70 percent of the country is covered by Kalahari sands.

Poor rainfall and generally low-phosphorus soils produce grasses of low nutritive value and low carrying capacity. The high sand content of Botswana soils is partly responsible for the high evapotranspiration, which in turn adversely affects effective rainfall for crops. Excess acidity or alkalinity is another limiting factor.



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Figure 1: Ecological Zones

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1983.

Kalahari sands usually tend towards acidity, except in the Okavango Delta area.

Organic matter is minimal in Botswana's soils; if added, it could improve soils' structure, including their ability to retain moisture. Organic matter levels are almost always low except for short periods after harvest or following the application of kraal manure.

Surface water is very scarce throughout the country, except in the Okavango Delta in the northwest. As a result, the groundwater system plays a very important role in the livelihood of Botswana.

While the Okavango Delta has aquatic plants, vegetation in other parts of the country is sparse due to dry spells and periodic severe droughts. Because of its higher rainfall, the Chobe District in the northeast supports a belt of indigenous forest and dense bush. Limited commercial hardwood exploitation is possible in this area. The rest of the country is characterised by scrub and tree savannah. The Kalahari Desert supports only small-shrub savannah.

4. Climate

Botswana's climate is semiarid and subtropical, with cold, dry winters and generally wet summers. However, both country-wide and local dry spells often occur, even during the rainy season (November to March). Summer temperatures average 23° C to 28° C; winter temperatures average between 15° C and 20° C, but fall dramatically at night. Temperatures may reach 38° C in the summer, but they seldom fall below 5° C in winter. There are, however, wide diurnal changes. No part of the country is entirely free of the risk of frost, although in the northwest frosts are few and mild. Further, extreme and rapid changes of temperature that occur in part as a result of low rainfall and sandy soil adversely affect planting and germination. Crops such as millet and some varieties of sorghum and maize are best able to withstand high temperatures, if moisture stress is not too severe.

Average annual rainfall ranges from less than 250 mm in the southeast to more than 650 mm in the northeast. (See Figure 2.) Generally, the low and erratic rainfall is a serious constraint to agricultural development. Seasonal variations range from as high as 80 percent in the southeast (hence low rainfall reliability) to less than 25 percent in the northeast. In addition, rainfall distribution varies greatly both between and within areas and seasons. The climate in the east tends to be more favourable for agriculture, hence the higher concentration of people in this part of the country.

B. The People

1. Population

At the time of the 1981 Census, Botswana had a population of about 940,000. An additional 42,000 were estimated to be living

abroad, most of them as workers in South Africa. The high annual population growth rate of 4.6 percent over the past decade could be due to net inward migration and/or to underestimation of the population in the 1971 Census. Botswana's population density of 1.6 persons per km² is among the lowest in the world. The majority of the people, however, live in the eastern part of the country. Most (83 percent) live in rural areas. (See Figure 3.) The major urban centres--Gaborone (the capital), Francistown, Lobatse, Selebi-Phikwe, Orapa and Palanye--are also located in the east. The percentage of the population living in urban areas increased from 8 percent in 1971 to 17 percent in 1981, doubling in the past decade. The urban population has grown at an average annual rate of about 11 percent, while the rural population growth rate is about 4 percent. (See Table 1.)

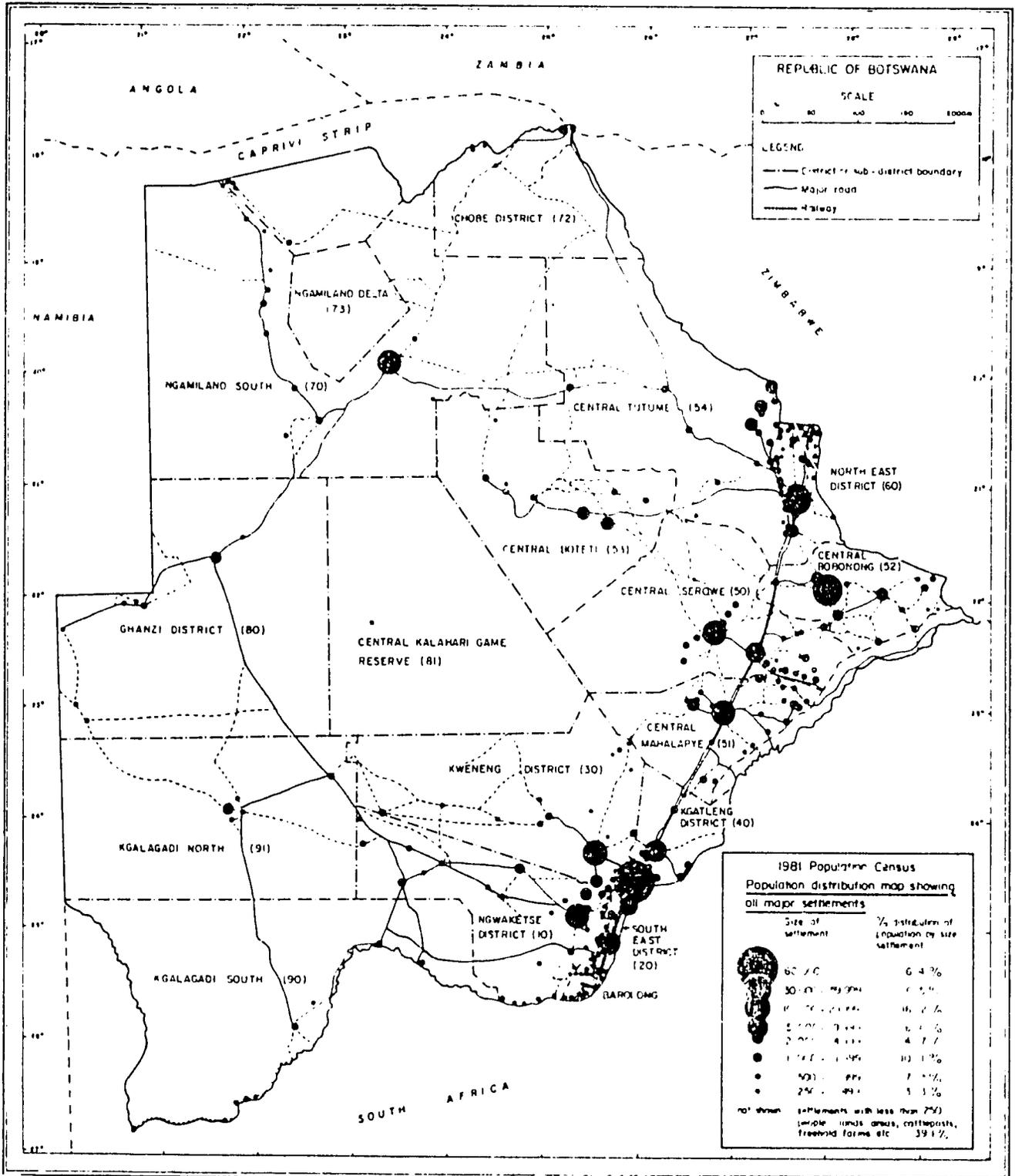
Internal migration from traditional settlements, such as cattle-posts and villages, to urban centres in Botswana has accelerated since Independence. This migration is due in part to the lack of employment opportunities and social services in the rural areas. Poor return from high-risk agriculture has also contributed to this movement.

About 50 percent of the population is under 15 years of age; 54 percent of the population is female. The 1981 Census also indicated that 45 percent of all households in Botswana were female-headed. This phenomenon has been both the cause and the effect of major socioeconomic changes taking place. Migration of males seeking wage employment has contributed significantly to this situation.

A large number of Botswana emigrate to South Africa to work in the mines or in the towns. The majority are males from 15 to 34 years old; about half are illiterate, and two-thirds have no schooling. However, the number of Botswana migrants working in South African mines has decreased significantly (from over 40,000 in 1976 to under 18,000 in 1981) due to South Africa's policy of recruiting mine labor primarily from within South Africa. In 1971, 8 percent of Botswana resided outside the country, primarily in South Africa, and 80 percent of these were men; in 1981, only 4 percent of Botswana resided outside the country. In both 1971 and 1981, 2 percent of Botswana's population were foreigners.

The 1981 Agricultural Survey found that there were 31,400 female farmholders in Botswana, accounting for about 38 percent of all farmholders. Women constituted about one-third of the total farming households in each of the six regions, except in Francistown where they accounted for 50 percent of the total. Women also provide the bulk of labour for weeding. Yet women have the least access to the basic resources of draughtpower, equipment, land and cattle. Between 30 and 57 percent of female-headed households have no cattle, while only 19 percent of the male-headed households have none.¹

The per capita GNP was estimated at US\$ 902 in 1983, a figure higher than that of most of Botswana's developing neighbours. The Physical Quality of Life Index (POLI) was 44, on a par with



BOTSWANA: AGRICULTURAL RESEARCH RESOURCE ASSESSMENT

Figure 3: Population Distribution (1981 Census)

Source: Central Statistics Office, Ministry of Finance and Development Planning, Census Administrative/Technical Report and National Statistical Tables (Gaborone: Government Printer, 1983), p. 36.

BOTSWANA: AGRICULTURAL RESEARCH RESOURCE ASSESSMENT

Table 1: Social and Economic Indicators of Development

Indicator	Average Annual Growth Rate (percent)	Comment
Total Population ^a	3.1 - 4.6	Annual growth rate for this 10-year period is ostensibly 4.6 per cent. It is generally believed ^a that the 1971 census underestimated the population and a rate slightly less than 4.0 is more likely.
1981 census	940,000	
1971 census	585,000	
Percent of Total Population Living in Rural Areas ^a	4	In comparison, the urban population growth rate is approximately 11 percent per annum.
1981 census	83%	
1971 census	92%	
Percent of Labour Force Involved in Agriculture ^a		The actual number of persons involved in agriculture has increased by about 20 percent over the decade, whereas the overall population has increased between 35 and 45 percent.
1981 (IBRD)	79%	
1971 (IBRD)	83%	
Percent of Population Under 15 Years of Age ^a		
1981 census	47%	
1971 census	45%	
Percent of GDP Attributable to Agriculture ^a		The importance of agriculture has been greatly diminished in <u>relative</u> terms due to the growth of mining since 1969. There has also been, however, a negative growth rate in <u>real</u> terms of 4.5 percent per year.
1980-1981	12%	
1973-1974	34%	
Per Capita GDP ^b	7.9	This average annual growth rate is calculated for the years between 1960 and 1980. ^b
1983 (estimated US\$)	\$902	
Physical Quality of Life Index (PQLI) ^c	44	This figure is on par with most neighbouring countries, but about one-half that of most high-income countries. (The PQLI for the U.K. is 95 and for the U.S. 96.)

BOTSWANA: AGRICULTURAL RESEARCH RESOURCE ASSESSMENT

Table 1: Social and Economic Indicators of Development (cont.)

Indicator	Average Annual Growth Rate (percent)	Comment
Literacy ^c		
1983 (estimate)	33%	Literacy rate is measured among adults 15 years and older.
1972	20%	
Life Expectancy at Birth ^d		
1981	57 yrs.	
Volume of Agricultural Production, 1969-71 to 1977-79 ^c		
Food	1.1	
Non-Food	2.0	
Total Agricultural Production Per Capita, 1969-71 to 1977-79 ^d		
Food	-1.1	On a per capita basis, agricultural production has decreased over the years 1969-1979. The decrease is most marked in food production.
Non-Food	-0.2	
Food Self-Sufficiency Ratios ^e		
1964-1966 average	25	
1978-1980 average	37	

^aStatistics Office, Government of Botswana, Country Profile, 1982.

^bIBRD, World Development Report 1983 (Oxford University Press, 1983), p. 204.

^cJohn P. Lewis and Valeriana Kallab, eds., U.S. Foreign Policy and the Third World-Agenda 1983, Overseas Development Council (Praeger Publishers, 1983), pp. 212-213.

^dSingh, Sub-Saharan Agriculture-Synthesis and Trade Prospects, World Bank Working Paper Number 608 (World Bank, 1983), p. 26.

^eRatio = $\frac{\text{Production of cereals}}{\text{Production} = \text{imports} - \text{exports of cereals}}$ X 100. Formula and statistics from Sub-Saharan Agriculture- Synthesis and Trade Prospects, p. 30.

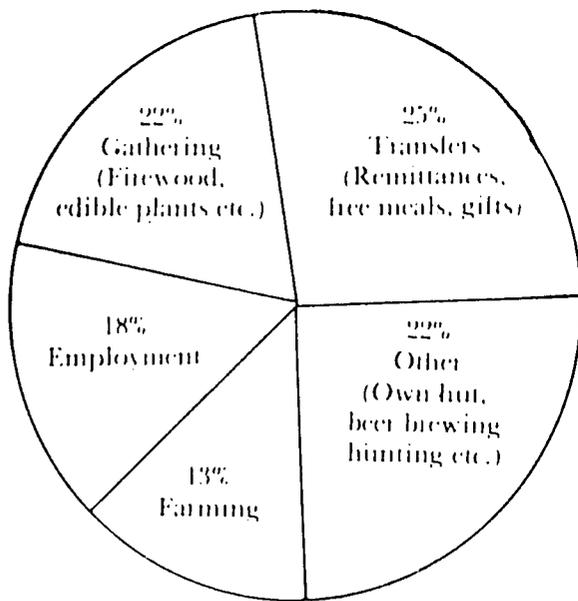
neighbouring countries, but less than half that of most higher-income countries.

2. Occupational patterns

Most of the people of Botswana, in both the urban and rural areas, are either unemployed or underemployed. The fact that the number of Botswana migrants employed in South Africa has diminished by more than half since 1976 adds to the existing problem, especially in urban areas. Those who have been dependent on the remittances received from their family members working in South Africa also have been adversely affected.

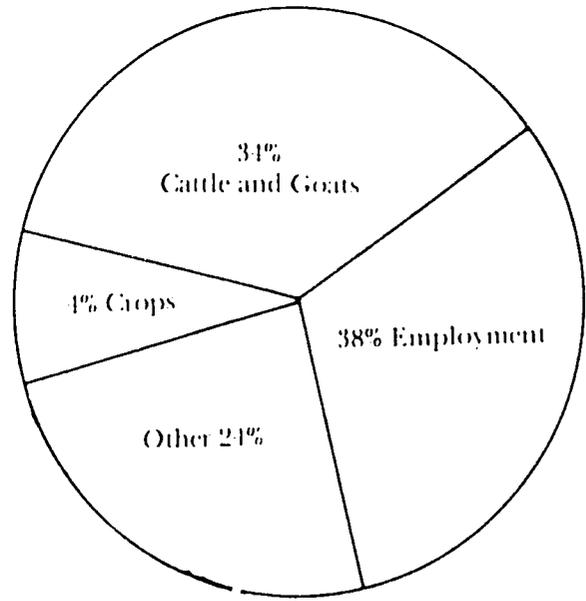
The labour force in Botswana is estimated to be growing at an annual rate of 3 percent. Wage-earners, those employed in the formal sector, constitute about 17 percent of the total labour force and about 10 percent of the population. They received approximately 37 percent of the GDP in 1979/80; on the other hand, the rural population (about 80 percent of the total) received only 12 percent of the GDP. The principal beneficiaries of Botswana's economic growth have been civil servants and those employed in the private sector. The public sector was the largest employer, providing 28 percent of the jobs in the formal sector. The government's share of formal sector jobs was followed by construction (16 percent), wholesale/retail trade and hotels (12.5 percent), and mining and quarrying (8.6 percent). The role of agriculture (freehold and commercial) has been insignificant (5.2 percent) in this sector. The mean monthly earnings of those employed in the formal sector differ significantly between citizens and non-citizens and between sectors. For instance, while the average monthly earning of citizens employed in agriculture was US\$ 38 in 1980, that of non-citizens in this sector was US\$ 442; in electricity and water the earnings were US\$ 185 and US\$ 1,559 for citizens and non-citizens respectively. The monthly earnings in government positions were also significantly different for citizens and non-citizens.

Employment in agriculture involves many Batswana, but most in this sector are underemployed even though they may work in a combination of agriculture and off-farm activities. Cattle, for example, provide no employment for the 30 percent of farm families (84,200 households) who do not own any cattle. Furthermore, 45 percent of the national herd of about three million cattle are owned by less than 10 percent of the farming households. The most disadvantaged in agriculture are women, the elderly and children. Consequently, most of them engage in a combination of risky agriculture and off-farm activities, such as beer-brewing, clothing production and basket-weaving. As a result of these and other disparities, farm income contributed only 13 percent of the total income of the poorest households while contributing 65 percent of the income of the richest households. (See Figure 4.) Off-farm activities contributed 44 percent to the income of the poorest households and less than 20 percent to the income of the richest ones.



