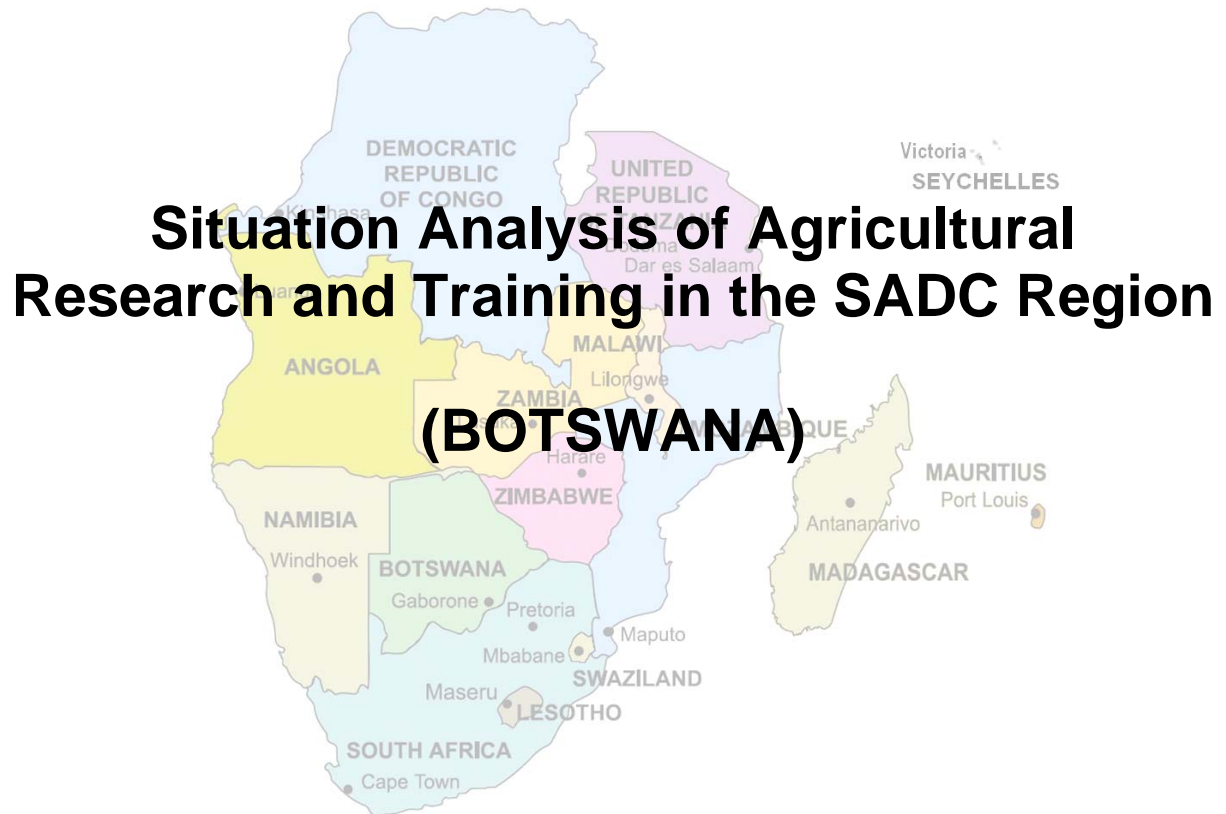




IMPLEMENTATION AND COORDINATION OF AGRICULTURAL RESEARCH AND TRAINING (ICART) IN THE SADC REGION



***FANR Directorate
SADC Secretariat
July 2008***

“The authors accept sole responsibility for this report drawn up on behalf of the Regional Authorising Officer of SADC Secretariat. The report does not necessarily reflect the views of the SADC Secretariat, nor of the European Commission”

**BOTSWANA SITUATIONAL ANALYSIS ON AGRICULTURAL RESEARCH
AND TRAINING**

FINAL REPORT

BY

BOTSWANA COLLEGE OF AGRICULTURE CONSULT (PTY) LTD)

SUBMITTED TO

ICART-SADC

MARCH 2008

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ABBREVIATIONS AND ACRONYMS

AEE	Agriculture Education and extension
NARS	National agriculture research system
BRSTFA	Botswana Research, Research and Technology Funding Agency
MFDP	Ministry of Finance and Development Planning
EU	European Union
AEL	Agriculture Engineering and land planning
ASP	Animal Science and planning
BCA	Botswana College of Agriculture
BIDPA	Botswana Institute for Development and Policy Analysis
BNRS&T	Botswana national research, science and technology plan
BOTEC	Botswana Technology Center
BRSTFA	Botswana Research Science and Technology Funding Agency
BS	Basic Science
BVI	Botswana Vaccine Institute
CSP	Crop science and department
DAR	Department of Agricultural Research
DRST	Department of Research, Science and Technology
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
MCST	Ministry of Communications, Science and Technology
MDG	Millennium development Goal
MoA	Ministry of Agriculture
MoE	Ministry of Education
NAMPAADD	National Master Plan for Arable and Dairy Development
NARS	National Agricultural Research Systems
NDP	National Development Plan
NFTRC	National Food Technology Research Center
NGO	Non-Government Organization
NVL	National Veterinary Laboratory
SADC	Southern African Development Community
UB	University of Botswana
UNDP	United Nation Development Programme
VPR&D	Veld Products Research and Development

EXECUTIVE SUMMARY

This report contains the findings of a broad assessment of registered institutions, organizations and Ministries that are stakeholders in the NARS and have a number of common issues that could form the basis of a functional NARS. The activities, human resources, and organizational structure (where possible) were assessed and appraised. The report starts with a brief introduction on agriculture in Botswana and its policy. A description on the concept of NARS is also given.

The main body of the report describes the status of NARS in the country in which the different institutions are discussed. The current NARS in Botswana is composed of a few ministries and organizations/institutions with all or part of their mandate in agricultural research. Three ministries have been identified to be involved directly and indirectly in NARS: the Ministry of Agriculture (MoA), Ministry of Communications, Science and Technology (MCST), and Ministry of Education (MoE). The Ministry of Agriculture has the largest mandate in the national agricultural policy. The recently formed MCST has a mandate to formulate science and research policies as well as coordinating the implementation. However, these have not yet been put in action and therefore there is still a disconnection between the ministries. The institutions identified were categorized into policy organizations (BIDPA), universities and training (BCA, UB), government controlled (DAR and NVL), non-governmental (VPR&D, Thusano Lefatsheng, FAB) and parastatals (BOTECH, BVI, NFTRC). Out of these only DAR and BCA cover all aspects of agriculture. The other institutions cover different mandates within agriculture and related fields such as agroforestry, conservation of veld (indigenous) products, animal diseases, food technology, etc. Institutions such as BIDPA, BOTECH and UB have their activities representing a relatively small part of their mandate on agricultural research. The three non-governmental organizations identified are heavily involved in community projects. The financial resources of the government controlled institutions, parastatal institutions, and universities are almost exclusively provided for by Botswana government.

The study identified challenges and opportunities on the agricultural research systems of the country. The major constraint identified is a lack of a specific agricultural research policy, which lead to a stream of other constraints. The constraints identified, among others, include: lack of established research priorities; lack of coherent monitoring and coordinating mechanisms; lack of linkages between and within institutions; lack of linkage with the end user (farmer); inefficient use of resources, etc. Recommendations made include the need for establishment of a specific research policy and a relevant coordinating body.

INTRODUCTION TO THE STUDY

The programme Implementation and Coordination of Agricultural Research and Training in the SADC Region (ICART) is a regional agricultural research and training program operating under the auspices of the Food, Agriculture and Natural Resources Directorate (FANR) of the SADC Secretariat, responsible for the coordination of the agricultural research and training programmes.

ICART's overall objective is to contribute to regional economic growth and poverty alleviation by organizing within the SADC region innovative agricultural research and training activities to promote sustainable use of natural resources. This will lead to increased agricultural production through application of improved technologies, and the implementation of policies that will enable resource-poor smallholders to achieve improvements in their livelihoods. Research findings and the training of researchers and professionals will contribute to the creation of an enabling environment for all stakeholders in agricultural production, thus improving both the food security and economic status of the countries concerned.

As part of the activities of the ICART project, a four-phase Situation Analysis is being implemented in order to identify, appraise and assess constraints, and recommend support strategies for existing National Agricultural Research Systems, and for research networks servicing agricultural production and rural development in the SADC region.

The programme is designed to enable national agricultural research programmes, and National Agricultural Research Systems (NARS) where they already exist (involving public sector research and training institutions in agriculture, private sector research and technology generation companies, and professional agricultural organisations) to generate through empirical means innovative solutions to:

strengthen both in-country and regional cooperation in order to increase agricultural production, productivity and quality
improve incomes of small-scale farmers and profits for processors, traders and other beneficiaries, while maintaining the natural resource base.

Where NARSs do not currently exist, specific recommendations will be made to promote the concept, and formally establish them.

Phase 1 of the Situation analysis consisted of a desk study of information available at the SADC Secretariat and through the Internet.

Phase 2 consisted of four consultants effecting country visits to establish a rapid appraisal of the institutional set up within SADC Member states and establish a preliminary comparison of the 14 member states, based on their short visit.

Phase 3 consists of gathering information through national consultants to supplement the Phase 2 information gathering process and to produce country reports.

Phase 4 will consist of reviewing the country reports and other material gathered on networking initiatives in the region to produce a regional synthesis of Agricultural Research and Training in the region, as well as draft a strategy document for the support to regional networks for the SADC Secretariat.

Tasks and Activities

Specifically, Phase 3 of the consultancy consists of gathering information on the following 12 main issues.

Point 1 - Assessing with the relevant Ministries the policies for research and training in agriculture
Point 2- Private sector organizations, their research needs and their role in Research and Training
Point 3 - Establish the list of registered institutions/ organizations delivering agricultural research
Point 4 - Establish the list of registered Institutions/organizations delivering high level training and in service professional training in agriculture
Point 5 - Address with the Ministries the formal existence of NARS and the monitoring mechanisms, the contribution of research stakeholders.
Point 6 - Provide charts indicating institutional structures and relationships
Point 10 - Document the working methodologies for research
Point 16 - Identify actual and potential demand for cooperative relationships between research and training institutions and the farmers' organizations and private sector
Point 17 - Appraise in - country research alliances
Point 18 - Appraise research alliances developed across the SADC region
Point 19 - Appraise cooperation with foreign international research institutions
Point 20 - Identify the needs for research networks serving SADC priorities

PROJECT APPROACH AND METHODOLOGY

The methodology and modalities for this situation analysis was discussed at a workshop in South Africa, in October 2007. Following discussions with the SADC ICART team, the Terms of Reference was streamlined to 12 core points.

The general method proposed for the implementation of the Situation Analysis is as follows:

Step 1. Identify and collect the policy documents or the policy orientation with the appropriate resource persons in the Ministries and assess how the implementation of those policies was planned in every Research and Training institution
Step 2. Produce organizational charts of the institutions, including their relationships with the Ministries, and analyze how this institutional set up is managed as a NARS.
Step 3. Identify the following:
i) existing cooperation mechanisms with research stakeholders
ii) cooperation mechanisms between research institutions, between training institutions and between training and research institutions at country level
iii) cooperation between institutions in diverse SADC Countries,
iv) cooperation with foreign institutions and through international networks,
v) needs and demands for further cooperation through network

Data Collection Process

The information for this study was mainly collected through the following:

A desk study of the existing documents, in particular, policy papers from the Government of Botswana and parent ministry; strategic plans for the sector and/or subsectors; research programmes of research and extension organisations; and other relevant documents and the phase 3 report.

BACKGROUND INFORMATION ON AGRICULTURE IN BOTSWANA

Botswana is a land-locked country located in Southern Africa. It is bordered and shares the longest border to the by Namibia, Zimbabwe to the east, Zambia to the north and the Republic of South Africa (RSA) to the south. The area of Botswana is 582'000 km divided into three ecological zones of the Kalagadi Desert, the Okavango Swamps and the hard-veld in the east of the country. The country is sparsely populated by a population of 1.7 million people. Botswana is a semi-arid country an erratic rainfall that supports all agricultural activities carried out to sustain livelihoods of many households. Forty-six (46) percent of the population live in rural areas and depend on agriculture for sustenance. There is a rapid urban migration with about 54% of the nation now living in towns compared to 9% some thirty-six years ago.

The Kgalagadi Desert stretches from down south-west around Bokspits up to the Gantsi district consisting largely of sandy soils not suitable for arable agriculture because low rainfall distribution including low moisture retention capability of this type of soil. However, the marginality of the area favours livestock agriculture and wildlife. The best beef cattle and large game ranches are produced and found in this ecological region.

On the other hand, the Okavango delta is the wettest region of the three and it houses the largest inland water basin that has some of the best fauna and flora found in the world. The soils bordering the basin are the black cotton clays types that are very fertile. The biggest arable farmers are found in this area around Pandamatenga village. Farmers here own very large tracts of fertile land where they produce mainly sorghum, maize, sunflower and cotton. Rainfall around this region averages around 650 millimeters per year.

The hardveld region is where most Batswana farmers are found practicing both the traditional and modern types of farming. Both arable and livestock agriculture (Figure 1) are concentrated in this area and varied types of agricultural technologies are used. Arable farming in this area has not done well as compared to livestock production over the years. Low crop yields, poor management skills and environmental degradation are evident.