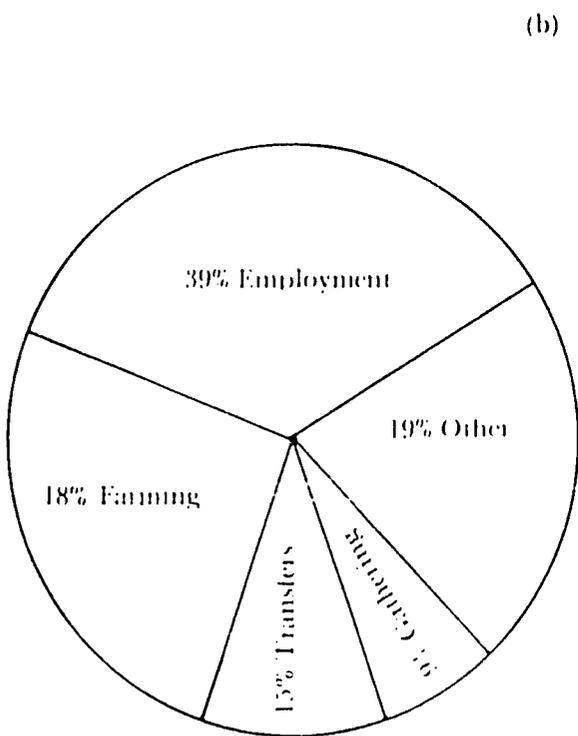
Poorest Households (lowest 10%)
Average income: P160 p.a.
(70% in kind)

(a)



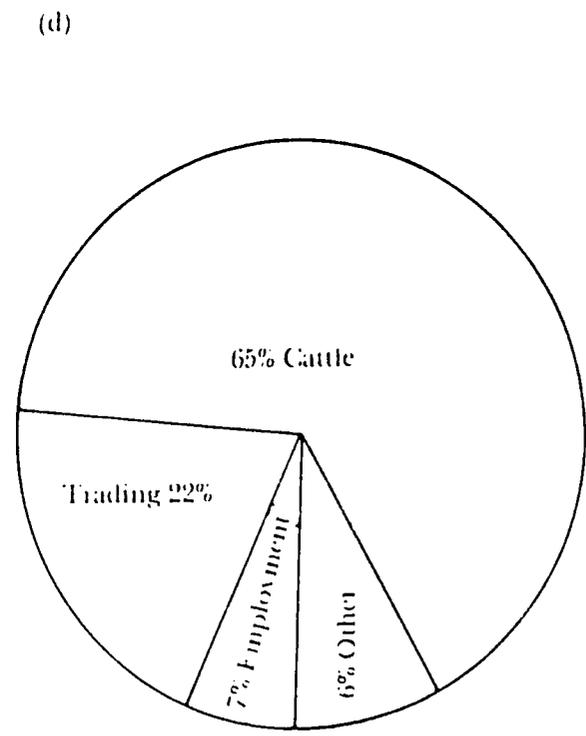
Upper Middle Income Households
(60-95 percentile)
Average income: P1 670 (40% in kind)

(c)



Lower Middle Income Households
(15-50 percentile)
Average income: P130 (50% in kind)

(b)



The Richest Households (99.0-99.9)
Average Income: P9 110 p.a. (30% in kind)

(d)

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Figure 4: Sources of Income of Rural Households

Source: Rural Income Distribution Survey from the Ministry of Finance and Development Planning, National Development Plan 1979-85 (Gaborone: Government Printer, 1980), p. 4.

3. Language and ethnic groups

Most of the citizens of Botswana are members of one of eight major Setswana-speaking tribes or clans. (The Tswana are a subgroup of the Sotho people, who share a common origin with other southern Bantu-speaking peoples.) Setswana and English are the official languages. The people are called Batswana in the plural; one person is called a Motswana. Minority groups include the Kalanga in the northeast, Bushmen and other semi-nomadic groups in remote areas, and the Herero in the west. There are also a small number of citizens of European origin.

4. Religion

The majority of the people subscribe to indigenous beliefs; about 15 percent are members of Christian religions.

5. Educational system

Of the primary school-aged children in Botswana, 93 percent are enrolled in primary school.

Although there has been an increase in educational opportunities for Batswana since Independence, secondary schools in Botswana still are able to absorb only about 30 percent of Standard 7 graduates into Form I. Thus, about one in five persons in the age group attend secondary school. A very small number of Batswana, about 1 percent of the age group, attend institutions of higher learning.

It has been estimated that about 35 percent of the adults in Botswana are literate in Setswana and 24 percent in English.

Technical training institutions include: the Botswana Agricultural College, which is discussed in Chapter IV of this report; Botswana Polytechnic which offers certificate and diploma courses in mechanical and electrical studies; and the Botswana National Health Institute which offers training courses at five Government hospitals for nurses and health care specialists.

Botswana has a National University located in Gaborone, which was established on July 1, 1982 as the University of Botswana. Some of the facilities formerly had been part of a Regional University with Swaziland and Lesotho. The National University offers degrees and diplomas in education, the humanities, basic sciences and social science. Three teacher training colleges, located at Francistown, Lobatse and Serowe, are affiliated with the University.

The inability of Botswana to provide more opportunities for higher education frustrates its efforts to localise posts. For instance, in 1980, 21 and 19 percent of the posts in the central government and the Ministry of Education, respectively, were held by expatriates. The dependence on expatriate staff and untrained teachers in the educational sector, in particular, has been very

serious. In 1981, about 43 percent of the 921 secondary school teachers were expatriates, and 34 percent of the 5,974 primary school teachers were untrained. The dependence on expatriate staff, especially in mathematics and science, may cause a lack of continuity and the inability of the country to design educational curricula appropriate for its development efforts. Even if the goals of the present National Development Plan for mathematics and science teachers are met, Botswana will still meet less than 30 percent of its requirements in these areas. The University prepares very few teachers of mathematics and the sciences. As in other developing countries, the education profession must compete with other professions--for example, engineering, medicine and agriculture--for science graduates.

C. Government and Political Framework

1. Structure of government and political parties

Botswana is a republic with a parliamentary democracy. It is also a non-racial and multi-party democracy which maintains freedom of speech, press and association. The Constitution provides for a unicameral legislature, the National Assembly. Members are elected from 32 constituencies. Membership is shared among the ruling Botswana Democratic Party, the Botswana National Front and the Botswana Peoples Party. However, there are additional legal parties which also participated in the recent elections for the Presidency and the National Assembly.

The President is the leader of the majority party and selects his Cabinet Ministers from members of the legislature.

Botswana also has a House of Chiefs with 15 members. The House of Chiefs has no legislative powers but advises on legislation affecting tribal matters.

An independent judiciary is presided over by the Chief Justice of the High Court. In addition, there are local Customary Courts which deal with cases based on customary law, and which are presided over by chiefs and headmen. More serious legal matters are considered in the Magistrates Courts, the Court of Appeal and the High Court.

The Central Government includes the following major units: The Office of the President; the Department of External Affairs; and the Ministries of Finance and Development Planning, Agriculture, Commerce and Industry, Education, Communications, Health, Home Affairs, Mineral Resources and Water Affairs, Local Government and Lands.

2. National budget

Botswana's fiscal practices are sound and conservative with recurrent revenues consistently exceeding expenditures. This has resulted in surpluses available for financing most of its capital

expenditures, with external grants and loans meeting the remaining capital requirements. The principal sources of government revenues are: rebates from the Southern Africa Customs Union; royalties, dividends and taxes from mineral sales; and corporate and personal income taxes. The 1981/1982 recurrent revenue was US\$ 267 (P 281 million) and recurrent expenditures totalled US\$ 189 million (P 199 million).² The capital expenditure was US\$ 132 million (P 139 million). US\$ 81 million (P 82 million) of this came from recurrent revenue, US\$ 36 million (P 38 million) from external grants, US\$ 11 million (P 12 million) from loans and US\$ 7.6 million (P 8 million) from a decrease in the cash balance.

3. Membership in international organisations

Botswana is a member of the United Nations and most of its specialised agencies. A former British protectorate, it is a member of the Commonwealth of Nations and of the European Economic Community. It is a member of Third World organisations, including the Lome Convention and the Nonaligned Movement. Botswana is active in associations of African nations including the Organization of African Unity, SADCC, the front-line nations, and the Southern African Customs Union. The SADCC secretariate is based in Gaborone.

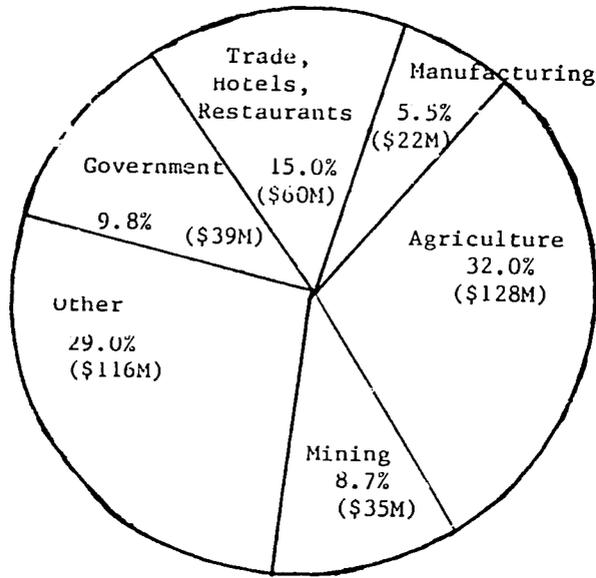
D. Economic Overview

1. General indicators

The Gross Domestic Product (GDP) of Botswana in 1980/81 was about US\$ 780 million (P 800 million). Twenty-six percent of the GDP came from mining, especially of diamonds and copper-nickel. Agriculture contributed only 12 percent to the GDP. This represents a significant change in the structure of the economy. (See Figure 5, which shows GDP by source.) From 1973/74 to 1980/81, the agricultural sector's contribution to the GDP declined from 34 percent to 12 percent, while the mining sector's share increased from 9 percent to 26 percent. However, agriculture also contributes to the manufacturing sector, which is dominated by the Botswana Meat Commission. The manufacturing sector's share of the GDP remained about the same (increasing from 5.5 percent to 6.0 percent) during this seven-year period. The trade, hotels and restaurants sector's contribution to the GDP rose from 15 percent to about 24 percent, and the government sector's contribution increased from 9.8 percent to 14 percent. According to the Government of Botswana Central Statistics Office, the real average annual growth rate of the GDP during this period was 10 percent. It was projected in the latest National Development Plan that the GDP will have increased in real terms by an average of 10.1 percent per year between 1979/80 and 1984/85.

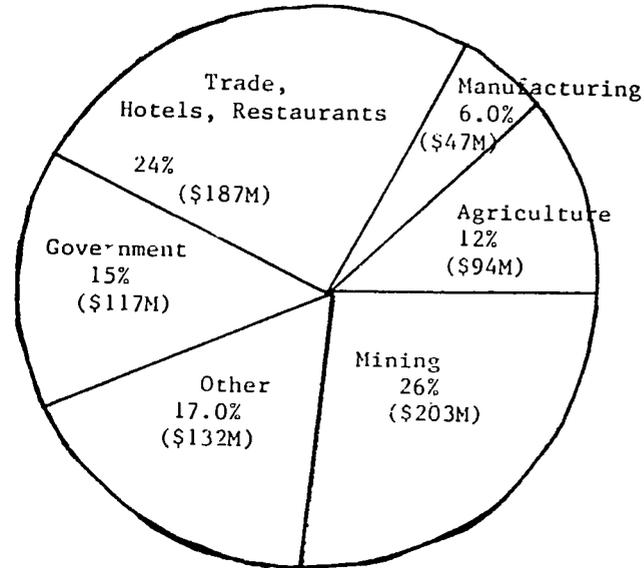
2. International trade

Botswana's export trade is dominated by diamonds (60.8 percent) and copper-nickel (20.7 percent). From 1978 to 1980 the



1973-74

TOTAL^a \$400 Million^b



1980-81

\$780 Million

Real Annual Average Growth Rate of GDP between 1973/1974 and 1980/1981 was 10% according to the GOB Central Statistics Office Report (1982). The large increase in the mineral production is the main reason for this high growth rate.

^a1981 Dollars.

^bThis figure was derived from the 1980/81 \$780 million figure and the known rate of 10 percent.

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Figure 5: GDP by Source

Source: Statistics Office, Government of Botswana, Country Profile, 1982.

share of exports contributed by minerals doubled from 41 percent to about 82 percent. During this time, agriculture's contribution decreased by almost 50 percent, from 14.7 percent to 8.0 percent, particularly because foot and mouth disease has adversely affected Botswana's beef exports.

Botswana's main imports in 1980 were food, beverages and tobacco (16 percent); fuel (13 percent); machinery, equipment and vehicles (27.2 percent); and metal and metal products (11 percent). The proportions of these items in relation to the country's total imports did not change significantly from 1978 to 1980.

Most of Botswana's import trade is with the Common Customs Area (South Africa, Lesotho and Swaziland), while its export market is largely in Europe, followed by North and South America. Botswana's trade with African nations other than members of the Common Customs Area is very insignificant. However, with the formation of the Southern African Development Coordination Conference (SADCC), it is hoped that trade with Africa will grow. Among SADCC's long-term goals are: reducing dependency on South Africa; increasing interstate economic and technical cooperation; and improving the use of scarce human and physical resources to the benefit of all while acknowledging the comparative advantage of each member state.

3. National Development Plan

The four major objectives of the fifth National Development Plan (1979-1985) are rapid economic growth, social justice (which implies an adequate income for all), economic independence and sustained development. Overall, the plan emphasised employment creation and rural development. Among the strategies to encourage production in rural areas are providing producers with access to markets through membership in the EEC and the Southern African Customs Union and, more directly, providing farmers with guaranteed market outlets through the Botswana Meat Commission and the Agricultural Marketing Board. Key elements of the Rural Development Strategy are the Tribal Grazing Land Policy and the Arable Lands Development Programme, which aim to increase the productivity of the traditional farmers.

The four aims of agricultural policy are: to help those involved in agriculture to enjoy adequate and secure livelihoods, to help create more such livelihoods to meet the demands of a growing labour force, to raise national income by increasing the value of agricultural production and to maintain agricultural land for future generations. At times there may be difficult choices between "small farmer" strategies that focus on employment (the first two aims) and "large farmer" strategies that focus on production or profitability (the latter two aims). The most difficult choice, however, is between small farmers and non-farmers who lack productive assets, a substantial part of the rural population, especially the female-headed households.

The Plan directed a shift in emphasis from livestock to arable farming because the opportunity for employment creation is greater in the latter and because of the need to reduce the nation's dependency on food imports. However, the Plan indicated that slightly more of governmental resources allocated to agriculture would be dedicated to livestock than to farming because the former constitutes 80 percent of agriculture's contribution to the GDP. In the livestock sector itself, land use and herd management in the communal areas were given priority.

4. External aid

The Government of Botswana sees that donor assistance is in accord with its national development spending priorities. In 1981-1982 most donor assistance focused on education and agriculture. Major bilateral donors, and total funds disbursed from 1978-1982 include: Germany with (US\$ 83.2 million), the United Kingdom with (US\$ 77.7 million), Sweden (US\$ 75.4 million), the United States (US\$ 60 million) and Norway (US\$ 47.2 million). Bilateral aid in 1982 totaled US\$ 84.1 million.³ Most assistance from international agencies has consisted of loans from the World Bank, the African Development Bank, and the EEC. The largest multilateral source of grants was the United Nations (UN), with US\$ 2.3 million having been given through the UN Development Programme (UNDP) in 1981-1982, and US\$ 10 million through other UN agencies. Bilateral aid, totaling US\$ 93 million in 1979, was 79 percent of total official development assistance received by Botswana. It was also 16 percent of the GNP and 52.6 percent of gross domestic investment in that year.⁴

5. Food aid

The Nutritional Surveillance System, which monitors monthly the conditions of children up to four years old, reports that over a quarter of Botswana children attending about 380 clinics in the country in a given month are nutritionally at risk. A high level of physical underdevelopment, exacerbated by protein calorie malnutrition, is also reported. Malnutrition among children is both seasonal and area-based. Serious malnutrition among children reaches its peak in November and December when food supplies are lowest, and falls in June and July during crop harvests. In drought years, however, the problem of malnutrition may be very critical if immediate outside food assistance is not readily available. Due to the current drought, a high percent of Botswana are receiving food aid.

E. Agriculture

1. Land use and tenure

As a result of the zoning exercise of the Tribal Grazing Land Policy (TGLP), about 12 percent of Botswana's surface area has been zoned as commercial, and 30 percent designated communal; the

eventual use of 25 percent is still undecided (See Table 2.) The remaining 33 percent is made up of land for game resources and wildlife management (27 percent), forests (1 percent), and existing freehold and leasehold farms (5 percent) which fall outside the scope of the TGLP land-zoning exercise.

Lands designated as communal and freehold are being used for both crop and livestock production. Land that has been designated commercial, however, is limited to cattle ranching. It can be developed for commercial cattle ranching by an individual or group by signing a 100-year renewable lease. All prospective cattle ranchers signing leases are expected to follow modern management techniques in order to make their ranches commercially viable units. Freehold farmers are also expected to use modern techniques. Rights of usufruct are granted to each member of district communities for the land zoned as commercial in that district.

The greater proportion of commercial, communal, unzoned, and free or leasehold land is presently used for livestock, although some of these areas are not fully exploited by livestock due to inadequate water supplies. It is also hoped that land that is not yet zoned can be used for commercial ranching when the need arises.

2. Principal agricultural production systems

a. Crop production

There are three basic production systems in Botswana: communal or traditional, commercial/freehold, and governmental⁵. In 1980, farmers in the traditional sector (those who produce crops principally for home consumption) accounted for 85 percent of food grain production, while the commercial farms contributed only 15 percent. (See Table 3.) The traditional sector accounted for 96 percent of all land planted in the major food crops (sorghum, maize, millet and beans/pulses). (See Table 4.) Production of the major cash crops (groundnuts and sunflowers) was about equal in the traditional and the commercial sectors (53 percent versus 47 percent, respectively). The commercial sector, however, accounted for 63 percent of the area planted in these crops. Commercial farmers enjoy a monopoly in the production of vegetables and citrus fruits.

In order to give some indication of the potential production resulting from application of improved technology in Botswana, estimated yields of the commercial and traditional sectors were compared with those of agricultural research stations. No attempt was made to conduct a comparative economic analysis of the systems that produced different yields. It was impossible to obtain yield estimates of certain crops from data available from various departments within the government.

Table 4 compares the yields of both food and non-food cash crops by production system. As would be expected, yields obtained from the

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Table 2: Land Zoning and Use

<u>Land Use Category</u>	<u>Area</u> (000 km ²)	<u>Percentage of Total</u>
Zoned Commercial	67.8	11.6
Zoned Communal	172.7	29.6
Not Yet Zoned	148.5	25.5
Free or Leasehold Farms	27.6	4.7
National Parks and Reserves	103.5	17.7
Wildlife Management Areas	63.0	10.8
TOTAL ^a	583.1 =====	100.0 =====

^aTotal differs slightly from Botswana's total area due to the disparate sources of land use data. Percentages have been rounded.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1983.

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Table 3: Attributes of the Traditional and Commercial Farm Sectors

	<u>Farms</u>		<u>Cattle</u>		<u>Smallstock</u>		<u>Food Crop^a Production</u>		<u>Cash Crop^b Production</u>	
	<u>Number</u>	<u>Percent</u>	<u>Thousand Head</u>	<u>Percent</u>	<u>Thousand Head</u>	<u>Percent</u>	<u>MT</u>	<u>Percent</u>	<u>MT</u>	<u>Percent</u>
Traditional Sector	80,000	99.6	2,455	84.3	758	96.4	38,105	85.1	903	32.2
Commercial Sector	360	0.4	456	15.7	28	3.6	6,695	14.9	1,897	67.8
TOTAL	80,360	100.0	2,911	100.0	786	100.0	44,800	100.0	2,800	100.0
	=====	=====	=====	=====	====	=====	=====	=====	=====	=====

^aIncludes sorghum, maize, millet and beans/pulses.

^bIncludes groundnuts and sunflowers only. Commercial farmers enjoy a virtual monopoly in the production of other cash crops such as cotton, citrus, etc.

Source: Agricultural Statistics Survey, 1980.

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Table 4: Area Planted, Production and Yields by Production System for Principal Crops, 1980-1981

	Area, 1981 ('000 ha)		Production, 1980 ('000 MT)		Production, 1981 ('000 MT)		Acreage Yields (kg/ha)				Optimum Research Yield, 1979
	Tradition- al Sector	Commercial Sector	Tradition- al Sector	Commercial Sector	Tradition- al Sector	Commercial Sector	Tradition- al Sector, 1980	Commercial Sector, 1980	Tradition- al Sector, 1981	Commercial Sector, 1981	
Sorghum	118.4	4.0	27.2	1.9	26.5	1.8	215	460	224	450	2,544
Maize	53.7	5.6	6.9	4.7	16.4	5.0	167	907	306	893	2,728
Millet	12.6	0.1	2.3	-	1.8	0.06	NA ^a	NA	144	600	- NA
Beans/ pulses	<u>14.5</u>	<u>0.2</u>	<u>1.8</u>	<u>0.05</u>	<u>2.6</u>	<u>0.1</u>	144	250	176	700	1,303
Subtotal, ^b Food Crops	199.2	9.9	38.1	6.7	47.3	7.0	-	-	-	-	-
Sunflower	1.0	1.9	0.2	1.2	0.4 ^c	0.4 ^c	151	367	385	508	1,000
Groundnuts	<u>1.7</u>	<u>2.6</u>	<u>0.7</u>	<u>0.7</u>	<u>0.7^c</u>	<u>0.7^c</u>	116	515	416 ^c	416 ^c	1,119
Subtotal, ^b Cash Crops	<u>2.7</u>	<u>4.5</u>	<u>0.9</u>	<u>1.9</u>	<u>1.1</u>	<u>1.1</u>	-	-	-	-	-
Total ^b	<u>201.9</u>	<u>14.4</u>	<u>39.0</u>	<u>8.6</u>	<u>48.3</u>	<u>8.1</u>					

^aNA = Not Available.

^bInconsistencies due to rounding.

^cFigures appear questionable; may be in error.

Sources: Central Statistics Office, Ministry of Finance and Development Planning, Country Profile, Botswana, October 1982; Agricultural Statistics Survey, 1980; Division of Arable Research, Department of Agricultural Research, Annual Report, 1979/80.

government research station experimental plots and fields were considerably higher than those of the traditional and commercial sectors. When yields of the commercial and traditional systems were compared, it was found that yields in the commercial sector were higher than in the traditional sector by a factor of two or more to one in all the crops. While the sorghum yield in the traditional sector is half that of the commercial sector, maize yield from the traditional sector was only one-fifth that of the commercial sector.

Although these results reflect performances of the various production systems, they do not necessarily mean that one sector is more efficient than the other. For instance, it would be inaccurate to suggest that the commercial sector is more economically efficient in grain production than the traditional sector. Unless the physical, technical, social, and economic circumstances of each system are analysed and understood, conclusions about economically feasible yields would be unwarranted. There are few instances in Botswana where experiment station research results have been evaluated on farmer fields to determine their appropriateness and cost-effectiveness. Almost all the commercial farmers and the government research stations utilise modern inputs, such as fertiliser and hybrid seeds, and other modern methods of farming. Their resource base is very different from that of the majority of small farmers in the traditional sectors, who rarely use fertiliser or hybrid seeds. They resist using hybrid seeds, partly because of palatability; many still prefer the long-maturing local varieties.

Insufficient labour is a major constraint to increased agricultural productivity. The lack of available labour during critical periods, e.g., for ploughing, planting, weeding and bird-scaring, is perceived by farmers as partly responsible for poor agricultural production. Yet, due in part to long periods of slack labour demand, there has been considerable migration from the rural districts to urban centres. Most of the people who migrate are able-bodied males between the ages of 15 and 34, who could best contribute their productive labour to agriculture.

A majority (70.9 percent) of farmholders, however, use draught animals for cultivation. An additional 16.4 percent use tractors. Even so, 95.4 percent rely on broadcasting for planting their crops.⁶

The Arable Lands Development Programme (ALDEP) is designed to improve the resource base of the majority of small farmers, hopefully enabling them to adopt modern agricultural practices. For instance, ALDEP will subsidise small farmers to purchase draughtpower, farm implements, and fencing material, improving their basic resources. In addition, grain pricing policies are being designed to encourage more production. The comparative average yields of Table 4 suggest that, even in the difficult ecological situation in Botswana, the technical limits of production for both the traditional and the commercial sectors are much higher than what is currently attained. Achieving higher yields in either sector will depend on the availability of

improved technical packages that take into account the economic and other constraints facing each sector. However, if it were possible to double the sorghum yield in the traditional sector from 225 to 450 kg/ha, this would contribute greatly to the welfare of the rural population. Since a majority of the total production is by the traditional sector, even this moderate increase would contribute greatly to the achievement of national food security goals.

b. Livestock production

Communal, commercial and governmental production systems are also utilised in raising livestock. In 1980, traditional farm households, accounting for 99.6 percent of all farming households in Botswana, owned 84 percent of the cattle and 96.4 percent of the smallstock. The commercial sector, with less than 1 percent of the farming community, owned 16 percent and 3.6 percent of cattle and smallstock, respectively. (See Table 3.)

The differences in productivity between these systems were not as great in livestock production as in crop production. In general, commercial farmers and the government research stations use better husbandry methods than traditional farmers. They take frequent disease and parasite control measures; use better grazing systems, especially rotation; provide feed supplements and a regular water supply; and maintain a better bull/cow ratio. Some of these methods are not practiced by small farmers due to their circumstances. For example, disease control is difficult in the unfenced areas of communal land.

3. Wildlife and forestry

Although forestry is unlikely ever to contribute significantly to the economy (only 1 percent of Botswana is forested), the plant and animal genetic resources of the Kalahari Desert could prove immensely valuable in the long-term development of Botswana's agricultural productivity.

4. Agricultural marketing and credit

a. Marketing

(1) Crops

While small-scale farmers sell food crops among themselves, the government-owned Botswana Agricultural Marketing Board (BAMB) is responsible for marketing both food and non-food crops in Botswana. The BAMB markets through agencies and branches throughout the country. Its policy takes into account the transportation costs of each zone: those areas nearer the railway line receive lower prices than remote areas, in order to encourage production in the latter. For cereals, the Board pays producers the price it would cost

to import the commodity into the country. For oil seeds, producers are paid the export price, less transport and handling costs.

Among farmers, bartering is sometimes practiced. For instance, four 70 kg bags of sorghum can be exchanged for a cow.

(2) Livestock

While a few small-scale livestock producers sell some of their livestock to local traders and butcheries, the government-owned Botswana Meat Commission (BMC) is responsible for almost all marketing of livestock in the country. The BMC also is responsible for exporting beef, Botswana's major agricultural export item, to the European Common Market and other countries. Cattle are trekked, trucked or railed to Lobatse for slaughter. While there is a new abattoir in the Northwest (Maun) which also slaughters cattle, its beef is not destined for the EEC. Smallstock marketing to BMC is very insignificant.

b. Credit

Credit is available to farmers through the National Development Bank. Most loans, however, are in the livestock sector. Ranchers can use their cattle as collateral, and greater potential for cash returns exists through the well-developed export marketing system for beef.

For related reasons, farmer investment in fertiliser is very low. Farmers in Botswana use an average of only two kg of fertiliser per ha.

5. Food security

Meeting national food security objectives in Botswana has special significance for research and associated services, as it will require that the capability of the traditional sector for increased food output be improved dramatically. Of the 84,560 farms reported in 1981 Agricultural Statistics, only 360 were classified as commercial farms. The output of the traditional sector represented 99 percent of the cattle production, 93 percent of the sorghum, 76 percent of the maize and virtually all of the millet, beans and pulses production of the nation. Almost all the rural population live and work in this sector.

Despite low annual offtake from the national cattle herd, the traditional sector, because of its predominance in the total cattle sector, contributes greatly to the GNP through the export of beef. On the other hand, crop production from this sector is almost totally consumed within the sector, yielding little marketable surplus for urban consumption or for export. Average yields of food crops in this sector are among the lowest in Africa. If, for example, average yields of sorghum by farmers in the traditional sector were increased to 450 kg/ha, which appears achievable, national output of this crop would be increased by 25,000 MT.

This emphasis on the traditional sector also supports the possibility of generating increased per capita incomes to reduce dependence on employment in South African mines, which has declined in recent years. Reduction in the rate of rural to urban migration would likewise reduce pressure on available food supplies, housing and other services in the urban centres. Prospects for the traditional sector's producing a sizeable marketable surplus for urban consumption are highly dependent on the ability of the research institutions to fashion adaptable technologies, not only for production, but also for storage, marketing and other problem areas.

6. Ministry responsible for agriculture

The Ministry of Agriculture (MOA) was organised in 1935, combining in one ministry the Departments of Agriculture and of Veterinary Services. Since then MOA has undergone several changes in organisation. At the present time, the principal divisions are the Department of Agricultural Research (DAR), the Department of Agricultural Field Services (DAFS) and the Department of Animal Health (DAH). Each of the three divisions, in addition to its primary responsibility, also has assigned to it service and other functions. For example, the DAR, in addition to research, has responsibility for seed multiplication. The DAFS, whose primary role is extension, also has responsibility for handling certain input distribution tasks, especially at the field level. Likewise, the DAH, whose chief responsibility is the national animal health programme, also provides local livestock advisory (extension) services.

¹Central Statistics Office, Botswana Ministry of Finance and Development Planning, Country Profile: Botswana, October, 1982.

²Based on the 1982 official exchange rate of approximately 1 pula equals .95 US dollars.

³United States Agency for International Development, Congressional Presentation, Fiscal Year 1985, Annex I: Africa (Washington, DC: GPO, 1984) p. 475.

⁴The World Bank, Accelerated Development in Sub-Saharan Africa: An Agenda for Action, (Washington, DC: The World Bank, 1981), pp. 164-65.

⁵Commercial production here includes both farmers in the communal areas who farm commercially and those with freehold farms. The "government" system refers to improve management practiced on research farms, which does not contribute directly to Botswana's agricultural production.

⁶Central Statistics Office, Botswana Ministry of Finance and Development Planning, Country Profile: Botswana, October, 1982.

III. AGRICULTURAL RESEARCH INSTITUTION

A. Overview of Agricultural Research in Botswana

All ongoing agricultural research currently being conducted in Botswana is done by the Department of Agricultural Research (DAR) of the Ministry of Agriculture. In this chapter, therefore, only the DAR will be discussed. However, at times, other research projects related to agriculture may be carried out by the National Institute of Research or by the University of Botswana.

B. The Department of Agricultural Research

1. Organisational structure and purpose

The Department of Agricultural Research (DAR) of the Ministry of Agriculture (MOA) is responsible for developing and testing agricultural technology appropriate to the problems of farmers and in concert with the national goal of increased food production and a better standard of life for all. The severe ecological and natural resource constraints of Botswana make this task among the most difficult and challenging of all national development goals to achieve.

The DAR headquarters and major facilities are located at Sebele, about 10 km north of Gaborone. Substations are located at Mahalapye (Central District) where farming systems research is a principal activity; at Goodhope (Southern District) where dryland farming research is a major activity; and at Maun (Northwest District) where research in flood recessional agriculture, water control and land development are major areas of investigation. (See Table 5.) The substations provide limited facilities for extending research activities to other agro-ecological zones. In addition to these substations, there is a network of 18 beef cattle ranches and two communal grazing areas in the principal cattle-producing areas, which provides field test sites for the animal production and range management research programmes.

The department consists of four administrative units under the Director: the Arable Research Programme Unit (ARPU); the Animal Production Research Unit (APRU); the Estate Management Unit; and the Laboratory Services Unit. (See Figure 6.)

2. Research programmes

Livestock research and, more recently, food crop research have been the DAR's principal emphases since Independence. The two major research programme areas of the DAR are livestock (both beef and dairy cattle, and small stock, except poultry) and the major food crops (sorghum, maize, millet and beans/pulses).

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Table 5: Agricultural Research Institutions: Funding, Location, Activities and Staff, 1984

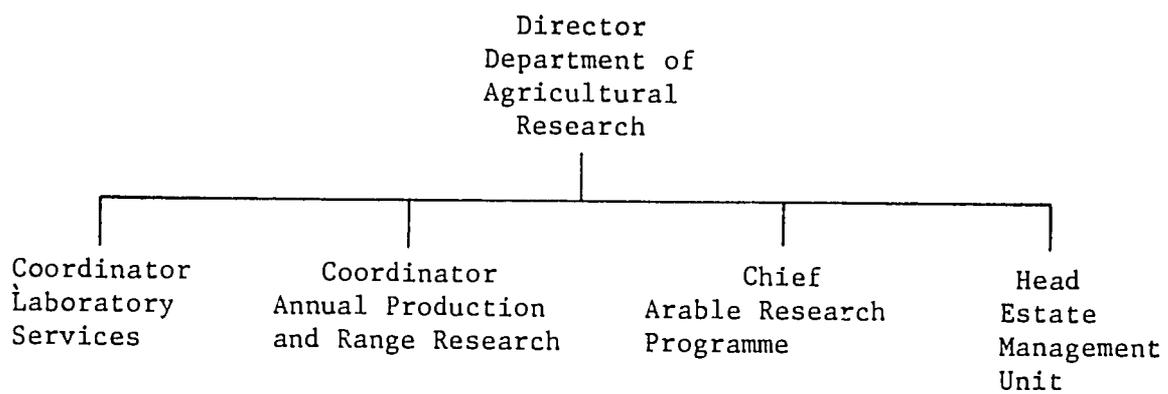
<u>Institution</u>	<u>Funding</u>		<u>Location</u>	<u>Principal Research Activities</u>	<u>Number of Staff</u>				
	<u>Source</u>	<u>Amount (US\$)</u>			<u>Professional^a</u>	<u>Adminis-trative</u>	<u>Technical^b</u>	<u>Support Services</u>	<u>Total</u>
Dept. of Agricultural Research	GOB	2,586,632	Gaborone	Headquarters (Administration plus dryland crop and farming systems research)	35	10	24	30	99
	Donors : USAID	68,243 ^c							
	FAO		Good Hope	Dryland crop research	-	-	-	2	2
	U.K.		Mahalapye	Dryland crop and farming systems research	-	1	2	1	4
	SIDA		Maun	Dryland crop research, Malapo Development	4	3	2	3	12
			APRU Ranches (20 ranches)	Range research and beef production	-	-	2	26	28
			Francistown	Farming systems	4	1	2	-	7
TOTAL		<u>2,654,875</u>			<u>46</u>	<u>15</u>	<u>32</u>	<u>62</u>	<u>155</u>

30

^aProfessional = BSc degree or above.

^bTechnical = diplomate.

^cCurrent figure is not typical because several major projects have been recently completed and proposed projects have not yet been funded.



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Figure 6: Organisation Chart of the Department of Agricultural Research

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1983.

a. Animal production and range research activities

The Animal Production and Range Research programme was formally organised in 1970, though there had been earlier efforts by the MOA to improve the production of livestock, especially cattle, through better use of range resources. The following are the programmes of the Animal Production Research Unit (APRU).

(1) Animal breeding and breed evaluation

This is a long-term programme which has as its main objectives: (1) the evaluation, through performance testing, of the major, locally available breed types to determine their qualities; (2) continued performance testing and selection of superior types for further improvement; and (3) exploitation of heterosis effects through crossbreeding. The programme now is focusing on the development of an adaptable composite breed, well suited to the Botswana range environment and ecology.

(2) Animal nutrition

This is another long-term programme which has collected background data on the impact of various kinds of nutritional stress on livestock production. It is also analysing the potential of crop residues and "purpose" summer fodder for animal feed.

(3) Range management and range/pasture improvement

The range management and pasture improvement programme is still another long-term activity. Included in this research are the following main components: (1) evaluating grazing systems and stocking rates, both for commercial and for tribal land environments; (2) evaluating both annual and perennial grass species, and field testing methods of introducing useful grasses into the range, including developing recommended packages of practises; and (3) evaluating costs and benefits of alternative techniques of range bush control.

(4) Animal production standards

Management standards which make possible the utilisation of the range management and breeding research results by producers have been developed over time. While this "reasonably acceptable" level of management is still being refined by new research findings, the recommendations are now provided to both commercial and traditional (cattle post) producers.