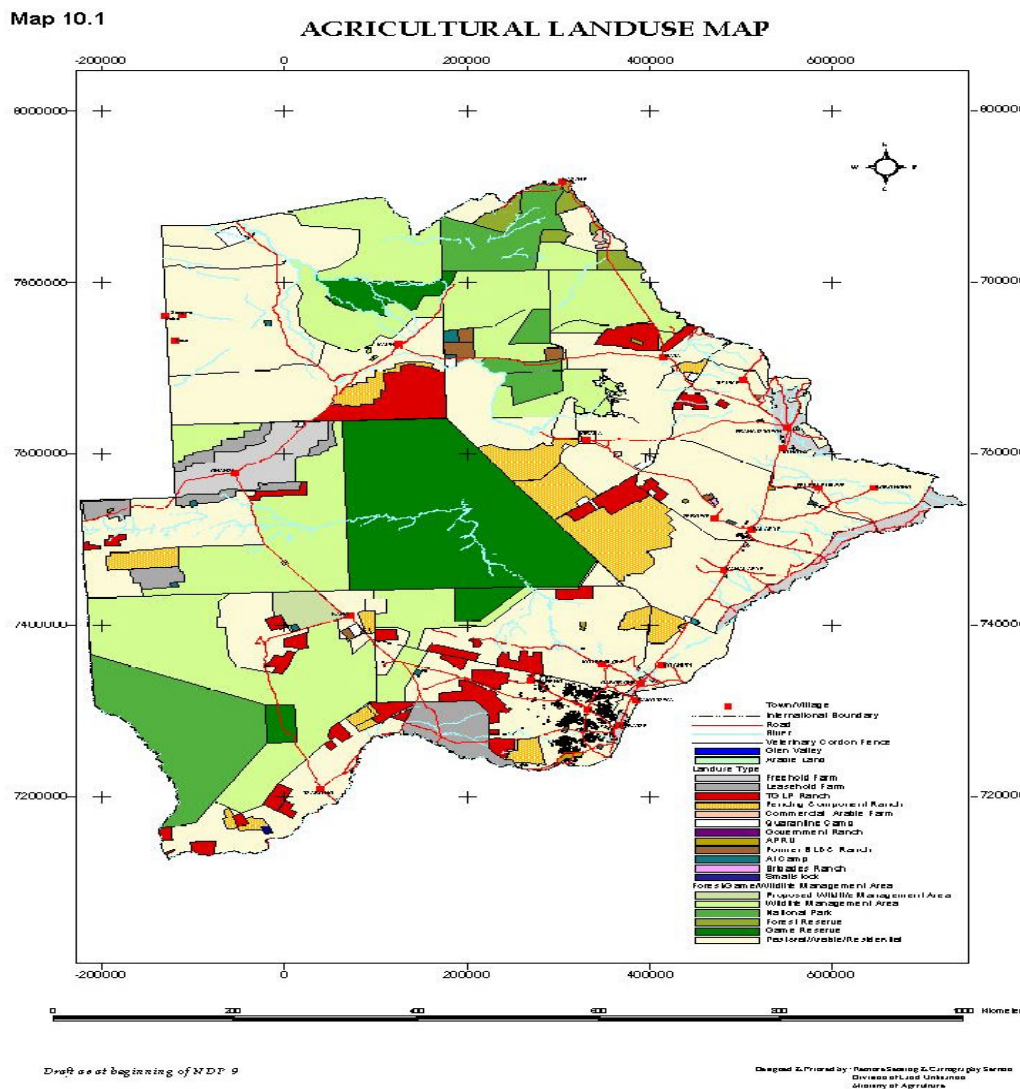


Figure 1: Agricultural Land Use in Botswana

This study is the third phase of a scheduled approach to carry out a situational analysis of the status of National Agricultural Research Systems (NARS) in Botswana and other member states of the Southern African Development Community (SADC). The situational analysis was set to examine the existence of the NARS in Botswana; identify Ministries responsible for guiding policy for agricultural research and training; establish coordination of the functions of the NARS in Botswana and existence of networking alliances within Botswana, across SADC region, and cooperation with foreign/international research institutions, and therefore assess the needs for research networks serving SADC priorities. These outcomes would enable the implementation and coordination of agricultural research and training; identifying areas of agricultural research and training that needs support for effective and efficient management of NARS. The information gathered in this study will then be used to support the next phase of the programme.

Physical Characteristics

Botswana is saucer-shaped and lies nearly one thousand (1000 m) metres above sea level. Just like a saucer, most of the country is flat. In the east, next to the Limpopo drainage system, the land rises to above 1200 m, and from the Limpopo Valley, gradually descends from 900 m in the south to 500 m at the confluence with the Shashe River. In the northwest, the Okavango River drains inland from Angola to form the Okavango Delta. The central northeast consists of large calcrete plains bordering Makgadikgadi pans.

More than two-thirds of Botswana's land area is covered by thick sands of the Kalagadi Desert that reach depths of up to 120 m. the vegetation found in the desert consists of shrubs and grasses. In general, Botswana has geologically old, highly leached, poorly structured and infertile soils with limited vegetation cover.

Botswana's climate is arid and semi-arid with a mono-modal rainfall regime. The rains fall during summer, usually between October and April. The average annual rainfall

ranges from 250 millimetres in the extreme southwest to 650 millimetres in the extreme north. For the country as a whole, the mean rainfall is approximately 475 millimetres per annum. The winter seasons are cold and dry, commencing from May and ending in July. Cyclic droughts are common occurring every 5 – 10 years.

The conditions described fairly indicate that the country is not well endowed with natural physical characteristics for agriculture. It is estimated that only about five (5%) percent of the total land area is considered suitable for arable agriculture and only about one (1%) percent is under cultivation yearly. Satellite imagery carried out by TAHAL consultants for NAMPAADD indicated that there are approximately 190,000 hectares of land suitable for agriculture. Rain-fed agriculture is possible for only one season but it is very risky, especially as a result of unreliable rainfall and poor soils. Contrastingly, surface water for irrigation is scarce and ground water resources are limited and expensive to exploit for irrigation.

Agro-ecological Zones

For management purposes, the country is divided into eight agro-ecological zones shown below:-

- **Zone 1** – covers the narrow strip of alluvial soils on the Botswana bank of the Zambezi and three areas of dark clay soils in eastern Chobe (Kachikau, Kasane, and Pandamatenga). It receives between 600 – 700 millimetres of rainfall of which 92% falls between November and March. This area is free from frost. The heavy clay soils in this area present some difficulties to cultivation. This zone occupies 0.02 % of the country. The Pandamatenga commercial farms are located in this zone.
- **Zone 2** – the soils in this zone are predominantly Kalagadi sands. These are light soils that are poor in all plant nutrients. The Maun-Nata road and a projection of line west of the delta have been selected as the southern boundary of this zone because it is a useful mark which conveniently coincides with 500 millimetres

rainfall line and extreme frost of -3 to -4°C significant for several crops. The zone covers 20% of the country.

- **Zone 3** – this zone coincides with an area of alluvial soils and the general possibility of irrigation. Rainfall is reasonable at 450 – 550 mm and the average temperature range is 10 to 30°C which is also reasonable. There are few frosts but the possibility of frosts extends over four months. It covers one percent of the country.
- **Zone 4** – this area covers the Makgadikgadi pans, where adaphic factors limit the number of crops which can be grown. Generally, the soils in this zone are either dark clays derived from basalt coarse sands or saline or alkaline pan soils. Calcrete layers are common. There is an area of internal drainage and its boundaries coincide roughly with the 900 m contour. The zone covers 1.8 percent of the country.
- **Zone 5** – together with zone 8, this zone is largely occupied by the Kgalagadi sands. However, sands in this zone are much finer (15% medium to 75% finer) compared to those in zone 8. A greater nutritive grass species are also found here than in zone 8. Annual rainfall is 400 mm and annual variation is greater in zone 8. The nutrient status is very poor and poor to occasional medium. The zone covers 34% of the country.
- **Zone 6** – this zone is defined on its western side by the edge of the sandveld and on its eastern side by the 400 – 450 mm of rainfall isohyets, the boundary between the early and late tertiary erosion cycles, and by average maximum temperatures of 32 to 33°C . it coincides with higher and less variable rainfall, and slightly lower summer temperatures. The nutrient status is low to moderate. The zone covers 16.5% of the country.
- **Zone 7** – mean rainfall in this area is lower (350 – 450 mm), summer temperatures are higher by a few degrees and frosts are few and mild. Evapotranspiration is high. The zone covers 3.8% of the country.
- **Zone 8** – occupied by the Kgalagadi sands. The sands tend to be coarser (25% medium sand and 60% fine sand). Grass species are normally of poor quality. Temperatures rise higher and fall lower in this zone. Frosts are more numerous

and more severe in this zone. Nutrient status is very low and growing of crops is very limited. This zone covers 22.6% of the country.

Structure of the Agricultural Sector

The sector is dualistic, composed of both the traditional farmers and commercial farmers, with the main differences being land tenure, use of technology, and marketing of agricultural outputs. The smallholders live in communal lands where they practice mixed farming of crops and livestock. They depend on rain-fed agriculture and low-input low-output farming systems. The commercial farmers, who constitute about one percent of the total number of farmers, occupy medium to large scale farms on freehold land and apply modern and capital intensive farming techniques, including irrigation. They tend to also specialize in cattle production.

Agricultural activities include the rearing of livestock, crop production and, to a lesser extent, fishery and forestry. Livestock, particularly cattle grazing, is by far the most important agricultural activity, accounting for about 80% of the sector's output. It is therefore the mainstay of Botswana's agriculture. According to the Central Statistics Office (CSO), in 2003 Botswana had a livestock population composed of 2.03 million cattle; 1.35 million goats; 220,000 sheep; 493,000 donkeys; 7000 horses; 4000 pigs; 650,000 chickens and 3,000 ostriches. Off-take rates are low among the traditional cattle keepers, ranging between 8 – 10%. The country enforces rigorous animal health standards with a system of cordon fences and strict animal movement regulations. It is currently classified by the international animal society organization, **Office Internationale des Epizootees (OIE)**, as 80% free of Foot and Mouth Disease (FMD). Since 2000, Botswana has been implementing the Livestock Identification Trace-back System (LITS) which has helped it to improve cattle data collection and to meet the latest beef export requirements, particularly to the lucrative European Union (EU) market.

The crop production sub-sector is mainly composed of the production of staple sorghum and maize crops but also includes beans, cowpeas, groundnuts, millet, wheat and sunflower. Most crop production takes place in the eastern part of the country. Yields are

low, ranging between 250 – 300 kg per hectare for both sorghum and maize, and fluctuate considerably depending on the climatic conditions, particularly rainfall, in any given season. In terms of cereal production, annual output fluctuates but has averaged about 18,000 tonnes which is less than ten percent of the mean annual national requirements of around 211,000 tonnes.

The fishery sub-sector is very small, largely because of the death of surface water bodies. The total reported catch is 130 tonnes per year compared with some 3,000 tonnes of fish imported annually. Tilapias are the major species with catfish available but difficult to market. The Okavango and Chobe river systems constitute the major fisheries, with some fishing undertaken in large dams.

About sixty percent of the land area of Botswana is covered by forests, open woodland and tree savannah. According to CSO, dense woodland composed of deciduous forests is found in the north of the country and covers about 5.7% of the country's land surface. The contribution of trees, forests and woodlands to the national economy are difficult to quantify since they do not often provide direct benefits but serve as an essential foundation for other important sectors such as wildlife, tourism, and livestock rearing whose linkages are very difficult to quantify. In addition, forests and woodlands contribute as follows:

- Provide fuel energy to over sixty percent of the population
- Provide numerous cultural, economic, ecological and environmental benefits
- Contribute to household food security by providing wild foods such as honey (inclusive of bee-keeping), fruits, game meat and caterpillar (*Imbrasia bellina*)
- Meet rural subsistence needs by providing construction and fencing materials as well as herbal medicines
- Generate income by providing for handicraft production and fruits, and other veld products for sale
- Protect the environment by reducing soil erosion, conserving watersheds, and sequestering carbon.

FARMING SYSTEMS, AGRICULTURAL ACTIVITIES AND LIVELIHOOD SYSTEMS

Environmental factors have determined the kinds of crops and animals that can be raised in the country. Due to the semi-arid climate and erratic rainfall, arable land is limited to less than 1% of the total area of the country; hence, the country relies heavily on food imports. The rural population spends most of the summer months trying to grow crops with the aim of increasing income per household. The average area planted to arable crops varies with seasons and ranges between 250 000 and 380 000 hectares. Major field crops grown include sorghum, maize, millet and watermelons. In general yields are typically limited to less than 400 kg ha⁻¹ under traditional systems, and can be over 2000 kg ha⁻¹ in commercial farming. This has also been demonstrated in research trials.

Livestock farmers in Botswana keep animals of all sizes from cattle to poultry with cattle, sheep and goats dominating the livestock sector. Beef is an important export commodity and ostrich farming is being developed and may also become an important meat export. Livestock makes vital contributions to human nutrition and health, food security and income generation. In addition to providing food animals are also sources of energy for agricultural processes and transport, and manure for crop production and household fuel. Animals also serve as readily convertible assets to be realized in times of planned or exceptional need.

Economic and Social Context

Agriculture remains a dominant sector in Botswana, though its contribution to the Gross Domestic Product (GDP) has fallen dramatically from about 40 % at independence (1966) down to approximately 1.7 % in 2006, mainly due to mining, tourism, manufacturing and service industries. The sector is also undermined increasingly by erratic climate, particularly recurring droughts. In addition, the sector's contribution to formal employment has also declined. Nevertheless, the sector remains very important as a source of food, income, employment and capital formation for the majority of the population, particularly in the rural areas. It is estimated that approximately 50% of the country's population depend on agriculture for food and income. Off-farm, off-season

and non-agricultural employment opportunities that are mainly in the urban centers contribute to rural-urban migration and reduce the amount of the labor-force in agricultural areas. Most of the population and economic activity of the country is located in the southeast and east central regions. Despite the minor contribution to the macro-economic structure of the country, the sector is of national significance to Botswana because it provides about 20% of employment generated within the country and about 50% of the total population resides in rural areas depending on arable and pastoral farming for their income. The table below summarizes the GDP contribution of agriculture compared to other selected sectors of the economy.

Table 1: Sectoral Contribution to National GDP (%)

Year	1975	1980	1990	2000	2006
Agriculture	24.2	13.1	5.1	2.4	1.7
Mining	12.7	30.3	39.2	39.6	41.4
Manufacturing	6.9	4.4	4.8	4.1	3.3
Services & Others	56.2	52.2	50.9	53.9	53.6
TOTAL	100.0	100.0	100.0	100.0	100.0

Source: Central Statistics Office (CSO).

Natural Resource Management

Although Botswana is well endowed with minerals, wildlife, rangelands and veld products, it has very limited soils suitable for agriculture. The main land uses are arable and pastoral agriculture, tourism, hunting and gathering, mining and human settlement. The combination, pattern and extent or intensity of the various uses is determined by the resource endowment, physical land characteristics as well as cultural and socio-economic norms.

The increase in the number of livestock combined with the low off-take rates among the traditional cattle farmers has resulted in rangeland degradation and localized conflicts for grazing land. These conflicts, along with human population growth, have led to land

encroachment and conversion such that settlements are turned into arable, and arable land is turned into grazing and grazing land into wildlife area. The end game of these land use conflicts and conversions has been unsustainable land resource management and environmental degradation. The rapid urban migration puts increased pressure on urban land. For the better and sustainable use of land resources, it is necessary for the government to evolve and enforce land use plans.