(5) Range monitoring

Monitoring of the quality and quantity of forage and other growth on range land has been a cooperative effort of the Division of Land Utilisation and the Department of Agricultural Field Services. While these units have been responsible for gathering the data through survey techniques, the analysis of the data has been the responsibility of the APRU of the DAR. The programme is now under careful review to determine its long-term utility and to ascertain if there are more cost-effective techniques of data collecting.

(6) Dairy development

The purpose of the recently-proposed dairy development activity will be to introduce innovative management techniques, tailored to the capability of smallholders, for milk and milk by-product production. It is proposed to develop package recommendations including information on breed identification, types of fodder useful for dairy cattle, and animal and pasture management. The GOB has already allocated its funds for this activity and expects to receive additional donor support.

(7) Joint ILCA/APRU Project

The ILCA/APRU Project is a joint project between the International Livestock Centre for Africa (ILCA) and the Ministry of Agriculture's Animal Production Research Unit (APRU). It is a two-year project that is scheduled to terminate by the end of 1984. About US\$ 160,000 has been allocated to the project by the ILCA and GOB, who provided 20 and 80 percent of the project's funds, respectively. Its main objective is to assess grazing resources in the communal areas which will lead to better utilisation of local grazing resources. The project already has gathered information on cattle populations, distribution and movements as related to range and environmental resources.

b. Arable research programme activities

(1) Variety trials

Each year the DAR conducts performance tests on varieties of the major cereals grown in Botswana. These trials are conducted at five locations representing different ecological and climatic areas. Factors such as yield, tillering, drought tolerance, maturity date, and insect and disease resistance are measured. Farmer recommendations are developed, based on the research results.

Results of previous trials revealed that varieties and hybrids developed for conditions outside Botswana do not produce as well in Botswana as locally selected ones. As a result, a sorghum and millet breeding programme has not been initiated to raise the productivity of these two cereal crops through improved varieties.

(2) Dryland Farming Research Scheme

The Dryland Farming Research Scheme project, which started in 1970, has just been completed. Its main objective was to improve dryland crop productivity through population studies and a better understanding of the soil, crop physiology, and water conservation techniques. It has provided a substantial data base on agronomic-soils-moisture-management relationships.

(3) Ngamiland Agricultural Development Project

The Ngamiland Agricultural Development Project, started in 1979, is scheduled to phase out in 1985. Based in the northwest part of the country, along the Okavango Delta, it has received about US\$ 1 million in support from the Swedish Agency for Research Cooperation with Developing Countries (SAREC). The project has included a strong survey component and is endeavoring to develop alternative technological packages for several categories of producers, based on factors such as herd size and land access.

(4) Agricultural Technology and Improvement Project

The Agricultural Technology and Improvement Project is one of the farming systems projects of the DAR. It was initiated in 1981; the present activity is scheduled for completion in 1989. The project concentrates its efforts in the eastern part of the country, in the Mahalapye, Shoshong and Francistown-Tutume areas. It is now establishing its data base and developing close coordination between research and extension staff and programmes in its areas of operation. The life-of-project funding of about US\$ 9 million is provided by the GOB and USAID, for 25 and 75 percent, respectively.

(5) Evaluation of Farming Systems and Agricultural Implements Project

The Evaluation of Farming Systems and Agricultural Implements Project (EFSAIP) started in 1976 and terminated in March 1984, at which time the Botswana counterparts were incorporated into the regular projects of the DAR or into a new farm machinery development unit. This new activity will move the testing of implements directly to farmers' fields. Many farmers who participated in the EFSAIP project were most reluctant to give up the equipment and purchased it. About US\$ 800,000 was allocated to the EFSAIP by the UK.

(6) FAO/Melapo project

The first phase of the FAO/Molapo project, started in 1973, is now completed. The FAO contributed about US\$ 1.2 million during the ten-year life of the project. Its major objective was to improve the productivity of smallholders on the Okavanga Delta's Malapo floodplain. It included research and testing of improved water conservation and tillage practices. The activity is now continued in

a new five year project funded by the GTZ. While this new project is administered by the DAFS and is more development- than research-oriented, the DAR will continue to contribute staff time and expertise to it.

(7) Horticulture research

The horticulture research conducted by the DAR includes testing of varieties of vegetables under Botswana conditions. There is an economic analysis component which is working on marketing studies and production economics.

(8) Cowpea improvement

This new project, started in 1982-83, is one of two DAR projects funded by USAID and identified as a Collaborative Research Support Project (CRSP). There are 18 Latin American and African countries with bean/cowpea CRSPs. The Botswana project is carried out in collaboration with Colorado State University which is currently providing approximately US\$ 20,000 and six person-years of technical assistance. Its objectives are to perform field testing and variety improvement, and to examine soil and water management practices and harvesting techniques. Training of Botswana researchers is also an important aspect of the project.

(9) International Sorghum and Millet Project

The new International Sorghum and Millet (INTSORMIL) Project is also an USAID-funded CRSP. The University of Nebraska is coordinating this CRSP research programme, which has projects in 13 countries and collaborates with several International Agricultural Research Centres. Its objectives are to strengthen linkages between institutions interested in sorghum and millet research, to mobilise and coordinate research talent and to assist in information exchange. INTSORMIL supports the training of Botswana scientists who are working in sorghum and millet research programmes. Its initial effort will be a three-year programme with a grant of US\$ 450,000.

(10) Other minor research activities

There are four other, ongoing, small research projects: studies on legume-cereal rotations; research on fertiliser requirements for arable production; research on sunflower production potential; and groundnuts.

3. Human resources

a. Staffing patterns

The number of administrative, professional, technical and support staff of the DAR are shown in Table 6. The DAR has

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Table 6: Total Agricultural Research Staff, 1984

	<u>Administrative</u>	<u>Professional^a</u>	<u>Technical^b</u>	<u>Support Staff</u>	<u>Total</u>
<u>Total Authorized Posts</u>	14	31	34	75	154
<u>Positions Vacant</u>	2	1	2	17	22
<u>Nationals (Citizens)</u>					
Staff in training	-	14	-	-	14
Staff on long-term leave ^c	-	-	-	-	-
Number of nationals currently in posts	12	17	32	58	119
Expressed as a percent of authorized posts	86	55	94	77	77
<u>Expatriates</u>					
Serving in authorized posts ^d	2	14	-	-	16
Expressed as a percent of authorized posts	14	45	-	-	9
Not in authorized posts	1	15	-	4	20
Total number of expatriates	3	29	-	4	36
<u>Total Number of Staff</u>	<u>15</u>	<u>46</u>	<u>32</u>	<u>62</u>	<u>155</u>

^aProfessional = BSc or above.

^bTechnical = diplomate.

^cLong-term leave is leave of three months or more.

^dIrrespective of source of funds.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

increased the number of its research personnel considerably over the last few years, and now consists of 61 professionals and administrators. The DAR is heavily dependent on expatriates: currently, the Director of the Department and the heads of the divisions and projects are all expatriates. However, the Estate Management unit, the administrative support staff, and the laboratory are supervised by Botswana citizens. In total, expatriates now occupy more than one-half of the administrative and professional positions in the DAR.

Nationals who are qualified and experienced in research build programme continuity. Expatriate staff have short tenure within projects, often staying for no more than two to three years. Staff changes can be disruptive to the project focus and to the achievement of its objectives. Localisation of the DAR staff has been particularly difficult because of the scarcity of students in Botswana who have science credentials at the senior secondary level, which is a necessary prerequisite for training in professional agriculture.

The programme area foci of the professional resources of the DAR are shown in Table 7. Thirty-five percent of the staff effort is dedicated to food crops, principally sorghum, 27 percent to farming systems research, and 24 percent to livestock and range management. The academic training of professionals working in the various programme areas is shown in Table 8.

Table 9 summarises the disciplines of the professional staff of the DAR. There are 11 nationals trained to the Master's level; none have PhDs at this time. Few nationals are represented in the disciplines of agricultural engineering and veterinary science.

b. Staff training

The plans for training DAR staff are shown in Table 10. Although 14 DAR staff members are currently receiving degree-level training, the impact is likely to be minimal in the next few years because of the long training periods required. Eight of the 14 staff studying for degrees are studying agronomy and crop-related subjects; five are studying livestock or range management and one is in training as a horticulturalist. The areas of agricultural engineering, veterinary science and economics/social science need to be strengthened.

Over the next five years, the DAR plans to add additional staff persons trained in the various disciplines at needed academic levels. Because of the lack of in-country training facilities for degree and professional specialties, these persons will need to be trained in the developed countries. There is no provision to train local persons as veterinarians in the DAR. The DAR plans to train almost twice as many senior agriculture crop scientists as livestock specialists. In addition, no economists and social scientists are included in the projected plans of the DAR.

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Table 7: Summary of Professional Staff Effort and Source of Funds by Programme Area of Agricultural Research, 1984^a

<u>Commodity-Related Programme Areas</u>	<u>FTE^b</u>	<u>Source of Funds^c</u>	<u>Percentage of National Research Effort</u>
<u>Food Crops</u>			
Maize	1	USAID	2
Sorghum	11	UK	18
Millet	1	USAID	2
Pulses	5	USAID	8
Fruit/Vegetables	2	Voluntary Agencies	3
Oilseeds	<u>1</u>	France	<u>2</u>
Subtotal, Food Crops	<u>21</u>		<u>35</u>
<u>Livestock/Range</u>			
Beef cattle	3	FAO	5
Dairy cattle	3		5
Sheep	1		2
Goats	1		2
Range management	<u>6</u>		<u>10</u>
Subtotal, Livestock/Range	<u>14</u>		<u>24</u>
<u>Other Programme Areas</u>			
Farming systems	17	USAID, SIDA, UK	27
Land/water conservation	2		3
Farm power	1	UK	2
Seed technology	2	USAID	3
Soil analysis	2		3
Data processing	<u>2</u>		<u>3</u>
Subtotal, Other Programme Areas	<u>26</u>		<u>42</u>
TOTAL	<u>61</u>		<u>100</u>

^aProfessional staff are those with a BSc degree or above; includes administrative staff.

^bFTE = Full Time Equivalent.

^cThe Government of Botswana provides funding for all of the programmes. Additional funding is provided by the outside donor sources listed.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

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Table 8: Disciplines of Professional Staff Related to Agricultural Research Programme Area, 1984

<u>Programme Area</u>	<u>Discipline Areas</u>	<u>Number of Professionals</u>						<u>Total</u>
		<u>Nationals</u>			<u>Expatriates</u>			
		<u>BSc</u>	<u>MSc</u>	<u>PhD</u>	<u>BSc</u>	<u>MSc</u>	<u>PhD</u>	
<u>Food Crops</u>								
Maize	Agronomy, crop physiology, entomology, horticulture, and soils	-	1	-	-	-	-	1
Sorghum		2	2	-	-	2	5	11
Millet		-	1	-	-	-	-	1
Pulses		-	2	-	2	-	1	5
Fruit/Vegetables		-	-	-	1	1	-	2
Oilseeds		-	-	-	-	1	-	1
Subtotal, Food Crops		<u>4</u>	<u>4</u>	<u>-</u>	<u>3</u>	<u>4</u>	<u>6</u>	<u>21</u>
<u>Livestock/Range</u>								
Beef cattle	Animal nutrition, pathology, production, and range ecology	1	1	-	-	-	1	3
Dairy cattle		2	-	-	-	-	1	3
Sheep		1	-	-	-	-	-	1
Goats		-	1	-	-	-	-	1
Range management		<u>2</u>	<u>1</u>	<u>-</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>6</u>
Subtotal, Livestock/ Range		<u>6</u>	<u>3</u>	<u>-</u>	<u>1</u>	<u>1</u>	<u>3</u>	<u>14</u>

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Table 8: Disciplines of Professional Staff Related to Agricultural Research Programme Area, 1984 (cont.)

<u>Programme Area</u>	<u>Discipline Areas</u>	<u>Number of Professionals</u>						<u>Total</u>
		<u>Nationals</u>			<u>Expatriates</u>			
		<u>BSc</u>	<u>MSc</u>	<u>PhD</u>	<u>BSc</u>	<u>MSc</u>	<u>PhD</u>	
<u>Other Programmes</u>								
Farming systems	Agr. economics	6	3	-	-	2	6	17
Land/water conservation	Agr. engineering	-	-	-	-	2	-	2
Farm power	Agronomy, soils	-	-	-	1	-	-	1
Seed technology	Seed technology	1	-	-	1	-	-	2
Soil analysis		-	1	-	-	-	1	2
Data processing		1	-	-	-	-	1	2
Subtotal, Other Programmes		<u>8</u>	<u>4</u>	<u>-</u>	<u>2</u>	<u>4</u>	<u>8</u>	<u>26</u>
TOTAL		<u>18</u>	<u>11</u>	<u>-</u>	<u>6</u>	<u>9</u>	<u>17</u>	<u>61</u>

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

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Table 9: Summary of Technical Skills of Agricultural Research Professionals by Degree Held, 1984

Discipline Areas	Nationals							Expatriates							Total		
	BSc		MSc		PhD		Subtotal		BSc		MSc		PhD			Subtotal	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M		F	M
<u>Plant/Soil Science</u>																	
Crop breeding	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	1
Agronomy	2	3	1	2	-	-	3	5	-	2	-	3	-	7	-	12	20
Crop physiology	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1
Entomology	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1	2
Horticulture	-	1	-	1	-	-	-	2	-	-	-	1	-	-	-	1	3
Range ecology	-	3	-	-	-	-	-	3	-	-	-	1	-	1	-	2	5
Seed technology	-	2	-	-	-	-	-	2	-	1	-	-	-	-	-	1	3
Soils	-	1	-	1	-	-	-	2	-	-	-	-	-	2	-	2	4
<u>Animal Sciences</u>																	
Animal nutrition	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	1
Animal pathology	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1
Animal production	1	2	-	-	-	-	1	2	-	1	-	1	-	2	-	4	7
<u>Other Discipline/Fields</u>																	
Agr. economics	-	-	-	3	-	-	-	3	-	-	-	2	-	2	-	4	7
Agr. engineering	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-	1	2
Statistics	1	-	-	-	-	-	1	-	1	-	-	-	1	-	2	-	3
Water development	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Subtotal, F/M	4	14	1	10	-	-	5	24	1	5	-	9	1	16	2	30	61
TOTAL	<u>18</u>		<u>11</u>		<u>-</u>		<u>29</u>		<u>6</u>		<u>9</u>		<u>17</u>		<u>32</u>		<u>61</u>

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

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Table 10: Training Plans for Staff of Research Institutions, 1984

<u>Level</u>	<u>in-country</u>	<u>In Africa</u>	<u>Outside Africa</u>	<u>Total</u>
<u>Current Situation</u>				
Doctorate	-	-	4 ^a	4
Masters	-	-	5 ^b	5
Bachelors	-	-	5 ^c	5
Diploma	7	-	-	7
Special skills	-	3	-	3
Subtotal, Current Situation	<u>7</u>	<u>3</u>	<u>14</u>	<u>24</u>
<u>Future Plans for Training^d</u>				
Doctorate	-	-	5	5
Masters	-	-	10	10
Bachelors	-	-	10	10
Diploma	<u>30</u>	-	-	<u>30</u>
Subtotal, Future Plans	<u>30</u>	-	<u>25</u>	<u>55</u>

^aOne each in entomology and plant physiology; two in animal breeding.

^bOne each in plant pathology, range science, cowpea agronomy, plant physiology and seed t

^cOne each in animal science, horticulture, range science; two in agronomy.

^dDisciplines not specified.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

4. Research facilities

a. Buildings

Several new buildings have just been completed for the DAR. The Department now has seven laboratories, with a total floor space of approximately 500 m². All are in good to excellent condition, with the exception of the crop physiology laboratory which needs some improvement. These laboratories are used for soil and plant analysis, and for entomology, plant pathology, seed technology, rumen concentrate analysis and crop physiology investigations. In addition, the DAR has three greenhouses in good condition, with a total floor space of about 580 m². There are five offices used for administration; while the one at headquarters is in good condition, the four countryside offices are in poor condition. There are also three workshops (for maintenance, farm implements storage and implements fabrication) and a seed processing plant. The workshops are in only fair condition, while the seed processing plant is in good condition. There is also a clinic, a consumer cooperative shop and a primary school.

b. Equipment

Besides laboratories, greenhouses, offices and workshops, the DAR has a substantial complement of equipment, including 24 trucks, 30 four-wheel drive vehicles, 17 tractors and associated tools. Laboratory and field equipment include a plot planter and thresher, forage digester and dryer, ultra-centrifuge and germination cabinet.

c. Library

The DAR has approximately 1,000 books, and acquires about 100 new books and 120 periodicals and scientific journals each year. The Department has access to agricultural information from several international organisations including: ILCA, International Institute of Tropical Agriculture, International Maize and Wheat Improvement Centre, International Crops Research Institute for the Semi-Arid Tropics, USAID, International Development Service and FAO/UNDP. Besides access to these centres, the Department also benefits from the inter-library loan system from countries such as the US, Zimbabwe, South Africa and the United Kingdom. Over the last five years, the DAR has produced many reports about livestock and arable farming.

d. Computers

The DAR is now operating five microcomputers at its main station in Sebele. These include three Apples (two IIe and one Apple III) and two Hewlett/Packards (HP-86).

e. Land

As noted above, the Animal Production Division of the DAR has 18 ranches and two grazing cells. These ranches are located in Botswana's eight ecological zones and three vegetative zones (the hardveld, sand veld and mopane veld). Together, they consist of 40,400 ha of rangeland. 400 ha are used for raising beef and small stock for the Botswana Agricultural College; most of the remaining 40,000 ha are used for the maintenance of the experimental beef herd, with some used for experimentation by the programmes of the Animal Production Division.

The Division of Crop Production carries out field experiments at Sebele (the Headquarters) and/or the substations (at Maun, Mahalapye and Goodhope). Approximately 200 ha of cultivated land are used for dryland crop production (sorghum, maize, millet, groundnut, and sunflower). Seven ha of the DAR's arable land are under experimental irrigation for horticulture and germplasm screening. The livestock division uses 50 ha for experimentation.

5. Financial resources

For the past three years, the GOB has spent, on the average, about US\$ 2.10 million for the DAR operating budget. The operating (recurrent) and capital budgets of the DAR for the 1984-1985 fiscal year are shown in Table 11. The GOB is the source of over 95 percent of the operating budget funds. The DAR's operating budget does not include expenses for vehicles and machinery, which are budgeted for separately by the Ministry of Works and Communications. Of the US\$ 0.37 million available to the DAR for capital investment this fiscal year, the GOB contributed 81.5 percent and donors (Sweden, UK and US) contributed 18.5 percent. Donors funded 45 percent of the total budget of US\$ 3,021,399 for 1984-84.

The specific donor-funded agricultural research activities are outlined in Table 12.

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Table 11: Funding of Agricultural Research, Training and Extension Institutions, 1984-1985^a

Source	Research Institution		Training Institution		Extension Institution	
	Recurrent (US\$)	Capital (US\$)	Recurrent (US\$)	Capital (US\$)	Recurrent (US\$)	Capital (US\$)
<u>Government of Botswana</u>						
Directly allocated	2,259,574	-	997,722	-	5,607,852	-
Allocations for services ^b	313,043	-	104,348	-	1,391,304	-
Domestic Development Fund	14,015	298,638	-	17,263	838,063	87,405
Subtotal, GOB	2,586,632	298,638	1,102,070	17,263	7,837,219	87,405
<u>Other Sources</u>						
SIDA	50,740	34,289	-	-	-	-
USAID	16,868	3,307	-	208,054	88,225	73,350
U.K.	635	30,290	-	-	-	195,177
GTZ	-	-	-	-	16,065	-
EEC	-	-	-	-	124,784	313,723
IBRD	-	-	-	-	141,800	-
IFAD/APB (UN)	-	-	-	-	66,352	539,628
Subtotal, Other Sources	68,243	67,886	-	208,054	437,226	1,121,878
TOTAL	2,654,875	366,524	1,102,070	225,317	8,274,445	1,209,283
Percent Donor-Funded	2.6	18.5	0	92.3	5.3	92.8

^aData are for 1984-1985 budget year, beginning April 1984.

^bAllocations for telephone, transportation and fuel.

Source: Ministry of Finance, Government of Botswana.

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Table 12: Donor-Funded Agricultural Research Activities, 1984

<u>Donor Country</u>	<u>Activity</u>	<u>Expected Results</u>	<u>Duration</u>	<u>Expatriate Technical Support (FTE)</u>	<u>Country Contribution (US\$)</u>	<u>Donor Contribution</u>	
						<u>Recurrent (US\$)</u>	<u>Capital (US\$)</u>
Sweden (SIDA)	Agricultural Development in Ngamiland	Improvement of maize/millet production	1980-1986	1	34,677	50,437	34,124
United States (AID)	Agricultural technology improvement project, bean-cowpea (CRSP)	Food production	1982-1992	6	53,065	16,787	3,291
United Kingdom	Evaluation of farming systems and agricultural implements	Introduction of animal-powered equipment	1976-1984	2	13,948	675	6,780
	Central Research Station	General support	continuing	0	30,053	-	23,366
	Dryland farming research scheme	Soil water relationship	1969-1984	3	-	-	-
Other Countries (6)	Salary supplementation for expatriate staff in authorised posts		continuing	14	-	-	-
TOTAL				<u>26</u>	<u>131,743</u>	<u>67,899</u>	<u>67,561</u>

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

IV. AGRICULTURAL TRAINING INSTITUTION

A. Overview of Agricultural Training in Botswana

Achieving higher levels of agricultural productivity requires people trained in a range of specialties for work at all levels within the agricultural sector. This need was recognised prior to Independence, in the early 1960s, by the establishment of the Agricultural Training Centre at Mahalapye and the Veterinary Training School at Ramatlabama, each offering training to the certificate level. Additional opportunities for training at the certificate, diploma and degree levels became available with the establishment of the University of Botswana, Lesotho, and Swaziland in 1964. In 1975, Lesotho withdrew to establish its own institution. Botswana withdrew in 1982 to establish the University of Botswana. At the present time, however, the University of Botswana does not offer degree-level training in the agricultural sciences.

After Independence in 1966, the Botswana Agricultural College (BAC) was established at Sebele (near Gaborone and adjacent to the main research centre) with the transfer of the agricultural certificate course from Mahalapye. In 1970, the College established an animal health certificate programme by transfer of the programme from Ramatlabama. A certificate-level programme in community development was initiated at the College in 1972, but it is no longer being offered.

In addition, a special training course is offered at the Ranch Management Centre at Ramatlabama for potential managers of the Tribal Grazing Land Policy (TGLP) ranches. The TGLP provides managers to individuals and groups who qualify, assisting them in establishing commercial-type ventures aimed at reducing overgrazing of communal lands through better grazing systems and optimal allocation of water resources.

Formal linkages between the BAC and the DAR have been described by some officers as "very disappointing" and "very unsatisfactory and weak". The College, however, does have a generally good working relationship with the DAFS of the MOA. During the school term, students conduct "practicals" and attend demonstrations in the surrounding villages, working closely with local extension staff. When the students are on their field exercises during the holidays, they are assigned to local extension officers in order to familiarise them with local conditions. In this way they develop practical insight into extension work and experience. While the College does not offer any short courses, it serves as a meeting place for conferences, seminars, and workshops undertaken by various departments both in the MOA and in other Ministries.

B. The Botswana Agricultural College

1. Organisational structure and purpose

The Botswana Agricultural College (BAC) of the Ministry of Agriculture is the principal training institution providing certificate- and diploma-level programmes in the areas of agriculture and animal health. Graduates of these programmes provide the technical skills for the Ministry of Agriculture and for the Ministry of Local Government and Lands, primarily at the field level.

2. Training programmes

BAC programmes consist of approximately 50 percent practical work and 50 percent classroom instruction. Until 1981, the College offered only certificate (two-year) courses in agriculture, animal health, and community development. The latter course had provided Assistant Community Development Officers for the Ministry of Local Government and Lands. With the expansion of facilities and staffing in 1981, the College was able to introduce two-year diploma courses in agriculture and animal health and production, with an initial enrollment of about 20 students in each course. The College also has doubled enrollment in the agriculture and animal health certificate programmes. At this time the diploma course in agriculture has 20 students and the diploma course in animal health has 19. The animal health certificate course has 57 students, and the agriculture certificate course has 47. (See Table 13.)

The entry qualifications for the certificate course require applicants to have a Junior Certificate (three years of secondary school education), a General Certificate for Education or a Third Class Cambridge School Certificate, i.e., five years of secondary education. To qualify for a diploma programme, candidates should have a certificate in agriculture or animal health with a minimum of two years of field experience or a high passing mark in the Cambridge School Certificate examination.

The expenses of all Botswana students are paid by the Government of Botswana. In return, diploma graduates are expected to work for the GOR for a minimum of two years and to remit 10 percent of their salaries to the government during that period. Certificate graduates are expected to work for the government for a minimum of three years.

2. Human resources

a. Staffing patterns

The BAC has a total staff of 55 persons, with a current administrative staff of 5 persons. (See Table 14.) The BAC is headed by a Principal, currently a local graduate with overseas training, who is responsible directly to the Permanent Secretary of Agriculture. The Principal is assisted by a Deputy and by the Course Directors of

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Table 13: Agricultural Training Institutions, Degrees Offered, Number of Staff and Students, 1984

<u>Name of Institution</u>	<u>Degrees, Diplomas, or Certificates Offered</u>	<u>Number of Staff^a</u>	<u>Enrollment</u>		
			<u>F</u>	<u>M</u>	<u>Total</u>
Botswana Agricultural College	Certificate in Animal Health	47	3	54	57
	Certificate in Agriculture		19	28	47
	Diploma in Animal Health		2	17	19
	Diploma in Agriculture		7	13	20
TOTAL			<u>31</u>	<u>112</u>	<u>143</u>

^a Common teaching staff for both agriculture and animal health programmes at both levels.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

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Table 14: Total Agricultural Training Staff, 1984

	<u>Administrative</u>	<u>Professional^a</u>	<u>Technical^b</u>	<u>Support Staff</u>	<u>Total</u>
<u>Total Authorized Posts</u>	8	28	23	4	63
<u>Positions Vacant</u>	3	4	2	2	11
<u>Nationals (Citizens)</u>					
Staff in training	-	6	1	-	7
Staff on long-term leave ^c	-	-	-	-	-
Number of nationals currently in posts	5	18	20	2	45
Expressed as a percent of authorized posts	63	64	87		71
<u>Expatriates</u>					
Serving in authorized posts ^d	-	8	-	-	8
Expressed as a percent of authorized posts	-	29	-	-	13
Not in authorized posts	-	2	-	-	2
Total number of expatriates	-	10	-	-	10
<u>Total Number of Staff</u>	<u>5</u>	<u>28</u>	<u>20</u>	<u>2</u>	<u>55</u>

^aProfessional = BSc or above.

^bTechnical = diplomate.

^cLong-term leave is leave of three months or more.

^dIrrespective of source of funds.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

the Agriculture and Animal Health programmes. The course director of the animal health diploma programme is an expatriate. However, the other course directors are nationals, as are the Principal and Deputy Principal.

BAC has 28 authorised posts for professional (BSc and above) training officers. Four of these are vacant at this time: ten are filled by expatriates. In addition, two expatriates are in non-authorised posts. There are 18 nationals in professional posts. The technical disciplines represented among these are shown in Table 15. There are no PhD degree holders on the staff of the BAC. The MSc degrees held by the national professional staff include two in agronomy and agricultural engineering and one each in pathology, biochemistry, and agricultural economics. Six hold BSc degrees in animal science, and there are one each in general agriculture, biochemistry, agricultural economics, communication and land use. Three expatriates have MSc degrees in crop science and five in livestock and veterinary sciences.

Only two of four authorised posts for support staff, including dormitory matrons, are filled.

b. Staff training

At this time there is one staff member of the BAC in training for a MSc degree in range management. Five others are in BSc training in the following areas: pre-veterinary science, extension, agronomy, soil science and plant pathology. All of these are studying abroad, as shown in Table 16.

Future plans of BAC are to train: one staff member to the MSc level in animal nutrition; six more to the BSc level; one each in extension, laboratory technology, range management, agricultural communication; and two in agricultural engineering.

4. Training facilities

a. Buildings

Substantial additions in classrooms, administrative and staff offices of the BAC have been completed recently. The classrooms are in good condition, with 1,019 m² of total floor space. In addition, there are 530 m² of floor space dedicated to teaching laboratories. The College also owns several workshops, mainly used for demonstrations, whose total floor space is about 383 m². The library has 403 m² of space and the Lecture Theatre, which is principally used for films and seminars by both the College and the MOA's various departments, about 100 m². All of these facilities are in good condition.

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Table 15: Disciplines of Teaching Professionals, 1984

Discipline Areas	Nationals								Expatriates								Total
	BSc		MSc		PhD		Subtotal		BSc		MSc		PhD		Subtotal		
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	
General agriculture	1	-	-	-	-	-	1	-	1	-	-	-	-	-	1	-	2
Agronomy	-	-	1	1	-	-	1	1	-	-	-	1	-	-	-	1	3
Horticulture	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Microbiology	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Pathology	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Range ecology	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Animal science, general	-	6	-	-	-	-	-	6	-	-	-	1	-	-	-	1	7
Biochemistry	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-	2
Agr. economics	-	1	-	1	-	-	-	2	-	-	-	-	-	-	-	-	2
Agr. engineering	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	2
Extension	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Veterinary	-	-	-	-	-	-	-	-	-	1	-	3	-	-	-	4	4
Communication	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Land use	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
TOTAL	2	9	3	4	-	-	5	13	1	1	-	8	-	-	1	9	28

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

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Table 16: Training Plans for Staff of the Training Institutions, 1984

<u>Level</u>	<u>Number</u>	
	<u>In country</u>	<u>Outside Africa</u>
<u>Current Situation</u>		
Masters	-	1 ^a
Bachelors	-	5 ^b
Diploma	3 ^c	-
<u>Future Plans</u>		
Masters	-	1 ^d
Bachelors	-	6 ^e
Diploma	2 ^f	-

^aRange management.

^bOne each in veterinary, extension, agronomy, soil sciences and plant pathology.

^cTwo in animal health and one in agriculture.

^dAnimal nutrition.

^eOne each in extension, laboratory technology, range management, agricultural communication; two in agricultural engineering.

^fTwo in agriculture.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

b. Equipment

The BAC has access to several buses, trucks, and tractors, as well as shop and farm equipment for use in demonstrations and practical aspects of the curriculum. The BAC also has subject matter slides used in teaching, closed-circuit television, and overhead projectors.

c. Library

The library has 9,400 books available for student and faculty use, and acquires approximately 1,000 each year. In addition, the College receives 20 periodicals and scientific journals.

d. Land

The College has 30 ha that are used for student practical work and as demonstration plots. An additional 20 ha are used for student livestock projects. However, these facilities are shared with the DAR.

5. Financial resources

All recurrent costs for the operation of the BAC are provided by the Botswana Government. In 1984-1985 the recurrent budget for the BAC is US\$ 1.1 million. Over 90 percent of the capital budget of US\$.2 million for the current fiscal year has been provided by USAID. (See Table 11.)

V. AGRICULTURAL EXTENSION INSTITUTIONS

A. Overview of Agricultural Extension in Botswana

The Department of Agricultural Field Services (DAFS) is the country's primary extension institution. It also has considerable responsibility for delivery of agricultural inputs and services to farmers. However, the Department of Animal Health (DAH), primarily a field service organisation, also provides information on animal health at the field level. Both are departments of the Ministry of Agriculture.

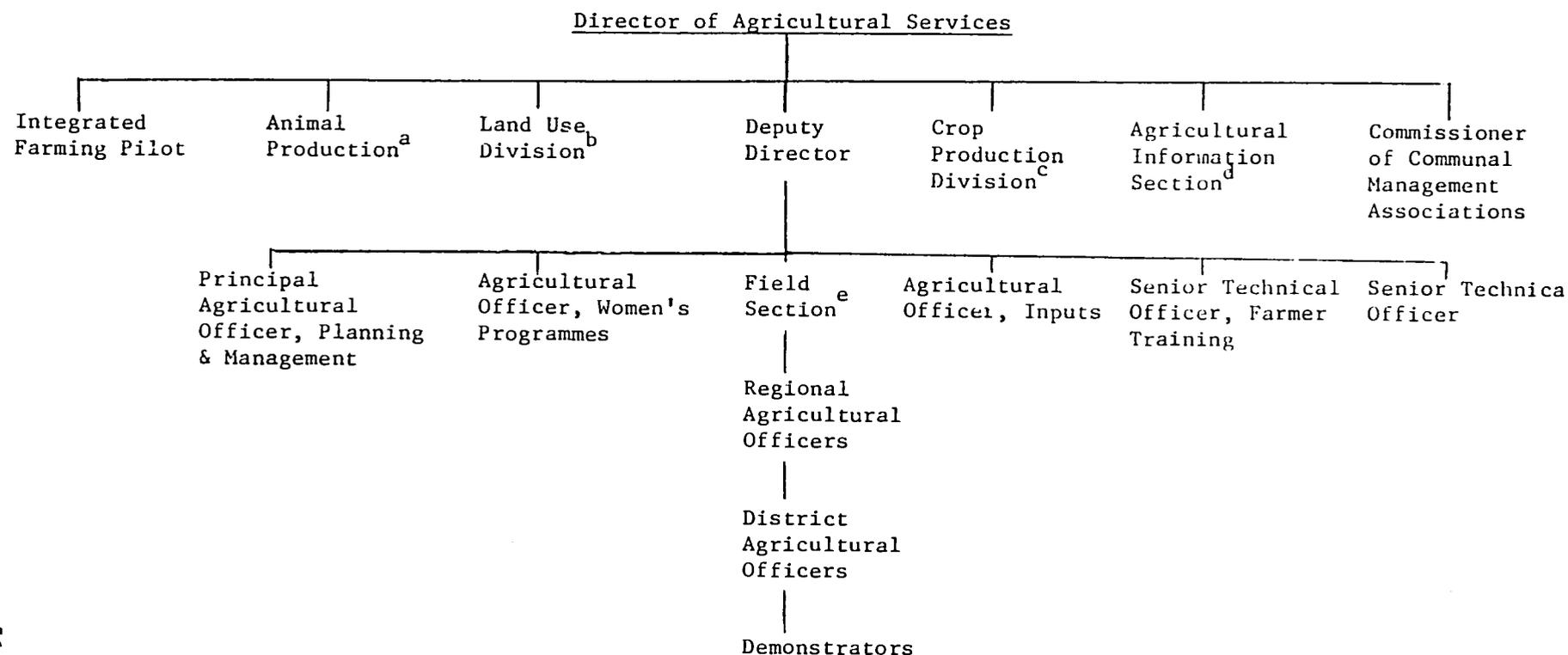
B. Department of Agricultural Field Services

1. Organisational structure and purpose

The DAFS is the largest department in the MOA. The Department, like others in the Ministry, has experienced changes in organisation and in the scope of services it provides since Independence. While the DAFS is mainly responsible for communicating innovations in agriculture from researchers to farmers, it is substantially involved in the delivery of other services as well. The organisation chart in Figure 7 shows the range of areas of activity of the DAFS.