Poverty

Poverty exists in Botswana, although its incidence is by no means the worst in the region. In fact, the incidence of absolute poverty has been reduced over the years, standing at thirty percent in 2002/03 (CSO – Household Incomes and Expenditure Survey) compared to forty-seven percent in 1993/94 and fifty-nine percent in 1985/86. poverty is generally pervasive in the country with the worst forms concentrated in the remote rural areas where there is high dependency on government welfare programmes, the highest illiteracy rates and the opportunities for formal employment are most scarce.

The country's National Strategy for Poverty Reduction (2003) identified three types of poverty in Botswana as follows:-

- Income poverty
- Human capabilities poverty
- Participation poverty

Income poverty manifests itself mostly among remote area dwellers, the aged, orphans and female-headed households. Its main causes are the limited access to formal employment as a result of a narrow economic base; the small domestic markets; difficulty in attracting the desirable levels of foreign direct investment (FDI) and the relatively slow growth in export performance and diversification. Other causes are the HIV/AIDS pandemic; poor natural resource endowment for arable agriculture; and lack of complimentary resources like credit, to facilitate investment in productive land use. Regarding human capabilities, Botswana has achieved remarkable progress in reducing

Capability Poverty as a result of rapid progress in education, training, health and nutrition. As for Participation Poverty, the government has made commendable endeavours in popular participation both through continuous policy dialogue and consultations with communities and other stakeholders and through the adoption of local government decentralization. But a lot still remains to be done in order to attain the desired levels of participation in the planning. This participation is also required in agricultural research training and development. All the above types of poverty adversely affect food security in as far as they negatively impact on people's capacity for "*physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs*"

Cross-cutting Issues

HIV/AIDS

Botswana is among the Southern African countries hard hit by HIV/AIDS pandemic but it has made significant progress in the prevention, care, treatment and mitigation of the disease. The prevalence rate stands at 24% among the population aged 15 – 49 years (UNAIDS, 2005), but with considerable differences between women and men in some age groups. In the age group 25-29, the prevalence rates for women show an alarming 42%, while the rate for men stands at 33%. Women and young people are among the most vulnerable groups in the country (UNAIDS).

Botswana has been successful in provision of care and treatment for people living with HIV and AIDS (PLWHA), thus allowing PLWHA to continue work in agriculture and other sectors, thereby mitigating some of the negative effects of HIV and AIDS on food security. However, it is still clear that the epidemic has had, and continues to have a negative impact on the food security situation in the country. The disease affects the most productive group (15-49 years of age) in society. The disease has adverse impact particularly on agricultural (especially food) production due to the deaths of agricultural workers. Small-scale agriculture is particularly vulnerable since it relies almost exclusively on family labour, particularly that of women.

A study on the impact of HIV and AIDS on food security and agricultural production in Botswana (Gobotswang et al. 2004) revealed the following trends:

- Reduction of labour capacity and a shift from productive work to care-giving activities.
- Shift in investments from agricultural inputs and management, e.g. livestock nutrition and health, to pay for medicines, transport and funeral costs.
- Migration from urban to rural areas by sick people, resulting in increased care-giving responsibilities in rural areas.
- Reduction in number of meals eaten per day among illness-affected households.
- Reduced work capacity and absenteeism by government agricultural extension services employees.

Gender

Botswana has taken significant measures to promote gender equality over the last two decades, notably through reviews and revisions of legal and policy frameworks and the elimination of gender inequality in education. Female-headed households account for 46% of all households in Botswana, and are over-represented among the unemployed (Botswana MDGR, 2004). There are approximately 113,000 agricultural holdings in Botswana of which 35% are headed by women. Slightly over half of the women now heading a rural household are widows, while about 30% of them were never married. The men heading a rural household tend to be married (75%).

The majority of the rural population and small-holder farmers are women and are more likely to be poor, illiterate, less informed and have less access to productive resources (including land) and opportunities for paid employment than urban people and male counterparts in rural areas. Women also lack knowledge about their rights including the right to inherit land, cattle, and other immovable property. The customary law of which most women in rural areas are married into also disadvantages them in that it confers almost all decision making powers for productive assets to men. The government of Botswana has made efforts to amend the Land Policy and Marital Act to allow women to

acquire immovable assets, but the implementation of these instruments at local levels and in financial institutions remains problematic.

Land Tenure

Botswana has a three-tier land tenure system as follows:- state land, freehold land and tribal (customary) land.

- **Tribal Land** constitutes about 70% of the total land area. The majority of people survive on customary land, mostly through subsistence farming. Up until 1970, tribal land was administered by respective local Chiefs. This changed and Land Boards were established and all land rights were vested in them. The Land Boards allocate land to citizens at no charge. This is a grant for the right to perpetual use of the land for residence, grazing and ploughing. As agriculture has become more commercialized, some agricultural is allocated under common law by way of lease for 50 to 99 years at a rental fee. Such leases are can be registered and can be pledged to financial institutions as security for a loan.
- **State Land** consists of about 26% of the total land area. It is composed mainly game reserves, forest reserves, farms, national parks and urban centres. The land is vested in the President of Botswana and allocated by the Ministry of Lands and Housing or by a municipality. The State land is allocated for periods of 50 or 99 years and the lessee is given a certificate of registered state title.
- **Freehold Land** accounts for 4% of total land area and is mainly used for commercial pastoral farms. The land is owned by companies and individuals in perpetuity. Freehold title was created before independence and the current policy is not to create any more freehold tenure.

Food Security

The World Food Summit (WFS) defines food security as a situation where “*All people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*”

At macro level, Botswana does not fit the definition of a food insecure nation. This is because although they locally produce on average only about 9% of their national cereal requirements, the country has financial resources to import the rest. However, household food security has a different dimension because it depends on the ability of the household to produce its own food or buy the available food on the market or both. The 30% of the population living in absolute poverty (Household Income and Expenditure Survey, CSO, 2003) will likely not afford to buy the required food needs and will therefore be food insecure. This group includes female-headed households, people living with HIV/AIDS and their families, the disabled, the elderly, orphans, the rural and urban poor and the unemployed.

Female-headed households, which constitute 52% of Botswana’s households, are food insecure largely because of gender imbalances which deny them ready access to physical capital (e.g. land) and financial resources for food production or income-generating activities. HIV/AIDS infected and affected households are food insecure largely because they are either too sick to tend to their farms or jobs or divert time from productive activities to caring for the sick. The disabled, the elderly and orphans are usually too weak to grow their own food or to generate income from elsewhere to purchase food. The rural and the urban poor and the unemployed lack resources for food production or for income generating activities and therefore are food insecure. Table 2 below shows the latest food balance sheet for the country.

Table 2: Annual Cereal Balance Sheet as at 31st October, 2006 (2006/07 Mid-marketing Year)

(000 tonnes)					
	Maize	Wheat	Rice	Sorghum/ Millet	Total
1. Domestic Availability	13	1	0	30	44
1.1 Opening stock (1/4/2006) (Formal/SGR)	2	1	0	4	7
1.2 Gross Harvest	11	0	0	26	37
2. Gross Domestic Requirements	144	84	36	57	321
2.1 Food Use	140	83	36	51	310
2.2 Feed Use	4	1	0	6	11
3. Desired SGR Carry-over stocks	10	8	3	14	35
3.1 SGR	0	0	0	10	10
3.2 Minimum Operating Stock	10	8	3	4	25
4. Drought Shortfall (1-2-3)	-141	-91	-39	-41	-312
5. Current Import Plans	155	80	36	20	291

Source: Botswana Food Security Bulletin, MoA

THE NATIONAL AGRICULTURAL RESEARCH SYSTEM (NARS)

Agricultural research is needed to systematically synthesize knowledge and experience gathered through collaboration with other stakeholders and partners in systems-building. It is also needed to develop and adapt concepts, tools, and analytical methods in research management that are relevant to developing country situations.

CONCEPT OF NARS

The development of agriculture requires the sustained generation and adoption of new and improved technologies that originate from organized science-based research activities. The pressures on developing countries to develop their agricultural sectors have increased dramatically over the past two decades and will continue to do so if not addressed urgently. A dynamic agricultural sector is central to social and economic growth in most developing countries, and technological progress is the key to agricultural development. The crucial challenge facing scientists and policy makers is achieving rapid, significant and sustainable increases in agricultural production, while conserving the environment and stimulating a strong rural economy. To do this, technological advances must be complemented and supported by appropriate food and agricultural policies that stimulate adoption of technologies for increased productivity, development of infrastructure, and strengthened institutional capacities in agricultural research and extension.

National agricultural research systems (NARS) have been found to play a key leadership role in generating and adapting technology required to meet the agricultural development challenge by identifying technical problems, developing and adapting appropriate technologies for solving these problems. It has been observed that advances in agricultural production are unlikely without a robust national research system. Whether primarily generating or adapting technology, NARS must be strong institutions if they are to contribute effectively to agricultural development.

CRITICAL FACTORS TO CONSIDER IN BUILDING EFFECTIVE NARS

The International Service for National Agricultural Research (ISNAR) has delineated a set of twelve (12) critical factors under three (3) distinct areas that determine the effectiveness and efficiency of a NARS as follows:

1. *The policy context of agricultural research*

- Interaction between national development policy and agricultural research.
- Formulation of agricultural research policy that involves:- priority setting, resource allocation, and long-term planning.

2. *Structure and organization of agricultural research*

- Structure and organization of research systems.
- Linkages between NARS and policy makers.
- Linkages between NARS, the technology transfer system, and users.
- Linkages between NARS and external sources of knowledge.

3. *Management of agricultural research*

- Programme formulation and programme budgeting.
- Monitoring and evaluation.
- Information management.
- Development and management of human resources.
- Development and management of physical resources.
- Acquisition and management of financial resources.

ORGANIZATION OF NARS

Organization and development of NARS has basically followed four models as stated below:-

- 1. *The integrated research, extension, and education model***:- an example of this model are the United States of America land-grant University system where the three areas to be serviced are housed together in one state university to service agricultural development and production.

2. ***The autonomous or semi-autonomous publicly or privately supported research institute model:-*** this model was pioneered in the United Kingdom. It was an important method of organizing research and export commodities during the colonial period. It is still being used presently to support research on export commodities and other commodities produced under plantation or other large scale forms of production.
3. ***The Ministry of Agriculture model:-*** this is the most common pattern for research on domestic/indigenous food crops and livestock in the smaller countries.
4. ***The Agricultural Research Council model:-*** this is a recent development. It is often used as a method of achieving more effective coordination of a system in which two or perhaps all three of the other models have developed alongside each other during an earlier period. India is an example where this model is being practiced.

The agricultural research system in Botswana is currently not well defined and structured. However, there are a number of public, private sector and non-governmental organizations (NGOs) that are involved in agricultural research and training that could be used as units or components of an agricultural research system. The Department of Agricultural Research (DAR) in the Ministry of Agriculture is a public body mandated to carry out agricultural research covering both arable and livestock agricultural production. On the other hand, Botswana College of Agriculture is a parastatal body established through an Act of Parliament (Act No. 9, 1991) under the Ministry of Agriculture, tasked with higher level agricultural training and research. Both these bodies are funded by government through the Ministry of Agriculture. No official or legal linkages exist between these two institutions although they are within the same ministry. There is a host of other NGOs (Thusano Lefatsheng, Veld Products (Pty) Limited) and private sector organizations that are involved in research and dissemination of information about new innovations. In the absence of a deliberate agricultural research policy and a coordinating agency, Botswana cannot be said to have a NARS in existence.

BOTSWANA AGRICULTURE RESEARCH AND TRAINING POLICIES

An agricultural research system consists of a number of elements which include funding bodies, research and training service providers and clients. The government of Botswana has elaborated some policies and strategies for the agricultural sector, although some go back to the 1990s and may be in need of revision. Three major documents outlining policy and strategy adopted by the government of Botswana that cut across all sectors of the economy of the country are the Millennium Development Goals (MDGs), Vision 2016 and the National Development Plan. In addition, there are various Ministries which have development policies with direct influence to agricultural research, training, development and productivity. Such ministries include Ministry of Agriculture (MoA), Ministry of Communication, Science and Technology (MCST), and Ministry of Education (MoE). Some other ministries have some influence on agricultural production in respect to some inputs that they are responsible for. These include Ministry of Mineral Resources, Energy and Water Affairs (MREWA), Ministry of Lands and Housing and Ministry of Environment, Wildlife and Tourism (MEWT).

Millennium Development Goals (MDG)

Botswana is a signatory to the United Nation's Millennium Development Goals. The first MDG covers poverty and hunger and is therefore pertinent to food security and nutrition under the realm of agriculture. The MDG's aim at, by 2015:

- Reducing by half the proportion of people living on less than a dollar a day;
- Reducing by half the proportion of people who suffer from hunger.

To achieve these aims, this MDG must be *linked* to the NARS such that appropriate institutions responsible for agricultural development and research, training, extension, funding and networking could be identified and tasked with achieving them, thus *linkages* are very essential in ensuring that these aims are not a dream but are realized.

Vision 2016

Botswana has prepared a homegrown long-term perspective plan known as Vision 2016. It is the overall umbrella development policy, a long-term vision for a healthy and prosperous Botswana. The document states that, “All Botswana should have access to good quality health facilities. This will go hand in hand with adequate nutrition for all citizens and provision of good quality sanitation and adequate supply of safe water for human needs”. It pledges that, by 2016, Botswana will be a prosperous, productive and innovative nation with a diversified economy with agriculture, industry, mining and services forming vital components. The Vision also pledges that by 2016, absolute poverty will have been eradicated country-wide.

Linkages with agricultural research must be established with the NARS if the vision is to be realized. It is obvious that various stakeholders within and without the NARS have to play a role to facilitate the attainment of the vision. Appropriate technologies, crop varieties and better performing breeds of livestock must be developed in order to increase yields and provide employment opportunities for the people to generate incomes, especially in the rural areas and the very poor households.

National Development Plan (NDP)

The National Development Plan (NDP) is a rolling 5-year medium-term plan, currently in its ninth series. The current plan, NDP 9, which covers the period 2003/04 – 2008/09, recognizes the importance of the agricultural sector in enhancing the growth of the national economy, food security, employment and poverty reduction, particularly in the rural areas where the majority of the poor live. The plan sets out the objectives of the development of the agricultural sector as being to:

- Improve food security at household and national levels;
- Diversify the agricultural production base;
- Increase agricultural output and productivity;
- Increase employment opportunities;
- Provide a secure and productive environment for agricultural producers;

- Conserve the scarce agricultural and land resources.

All agricultural research activities must be prioritized according to the national needs as determined by the National Development Plan. Linkages must be established among those public and private institutions tasked with agricultural research with the objectives of conducting appropriate research and eliminating duplication of research efforts and resource wastage. There should be coordination of research efforts whereby both human and financial resources are utilized optimally.