The DAFS is organised geographically into six regions, which in turn are subdivided into districts and extension areas. (See Table 17.) The regional and district offices are usually headed by graduate diploma-level staff. Each extension area is staffed by a certificate-level graduate who is responsible for 250-300 farming families. Some extension areas are very large and thinly populated. As a result, farming households are widely scattered, making farmer contact difficult and also limiting the extension staff's understanding of farmers' circumstances and their ability to assist with the farmers' problems. The village-based extension worker has to travel by bicycle, motorbike (if available), or even by foot. This shortage of suitable transportation and telecommunication facilities is a serious constraint to agricultural extension, as is noted in Chapter VII of this report.

The lack of effective linkages with the research programmes has been widely recognised. In addition to the Research and Extension Liaison Officers in the MOA, one for the livestock sector and one for arable agriculture, two committees have been established to foster improved internal linkages. The Arable Agriculture Development Committee is composed of researchers, extension workers and farmer representatives. Its purpose is to suggest broad policy guidelines for the development of extension programmes in arable agriculture. A second committee, the Arable Research Priorities Committee, also includes researchers, farmer representatives and extension agents. Its purposes are to ensure that researchers are aware of farmers' problems and to suggest priority areas for research.



^aThe animal production unit includes beef and dairy husbandry, goats and sheep, marketing, poultry, pig husbandry, and fisheries.

^bThe land use division includes dam building, range ecology, soil survey, soil conservation, cartography, land use planning, and forestry.

^cThe crop production division includes horticulture, seeds supply, marketing, and post-harvest.

^dThe agricultural information section includes publications, radio, graphics, campaigns, action research, and demonstrators' handbooks.

^eThe field section includes the Rural Training Centres, the Short Course Centres and a variety of agricultural officers and supervisors, including animal production officers, land use officer, and extension officers.

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Figure 7: Organisation Chart of the Department of Agricultural Field Services

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1983.

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Table 17: Agricultural Extension Institutions: Locations and Staff, 1984

<u>Institution</u>	<u>Location of Regional Offices</u>	<u>Administrative</u>	<u>Professional^a</u>	<u>Technical^b</u>	<u>Total</u>
Dept. of Agricultural Field Services	Gaborone (Headquarters)	11	20	71	102
	Southern Region	4	4	70	78
	Gaborone	6	3	59	68
	Central Region	8	3	91	102
	Maun	5	4	62	71
	Western Region	3	-	31	34
	Francistown	<u>4</u>	<u>3</u>	<u>63</u>	<u>70</u>
TOTAL		<u>41</u>	<u>37</u>	<u>447</u>	<u>525</u>

^aAcademic degree holders, BSc or above.

^bTechnical staff includes 91 diplomate holders; the remainder are certificate holders.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

2. Extension programmes

The major extension programme effort of the DAFS involves two broad areas: 1) increasing production of food crops (sorghum, maize, beans/pulses and millet), and 2) increasing production of livestock (cattle, goats, sheep, poultry and pigs). Fortunately for extension, much of the research information for both food crops and livestock production now has been based on local conditions. Especially during the last decade, this base of knowledge has been expanding. Much of this information is being applied by the better-endowed farmers in the relatively small commercial sector. However, a considerable effort will be required to utilise this growing data base in developing technologies for use by the vastly larger number of farmers in the traditional farming sector. Special efforts have been undertaken only recently to address the needs of the traditional farmers.

a. Farming Systems Research Programme

The Farming Systems Research Programme, although primarily a research effort, is designed to encourage improved linkages between research and extension. It is expected that better understanding of the factors that influence farmers' behaviour will lead to improved research and extension planning, and will set a pattern of formal and informal relationships between research and extension staff. The DAFS, in collaboration with the DAR, has become actively involved in this programme. They collaborate to bring specialists in research and extension together in an interactive process for the development and implementation of more effective programmes for small farmers. The DAFS has given cash crops--mainly sunflower, groundnuts, vegetables, and citrus fruits--a low priority.

b. Arable Lands Development Programme

A significant effort designed to increase production of food crops in the traditional sector is the recently established Arable Lands Development Programme. In addition to providing recommendations on crop practices, the programme provides subsidies and credit to farmers in communal areas for the purchase of draught power, implements, fencing materials, water catchment equipment, and other needs. A similar effort to introduce improved management and grazing techniques in communal areas is being attempted under the Tribal Grazing Land Policy. The GOB also procures other production inputs, notably improved seeds, for small farmers.

c. Agricultural Information Services Unit

The Agricultural Information Services Unit produces leaflets on subjects such as livestock diseases, row planting, and seed treatment, and general fact sheets on livestock and crop topics. It also produces a monthly publication in newspaper format, entitled Agrinews, which is distributed throughout the country.

The Agricultural Information Unit produces seven radio programmes each week which are broadcast over Radio Botswana. The Cooperative

Development Unit of the MOA produces one weekly radio programme dealing with cooperative issues.

3. Human resources

a. Staffing patterns

The numbers of administrative, professional and technical staff of the DAFS are shown in Table 18. While all of the administrative staff positions are held by nationals, 46 percent of the professional (BSc or above) positions are held by expatriates, most of whom serve at headquarters. The majority of the DAFS staff located at field posts are required to have only certificate- or diploma-level training; most have been trained within the country. Of the 585 established positions, 13 percent are currently vacant. Most of these vacancies are at the village level, positions that are especially critical for effective farmer-extension relationships.

The ratio of women to men currently working in the DAFS or slated to receive training seems extremely low. There are few female extension officers in the Department. At the time of the pilot ARRA in mid-1983, only 8 percent of the authorised posts were held by women (two-thirds of these were certificate holders) and 20 percent of those in training were women.

The Department's staff, by discipline, generally reflect the concentration of personnel by major programme areas. (See Table 19.) The programmes utilising agricultural engineers and range ecologists are understaffed at this time. While livestock and food crop production programmes are the major foci of the DAFS, the latter has a disproportionately smaller number of officers, and neither has well-trained professional staff at the district levels. The regional staff in these discipline areas are expected to visit regularly the district and village extension areas. Both the district and village extension officers must share their time and expertise between livestock and food crop production. It is very doubtful that extension officers with certificate-level training, who are constrained by transportation and communication problems, can be very effective.

The DAFS has a relatively large number of officers in information and broadcasting, all based at the national-level headquarters. The DAFS does not have any economists or social scientists on its staff. If such expertise is required, the DAFS requests assistance from the Division of Planning and Statistics of the MOA, which has several economists and rural sociologists.

The DAR offers farmers diagnostics services in entomology and pathology. However, since these services are provided from Gaborone, they are not easily accessible to many farmers. Horticulture is a minor programme area for the DAFS with officers based at national and regional levels.

Agricultural Management or Group Development Officers are generalists who encourage farmers to form groups and/or associations

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Table 18: Total Agricultural Extension Staff, 1984

	<u>Administrative</u>	<u>Professional^a</u>	<u>Technical^b</u>	<u>Total</u>
<u>Total Authorized Posts</u>	41	39	505	585
<u>Positions Vacant</u>	-	19	59	78
<u>Nationals (Citizens)</u>				
Staff in training ^c	-	22	51	73
Staff on long-term leave ^d	-	-	-	-
Number of nationals currently in posts	41	20	446	507
Expressed as a percent of authorized posts	100	51	88	87
<u>Expatriates</u>				
Serving in authorized posts ^e	-	17	1	18
Expressed as a percent of authorized posts	-	44	-	.3
Not in authorized posts	-	-	-	-
Total number of expatriates	-	17	1	18
<u>Total Number of Staff</u>	<u>41</u>	<u>37</u>	<u>447</u>	<u>525</u>

^aProfessional = BSc or above.

^bDiplomate and certificate (91 of total are diplomate).

^cStaff in training continue to hold authorized posts.

^dLong-term leave is leave of three months or more.

^eIrrespective of source of funds.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

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 Table 19: Summary of Extension Staff Effort and Source of Funds Related to Programme Area, 1984

<u>Programme</u>	<u>Funding Source^a</u>	<u>FTE^b</u>	<u>Percentage of Total Staff Time</u>
<u>Food Crops</u>			
Maize		4	11
Sorghum		1	3
Agr. small projects	USAID	1	3
ALDEP ^c	USAID, IFAD, UK	7	18
Horticulture		1	3
Subtotal, Food Crops		<u>14</u>	<u>38</u>
<u>Forestry</u>		<u>1</u>	<u>3</u>
<u>Livestock/Fisheries</u>			
Beef cattle	EEC, IBRD	4	11
Sheep	EEC	1	3
Goats	EEC	1	3
Swine		1	3
Poultry		1	3
Fisheries		1	3
Range management		3	8
Subtotal, Livestock/Fisheries		<u>12</u>	<u>32</u>
<u>Other Programmes</u>			
Farming systems	USAID	2	5
Land/Water conservation	UK	4	11
Irrigation		1	3
Farm storage		1	3
Rural institutions	GTZ	2	5
Subtotal, Other Programmes		<u>10</u>	<u>27</u>
TOTAL		<u><u>37</u></u>	<u><u>100</u></u>

^aThe Government of Botswana provides funding for all of the programmes. Additional funding is provided by the outside donor sources listed.

^bFTE = Full Time Equivalent.

^cALDEP = Arable Lands Development Programme.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1984.

for such purposes as fencing, spraying, and borehole syndication. They are based at both the district and village level, and work in collaboration with the general agricultural extension officers. They are trained to provide broad agricultural development and management information, and are not specialised in any particular field of agriculture.

A number of general extension staff at the district level also serve in the Rural Farmer Training Centres (RFTC). These centres schedule short-term training for farmers at five locations, covering most of the regions of the DAFS.

b. Staff training

In the next five years, the DAFS plans to increase its professional staff considerably. About half of the 51 staff currently receiving training at the diploma level are being trained elsewhere in Africa. (See Table 20). Owing to lack of degree-level training facilities in Botswana, most will be trained in developed countries outside Africa. A long-term goal, however, is that professionals in extension be trained either in-country or within the SADCC region.

4. Extension facilities

The DAFS has a rather extensive complement of outlying offices, including five Regional Offices, five Rural Farmer Training Centres, ten Demonstration Ranches, and 17 District Offices. All are in generally good condition. In addition, the Department has access, through the Central Transport Office, to a fleet of 106 large trucks, 97 four-wheel drive vehicles, and heavy earth-moving equipment, although these are often difficult to secure.

5. Financial resources

The operating (recurrent) budget of the DAFS for 1984-85 is nearly US\$ 8.3 million, 95 percent of which is from the GOB. However, over 90 percent of the US\$ 1.2 million budget for capital expenses is from outside donors: namely, IFAD, EEC, UK, and US. (See Table 11.)

C. Department of Animal Health

1. Organisational structure and purpose

The Department of Animal Health (DAH), established nearly 40 years ago, is responsible for the diagnosis, control, and prevention of livestock diseases. It also provides livestock production information to farmers via its Livestock Advisory Centres, which are located in nearly every part of the country. Recently, foot and mouth diseases and the control of tsetse flies in the northwest have been its major concerns.

The DAH is also responsible for the national abattoir. (See Figure 8.) The abattoir, headquartered at Lobatse, now has another branch at Maun in the northwest. The DAH, together with its two

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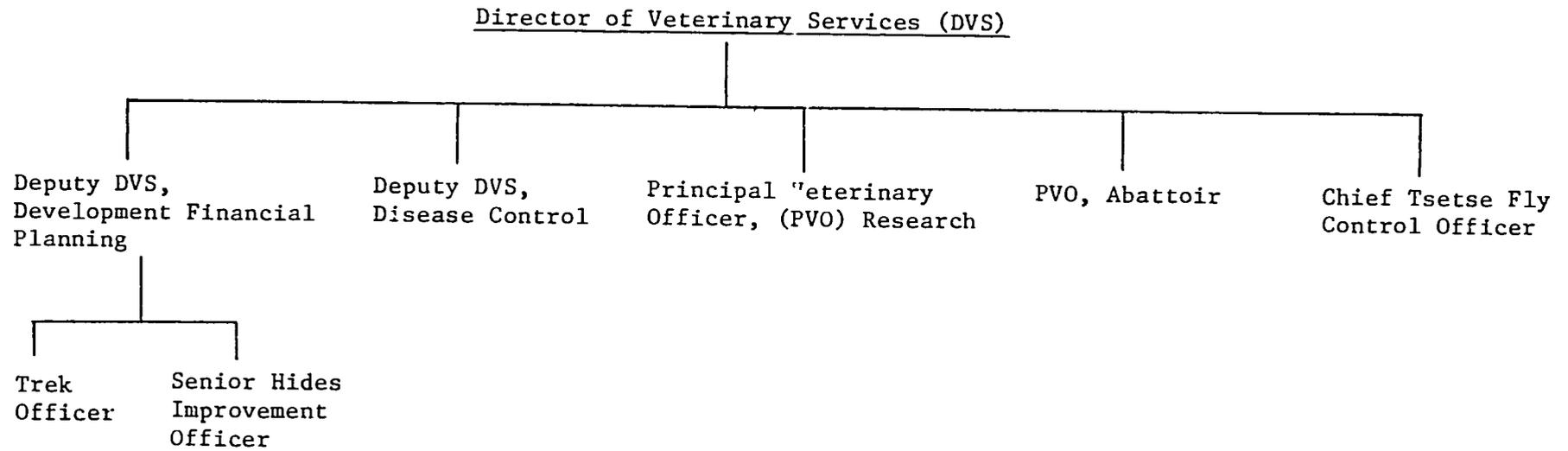
Table 20: Training Plans for Staff of Extension Institutions, 1984

<u>Level</u>	<u>In-country</u>	<u>In Africa</u>	<u>Outside Africa</u>	<u>Total</u>
<u>Current Situation</u>				
Bachelors	1	3	18 ^a	22
Diploma	27	20	4	51
<u>Future Plans for Training^b</u>				
Masters	-	-	2	2
Bachelors	-	2	4	6
Diploma	25	10	-	35
Certificate	100	-	-	100

^aAll in general agriculture.

^bDisciplines/Fields not specified.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1983.



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Figure 8: Organisation Chart of the Department of Animal Health

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1985.

abattoirs, plays a vital role in the meat industry, which accounts for a major share of Botswana's agricultural exports and foreign exchange earnings.

The major programme area for the Department is the prevention and control of diseases. This is achieved through vaccination and other health programmes and by the use of cordon fences to separate livestock (especially cattle) from wildlife and the diseases they transmit.

Unlike the DAFS, which has village-level staff, the DAH field staff are located only at the district level. The district staff are expected to visit the farming community during the vaccination campaign, which are scheduled according to a livestock disease-control calendar. At other times, a farmer with a livestock problem must contact the veterinary staff at the nearest district or regional office. The diagnostic laboratory services are concentrated in Gaborone and Lobatse. This has meant that farmers in the remote areas are disadvantaged. The Department does not have veterinary research facilities. Their field staff submits farmers' problems and specimens to headquarters and the diagnostic laboratory for resolution and analysis. After diagnosis, the laboratory staff reports back to the field staff. There is very little direct communication between laboratory staff and farmers.

2. Extension programmes

The Department issues a variety of circulars about effective control and prevention of livestock diseases and parasites. Additional circulars are issued on vaccination for dogs and other pets. These services are assisted by the Agricultural Information Section of the Department of Agricultural Field Services through its regular radio programmes which cover a variety of topics related to livestock production, animal diseases and parasite control.

Through its contribution to the monthly publication of Agrinews, the Department of Animal Health provides farmers with information on better livestock disease prevention, parasite control, and drugs and feeds recommended for good livestock management.

3. Human resources¹

The DAH has 25 veterinarians for the entire country, 22 of whom are expatriates. The DAH urgently needs trained locals, especially to assure the continuity of programmes. Few qualified candidates have been available for DAH positions. There are currently 159 citizens receiving training for the DAH, but only 11 are studying

¹The information in this section is based on the pilot ARRA study conducted in 1983. Since so few of DAH's resources pertain directly to extension, they were not included in the tables regarding total resources available for extension in Botswana, Tables 17-20.

for degrees in veterinary medicine. One is a woman with a junior degree in veterinary medicine pursuing a senior degree. the remaining 148 consist of 29 men and three women studying for diplomas in animal health and 111 men and five women studying at the certificate level. The Department of Animal Health, like the Department of Agricultural Field Services, has a disproportionately small number of female extension officers.

During the next five years, the DAH plans to prepare 360 additional personnel at various academic levels. Since Botswana does not have the facilities to train veterinarians, a majority of those in higher-level training will continue to be sent abroad, with some studying in other places in Africa. The establishment of veterinary training facilities in an African university, presumably within the SADCC area, could further support needed regional technical cooperation. This would contribute to efficient utilisation of present and planned national and regional resource centres. As with the DAFs, practically all the junior staff will be trained in-country.

4. Extension facilities

The DAH facilities are generally in good condition. Its extensive facilities include the central Veterinary Diagnostics Laboratory, the Botswana Vaccine Institute, the Tsetse fly laboratory, 27 livestock advisory centres, and 16 district and regional offices. It also has two abattoir plants, located at Labotse and at Maun. Its large complement of vehicles and equipment, some of its highly specialised, is in good condition.

5. Financial resources

The DAH's average recurrent budget of US\$ 9.8 million is financed almost entirely by the GOB. The GOB, CDA and other donors provide 56, 10 and 34 percent, respectively, of the capital budget of US\$ 5.8 million. These figures reflect the average for the past three years.

VI. CONSTRAINTS TO AND POTENTIAL FOR INCREASED PRODUCTIVITY IN BOTSWANA

Botswana may have the most fragile ecology of all SADCC countries. It is not endowed with uniform or adequate rainfall or ideal soils to provide a physical base for high-output crop production. A relatively narrow strip of the eastern part of the country is the principal crop and livestock production area.

This chapter will discuss direct (physical/biological) constraints and indirect (policy, institutional and rural tradition linked) constraints to increased productivity, especially by smallholders, of food crops (with a separate section for specialty crops) and of livestock.