The National Agricultural Policy (1991)

Following an Agricultural Sector Assessment report of 1990, the Government of Botswana approved an agricultural policy in 1991 with the following objectives: (1) to provide adequate and secure livelihoods for those involved in agriculture; (2) increase agricultural output; (3) increase food self-sufficiency; (4) conserve agricultural land resources; and (5) meet the employment demands of a growing labour force. The policy objectives are long-term in nature but required both short and long term strategies to achieve. The policy advocates that the development of technology through research and exchange of germplasm should remain a strategic issue in order to improve productivity and the viability of the sector. The strategy further entails that more productive links should be forged with extension and farmers. It observes the fact that a research strategy in agricultural development that does not take into account the objective physical, economic and institutional problems faced by farmers is unlikely to pay off in the long run. The policy proposed that national, regional and international resources including cooperation with organizations such as SADC, FAO, IITA, ILCA, ILRAD, ICRISAT, etc be mobilized to assist Botswana in developing technology for the betterment of the agricultural sector. The policy emphasizes the need for diversification in both commodity production and production systems. The policy also recommends targeted subsidies to achieve net socio-economic benefits both to individuals and the country. The policy acknowledges the lack of appropriate technology and sufficient skilled manpower for the agricultural sector. It recommends concerted effort in providing the farming community

with the necessary technology and trained manpower to ensure efficient production under the country's agro-ecological conditions.

In the past the Department of Agricultural Research collaborated with SADCC/SACCAR in testing crop varieties for use by farmers in Botswana. The Ministry of Agriculture (MoA) reiterated the need to seek cooperation and *linkages* with other Ministries at policy and strategic levels to ensure the efficient development of the agricultural sector.

The Revised National Food Strategy (2000)

The National Food Strategy (NFS) was first formulated in 1985, revised in 1996/97 and lastly in 2000. the Revised National Food Strategy (RNFS) is guided by the following major principles:- rapid economic growth; economic independence; and social justice, all of which are pertinent to food security and nutrition. The general objectives of the strategy are as follows:

- To ensure **physical availability** of adequate food supplies as national and sub-national levels through a sustainable combination of domestic production, imports and reserves, through well-dispersed and effective distribution and marketing networks.
- To ensure **economic access**, at household level, to avail supplies of food through a sustainable growth in incomes and employment, maintenance of a competitive price regime for basic food staples; and maintenance of targeted public assistance programmes for the needy and vulnerable.
- To provide primarily through physical availability and economic access support for sustainable **improvements in the nutritional status** of the nation.
- Within the framework of existing health legislation, controls, and consumer education, **to ensure food safety and quality**.

The specific objectives of the strategy are:-

- To achieve a two percentage points reduction per year in the proportion of households, which are food insecure, and below the poverty datum line for the next 20 years;
- To contribute to the reduction of the proportion of children underweight for their age from the current 15-7% by year 2015;
- To reduce the poverty rate among the people in remote areas, settlements and cattle-posts especially in the western regions by approximately 3 – 4% points per annum till 2015.

The Revised National Policy for Rural Development (2002)

This policy arose out of the need for a policy to guide, coordinate and harmonize the cross-sectoral rural development issues and programmes. It tackles nine major themes, namely:- livelihoods; land and natural resources; social protection; institutional framework and development; capacity building; gender; HIV/AIDS; poverty; and the environment.

The National Policy on Natural Resources Conservation and Development (1990)

This policy aims at sustainably improving the effectiveness with which natural resources are used and managed, taking into account the development, conservation and environmental goals.

Wetland Policy and Strategy

The NCS institutions coordinated the formulation of a draft Wetlands policy and Strategy for Botswana. The need for the conservation of wetlands resources was identified in 1994, and was followed by in-depth consultations across different Government Departments, Local Authorities, Local Communities and Non Governmental Organisations. The process to develop the draft Policy and Strategy started with the compilation of a National Wetlands Inventory and an Issues Paper, which outlined the major issues of wetlands in Botswana. These activities spanned the period 1997-2001. The elements of the draft Policy and Strategy on Wetlands emerged from the outcomes of

these initial phases. The main goal of the draft Policy and Strategy is "to promote the conservation of Botswana's wetlands in order to sustain their ecological and socio-economic functions as well as providing benefits for the present and future well being of the people." The draft Policy further recognises the following:

- The irreplaceable ecological and socio economic values of wetlands
- Botswana's internationally important and unique wetlands
- ongoing degradation of wetlands resources
- our responsibility for stopping wetlands loss and support.
- the need to maintain wetlands through sustainable use, improved management and full public

The National Strategy for Poverty Reduction (2003)

This is the government of Botswana's strategy for reducing poverty in the country, including the conceptual and cross-sectional framework for dealing with issues of poverty and poverty reduction. It also seeks to put in place a systematic monitoring mechanism and processes to track poverty and overall progress toward its reduction on an on-going basis. Among the programme interventions it recommends, several have a direct bearing on food security. They include small scale horticulture development; expanding rural employment opportunities through rain-fed crop production; increasing small-stock production; and strengthening the community based natural resources management programme (CBNRMP).

The National Master Plan for Arable Agriculture and Dairy Development (NAMPAADD)

This is currently under implementation and was commissioned under NDP 8. It devised strategies and programmes that would enhance the performance and sustained development of the agricultural sector. The plan mainly addresses rain-fed crop production (focusing on smallholder farmers); irrigated agriculture (to alleviate impact of

droughts); and dairy development (to remove the constraints that have arrested the growth of the subsector).

The National Plan of Action for Nutrition (2005)

In line with the world declaration on nutrition, Botswana has developed the National Plan of Action on Nutrition (NPAN) which has a 5-year horizon to 2010. The plan serves as a framework for strategies and programmes to improve the nutritional status of the population. The goal of the plan is to contribute to the overall socio-economic development of the country stipulated in the Botswana Vision 2016 and the National Development Plan 9. The NPAN comprises of eleven themes that provide comprehensive and clear guidelines of broad strategies to achieve stated goals and objectives in the short to long term. It aims at strengthening and supporting efficiency and effectiveness of food and nutrition services; develop guidelines and strategies for detecting, preventing and managing all major forms of malnutrition; maintain a national data base for monitoring, evaluating and reporting Botswana's major forms of malnutrition and the effectiveness of nutrition programmes; to prevent and manage infectious diseases, including HIV/Aids; to increase the level of nutritional awareness among the general public; and to protect consumers from food borne diseases through improved food quality and safety. The implementation of NPAN is accorded high priority by the government. Success will depend to a great extent on adequate resource allocation by the government, NGOs, private sector and donors. Support from all stakeholders is essential to ensure the realization of the goal of improving health, nutrition and quality of life of the people of Botswana.

The National Policy on HIV/AIDS

This policy sets out operational guidelines and the use of training manuals that have been developed, several multi-sectoral committees have been formed to fight the epidemic and free ARV treatment is being given to those infected.

Privatization and Liberalization

The Botswana economy is liberalized but, to protect local production of vegetables, no imports are allowed into the country during peak production seasons. Finance for agriculture from the National Development Bank (NDB) is also subsidized at a lending interest of 14 – 20% compared to 21 – 30% in the commercial banks. The country, through the parastatal Botswana Meat Commission (BMC) exports beef to the European Union (EU) and live animals to neighbouring countries.

All the above policies and strategies have agricultural implications requiring the establishment of appropriate linkages that can facilitate appropriate agricultural research, agricultural development, agricultural training and adequate dissemination of information thereof generated. It is abundantly clear that potential partnerships, co-operations and networking alliances between local institutions in both the public and private sector, regional institutions and international organizations can be fostered in order to achieve the desired levels of agricultural production through a well-structured and coordinated NARS. Although the agricultural policy mentions agricultural research, it does so with reference to DAR, in particular, as a public body within MoA.

INSTITUTIONS/ORGANIZATIONS CATEGORIZATION

Several institutions/organization have been identified that are involved in research and/or training as part of or as their main mandate. The various institutions have been categorized into policy organizations, public sector institutions, parastatal or semi-autonomous public institutions, universities and training organizations, private institutions and international institutions in the country. Some of the institutions will fall in more than one of these categories. A description of these categories and the institutions that fall within them are shown in Table 1.

Table 1. Institutional Categories

Category	Description	Institutions
Policy organizations	Institutions dealing with policy formulations and analysis	BIDPA, MoA, MoE, MWTE,
Public sector institutions	Institutions directly administered by government	DAR, NVL
Parastatal or semi-autonomous	Institutions wholly or partially owned and managed by government	BCA, BVI, UB, NAFTEC, BOTE, RICCO, RIPCO(B)
Universities and training organizations	Institutions that combine university level education with research	BCA, UB
Non-governmental institutions	Institutions not directly controlled by government	Thusanyo Lefatsheng, VPR&D, FAB
International institutions	Institutions whose mandate covers more than one country	SADC, FAO, UNESCO

Ministry of Agriculture (MoA)

This ministry has the overall responsibility for crop and livestock production. It spearheads the policy thrust for the sector and offers research, extension and training services. The responsibilities of MoA cover sectors of livestock, arable agriculture, conservation and cooperative development. Under MoA the Department of Integrated Agricultural Research, Botswana Vaccine Institute, and Botswana Veterinary Laboratory are responsible for research while Botswana College of Agriculture is responsible for both research and training in agriculture. MoA does not have a specific policy for research and training. Instead the national agricultural policy guides research and training activities by the departments and organization involved. The ministry's responsibilities have led to the creation of various departments: Department of Crop Production and Forestry, Department of Animal Health and Production, Department of integrated Agricultural Research, Department of Cooperative Development, Department of Ministry Management, Agricultural Resources Board Secretariat, and the support divisions of Agricultural Planning and Statistics and Agricultural Information and Public Relations Division. The ministry is also responsible for the public irrigation infrastructure and services. The ministry has a food security unit and a national Early Warning Unit which carries out crop estimates and issues regular bulletins. Some of the under-listed policies and strategies directly or indirectly impact on the mandate of the ministry.

Description of the departments are given below :

Department of Ministry Management

The overall objective of the Department is to provide and coordinate ministerial level, a full range of administrative resources and support services to all other departments of the ministry, to enable them to effectively carry out their functions, and thus attain ministry's national objectives. In order to achieve the above objectives, the Department of Ministry Management is responsible for the following major functions, Overall Administrative Coordination; providing Financial Support Services; Material and Supplies Service; Maintenance and Upkeep Services; Administrative Support Services; Personnel Administrative Services; Public Relations and External Liaison; Developing Administrative Capabilities within the Ministry and Management of the Department.

The Department of Animal Health and Production

The Department of Animal Health and Production is one of the biggest in the Ministry of Agriculture comprising five Divisions, Veterinary Field Services; Tsetse and Trypanosomiasis Control, Meat Hygiene and Quality Control; National Veterinary Laboratory; and Animal Production. Key projects in this department include: livestock marketing facilities; livestock water development; animal disease emergency control; services to livestock owners; improvements to disease control; livestock Identification and Trace back System (LITS). The overall objective of this department is to control nationally and economically important animal diseases, such as Foot and Mouth disease and Anthrax, as well as prevent and control disease outbreak through strict adherence of high standard of animal health, as well as improving sustainable livestock production and management practices.

Department of Cooperatives

Cooperative Societies in Botswana consist of Producer Cooperatives, Consumer Cooperatives, Multipurpose Cooperatives, Marketing Cooperatives, Savings and Credit Cooperatives and Secondary Cooperatives. The department continues to encourage the establishment and strengthening of all categories. Key project of this department is Cooperative Development. The overall objective is to provide a range of services to farmers in rural areas, especially in livestock marketing, supply of inputs and consumer goods by improving the working conditions of staff through the availability of offices and houses.

Department of Agricultural Research

The mandate of the Department of Agricultural Research is to generate improved crop and livestock production technologies through research to promote a productive and sustainable agricultural sector. In designing programs to carry out its mandate the Department has taken cognisance of the agricultural policy objectives of food security, diversification, sustainable resource utilization and economic viability. Key projects in this department include: agricultural research; research programme support. Research thrusts are in the areas of crop and livestock improvement, sustainable utilization of range resources, soil and water management, optimising utilization of locally available animal feed resources, crop pests and disease management and pasture and forage crop improvement.

Division of Agricultural planning and statistics

The Division of Agricultural planning and statistics provides statistical monitoring and evaluation, farm management, policy analysis and project planning services to the whole Ministry, and acts as the key link between departments and other Ministries. The Division coordinates and initiates sectoral policy studies / consulatancies to improve the performance of the agricultural sector through, inter alia, targeting of resource allocation. It also represents the Ministry in several multilateral and regional economic and trade

organisations. Key projects in this division include: MOA Computerisation; MOA Consultancies.

Division of Information and Public Relation

The Division supports the Ministry staff by designing and producing extension media such as leaflets, agricfacts, booklets, photographs, slides, radio programmes, notice boards, exhibitions, public address systems and conducting of intensive educational campaigns throughout the country on a variety of agricultural topics. The Division also trains its extension staff in making and using audio-visual media and service all the audio visuals of the Ministry. It achieves all its above mentioned tasks through its seven sections, namely, graphics and Printing, publications, campaigns, photography, audio-visual, broadcasting and Carpentry and painting workshop.

Department of Crop Production and Forestry

The Department of Crop Production main function is to provide technical services to farmers and general public in order to improve agricultural productivity and efficiency and thus improving people's living standards. This function is attained through four divisions: Land Utilization Division; Plant Protection Division; Beekeeping Division; Crop Production Division. Key projects of this Department include: Arable Land Development Programme (ALDEP), Irrigation Development, Emergency Plant Protection, Lands use Monitoring and Planning, Small Projects Programme, Horticultural Development and Soil Conservation. The overall objective is to promote productivity of the sub-sector in Botswana through provision of subsidies, inputs and introduction of appropriate technologies.

Land Utilization Division

This division is one of the four technical divisions of the Department of Crop Production in the Ministry of Agriculture. It is a large and diverse comprising of six sections responsible for land and water resources management. These are Soil Survey and Mapping; Land Husbandry (formerly Soil Conservation); Agricultural Land Use Planning; Water Development; Irrigation; Cartography, Geographic Information Systems (GIS) and Remote Sensing Sections. It employs a corresponding broad range of professionals and specialists such as Agricultural Engineers; Soil Surveyors; Land Use Planners; GIS and Remote Sensing specialists; Cartographers and Conservation specialists.