A. Food Crops

1. Current and potential yields

The major food crops produced in Botswana are sorghum and maize. Small amounts of millet and beans/pulses are also grown. In round figures, smallholder sorghum yields (200-225 kg/ha) are just under one-half those of the commercial sector, while maize yields of the smallholders (170-300 kg/ha) are about one-third those of the commercial farmers. (See Table 21.) Both types of producers, however, have far lower average yields than those attained at the research stations: 2,544 and 2,728 kg/ha for sorghum and maize, respectively. It is also important to remember that smallholders, even with their low yields, produce the great majority of these food crops. (See Table 4.)

While the data indicates a substantial opportunity to increase productivity by applying current crop research information, there is little potential to do so across the entire country. The research data results, in many cases, reflect the use of inputs affecting fertility, plant diseases, pest control and the timeliness of operations. Furthermore, in most cases the data is from locations on some of the country's better soils and micro-climatic zones. However, the many small-scale producers who have need of productivity improvements have limited land resources or finances for inputs to utilise the new production systems. They also may not have access to the other resources, such as personnel, management experience or mechanical power, which are essential in the more sophisticated processes.

2. Physical constraints

Since sorghum is the principal food crop grown in Botswana a number of staff members of agricultural research, extension and training institutions were surveyed in 1983 as to the relative seriousness of the constraints to increased production of sorghum. Their responses are shown in Table 22.

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Table 21: Indicators of Agricultural Productivity

<u>Crops</u>	<u>Yields</u> (kg/ha)		
	<u>Average</u> <u>Traditional</u> <u>Sector, 1981</u>	<u>Average</u> <u>Commercial</u> <u>Sector, 1981</u>	<u>Optimum,</u> <u>Research</u> <u>Station, 1979</u>
<u>Food Crops</u>			
Sorghum	224	450	2,544
Maize	306	893	2,728
Millet	144	600	NA ^a
Beans/Pulses	176	700	1,303
<u>Cash Crops</u>			
Sunflower	385	508	1,000
Groundnuts	416 ^b	416 ^b	1,119
<u>Cattle</u>	<u>Levels</u> (percent)		
	<u>Traditional</u> <u>Sector,</u> <u>1978-80</u>	<u>Commercial</u> <u>Sector,</u> <u>1978-80</u>	<u>Research</u>
Offtake	8	16	20 ^c
Mortality	11	4	10
Calving Rate	58	62	78

^aNA = Not Available

^bFigures appear questionable; may be in error.

^cResearch offtake should be interpreted cautiously. It includes young bullocks between 1 year and 1½ years which must be sold to the Government Bull Subsidy Scheme each year. The approximate offtake after adjusting for the bull subsidy scheme would be about 18 percent.

Sources: Central Statistics Office, Ministry of Finance and Development Planning, Country Profile, Botswana, October, 1982; Agricultural Statistics Surveys, 1978, 1979 and 1980; Division of Arable Research, Department of Agricultural Research, Annual Report, 1979/80; Ten Years of Animal Production and Range Research in Botswana, 1980.

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Table 22: Perceptions of Severity of Constraints to Achieving Higher Productivity of Livestock and Sorghum^a

Livestock Constraints	Beef Cattle	Goats/ Sheep	Average	Crop Constraints	Sorghum
<u>Physical/Biological</u>				<u>Physical/Biological</u>	
Climate	2.9	3.5	3.2	Climate	3.0
Annual rainfall	4.2	4.0	4.1	Annual rainfall	3.8
Rain distribution	4.5	4.0	4.3	Rain distribution	4.8
Soil suitability	3.1	2.0	2.6	Soil suitability	2.8
Soil degradation	3.6	3.5	3.6	Soil degradation	3.1
Soil topography	1.7	1.0	1.4	Soil topography	1.8
Natural forage supply	4.8	3.5	4.2	Plant diseases	2.4
Fodder supply	3.3	4.0	3.7	Pests/Insects	3.7
Other fodder supply	2.2	1.0	1.6	Predators	2.4
Water supply	4.5	4.5	4.5	Varieties/Species	2.4
Water access	4.7	4.5	4.6	Human power	3.5
Disease prevention	3.6	4.0	3.8	Animal power	4.0
Curative problems	3.3	2.5	2.9		
Pests/Insects	3.2	3.2	3.2		
Predators	2.1	2.1	2.1		
Species/Breeds	2.4	2.4	2.4		
<u>Economic/Policy</u>				<u>Economic/Policy</u>	
Input prices	3.0	3.0	3.0	Prices	3.1
Marketing	3.0	4.0	3.5	Marketing	3.2
Short-Term credit	2.6	2.6	2.6	Short-Term credit	3.9
Long-Term credit	2.8	2.8	2.8	Long-Term credit	3.3
Government subsidy	2.5	2.5	2.5	Government subsidy	3.6
Import policy	2.3	2.3	2.3	Import policy	2.4
Animal prices	3.1	3.1	3.1		
<u>Traditional</u>				<u>Traditional</u>	
Land tenure	3.0	4.2	3.6	Land tenure	2.1
Farm size	3.1	3.1	3.1	Farm size	3.6
Farm labor	3.5	1.0	2.3	Farm labor	-
Education	4.2	3.5	3.9	Education	3.7
Role of women	3.4	-	3.4	Role of women	-
Overall Average	3.2	3.0	3.1	Overall Average	3.2

^a Weighted average of respondent rankings: 1 = Not serious, 5 = Very serious. Number of respondents for beef was 18, goats/sheep 2, and sorghum 17.

Source: Data collected from the DEVRES/SADCC Agricultural Research Resource Assessment, 1983/84.

Some of the physical and biological constraints to increased food crop production affect both smallholders and commercial farmers; others adversely impact the traditional farmers to a greater extent than the commercial farmers.

An overriding factor affecting production of both smallholders and commercial farmers in any given season is the availability and distribution of rain. All other constraints are irrelevant during drought years.

Another constraint common to both types of farmers is the lack of high-yielding, adaptable varieties of sorghum, maize and millet. Development of varieties that will mature in a short growing season is especially important.

Constraints relating to soils affect both traditional and commercial farmers, and include low phosphate levels, poor mechanical properties, and high evapotranspiration rates. High soil temperatures affect the germination and emergence of sorghum, millet and sunflower.

Weeds, especially striga (witchweed), and insects limit the productivity of sorghum and cowpeas; field losses from birds have the strongest effect on sorghum and millet yields.

Physical constraints which especially impact traditional farmers relate to lack of farm power. In general, they suffer from both a shortage of human labour at key times during the growing season and a lack of timely access to animal or mechanical power, especially for seed bed preparation for planting. In addition, smallholders do not have adequate access to needed supplies, farm implements and technology.

3. Economic and policy constraints

Both smallholder and commercial farmers are adversely affected by technological packages that are not suitable for crop production under marginal moisture levels. While both groups suffer from lack of adequate and timely delivery of supplies of needed inputs, it is a more serious problem for smallholders who are without access to transport and who are dealing with small quantities. Marketing outlets and services are often inaccessible to those in more remote areas; again, this more seriously affects smallholders. Only a relatively few large-scale producers, both livestock and cereal farmers who have freehold title to their holdings, are able to secure credit, purchase on a large scale, and have access to transportation and communication.

4. Constraints related to rural traditions

Rural tradition-based constraints are especially troublesome for smallholders. The tradition of cattle roaming unfenced over communal land often results in damage to crops.

Traditional farmers living on tribal lands have little contact with modern technology or improved practices, and they have little incentive to produce more than what is needed for subsistence. Traditional farmers have access to a limited amount of land and are also constrained by the amount of labour available to plow, plant and harvest crops.

Thirty percent of the rural households are headed by women. Women are seen in the rural communities as producers of food. Women, however, have even less access to resources and collateral for investment credit than do men, and therefore are less able to participate in many programmes.

5. Constraints related to specialty crops

The production of specialty crops (fruits and vegetables) is relatively recent in Botswana. There are few vegetables produced for home consumption in the traditional sector. While there has been a small amount of adaptability testing, little research has been done on pests and diseases and on the effects of high and low temperatures under Botswana's condition.

As with cereals, access to water is the most serious problem. Specialty crops require irrigation and a reliable supply of water; however, there is no tradition of irrigation in rural areas. In addition, no systems have been developed for providing needed inputs or marketing these crops, and thus production to date has been limited to those farmers with land close to markets.

B. Livestock and Livestock Products

1. Current and potential yields

Livestock production plays an extremely important role in Botswana's agriculture since it accounts for about 80 percent of the sector's output. It is also important for the livelihood of the rural population. Of the estimated 85,000 farm families in the entire country, all but about 360 are engaged in traditional farming on tribal land. While most grow some crops for subsistence, 68 percent own cattle. More than one-half of the commercial farms specialise in cattle production as well.

Prior to the current drought, the national herd was approximately three million cattle, nearly 85 percent of which were owned by traditional farmers. (See Table 3.) Small stock--sheep and goats--are also held by many traditional farmers. In 1983, there were about 780,000 goats and 165,000 sheep. Some indicators of the relatively low productivity of the traditional sector in relation to the commercial sector may be seen in Table 21. While these statistics must be interpreted carefully, it is also clear that higher productivity, as measured by offtake and calving rates, is obtained on research stations than on commercial farms.

2. Physical constraints

The physical and biological constraints described in this section apply to both commercial and traditional farmers.

The land and water resources available for animal production are limited. Reports over the last several decades consistently note range degradation, especially around boreholes, as a serious factor constraining productivity. Drought is a factor affecting the size and quality of the national herd. When drought and overstocking occur at the same time, losses are very high.

The knowledgeable persons interviewed about the constraints to increased beef productivity in the 1984 ARRA survey emphasised especially the interrelated constraints related to rainfall and water and forage supplies. (See Table 22.)

Animal diseases, while present, are not as serious a problem as elsewhere in Africa, due in part to the dry climate and in part to the active and effective veterinary service. Foot and mouth disease is a serious problem, and has affected the exports of Botswana's beef products, especially from the north, to the EEC countries. The presence of the tsetse fly also has limited cattle production in some areas.

3. Economic and policy constraints

The most difficult constraint to deal with in increasing livestock production is the issue of providing equitable and adequate access to range and water resources, while maintaining the natural resource base in the fragile ecology of Botswana.

Transport of stock to market will need increasing attention as new areas are opened and as the new abattoir in the north becomes fully operational.

Insufficient meat processing capacity appears to be a constraint for the herd in the north. It is especially important in drought years to provide opportunities for producers to market their stock and reduce pressure on the range. The respondents to the ARRA survey indicated that marketing was a serious constraint to increased productivity.

4. Constraints related to rural traditions

Rural traditions, especially as they relate to land tenure and viewing cattle as fixed rather than productive assets, are a constraint to increased productivity. Cattle are held until past their prime marketing value, except in times of drought when they can no longer be supported on tribal lands. Communal grazing customs are another significant disincentive to modern herd management techniques and individual investment in new technologies. The low level of

education also seen as an important constraint. However, Botswana's small-scale producers are gradually changing from a principal focus on the number of cattle held to a more market-oriented view; this has been an important contribution to the growth of the livestock subsector.

5. Institutional constraints

Botswana has had animal production research programmes operating since the 1930s. The Animal Production Research Unit (APRU) was organised in 1970, with an initial priority of investigating the potential for improvement of beef cattle through breeding. It soon became clear, however, that a multidisciplinary structure with appropriate professional skills to cover a wide range of technologies was required to meet the problems of animal production in Botswana's semiarid environment. The early research programmes can be generally characterised as having been conducted on a highly technical level: planned, implemented and evaluated by expatriate scientists; and directed to the commercial producers.

However, the national development plans and government policies have begun to redirect somewhat the focus of livestock research.

In 1975 the GOB introduced the Tribal Grazing Land Policy (TGLP) to ensure sustained production on the country's most valuable resource, its rangeland. Tribal grazing land was zoned into commercial, communal and reserved areas. The policy was intended to change the traditional system of land tenure and use in the tribal grazing areas. The objective was to provide for leasehold ranches utilising commercial methods in these areas, while reserving the land around the villages for communal grazing to ensure that everyone had access to enough land to sustain the family. The programme has resulted, to date, in the demarcation of just over 300 ranches; about 100 have been leased. There are allegations that the programme is not yet effective since most of the tribal lands are remaining under traditional tenure and the "commercial" ranches being established benefit the very few who receive the leases from the land boards.

However, this programme has resulted in new directions for the APRU. Problems facing stock owners in communal grazing areas are much more difficult to solve than are those in the commercial ranch sector. Not only is the range itself apt to be of lower quality, but also the range is frequently under stress due to the tendency to overstock and exceed its carrying capacity. Destocking is a very sensitive issue, and is impractical to enforce without full community acceptance.

More effective packages, containing information adequate to the physical and economic limitations of smallholders, and which take into account the fact they engage in mixed farming need to be developed if they are to become productive enough to meet their own needs, as well as have a marketable surplus.

VII. STAFF ASSESSMENT OF INSTITUTIONS

The staff of the major agricultural research, extension and training institutions were interviewed in 1983 about the relative seriousness of various institutional constraints.

A. Agricultural Research

1. Overview: Staff's assessment of problems

It is generally accepted that the DAR has contributed much information for the development of agriculture in Botswana. However, as in most research institutions, the tendency has been to be preoccupied with technical results (such as yield, plant population, and growth rate) with little attention paid to the resource endowment factor of the highly heterogeneous farming community. The DAR, like most of its counterparts in the developing world,

"has usually been organised on single crop or single discipline lines, although the subsistence farmer, who is the client for much of this research, does not often practice extensive monoculture, but usually manages a complex system of inter-cropping. As a result of these circumstances, many research projects only a limited relationship to small farmer needs . . . [In addition, there has been a] general lack of national research policies that specify priorities so that these can be used to effectively determine the most appropriate allocation of available resources."¹

The DAR--and especially its Division of Animal Production, which strongly influenced the GOR to establish the Tribal Grazing Land Policy (TGLP)--has produced technically persuasive improvements in such areas as calving percentage, growth rates, calf mortality and liveweight gain. The techniques underlying these changes are most appropriate for use by large, commercial farmers.

Furthermore, through its animal breeding programmes, the DAR has provided the farming public with relatively encouraging results. For instance, the use of Brahman, Tuli and Simmental cattle breeds has been generally accepted in Botswana; improvement of the local breed, Segaolane, has also impressed some farmers in Botswana. A number of staff remarked that designing research programmes with a focus on the needs of small farmers who have severe resource constraints is now urgently needed. Furthermore, the DAR's change of research focus from being predominantly on livestock to being on arable agriculture and, more recently, horticulture and farming systems programmes is a positive change that should contribute measurably to the country's development.

The DAR's staff expressed concern over some constraints they felt adversely affected the Department's ability to achieve its goals. The

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most serious problems were felt to be the weak linkages with other MOA agencies and the need for an improved focus on smaller farmers' needs. A significant number indicated that lack of adequate transport and telecommunications, shortages of both junior and senior technical staff and support (service) staff, and poor conditions of service are also problems. These problems, however, are common to almost all MOA Departments.

The following sections discuss and summarise the comments made by DAR staff on specific issues that adversely affect the institution's ability to achieve its objectives.

2. Operating budget

Of the 15 DAR officers interviewed, only five considered the operating budget to be a serious problem. Those who expressed concern over the budget or lack of operating funds felt that they were unable to acquire necessary equipment and facilities for their projects. In addition, some felt that the process for allocating budgetary resources between and within programmes and projects needed to be improved. The tardy release of financial resources was also considered a constraint, because officers felt they could not carry out timely field observations or obtain needed casual labour.

3. Shortage of senior technical officers

Like most Departments of the MOA, the DAR suffers an acute shortage of local, qualified senior officers. The heavy dependence on expatriate personnel was seen by some of the research staff as creating serious problems of continuity and consistency in research focus. In turn, these adversely affected the ability of the DAR to develop appropriate small farmer technology. Some staff felt that some of the foreign-funded projects had done very little to identify and train local counterparts.

4. Shortage of junior technical staff

Seven out of the 15 DAR staff interviewed considered the shortage of junior qualified staff to be a serious constraint. In particular, the DAR lacks mid-level technical staff. Even if there were a larger pool of locally-trained junior officers, the sharp competition for them from other departments would make it difficult for the DAR to meet its annual hiring requirements. Consequently, the DAR research programmes are adversely affected by the shortage of qualified technical staff.

5. Facilities

In general, the Department's staff felt the present facilities were adequate and in relatively good condition, although there was some concern regarding the shortage and obsolescence of some research equipment. However, the maintenance of facilities and especially equipment was considered poor, largely because there were few in the DAR qualified to service them.

6. Transport

Six of the department's 15 staff members interviewed considered lack of good transportation a serious problem. Although a shortage of vehicles was indicated, they felt this was further aggravated by poor maintenance and management of the vehicle pool.

7. Telecommunications

One of the most serious problems, not only for the MOA but for the whole government, is the lack of telecommunication service, especially when research stations and test sites located in the rural and remote areas need to be contacted. This affects the costs of conducting research and the timeliness of operations.

8. Linkages with other MOA agencies

A majority of the 15 DAR staff interviewed expressed deep concern over the weak relationships and lack of communication between the DAR and other MOA departments. For instance, they questioned the usefulness of documents reporting on research results which are often too technical for junior extension staff to interpret and integrate for use in recommendations to farmers. An interpretive capability is urgently needed within the DAFS, to integrate research findings into extension programme components which could be carried out in farm demonstrations and included in educational materials.

In addition, many indicated that research programmes are often planned without input from other MOA agencies, especially from the DAFS, regarding the potential applicability of results for farmers. For instance, the DAR emphasises mono-cropping and row planting, and thus develops technology largely based on these techniques. Ninety percent of Botswana's farming population, however, still practice broadcasting. Likewise, the DAR has been developing beef production techniques quite well-adapted for commercial ranching conditions, while an overwhelming majority of livestock owners still practice cattlepost/communal livestock production. The staff felt that the existing research and extension coordinators in the MOA did not provide adequate help with interdepartmental liaison to develop technology targeted for use by small farmers.