The Division's core business is to promote sustainable land productivity through: promotion of good land husbandry practices; generation of land resources baseline data required for sustainable land resources management; development of surface and sub-surface water resources primarily for livestock watering and irrigation.

Soil Survey and Mapping Section

The section provides services such as soil mapping land evaluation and advisory services to various stakeholders on soil management and land use. This operates with three units as follows:

a) Soil Correlation Unit

This unit will be responsible for soil morphology and classification. It will also be responsible for standardization and harmonization of soil survey methodologies and correlation of soil classification systems. It will backstop all Soil Surveyors in Botswana on matters of soil correlation.

b) Land Evaluation Unit

This unit is responsible for developing guidelines and other tools that will be used throughout Botswana to identify various potentials of soil.

c) Regional Soil Survey Units

These units will be responsible for all the soil survey and mapping work at the agricultural regions. They will also be responsible for all soil advisory work to the farming community and other stakeholders. The Soil Correlation and land Evaluation Units will backstop the regional units from Headquarters.

Land Husbandry Section

The section provides nation-wide land rehabilitation and advisory services on environmental conservation matters including the rehabilitation of Pandamatenga Commercial Arable farms.

a) Land Husbandry Extension Unit

- Formulates field programme for promotion of agronomic land husbandry practices in order to sustain arable production particularly in communal areas;
- Defines and applies strategies that enhance the adoption of conservation practices by land users.
- Promotes sand dunes stabilization projects;
- Facilitates capacity building initiatives for all stakeholders who play an active role in projects aimed at combating land degradation.

b) The *Land Rehabilitation Unit*

- Undertakes field investigations in order to design physical conservation works;
- Design and assist land users to construct conservation works at both farm and catchment's level;
- Develop criteria for the design of water control structure;
- Carries out investigations in order to identify suitable technologies to land husbandry and rehabilitation (e.g. the use of bio-engineering technologies to conserve soil and thus sustain land productivity);
- Develops benchmarks and indicators for monitoring land rehabilitation projects.

c) Regional Land Husbandry Unit

- Undertakes programme implementation at the district and regional level;
- Undertakes land husbandry advisory services to farming communities and other stakeholders at regional level;
- Coordinates interventions and approaches on land husbandry practices at regional level
- Identifies critical catchments for rehabilitation purposes;

Land Use Planning Section

Prepares and implements agricultural Land Use Plans in collaboration with other stakeholders, demarcates ranches for livestock production and provides land use advisory services to land allocation authorities.

a) Land Resources Data Management Unit

- Compiles data on agricultural resources of the country
- Manages land resources data bases
- Responsible for management of simulation models.

b) Regional Land Use Planning Unit

- Prepares land use plans that are used as a guide for land development
- Conducts and coordinates natural resources surveys and feasibility studies for projects under consideration
- Responsible for implementation of land related policies
- Advises other government department on issues of land use planning.
- Develops sound land use planning procedures and guidelines

c) Ranch Demarcation Unit

- Carries out demarcation of ranches
- Assists farmers to develop ranches

Water Development Section

This programme provides the agricultural community with water resources in the form of small earth dams and wells for livestock watering and irrigation. Sand river abstraction and other Rain harvesting techniques are also piloted where there exist potential for their viability. The Water Development Section (WDS) comprises four (4) units named below. The section (which is larger than some divisions) however quantitatively and qualitatively seriously lacks qualified staff. The deficiency undermines its capacity to deliver services in a timely and efficient manner as required.

a) Mechanical Unit

This unit provides mechanical support to the construction crews. It is composed of Heavy Earthmoving machinery and light vehicles repair and maintenance teams. Its headquarters is located at DLU workshop, close to the Gaborone forestry nursery, where the supplies personnel are also based.

b) Design and Construction

This unit constitutes the core of the agricultural water development programme. Although currently located at headquarters, it is expected that its duties will eventually devolve to regional offices as more qualified engineers are recruited.

c) Well Development Unit

In addition to dam construction, agricultural water development also includes rehabilitation of wells, most of which are individually owned. The unit operates with two teams. Well development benefits more farmers than dam construction due to the wide distribution of well points across the whole country.

d) Water Resources Management Unit

Provision of water resources without a strong component of resources management is devoid of long term sustainability. This unit works closely with the Extension Staff in mobilizing and persuading farmers to carry out the necessary operation and maintenance of their structures.

Irrigation Section

Facilitates and develops irrigation schemes using water from boreholes, wells, rivers, effluent treatment plants and dams. It also provides advisory services to farmers in the form of training on the use of various irrigation systems and water management. Irrigation Section is made up of four units and are listed below. The section has the potential of assisting Botswana to have sustainable food security. The overall functions of this section are to:

- Fully carryout the assessment and evaluation of the irrigation potential countrywide.
- Support to any category of farmers i.e. individual, company, group, small-and-large-scale etc, in the implementation of viable projects.
- Provides advice to operational irrigation schemes and rehabilitation of those not operational.

The units of this section are as follows:

- a) Investigation, Design and Survey Unit
- b) Construction/Installation Unit (Mechanical Unit)
- c) Project Monitoring /Irrigation Water Management Unit
- c) Regional Unit

Cartography, GIS & Remote Sensing Section

The section provides mapping services, land resources inventory and monitoring data through the use of Cartography, Geographical Information System (GIS) and Remote Sensing facilities. The section is made up three units, which are: Cartography, Geographical Information Systems (GIS) and Remote Sensing.

a) Cartography Unit

- Carries out mapping functions as and when required by the departments of the Ministry of Agriculture.

- Procure maps and other digital data from DSM other sources for all Ministry of Agriculture users.
- b) Geographical Information System (GIS) Unit*
- Digitizes maps, collects and compiles related attribute data for agricultural and other users.
 - Provides an in-house decision support capacity for interpretation of natural resource and socio-economic data, in order to produce land use and resources management plans, etc.
- c) Remote Sensing Unit*
- Maintains an aerial photo library and a depository for Satellite Image in the Ministry of Agriculture. The satellite images are available for user reference at Ministry of Agriculture.
 - Supports programmes of other sections/divisions of the Ministry of Agriculture in the interpretation of remotely sensed data for resource survey.

Plant Protection Division

The Division of Plant Protection is one of the four divisions within the Department of Crop Production in the Ministry of Agriculture. The division was established in 1986/87 following a countrywide outbreak of locusts. It is mandated to spearhead the control/management of the crop pests and diseases. The Division ensures environmental sustainability through application of environmental friendly practices (e.g. integrated pest management). The core functions of the Division are as follows:

- To provide technical support to farmers and extension staff on management of crop pests and diseases
- To control migratory pests i.e. locust, quelea, African worm
- To monitor pests and diseases through surveys
- Implement the Agrochemicals Act of 1999

- To facilitate safe guarding of plant health by regulating importation and exportation of plant and plant products by issuance of phytosanitary certificates and import permits

The division of plant protection is made up of three main sections of Pest Management, Disease Management and Post harvest management. In addition there are three support units, namely Aviation, Mechanization & Pesticides Application Technology, and Crop Clinic.

*a) **Pest Management Section***

This is the backbone section of plant protection. The mandate of this section is to provide technical and professional advice on the management/control of migrant, non-migrant pests and weeds. The migrant pests include locusts, Quelea, and armyworm. Non-migrant pests include amongst others, pests such as bollworm, bagrada bug, corn cricket, rodents e.t.c. Control of migratory pests is the joint responsibility of the government and farmers, whereas with non-migrant pests farmers shoulder the entire responsibility. In an event where the pest outbreak is beyond the capacity of farmers government intervention may be sought.

*b) **Disease Management Section***

The mandate of this Section is to provide technical and professional advice to farmers through the extension service on the management of diseases of field and horticultural crops. The Section further provides guidance on disease diagnosis and management. Demonstrations on disease management are also carried out as part of farmer training.

*c) **Postharvest Section***

The core function of this section is to provide technical and professional expertise in handling, storage and preservation of food grain, grain products, fruits and vegetable commodities. The objective is to minimize losses along the food pipe-line. Some of the activities of this section include management of insect pests, rodents, microbial agents, and temperature and moisture levels in stored grain products.

d) Mechanization and Engineering Unit

The key function of this unit is maintenance and servicing of spraying equipments used in the control of pests and diseases. The unit also acquires new spray technologies, test and modify them to suit our local conditions, and our clientele, the farmer.

e) Aviation Unit

This unit is responsible for aerial control migrant pests such as *Quelea*, locust armyworm. Pests need to be controlled at earliest opportune time and the use of an aircraft helps to spray pests over extensive areas and relatively short time and thus reducing costs. The aircraft is also used in aerial supply of pesticides. Outside the spray season the aircraft is used to transport government officials. It has been engaged in fire tracking services.

f) Crop Clinic Unit

This unit is responsible for the collection identification of pest and disease specimens, also analyses damages caused by pests and diseases. Farmers and extension staff are urged to submit pest or disease specimens to the crop clinic where they will be identified as appropriate control measures recommended. There is a well-established collaboration line between the division's crop clinic and Department of research where samples are referred for detailed diagnosis.

Beekeeping Section (Apiculture)

The Beekeeping Section is the national apex body responsible for promotion of Beekeeping programmes or projects through manipulations of honeybees for maximum production of honey and beeswax, and enhancement of bee species conservation and protection against bee predators, pests and diseases. The Section has 4 Units as follows; Extension Service Delivery, Apiaries Development & Management, Bee Products Promotion & Marketing and Regional Beekeeping Units. A Unit in this regard is a primary component that implements specific functions of a Section.

a) Extension Service Delivery Unit

The unit is responsible for equipping the farming community and institutions with relevant skills and appropriate technical know-how to undertake Beekeeping as a potential venture for diversifying the agricultural sector. This will be accomplished through establishment of Backyard Beekeeping & Demonstration Apiaries, Migratory Beekeeping, and the Provision of Pollination Services & Regulations, Integration of Beekeeping in Conservation Programmes and creating Public Awareness on Bee Intrusion.

b) Apiaries Development & Management Unit

This Unit is responsible for designing, assessing and making recommendations on Projects Proposals & Approvals, Apiaries Development & Management, Bee Forage Improvement, Bee Research and Development on Bee Pests, Diseases and Bee Toxicology, Project Monitoring and Evaluation. In this regard, the Unit serves as advisory organ of the section to ensure undertaking of economical and sustainable programmes and projects.

(c) Bee Products Promotion & Marketing Unit

The Unit is responsible for Bee Products Promotion, Formation of Beekeepers Associations, Bee Products Quality Standards & Regulations, Monitoring of Bee Products Imports and Exports, Monitoring of Beekeeping Productions Levels and to disseminate relevant information to farming Community. In other words, this is an agency that conducts farmers' needs assessment surveys to identify possible avenues and strategies.

(d) Regional & District Beekeeping Extension Units

The Units is responsible for all matters pertaining to Beekeeping Technology Transfer and Industry Development in the Agricultural Regions and Districts. The Extension Service Delivery, Apiaries Development & Management and Bee Products Promotion & Marketing from Headquarters will provide technical support and assistance to the regional units. The essential obligation of the regional units is to provide an appropriate

technical know-how and adequate advisory service to the stakeholders for development of a technologically sound, sustainable and competitive beekeeping industry.

Crop Production Division

The Division of Crop Production is one of the divisions that form the Department of Crop Production. Its major responsibility is to provide specialized and appropriate technical information and support (provide back stopping) to the farming community through the existing delivery system for the improvement of crop production countrywide. The Division advises on the production of all types of crops (horticulture and field crops), crop marketing; the suitability, handling and maintenance of farm machinery and implements; food security matters and agro-processing. The crop production programmes and incentive schemes such as Arable Lands Development Programme (ALDEP) and Drought Relief Programmes are coordinated and administered under the Division.

Arable Land Development Programme (ALDEP) Section

The mandate of the section is to: Assist small-scale arable farmers who are not able to grow enough food for their needs by providing them with on-farm packages such as fencing materials, animal draft power, water catchment tanks, threshing machines, chaff cutters, animal drawn implements (such as ploughs, planters, cultivators, harrows and scotch carts).

- Facilitates technology transfer through the use of ALDEP Demonstration Farms (ADFs) where participatory trials and demonstrations are done.
- Facilitates training on the use of packages obtained.
- Encourages effective and efficient utilization of previously obtained packages.
- Caters for the neediest sections of the community (women farmers, old persons, farmers lacking labour and farm equipments) within the target group to increase production.

Agronomy (Field Crops) Section

The section exists to provide relevant information, transfer appropriate technologies, skills and knowledge to clients and other related stakeholders of production of field crops on efficient and sustainable basis. The emphasis is to equip farming community with field crop production to enable them to increase crop yields per unit area. Transfer of technology is undertaken regularly through crop demonstrations, field days and farm walks, conducting formal and informal training, etc.

Horticulture Section

The Horticulture Section is vested with the responsibility of overseeing the overall accelerated horticultural development in the national perspective, has the mandate to:

- Implement programmes for improving the production, productivity and utilization of horticultural crops.
- Support and assist in formulation of policies aimed for accelerated growth of the horticulture industry.
- Provide leadership and coordinate activities for promotion of horticulture.
- Work as a facilitator for transfer of technology to farmers and promote use of modern technology and its adoption.
- Promote better utilization and increased consumption of horticultural crops to ensure higher returns to farmers and natural security to people.
- Serve as source of all information on horticulture in the country.
- Develop a strong base for the supply of inputs, data, technology transfer and human resource developmental needs.
- Promote horticulture in the less endowed areas of the country for improving the nutritional and economic status of people in those areas.
- Facilitate the availability of disease free planting materials for horticultural crops.
- Promote diversification of horticultural crops through production of non-traditional high value crops.

Food Security Section

Food Security Section is mandated to monitor food situation at national and household level and develop intervention programmes to ensure food security. This is achieved through:

- Processing of monthly crop production/agricultural situation reports from Agricultural districts and forwarding the information to the National Early Warning Unit as a contribution National Early Warning Network. The reports play a large role in the decision making by government pertaining to national food security.
- Participation in the national drought assessment tours that are normally conducted twice in a year. The tours are responsible for assessing the food situation and coming up with recommendations with regards to the pertaining situation.
- Engaging in food security awareness programmes which are undertaken with the aim of improving the knowledge of food security and food processing.
- Promotion of intervention programmes to ameliorate the well being of the vulnerable groups in villages.
- Integrating training in nutrition education and food preservation to equip Home Based Care Committee members to enable them to in the knowledge of nutrition and income generating activities through home gardens and food processing with members of the community.
- Compile information on traditional and veldt product edibles to promote their utilization.

Crop Marketing Section

The Crop Marketing Section was established to advise the farming community in making marketing oriented production decisions thereby promoting crop diversification within agricultural sector. This is destined to stimulate increased local production of horticulture and field crops in an effort to reduce dependency on imports. The activities of the Crop Marketing Section are as follows:

- To facilitate marketing of horticultural and fields crops by producing a link between the production and the markets sector.
- To collect production and market information through surveys and disseminate it to end users be they producers, traders, or consumers.
- Assists in the development of a good system fro product grading, packaging and distribution.
- Facilitate the accessibility of inputs to producers by liaising with private and parastatal organizations responsible for the distribution of inputs.

Farm Mechanisation Section

The section's main activities are as follows:

- Monitors the quality of farming implements by the farmers. An example being monitory quality control of most of ALDEP implements – scotch carts, threshing machines, ploughs, planters etc.
- Conducts training for extension staff and farmers the primary practical principles on the use and maintenance of farming implements.
- Liaises/collaborates with the technology development institutions (such as Department of Agricultural Research, RIIC, etc) with regard to the information flow concerning the new agricultural equipment technology development.

National Master Plan in Arable Agriculture and Dairy Development (NAMPAADD)

The Ministry of Agriculture has launched the National Master Plan in Arable Agriculture and Dairy Development (NAMPAADD) on the 31st October 2002. NAMPAADD is a plan intended to streamline arable agriculture and dairy development programs to address the following existing policy objectives:

- Improvement in food security at both household and national levels
- Diversification of the Agricultural production base
- Increased agricultural output and productivity

- Increased employment opportunities for the fast growing labour force
- Provision of a secure and productive environment for agricultural producers; and
- Conservation of scarce agricultural and land resources for future generations

The plan is to be implemented over a period of ten (10) years. The first three years of implementation will include the establishment of pilot projects in areas of high production potential designated as priority areas in the Master plan. NAMPAADD is expected to make arable and dairy farming profitable and more attractive to farmers, thereby create employment opportunities, increase rural incomes and reduce rural to urban migration. It is also expected to succeed in transforming the agricultural sector because it commences at a time when public sector reforms that include quantifying performance objectives with measurable targets are being put in place to improve performance and accountability across the sector. NAMPAADD is different from previous agricultural programmes in that it will:

- Target active traditional and commercial farmers, thus will enable traditional farmers to transform to commercial farming and assist commercial farmers to upgrade their technologies and management levels.
- Encourage more involvement of the private sector and civil society in both farming and the provision of supporting services. This will promote and facilitate smart partnerships between investors and landowners and among farmers themselves.
- Promote the establishment of agro-industries such as cotton gins, agro-processing plants and other enterprises such as transportation to service the agricultural industry and create additional employment opportunities in rural areas.
- Depart from the present welfare oriented approach to a business approach to farming. Instead of relying on grants and subsidies, farmers and other participating entrepreneurs will be encouraged to access finance from CEDA and other financial institutions. Where incentives are justified they will be targeted to beneficiaries and areas where they guarantee a positive change to farm productivity.
- Establish with private sector involvement a contributory insurance scheme to cover agricultural production losses in years and in specific regions declared as

- eligible for compensation. This is expected to be a confidence building measure that will encourage investment into agriculture and improve access to credit.
- Provide an enabling environment for agricultural production, including the development of infrastructure to and in production areas with high potential.
- The plan intends to improve production in three broad areas; namely, Rainfed

Department of Agricultural Research (DAR)

The overall mandate of the Department of Agricultural Research is to carry out research to generate improved crop and livestock production technologies that promote the development of a productive and environment friendly agricultural sector. The department addresses this through commodity and factor focused programmes in arable, animal and range research. The arable research division mandate of conducting research on crops of importance to the farming system of Botswana as well as those with potential for diversifying the production base, with focus on agronomic and breeding aspects. The Animal Production and Range Research Division undertakes research, development and technology transfer to the benefit of the livestock industry in Botswana. The Arable Research Division conducts research in farm machinery, soil fertility, weed research and irrigation, oil seeds improvement (covering crops such as groundnuts, soybeans, sunflower, mungbeans, watermelons, etc.), grain legume improvement and horticultural improvement. The Animal Production and Range Research Division conducts research mainly on development and improvement of cattle, sheep, goats, range and pasture. The department also carries out research support services in seed production and certification, soil, plant and feed analysis and genetic resource conservation. DAR is also endowed with experiment stations in a number of locations scattered throughout the country. These require separate scientific staff and technicians to manage and maintain.

Division of Animal Production and Range Research

Beef Research is geared towards identifying the best beef breed and/or breed crosses for different agro-climatic zones of Botswana. Beef improvement research programmes are classified as follows:

- *Identifying the Best Combination of Breeds in Crossbreeding Programme*

- *Composite Breed*
- *Improving the Production potential of the Indigenous Tswana breed through a structured selection programme*

The general objective of the ***Dairy Research Program*** is to increase milk production at minimal cost, develop small scale processing technologies and marketing systems for milk and milk products in the rural areas. The program carries out the following research activities;- Evaluate the technical and economic management of dairy intensive system, develop crossbred lines for smallholder farms, Milk processing and marketing systems, technical training of farmers and socio-economic assessment of introduced technologies.

Evaluation of Tswana crosses for milk production under semi-intensive system at Sunnyside Ranch. Tswana cows are being bred to various dairy sires of Friesian, Jersey, Brown Swiss, Sahiwal and dairy Simmental to evaluate the performance of suitable dairy crosses

Milk Processing and Marketing systems

The project identifies socio-economic factors and constraints governing milk consumption and marketing in the rural areas and to plan a local marketing strategy for surplus production. Three milk collection centers were established in Oodi, Bokaa and Kumakwane to serve all dairy farmers in these areas with the marketing of milk.

Breeding and Selection of Indigenous Sheep and Goats

Research studies conducted during the 1970s and 1980s showed that the local breeds of sheep and goats have potential for meat production in this country. The breeding and selection project was therefore undertaken with the objective of improving the efficiency of these breeds for meat production, while at the same time encouraging the Batswana communities to harness them into their farming systems.

Characterization of livestock feed resources and identification of nutrient deficiencies through laboratory analysis and animal experiments. Browse trees and shrubs are

useful in livestock feeding as browse prove the only feed of good quality when the amount and quality of grass decline during the dry periods

Develop supplementary feeding for improved livestock reproduction and growth. Local feed resources are used to improve time to reach slaughter weight in intensive and extensive livestock management. The program investigates ways through which the rangelands can be used sustainably, provide rehabilitation of degraded rangelands and screening plant germ-plasm that can be used in pasture and fodder production as well as development of technology for increasing productivity.

Efficient utilization of goats in bush control. Goats adequately control bush encroachment without damaging the grass cover.

Fencing encourages vegetation recovery and range rehabilitation. Use of fencing allows control of stocking Rates and increase grass yields

Early weaning project. The early weaning project, whereby Friesian dairy calves are introduced to solid feeds to reduce milk consumed by the calves has shown that calves introduced to solids at six weeks grow at the same rate as those weaned at 12 weeks. Analysis of the data to determine the economics of early weaning is still in progress.

Milk processing and marketing. Under the milk processing and marketing project, the Department has completed the establishment of three Milk Collection Centres at Kumakwane, Oodi and Bokaa. The Kumakwane Centre has been in operation since September, 1994, and dairy farmers around the village sent their milk to the Centre for sale to the public. The Department continues to monitor the project to determine its sustainability.

Lablab processing. Investigations on the processing on lablab as hay using the RIIC chaff cutter.

Stocking rate trials. Stocking rate trials using 2,4,6,8 and 12 ha/1su at two ranches showed that the performance of the animals and the range is optimized at 8-12 ha-1su. At 6 ha-1su, the animals did not lose weight but gained very little during the drier months.

Grazing Systems studies utilizing 1 paddock (continuous grazing), 3 paddock and 9 paddock rotational grazing showed that the continuous system was better than the multi paddock systems.

Growth trial. A growth trial using 18 month old intact males of Brahman and crosses of Sussex, South Devon and Charolias with Tswana cows was carried out.

Composite breed trial. The first Botswana's own beef composite breed produced 18 females and 4 males. Females were bred at 24 months as part of the multiplication process.

Selection and Conservation Programme. The indigenous Tswana cattle, sheep and goats selection and conservation programs are going well. Selection is based on survival, mothering ability, growth rate and structural soundness. Cattle comprise of two herds of 300 breeding females and selection done at 7 months or 18 months of age. Sheep and goat flocks comprise of two herds each of 250 breeding ewe/does where selection is done at 4 months or 12 months of age.

Partners

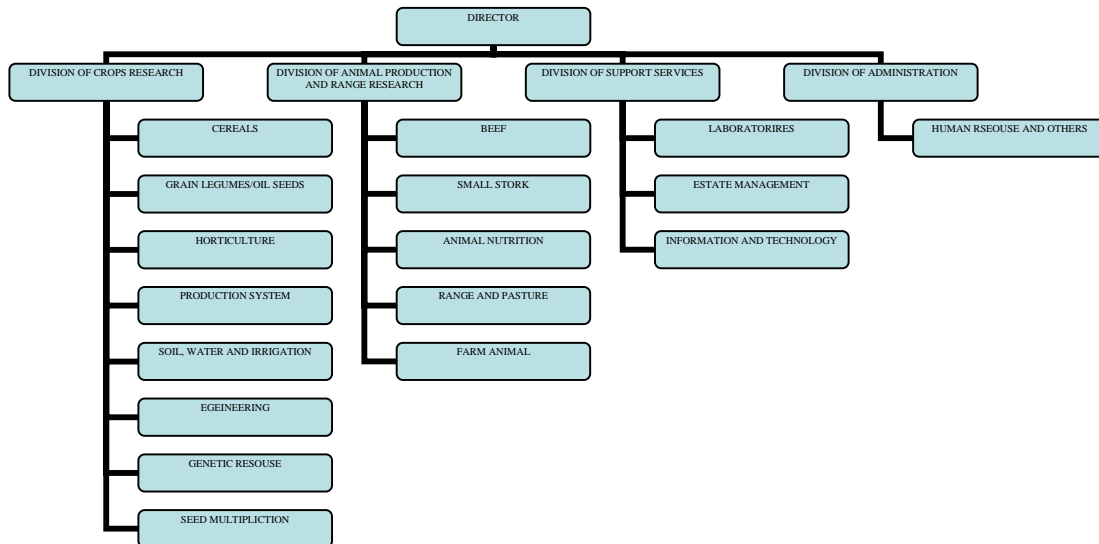
Botswana College of Agriculture; Ministry of Agriculture; Government of Botswana; CTA.

Major Publication

- BARIN: Proceedings of Conference on Agricultural Research and Development in Botswana Vol. 1 2005
- National Biosafety Framework Report - February 2006
- Proceedings - First National Biosafety Workshop - April 2004
- Proceedings - First National Biosafety Workshop - April 2004

- The National Assembly of Botswana approved the National Conservation Strategy (NCS) in December 1990. The NCS identified several major environmental issues that needed to be addressed.

Organizational structure



National Veterinary Laboratory (NVL)

The National Veterinary Laboratory fall under the Department of Animal Health and Production of MoA. Its mandate in research is limited to provide laboratory services for surveillance of FMD and other diseases; monitoring of abattoir hygiene, residue monitoring as well as testing for quality control of meat, milk and by-products for purpose of facilitating both internal and external trade.

Botswana Vaccine Institution (BVI)

BVI has been established as an emergency project under the Veterinary Department of Ministry of Agriculture, following Foot and Mouth Disease (FMD) outbreak of 1997/78 in the northern Botswana. The institute provides training courses in diagnosis, epidemiological work and disease control. Research and epidemiological work are part of the main work of BVI and enable BVI to respond to customer’s request for assistance during the disease outbreak investigations and related activities. BVI services include

differential diagnosis for FMD, comparisons between field strains and vaccines, selections of appropriate vaccine strains and immunological monitoring of vaccinated animals.

BVI Management team is lead by the General Manager who is also the Company Secretary, deputized by the Technical Manager, who is the head of Merial Technical Mission at BVI. The rest of the senior management comprises Finance and Administration Manager, Engineering Manager, Production Managers, Chief Veterinary Officer and OIE/QC Manager. BVI is governed by seven non-executive members of the Board of Directors, five local and two representatives of Merial. The Director of Animal Health and Production is an ex-officio member of the Board and the Minister of Agriculture appoints the rest of the local members.

BVI maintains stocks of regional serotypes of FMD viruses, inactivated antigens of exotic types as well as appropriate immune sera and supplies the National Laboratories upon request. As OIE Reference Laboratory for FMD, the institute provides training courses in diagnosis, epidemiological work and disease control. Research and epidemiological work are part of the pillars of BVI's work and enable BVI to respond to customer's request for assistance during the disease outbreak investigations and related activities. Research areas of BVI include differential diagnosis for FMD, comparisons between field strains and vaccines subtypes, selections of appropriate vaccine strains, and immunological monitoring of vaccinated animals.

Botswana College of Agriculture (BCA)

BCA is a parastatal under the Ministry of Agriculture and an associate institution of the University of Botswana. BCA exist to produce high quality graduates, generate suitable technologies and provide advisory services to improve agriculture productivity through innovative teaching, relevant research, and customer-driven service. Botswana offers training at certificate, diploma, bachelor and Masters level through five academic

departments of Agricultural Economics, Extension and Education, Agricultural Engineering and Land Planning, Basic Sciences, Crop Sciences and Production and Animals Sciences and Production. The College Farm also has facilities such as the center pivot irrigation system, various farm implements and animals for supporting staff research.

The research activities of BCA are conducted through the academic departments. As of November 2006, BCA had a total of 104 academic staff (both citizens and non-citizens); 45 with PhD, 47 with Masters degree, and 12 with Bachelors degree. Each academic department has developed research themes under which research project proposals are developed. However, in most cases, research is defined mainly by the researchers themselves. In some cases researchers follow research based on their previous graduate theses, or based solely on their promotion requirements and less on the national objectives and needs. The academic staff members allocate a large part of their working time to teaching activities (lectures and student supervision), research and a much smaller portion to extension activities (commonly known as Service). The Service time is not necessarily related to the research being done, but it is commonly expended in sitting in various committees both within BCA and outside institutions. Funding of research is through the Research and Publications Committee (RPC) from the total annual budget which is funded essentially from the national/state budget. The budget is mainly used for educational purposes allocated to salaries and for all other expenses. Members of staff are encouraged to conduct collaborative research within and among departments, and with national and international institutions, and therefore in a very few cases researchers do apply for competitive international and regional funding. The RPC also funds a publication of the Botswana Journal of Agricultural and Allied Sciences (BOJASS) which is mainly utilized by the local staff.