9. Conditions of service

Thirteen of the fifteen staff expressed concern over the poor conditions of service that prevail in the DAR. In particular, housing was considered to be very inadequate: it was noted that certain officers were compelled to share housing with others against their will. Promotion prospects, especially for the junior research staff, seemed bleak and could affect their morale and, presumably their productivity. Some of the officers felt that promotion prospects in other Ministries appeared to be better than in the MOA.

B. Agricultural Training

1. Overview: Staff's assessment of problems

Although the College has been successful in establishing an effective training programme and has also been very helpful to farmers around the College, most of the 13 staff members interviewed felt that a number of important constraints limit the institution's ability to achieve fully its purpose and potential contribution.

2. Relations within the Ministry of Agriculture

The College's staff, in particular, felt that there was a very weak linkage between the DAR of the MOA and the College. Although occasionally some Research Officers teach at the College, this is done on an ad hoc basis: consequently, both the academic staff and the students are not adequately exposed to the research programmes. There was a feeling among BAC staff that joint research and teaching appointments should be promoted and institutionalised in order to reduce the knowledge gap that besets the two institutions. For instance, the DAR is involved in the fabrication of animal-drawn implements, but neither the staff nor students in the Agricultural Engineering section of the College participate in the programme.

The linkages between the BAC and the DAFS were generally considered to be adequate.

There was little feedback between the former students of the college presently employed in the field and the college itself, regarding the strengths and weaknesses of the knowledge and skills acquired by the students during their training. Such feedback would enable the BAC to identify its strengths and weaknesses, and to improve the curriculum in order to make the training programme more relevant to the country's needs. For instance, inter-cropping and mixed-cropping have received very little attention at the college, yet the majority of crop farmers in Botswana still mix their crops.

The BAC staff recommended that the linkages, communication, feedback and working relationships between the college, other appropriate departments in the MOA and other Ministries be strengthened and eventually institutionalised, in order to enhance the development of appropriate technology for farmers.

3. Operating budget

The staff felt that the shortage of operating funds has adversely affected the ability of the institution to provide faculty and students with vital information and experiences based on actual field circumstances. For example, the staff expressed concern over the lack of financial resources to purchase books and demonstration materials for students. This constraint has forced teachers to prepare notes for students as substitutes for textbooks. Meager travel funds have forced the College to eliminate its vital extension programme, designed to give the students practical experience based on case studies gathered from surrounding villages.

4. Shortage of trained and qualified senior teaching staff

Over one-third of BAC's senior teaching staff are expatriates. When the teaching staff is classified according to academic level, the problem of localisation becomes more serious. Currently, BAC does not have a local staff person with a PhD degree. Of the staff members at the MSc level, 50 percent are expatriates. All four veterinarians are expatriates. As was pointed out earlier, the need for increased localisation for this institution is especially acute both in animal health and in agronomy.

One of the major concerns raised by the College staff during the interviews was the failure of the Ministry to fully develop a national, long-range plan for training of degree-level personnel, especially in areas of critical need. At present, the allocations of highly-trained local persons is achieved by competition among various departments in the Ministry, the BAC and other agencies. Thus, given the severe national shortage of trained Batswana at the various degree levels, the College is now forced to compete for such scarce personnel especially with other Departments of the MOA: this situation is unlikely to change in the near future.

At present, the College has a relatively heavy concentration of animal scientists. This can be understood because the country's agriculture historically has been and continues to be livestock-based. However, the equity emphasis expressed in the National Plan would require, in the long run, that the country diversify its agricultural/rural economy. This, in turn, would change the mix of the professional disciplines required in the MOA, BAC and other agencies. Consideration of the mix of disciplines required to support the shift in the Ministry's programme emphasis is needed and could be part of a national, long-range plan for increasing the number of local personnel with advanced degrees.

5. Conditions of service

Among the major problems over which the College staff expressed concern were the conditions of their service. The staff felt that better housing should be given top priority to improve morale. Serious concern was expressed over promotion and salary policies as well. A majority felt that upward mobility was hampered by the lack of available posts. The staff felt there was a need to be more productive. In addition, staff requested that short in-service training programmes be provided. Given the dynamic nature of agriculture, the need to keep abreast of new technological changes in a training institution is very critical. Finally, the staff recommended that a comprehensive plan to improve the conditions of service be developed in order to improve productivity of the College staff.

C. Agricultural Extension

1. Overview: Staff's assessment of problems

The DAFS has tried to increase its contact with farmers through the various means at its disposal. In particular, it believes that its work has greatly accelerated the adoption of improved cattle management techniques. On the other hand, many feel that the DAFS had little impact in increasing the adoption rate of crop husbandry innovations. While farmers are becoming aware of disease control, dehorning, and other production management practices in livestock production, a very insignificant number of farmers follow DAFS crop husbandry recommendations. For example, of the estimated 90,000 farming households in Botswana, less than 10 percent plant their seeds in rows: the majority still broadcast seeds. While large farmers plough under crop residues immediately after harvest, a recommended soil moisture conservation practice, far less than 10 percent of the total farming households follow this recommendation.

Most of the staff interviewed pointed out that highly variable rainfall patterns are partly responsible for the poor adoption of recommended arable practices and for the resulting low food grain production of the major food crops. It is difficult to persuade farmers to adopt new crop production practices under such a high-risk situation. Others pointed out that disparity between the larger resource base of livestock growers and the smaller resource base of many arable farmers may explain, in part, the differences in the rates at which improved practices are adopted in each sector. Several felt that greater effort must be devoted to tailoring practices more precisely to fit the needs of farmers, especially those in the traditional sector.

The DAFS staff expressed concern over other problems that affect DAFS' ability to achieve its goals. A summary of their comments on these other problem areas is set out below.

2. Operating budget

Some of the staff interviewed considered insufficient operating funds to be a factor contributing to poor extension service. For instance, it was pointed out that there was a shortage of equipment and facilities for use in soil conservation, small stock, information and youth programmes. The inadequacy of such resources led to poor farmer-extension contact.

3. Shortage of senior technical staff

Shortage of senior technical staff is a serious problem for all MOA departments. Few students qualify to study science at the University of Botswana. On the average, about 60 enter for degrees leading to science-related careers each year, yet less than 10 percent of these choose agriculture as their career.

In addition to the low enrollment of science students at the University, the traditional tendency of the MOA to spread out and thus delay the further training of serving officers also partly contributes to the shortage of more highly-qualified personnel. The most affected sections of the DAFS were those of Horticulture, Range Ecology/Management, Information and Broadcasting, Small Stock, Land Use, and Agronomy. Some officers raised concern over the serious misallocation of the already scarce human resources in the DAFS. Others felt that some of the senior staff lacked the practical experience required to be effective. A few officers pointed out that there was a tendency for the Division of Planning Statistics to receive a disproportionately large number of highly-trained personnel.

4. Shortage of junior technical staff

The shortage of qualified junior staff is related primarily to the lack of availability of adequate local facilities for additional students. Although the BAC has recently doubled its enrollment of students, at the projected level of expansion of the Ministry's programmes the supply of trained individuals will continue to fall short of the demand. Furthermore, there is sharp competition for their services within the MOA. Some officers expressed concern over the limited technical competence and practical experience of many junior officers and the lack of effective supervision of these officers by their immediate superiors.

5. Support staff

The support staff lack specialised training in their present jobs. This was a concern expressed most seriously by Information/Broadcasting, Small Stock and Land Use staff. The support staff also generally lack practical experience.

6. Access to research

Access to the DAR staff was generally considered by the DAFS staff to be a minor problem. However, it does appear that some extension officers do not seem to be aware of the availability of research services and facilities supporting their extension services, e.g., soil testing, entomology, and plant pathology diagnostic services. It appears that better communication between MOA agencies, stressing mutual assistance, should be given more emphasis.

7. Lack of inputs or timeliness

The shortage of farm inputs and their untimely delivery to farmers have been cited by DAFS staff as very serious problems. Sufficient supplies of seeds and other farm inputs either have not been delivered or were delivered too late to farmers. The Department's staff felt strongly that this problem complicated their extension work significantly. To aggravate matters, seeds are initially processed and packaged at one centre (Gaborone) from which they are later distributed to various parts of the country. This service needs to be decentralised as much as possible to facilitate timely delivery of farm inputs. The staff also expressed concern about the inability of transport facilities to convey these inputs to farmers in remote areas on a timely basis.

8. Lack of useful research information

The amount of useful research information has been considered by the Department's staff to be seriously inadequate. For instance, the staff expressed concern about the lack of reliable technological recommendations about crop production suitable for small-scale farmers. Two studies on the traditional arable sector in Botswana have recently been completed.² Both examine the impact of different arable production practices on harvesting rates and average food crop production levels in the traditional sector. The agricultural extension staff has been recommending some of these practices to farmers. However, the recommendations are based largely on technical coefficients such as yield and planting populations, and do not sufficiently take into account the resource base of farmers. Thus, almost all of the practices recommended by conventional research to date have required more inputs per unit area than are available to most small farmers. Labour has been considered by most studies, and by the Department's staff, to be one of the major limiting factors in agriculture.

The 1980 Agricultural Survey and the 1981 ALDEP Pilot Project concluded that, although row-planting of maize may result in yields significantly higher than broadcast planting, row-planting without the use of other complementary inputs and management practices (such as timely planting, weeding, and use of improved seeds) will not guarantee higher average production levels, especially among small farmers. This suggests the importance of adopting a broad farming systems perspective in research efforts which will take into account

the interaction of more of the important factors in production. It appears that the MOA, through a joint inter-departmental technology development programme, can improve its ability to provide farmers with adaptable and reliable agricultural production information. The FSRP should provide a useful framework for diagnosing and understanding the circumstances of small farmers.

9. Policy problems

Although the MOA has been trying hard to provide assistance to farmers as fairly as it can, the DAFS staff expressed concern over the relatively low subsidies available for crops as compared to those available for livestock. Assuming that crop production is more risky than livestock production in Botswana, the staff felt that crop-producing farmers who attended the seminar previously mentioned confirmed that their livestock counterparts received more material assistance from the GOB than did they. In addition, much of the credit available from the National Development Bank is designed to support livestock production. Several staff members felt a need for a study of the costs and benefits of subsidising farmers in Botswana, with a view to developing a comprehensive programme to ameliorate small farmers' problems.

10. Transport

Although they recognised that there is a general shortage of transportation facilities (especially vehicles), the Department staff felt that this problem was exacerbated by poor allocation of vehicles between and within Departments. For instance, the districts tended to get fewer vehicles than headquarters. The DAFS staff expressed concern over the lack of accountability by some officers when using these vehicles. Some officers felt that poor maintenance and delay of vehicles during servicing also complicated the transport service.

11. Telecommunications

The lack of reliable telecommunication service, especially with the remote rural areas, has been a serious and recurring problem throughout the country. There is very little the DAFS or the MOA can do, since the service falls outside of their responsibility. Hopefully, telecommunications will improve in the near future.

12. Conditions of service

The Department's staff expressed deep concern over the poor conditions of service in their present job situation. There is a serious shortage of housing for field staff, especially for the junior, village-level extension staff. Several officers considered the present housing of the junior staff in the field rather unsatisfactory and uncomfortably hot. Those who worked in urban areas also experienced the same housing difficulty. While this problem in general is common to all offices of the GOB in rural areas and towns,

the junior MOA field staff, when comparing themselves to fellow field staff working for other Ministries, found that their accommodations were disproportionately inferior.

The Department's staff felt their promotion prospects seemed very bleak, especially in view of escalating costs of living. For instance, it is not uncommon for junior officers to spend more than ten years at the same level of remuneration. They felt such a condition adversely affected their morale and productivity.

13. Linkages with other MOA agencies

The DAFS staff felt that the relationships and communication between various MOA departments, especially between the Research, Training and Planning Departments, appeared weak and needed much improvement to facilitate a more effective extension service to farmers. Although there have been research-extension coordinators within the DAFS, the staff felt that this was not adequate to meet the problems of small farmers. For instance, there has been very little useful animal production technology developed for small farmers, especially regarding grazing and management systems.

However, it is hoped that the multi-pronged approach of the FSRP will bridge the gap between and within the various MOA agencies. In addition, there are joint committees on which most of the MOA agencies are represented, such as the Arable Research Priorities Committee and the Animal Production Technical Committee. However, the effectiveness of these committees needs to be monitored to determine their impact on the overall development of technology appropriate for the majority of small farmers.

¹Douglas Daniels and Barry Nestel, eds., Resource Allocation to Agricultural Research (Proceedings of a workshop held in Singapore, June 8-10, 1981), (Canada: International Development Research Centre, 1981), p. 9.

²John Litschauer and William F. Kelly, Traditional Arable Production Practices in Botswana. (Gaborone: Division of Planning and Statistics, Ministry of Agriculture, 1981); Howard K. Sigwele, An Analysis of Research and Extension Strategies to Improve Cropping Systems for Small Farms in Botswana (Research paper for M.S. in Agricultural Economics), Michigan State University, East Lansing, Michigan, US, 1982.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Chapters VI and VII of this report discuss direct and indirect constraints to increased agricultural productivity as well as constraints seen by staff of the DAR, the BAC and the DAFS. This chapter will not discuss these constraints again in detail but will refer to them as a basis from which to discuss recommended actions.

A. Strengthening Botswana's Agricultural Institutions

The capacity of Botswana's research, training, and extension institutions to contribute to increased agricultural productivity could be strengthened through improvements in the three areas discussed below. In addition, many of the comments in Section B are relevant to the constraints in Botswana's agricultural institutions noted earlier.

1. Linkages

The GOB is working to improve linkages among its several operating agencies in the MOA. This is reflected, at least in part, by the close coordination now observed between the Arable Research Programme and the APRU. Similarly, the farming systems research projects are also striving for better communication and cooperation among research, extension, and farmers. This strategy can be even more strongly implemented and should be enacted at all levels--at the administrative and professional staff levels as well as at the working staff level in the departments. Only by example will this concept become established. There is also an opportunity, through the SADCC relationships, to establish strengthened linkages with institutions in other countries having similar problems.

2. Transport

The MOA needs to address its extreme problems in maintaining and servicing its transport fleet. No other problem seems to have frustrated programmes and efforts as completely as the lack of timely access to needed transport. Crops and animals operate on seasons, rather than by the bureaucratic schedule of a service agency, and are adversely affected if needed goods and services fail to arrive at the appropriate times.

3. Terms and conditions of service

Terms and conditions of service which are sensitive to staff concerns and are perceived as helpful rather than unsupportive are essential to improving the motivation and morale of staff.

B. Dealing with Constraints Affecting Crop Production

1. Food crops

Direct physical and biological constraints to crop production discussed earlier included:

- o The lack of availability of moisture;
- o Unavailability of high-yielding varieties suited to the extremes of Botswana's environment;
- o High soil temperatures restricting germination and growth;
- o Low-phosphate soils with poor mechanical properties;
- o Losses due to weeds, pests, and diseases;
- o Lack of or limited access to farm power; and
- o Shortages of farm or family labour at critical times during the growing season.

Indirect constraints include:

- o An inadequate input supply and delivery system;
- o Inappropriate technical packages to meet smallholder needs and allay concerns regarding risks;
- o Inadequate marketing services;
- o Damage from livestock; and
- o Inadequate contact with field agents.

The farming systems projects now in place provide a basis for a strong MOA strategy to build linkages and involvement among smallholders, researchers, training officers and the DAFS to focus on problem-solving and service. Such a strategy should include the requirement that research and economic analyses relate proposed technological packages to the attitudes and abilities of smallholders rather than to idealised or maximised conditions. Lack of access to farm power, labour shortages, and losses due to birds, other pests, and weeds seem to be very important constraints to productivity: consideration of all of them should be strong components of research and extension strategies.

2. Specialty crops

Development of specialty fruit and vegetable crops is constrained by a set of factors in addition to those affecting the mainly rainfed food crops. These include:

- o Limited access to and supply of water;
- o Inadequate understanding of climatic extremes in relation to specialty crop species or varieties;
- o Inadequate information on pest and disease control;
- o No tradition of irrigated agriculture;
- o Little effective input distribution or marketing services; and
- o Uncertain potential, economically and technically, for smallholder participation.

Prior to any expansion of research and extension for specialty crops, it would be useful to perform a careful analysis and evaluation of its potential for substantial smallholder participation. From such an analysis, a coherent and practical strategy could be formulated. At this time, it is unclear what the production potential is and what related overhead costs would be for a strong specialty crops programme of research, training, extension, and related services.

C. Dealing with Constraints Affecting Livestock Production

Direct physical and biological constraints to livestock production noted earlier include the limited capacity of the land and water resource base, frequent droughts, and disease. Indirect constraints include limited or differential access to resources, a lack of adequate transportation of animals to market, and insufficient abattoir capacity, especially in drought years.

The physical and biological constraints to livestock production in Botswana have been studied and reported on for many years. There is an extensive body of research which is of high quality and quite specific regarding these constraints.

There are some long-term, troublesome areas, however, where factual knowledge is not available, where opinion and "common knowledge" are the rule and where research has not provided information essential to policy formulation and the development of effective strategies. Better information is needed in the difficult and sensitive areas relating to rural traditions and, in particular,

to water rights and access to rangeland. A research strategy should be developed which includes such elements as:

- o A focus on the traditional sub-sector, to better assure the relevance of research and extension programmes;
- o The development of an efficient methodology to monitor accurately the carrying capacity of the resource base;
- o Continued efforts to implement or adapt the TGLP to the needs of the smallholders and the country;
- o Improved linkages and collaboration between crops and livestock research programmes and between research and extension; and
- o Continued analysis of animal transport, marketing, and related issues.