Programs Offered

Diploma Programs

Higher Diploma in Agricultural Education

Higher Diploma in Agricultural Engineering

Higher Diploma in Animal Health and Production
Higher Diploma in Agriculture
Higher Diploma in Forestry and Range Ecology
Higher Diploma in Horticulture
Bachelors Degree Programs
Bachelor of Science (Agricultural Education)
Bachelor of Science (Animal Science)
Bachelor of Science (Agriculture)
Bachelor of Science (Crop Science)
Bachelor of Science (Agricultural Mechanisation)
Bachelor of Science (Soil and Water Conservation Engineering)
Masters Degree Programs
Master of Science (Agricultural Education)
Master of Science (Crop Science)
Research activities

College's Vision and Mission statements research is one of the main components in addition to teaching and service. The College endeavors to carry out relevant research in order to generate suitable technologies and provide relevant advisory services to the Agricultural and related sectors in Botswana and beyond. The College has adequate human and physical resources for research distributed in the Departments of Agricultural Economics, Educations and Extension (AEE), Agricultural Engineering and Land Planning (AEL), Animal Science and Production (ASP), Basic Sciences (BS) and Crop Science and Production (CSP). The College Farm also has facilities such as the center pivot irrigation system, various farm implements and animals for supporting staff research.

Each department has developed research thrusts or themes under which research project proposals are developed. Funding of research is through the Research and Publications Committee (RPC) of the College and international research funding organizations. Members of staff are encouraged to conduct collaborative research within and among departments, and with national and international institutions. Check individual departments for more information on completed and current research projects and staff

publications. The RPC is funding the publication of the Botswana Journal of Agricultural and Allied Sciences (BOJASS).

Department of Economics, Educations and Extension

Each unit in the department has come up with research thrusts to guide on going research work undertaken by members of the department as a way of enabling the department to inform through research.

Economics Unit

Education Unit

Extension Unit

Economics Unit:

Research thrusts:

These are grouped into those addressing Marketing, Demand, Supply Response and Land Reform as follows:

Marketing of non-traditional cash products

Marketing completes the production process that began on the farm because it ensures that products reach the consumers. Thus, the agricultural production process is not complete until the product reaches the ultimate consumer. In recent times, there has been emergence of a number of small agricultural enterprises such as poultry, horticulture and others. These small enterprises' development has been hampered by several factors, chief amongst them being in ability to penetrate the available local markets. An understanding of the barriers that prevent smallholders to participate and increase their level of participation in agricultural markets is important if they are to be developed and integrated in to the agricultural marketing system.

Market participation by smallholder farmers

More often than not studies have found that smallholder farmers fail to fully participate in agricultural commodity markets. In instances where they participate, their level of participation is quite low relative to their commercial counterparts. In the developing world and Africa in particular, neoclassical economics has failed to explain this observed behaviour. Instead a new paradigm by the name of New Institutional Economics has been

developed to fill this gap. In particular smallholder farmers' minimal participation or lack of participation has been explained in terms of the transaction costs they face. In order to increase smallholder farmers' participation in the markets we therefore need to identify these transaction costs factors and try to eliminate or minimize them.

Demand Analysis of Food Products in Botswana

Agricultural producers must produce products that are highly demanded by consumers if they are to obtain high prices. Demand patterns for food products change due to several factors such as the demographic characteristics, per capita income, and technological developments. It is therefore important for food producers and suppliers to take track of these changes so that they supply the right products to the ultimate consumer. Knowledge of the demand patterns and elasticities will also provide useful information to policy makers.

Production and supply response of agricultural products

A number of government policies and programmes have been formulated and implemented in order to stimulate the agricultural sector in general. Some of these policies or programmes have been sector specific, with the main aim of diversifying the agricultural production base. However, success of these policies and programmes has been very limited indeed with a few exceptions. Most of these policies or programmes have been implemented with the major objective of increasing local production in order to substitute imports. It becomes very important therefore to identify factors that influence production and supply response in various sub sectors of the agricultural sector in order to come up with appropriate policy advice for each sub sector.

The effects of land reforms on agricultural performance

Studies have identified determinants of livestock productivity under different land tenure systems in Botswana. Studies are required to apply the New Institutional Economics (NIE) to analyse the effect of, for example transaction costs on livestock productivity. Institutional arrangements such as equity- shares programme are advocated as a land reform. A study to identify the constraints of such institutional arrangement on livestock productivity is necessary to provide some insight to policy makers.

On going research:

Education Unit:

Research thrusts:

Curriculum Studies in Agricultural and Vocational Education Programmes

Viable educational programmes are characterized by their ability to change with the changing world . Change will take place in the schools and whether the change is rational or not, will depend upon the research information available to inform and educate stakeholders in agricultural and vocational education. Consequently, conducted research in an area such as : (a) The role of information and communication in technology in agricultural education: (b) Social issues and problems in formal and non-formal agricultural and vocational education; and (c) The perceptions of stake holders regarding relevant concerns in agricultural education should be the basis for recommending changes in the curricula of formal and non-formal agricultural and vocational education programmes.

Testing and Assessment in Agricultural and Vocational Education Programmes

Student learning and performance ride on the relevance, reliability and validity of testing and assessment procedures and practices in agricultural education programmes. Research findings make learning assessment an ongoing part of a training and fundamental part of students' preparation for the world of work in agriculture or agricultural related professions. By focusing research on testing and assessment in agricultural education programmes at different levels, agricultural educators provide the measures by which to define success and recommend changes in the assessment and testing procedures and practices in the programmes.

Towards Improving Agricultural Education in Botswana

The quality of any instructional endeavours in agricultural and vocational education, whether formal or non-formal, is directly related to the competence of the individual teacher who is planning, directing and evaluating the endeavour. Today there are many issues and problems in agricultural education in Botswana including but not limited to: (1) Factors affecting agriculture teacher “burn out” in schools; (2) Impact of HIV and

AIDS pandemic on agriculture teaching profession; (3) Factors affecting the teaching of agriculture in schools and teacher training institutions and (4) the role of agriculture teacher education institutions in restructuring the curricula to meet needs and challenges in the profession, Research in these and many other areas in agricultural education will legitimize changes that are recommended for improvement in the agriculture education programmes.

Education in Rural Schools

Agricultural education programmes in rural schools function in environments quite different from urban settings in Botswana. This creates the need for research in rural agricultural education in a number of key areas, including but not limited to (a) Examining the durability of the career choices of school rural children and their out-mobility from rural communities; (b) A qualitative study to assess the perceptions of administrators, teachers, community, leaders and students about agricultural education being offered in rural communities and the importance of the schools to the well being of the communities; (c) Factors affecting the decisions of the rural secondary pupils to enroll in agricultural education programmes; (d) The role of the rural schools in providing a path of upward mobility for rural poor youth and (d) Determining the factors influencing community support for schools.

Levels of Cognition in Agriculture

Future secondary agriculture teachers should not afford to devote too much time to having students to merely memorise facts and figures related to agriculture. Teachers must learn to help students become proficient at higher order of thinking levels. Research in cognition will examine : (a) the effects of learning styles on levels of cognition; (b) relationships between the levels of cognitive performance and critical thinking ability in agriculture; (c) cognitive levels of teaching and testing in tertiary agricultural education institutions in Botswana and (d) cognitive levels of teaching and learning in adult agricultural education programmes.

Teacher Education and The Teaching of Agriculture in Schools

On going research:

Factors Affecting Teaching of Agriculture in Secondary Schools of Botswana. A national study funded by the Research and Publication Committee of Botswana College of Agriculture. (2006 -2007)

Extension Unit:

Research thrusts:

Agricultural Technology Dissemination and Adoption

Perception of Agricultural Extension Workers towards Government Agricultural Extension Policies in Botswana .

In 1996, several policies were formulated by the Ministry of Agriculture to enhance the performance of extension workers in the process of transferring farming technologies to farmers. These policies were in the areas of principles, philosophies, objectives, Extension teaching methods, teaching materials, and the roles expected to be played by technical assistants, technical officers and subject matter specialists to foster agricultural development and technology transfer. Some of these policies may now be irrelevant to the extension system and may need to be reviewed. Results obtained from this research should reveal some new policies that would enhance agricultural development and technology transfer and those that would have to be modified.

Perceived Needs of Agricultural Extension Workers In Botswana.

Agricultural Extension Workers have often been blamed for their inability to transfer technologies developed at the Research Institutes to the end users without focusing on some factors that can affect technology transfer. Research has shown that if these factors are not identified and dealt with appropriately, extension workers are most likely to fail in performing Their roles effectively and efficiently. This research work will focus on identifying these factors with the aim of pointing out to the Ministry of Agriculture the dangers that these can pose to the role of technology transfer expected of an Extension worker.

Women and Social Groups Empowerment in Agricultural Development

Many scholars have alluded to the fact that women and some social groups have been marginalized in the process of Agricultural development in Botswana. For example, the inability of women to own land in Botswana has often been cited as one of the major

problems confronting agricultural development in Botswana. Women constitute the majority of those who live in rural areas where agriculture could be better practiced. This research work will identify other areas that could restrain women and some social groups from participating effectively in Agricultural development.

AEL Research

Research

AEL has been active in a number of research projects over the years. Recent publications of each academic staff member may be viewed by visiting the staff member's webpage listed in the directory above. Current research projects in the department are listed below.

On-Going Research Projects:

Long-term environmental effects of soil management practices in the Pandamatenga farms (Tapela M, Kayombo B., Meulenberg F.)

Aerodynamic properties of Botswana grain crops (M. Tapela, R. Tsheko, E. M. Chimbombi)

Monitoring the effects of environmental parameters on poultry housing designs used in Botswana (R. Tsheko, H.J. Chepete, E. M. Chimbombi, D. J. M. Kamau and H. Masebu)

Precision Agriculture as a strategy to improve dryland farming in Botswana (R. Tsheko, B. Kayombo, S. Machacha, F. Meulenburg and J. N. Batisani)

Desert Margins Programme (DMP) Phase 1 : Biological Diversity with relevance to Climate Change and the Cross-Cutting Issue of Land Degradation (GEF funded Project).Kayombo B, project leader.

Applications of Remote Sensing for Integrated management of Ecosystems and Water Resources in Africa (UNESCO funded project) Tsheko R., project leader

Key Research Areas

Department of animal science

Range Science Research

Animal Production Research

Animal Health Research

On-going Research

Diagnostic Research

Incidences of cryptosporidiosis in calves, lambs and kids (S. P. Sharma - Team leader)

Improvement of indigenous chicken (E. Z. Mushi – Team leader)

Diseases of Ostriches (E. Z. Mushi – Team leader)

Heat increment of feeding in Tswana goats (J. M. Kamau - Team leader)

Effects of rerouting blood in the facial and angularis oculi veins (J. M. Kamau - Team leader)

Nutrition Research

Utilisation of key forage plants in two desert margin areas of Botswana. DMP/GEF research project.

Diet selection and influence of tannin containing browses in the nutrition of Tswana goats.

Study of the adaptive responses of the gastro-intestinal tract (GIT) of the ostrich (*Struthio camelus*) to variation in dietary intake and implications for health and general performance of the bird.

Evaluation of *Imbrasia belina* (Phane worms) as a livestock feed.

Field Research

Involved in research project on Cryptosporidiosis with Dr Sharma .

Selecting Tswana goat for parasite resistance and increased productivity with Dr Nsoso .

Range Science

Evaluation of rangeland responses to various management practices, environmental factors, restoration attempts as well as range animal behaviour and interactions for sustainable range and animal production

Preamble

More than 90% of the landmass in Botswana is classified as rangeland. Rangelands account for all beef production (about 80% and around 20% on communal and commercial rangelands, respectively) in the country. Trends in both livestock numbers and rangeland production show that cattle numbers are on the decline and small stock and

equine (donkeys in particular) are increasing while rangeland productivity is declining. The decline in cattle numbers is attributed to poor management, the results of which are frequently accelerated by drought. Sheep and goats, though wholly dependent on natural rangelands are less sensitive to rangeland degradation due to their morphological adaptations that allow them to forage more selectively than cattle.

Sustainable grazing management in rangelands

Rangelands are a house of natural resources in Botswana. They provide almost all the food for domestic animals as well as being habitat to all wildlife. The rangelands are often misused due to high number of animals or inappropriate grazing management. Information on appropriate stocking rate and grazing systems for each rangeland is lacking in most of Botswana.

Assessment of rangeland factors

Productivity of rangelands is determined by a variety of factors such as rainfall, temperature, season, soil, elevation, vegetation and industrial emissions. An understanding of the effects of these factors on the productivity of rangelands is essential managing rangelands.

Restoration of degraded rangelands

The productivity of rangelands in Botswana and other arid and sub-arid regions has been lowered by degradation. Investigation in restoration of these rangelands is essential to improve their productivity. Bush encroachment is one indicator of rangeland degradation. This is usually due to exclusion of fire and sufficient number of browsers. Use of fire and browsers can prove beneficial under this situation. Under degraded condition soil fertility is reduced. Addition of inorganic or organic fertilizers may improve the rangelands, especially in areas of optimum rainfall.

Resource use and partitioning by domestic and wild herbivores

Wildlife and range livestock populations are regulated by the availability of food, water and cover. The greater these basic components occur together, typically the greater the diversity in wildlife species and total number (including livestock). Management practices can promote or destroy habitat diversity, depending on their application. For instance livestock affect wildlife habitat directly by removal and/or trampling of vegetation that would otherwise be used for food and cover. Different types of livestock

may affect the vegetation of an area much differently because of differences in food habits. Contrary to the belief that cattle prefer grasses, sheep prefer forbs and goats prefer shrubs, research in many parts of the world continue to prove that forage preference by different animal species is highly influenced by heavy grazing and human activities which reduce plant species diversity. As range condition declines and plant diversity decreases, the nutritive value of wild ungulate diets declines because they are forced to be less selective. Given the economic and social importance of both wildlife and domestic animals to the country and the tendency for both types of animals to share habitats, attention needs to focus habit use, foraging habits, nutrition of the herbivores and human-animal land use conflicts.

Animal Production

Evaluation and utilization of resources in the development of sustainable livestock production in Botswana

Preamble

Animal Agriculture, especially the beef sub-sector contributes around 70% of agriculture's share of Gross Domestic Product (BIDPA, 2006) Livestock in general acts as a source of income at individual and household levels, create employment, provide services in support of crop production – in terms of draught power and manure used as an organic fertiliser in gardens and arable fields. They also provide status and prestige within the immediate community, fulfil social, cultural and religious requirements and obligations, provide food and other direct products, reduce and spread risk attached to failure of crops and generation and accumulation of wealth. Animal agriculture competes with the ever-increasing human population and settlements for space hence there is need to increase performance per animal on the limited space. There also is need to conserve the bio-diversity for future production and generations and also preserve the integrity of the environment through sustainable livestock production.

Sustainable dairy production

Botswana dairy industry is at its rudimentary stage. Milk products demands are met through importation. Data from Ministry of Agriculture shows that demands for fresh milk is increasing. Though the local number of dairy units has increased from 88 in 1996 to 183 in 2001, this increase has not marched by relative increase in milk production suggesting the inefficiency of milk production at farm level. The need to meet the country's demand for milk is partly been addressed by the government through the National Master Plan for Arable and dairy Development (NAMPAADD). However, concerned institution, which has a stake in agricultural development like Botswana College of Agriculture, has a role in developing innovations that would promote sustainable dairy production in Botswana. This can be accomplished through breed development, nutrition, diseases and reproduction management and marketing interventions.

Intensification of sheep and goat production

96% of the sheep, and 99% of the goats are in the traditional sector. However the productivity of these animals is low. Birth rate are low and this can be attributed to poor management of animals in terms of nutrition, reproduction and disease control. Another strategy in promoting productivity of this sub-sector is to develop niche products and find niche markets. This will improve the livelihoods of majority of the rural farmers.

Forage production, processing and evaluation

Nutrition is central to animal production. This because feeding influence growth, reproduction and the health of animals. In Botswana animal production is stifled by nutrition. There are times during the dry season when the quality and quantity of feed from the rangelands is inadequate. This calls for provision of good quality feed. Forage production using waste water for irrigation and rained fed systems would go a long way in giving solutions to this problem. Processing and evaluation these forages are needed to improve on utilization by livestock.

Sustainable ostrich production

Ostrich farming is a new sector in animal agriculture. It is still face with problems of establishing itself as an industry. Though many farmers may show interest in ostrich farming there is lack of information and little expertise in ostrich farming. Ostrich farming will diversify the agriculture form the traditional cattle sub-sector.

Animal Biotechnology

Indigenous breeds have the value of forming foundation stock for future crossbreeding and breed formation. It is important to know conserve and improve what we have through characterization of these breeds. Particular attention should be on the application of Biotechnology in DNA marking and fertility studies, disease resistance and carcass characteristics.

Evaluation of beef production systems

To diversify the beef industry and empower other section of the farming community it is important to promote various production systems. For instance, if some farmers are engaged in weaner production to sell to a feedlotter, it will spread the cost and risk.

Game farming and ranching

Game farming has become popular in recent times. For efficient use of the rangelands and marginal areas game farming need to be encourage. Multi-species systems can be used combining livestock with game to effectively take advantage of niche grazing habits of these animals. This also opens opportunities for agro-tourism.

Organic farming

Organic farming is becoming popular worldwide. This is prompted by concern for product contamination by chemical residues. In addition consumers now ask for agricultural products which a produced naturally. This scenario opens opportunity for local animals which traditionally are reared extensively with no additives in their feed.

Fish farming

As community become more prosperous their taste may change. Though Batswana are not accustomed to eating fish, city dwellers do buy fish. However fish is imported. There is a need to explore chances of fish farming for local and for export.

Non-conventional farm animals

As an attempt to diversify the economy, research and extension services dealing with un-conventional farm animals like rabbits guinea fowls, quails and Phane will be necessary. Such animals provide extra sources of nutrition particularly to the resource poor people and go along way to reduce poverty.

Livestock produce marketing and trade

The success of the livestock sector like other sectors of the economy depends on the availability of livestock markets and secure trade chains. There is need to research and keep abreast with new developments in this important area.

Animal Health

Pre, Para and clinical research of domesticated and wild animals for the enhancement of health and sustainable productivity

Preamble

Domestic animals in Botswana are afflicted by a wide range of diseases and conditions that affect their health, welfare, products and productivity negatively. Research at pre, para and clinical levels is important in order to understand their etiological agents, epidemiology, physio-pathology, clinical and preventative management. Some of the diseases from the wild and domesticated animals are transmitted to man in a variety of ways including ingestion of contaminated animal products. There is need therefore to research in a number of issues based on the current departmental expertise.

Evaluation and characterization of physiological and anatomical adaptations of animals Nature provides selection of animals that can survive in a specific area. Studying the anatomy and physiology of wild animals provide an indication of the best strategies that the animals use, for instance, to mitigate against periods of food and water scarcity. Man has attempted to do further selection systematically or non-systematically to enhance natural selection in the domesticated animal species. Acceptability of a selected animal by farmers requires a full description and demonstration of the best attributes shown by the animal. The available information adds great commercial value to the genetic pool of such an animal.

Improvement of health of large and small animal

Animals must be free from diseases for the efficient production of meat, milk, eggs and other livestock products. There is a need to study diseases that limit the productivity of

livestock so as to control such diseases. These diseases include bacterial, viral, parasitic and those transmitted by ticks such as heartwater.

Improvement of quality of animal products

Human population increase and urbanization has brought about intensification of livestock production and the development of large processing plants for foods of animal origin. Hence, the increased human health hazards from the food chain. For the sake of 'public good', there is need for, basic and applied research in the biology and epidemiology of emerging zoonoses, re-emerging zoonoses, food-borne pathogens, monitoring and assessment of the use of antibiotic and antimicrobial drugs on the evolution of resistant microbes, and monitoring of the level of all types of residues in animal products. Research in the stated areas should be extended to include occupational health hazards for farmers, processing plant workers, and food handlers.

Evaluation of reproductive and developmental biology of animals

To increase the productivity of domestic animals and to ensure the survival and sustainability of wild fauna, depend to a large extent on a capacity to influence the reproductive and developmental processes of these animals. Key to the acquisition of this is capacity lies in understanding the reproductive physiology of our animal species and how it may be impacted by internal and external factors. The developmental biology and reproductive physiology of the regional wild fauna represent a new frontier in which large gaps in knowledge exist. The exploitation (game farming, hunting) of the wild animal resource on a sustainable basis makes understanding how these animals develop and reproduce and the influencing factors an imperative.

Livestock health policies and epidemiology

A number of diseases are of critical importance to the animal industry in Botswana. They include foot and mouth, contagious bovine pleuropneumonia and heartwater. Rabies, brucellosis, salmonellosis, tuberculosis and *C. bovis* continue to pose a threat to human beings despite the application of international control protocols. Research on livestock healthy policies and their applications as well as the epidemiology of the above key diseases will be encouraged in the future. In particular, the role of the wild buffaloes and the jackals in the epidemiology of foot and mouth disease and rabies respectively as well as looking for a better vaccine for heartwater will be given priority .

Veterinary products and ethnoveterinary medicine

Ethnoveterinary medicine refers to people's knowledge, skills, methods, practices and beliefs about the care of their animals (McCorkle, 1986). Ethnoveterinary medicine is often taken to mean using medicinal herbs. In the villages many livestock farmers use many plant concoctions to treat their sick animals. This is mainly because these plant preparations are readily available and therefore cheap. There is a need to investigate the efficacy of these medicinal plants so as to find whether they should be used at all.

Animal welfare

The health of an animal, its productivity and eventually wholesomeness of its products depend much on the kind of welfare it is subjected to during production and on route to the marketing sites. Research dealing with animal welfare, behaviour, policy issues and advocacy for better welfare are critical in supporting a health animal industry.

CSP Research Projects

All the research conducted in the Department of Crop Science and Production is guided the department research thrust. The thrust puts emphasis on the following areas (themes): Crop Environmental Stresses; Biotechnology and Crop Improvement; Crop Diversification and Sustainable Management; Postharvest physiology and Technology of Perishable Crops; Agroforestry and Forest Products and Veld Products Development and Improvement.

Research Topics

BAMLINK

(Molecular, Environmental and Nutritional Evaluation of bambara groundnut (*Vigna subterranea* L. Verdc.) for Food Production in Semi-Arid Africa and India)

This research project, funded by the European Union, links partners in Africa, Europe and India in a programme that combines molecular, environmental and nutritional studies through to final product processing. Central to the work programme is the dissection of the underlying genetics of the crop and its evaluation across a range of environments for traits relating to abiotic factors that currently limit productivity, geographic range and

farmer and consumer uptake. Collaborators will identify genes and QTL's for drought, heat and cold tolerance and photoperiodic control of podding and will link genetic and biochemical composition of seeds to quantify nutritional composition, nutritive value and processing potential of genotypes. The development of molecular markers and genetic maps for bambara groundnut, will be coupled with agronomic and physiological assessment across locations. Gaining an understanding of the genetic basis of these traits and the development and dissemination of tools for their exploitation will provide the foundation for subsequent focused breeding efforts in bambara groundnut. At all stages, end-users will guide researchers toward desirable traits.

PEANUT PROJECT

"Basic and applied studies on aflatoxin and *Aspergillus flavus* management and interaction with peanut in the field" is a collaborative project with University of Georgia, USA, University of Wisconsin-Madison, USA, University of Botswana and Botswana College of Agriculture (Department of Crop Science and Production). This project is funded by USAID. The BCA is responsible for field evaluation of promising fungal, drought and insect resistant peanut germplasm under Botswana conditions. Seven breeding lines and 11 core collections (varieties) from the USA are being assessed and compared with two local varieties. Data being collected include agronomic characteristics, yield, incidence of *Aspergillus flavus* and aflatoxins in the nuts both in the field and after harvest.

For more information on Peanut project contact:

Dr EB Khonga email: ebkhonga@bca.bw

MAHUPU PROJECT

Propagation and processing of the desert truffle (*Kalahari tuber (Terfezia pfeilii)*)”
The project aims at addressing the dwindling yields of the Kalahari desert truffle due to drought, overgrazing and overexploitation. The project is assessing various tree species and cucurbits as symbionts of the truffle fungus and to assess the effect of fencing to reduce overgrazing and supplemental irrigation on truffle yields in the field. It is funded by the BCA RPC.

For more information on the Mahupu project contact:

Dr EB Khonga email: ebkhonga@bca.bw

BREEDING OF BLACKEYE COWPEA FOR ALECTRA VOGELII RESISTANCE

One of the constraints to cowpea production in Botswana is the incidence of a parasitic weed *Alectra vogelii* L. Benth, one of the Scrophulariaceae family. It causes substantial damage by attaching itself onto the cowpea plant and tapping nutrients from it. This causes severe grain yield reductions. Blackeye variety is highly susceptible for this parasite. Yield losses of up to 100% have been recorded in farmer's fields in some agricultural regions. It was therefore, deemed necessary to embark into a breeding program to insert the genes for *Alectra* resistance into Blackeye cowpea. With *Alectra vogelii* resistant Blackeye, all cowpea farmers will be able to grow and obtain high yields even in fields with high seed banks of the weed.

For more information on this project contact:

Mrs G. Mashungwa email: gmashung@bca.bw

MORAMA PROJECT

The aim of the morama project was to develop an understanding of morama bean (*Tylosema esculentum* (Burch) A. Schreb.), its distribution, biology and socio-economic potential as a crop. Morama is a wild perennial legume of southern Africa, which produces edible grain (seed) with a large content of protein (30-39%), of large lysine and relatively large S-amino acid content, and oil (35-43%) which has a large proportion of oleic (49%) and linoleic (24%) acid.

Morama is widespread, with large populations (around the central Kalahari) and Namibia, and smaller populations in the Transvaal region of South Africa. Morama grows in well drained, fine, generally calcareous sands, but also in regions of harder calcareous conglomerates, at pH 6 to 8.

Seed is frequently consumed (but roots much less so) as a good quality snack or main food, sometimes eaten fresh (when boiled), but generally roasted when mature.

Plants were grown, from seed, as a crop in field trials in Botswana, some flowered in the first year. The seed production is variable (in wild-growing plants also), suggesting that selection for higher yielding strains is possible.

Studies in laboratory and field using gas-exchange methods showed that morama has C3 photosynthesis: it uses water and nitrogen, responds to temperature, with similar efficiency to other C3 plants. Drought induces earlier leaf-folding and stomatal closure, but relative water content, and water and osmotic potential do not decrease greatly. Vegetative growth is rapidly slowed by water stress, and leaves drop (abscise) quickly. These features, and dependence of seed set on rain, show that morama is a 'drought-avoiding' species which survives by accumulating a large proportion of assimilates in the tuber.

Studies of N assimilation with ¹⁵N and biochemical analyses, show that morama does not form root nodules with symbiotic bacteria. Agronomic trials show that morama growth is not stimulated by application of N-fertilizers, indicating large efficiency in acquiring N. Similarly, phosphate fertilizers do not stimulate growth, suggesting a large efficiency in acquisition and use of P.

For more details on the morama project contact:

G. Ramolemana email: gramolem@bca.bw

DEVELOPMENT OF A CONTROL STRATEGY FOR GROUNDNUT LEAFMINER ON GROUNDNUT

This is a SADC funded collaborative project between researchers in the Department Crop Science and Production Grain Crops Institute at Potchefstroom in South Africa. The overall objective of the project is to provide data that will lead to the development of an integrated pest management (IPM) programme for groundnut leaf miner (*Aproaerema modicella* (Deventer) (Lepidoptera: Gelechiidae. The groundnut leafminer (GLM),) is an important pest of groundnut (*Arachis hypogaea* L.) in South and South-East Asia. In recent years it has been reported in some African countries (Uganda, Malawi, Mozambique South Africa and Botswana). It causes severe damage to groundnut crops.

The damage on groundnut leaves results in poor groundnut growth production and causes yield loss under heavy groundnut leaf miner infestations. To limit losses in yield, the insect needs to be controlled. There are no threshold levels established for control of this pest. Producers currently do not control the pest because no insecticide is currently registered for control of this pest in groundnut in South Africa and Botswana. It is hoped that the results from this project will increase and stabilize groundnut yields in smallholder farming systems in South Africa and Botswana. It is anticipated that the results will also be applicable to other SADC countries with similar environmental conditions.

For more information on this project contact:

M. Obopile at email: mobopile@bca.bw

SORGHUM ENTOMOLOGY PROJECT

Molecular, Environmental and Nutritional Evaluation of bambara groundnut (*Vigna subterranea* L. Verdc.) for Food Production in Semi-Arid Africa and India)

This research project, funded by the European Union, links partners in Africa, Europe and India in a programme that combines molecular, environmental and nutritional studies through to final product processing. Central to the work programme is the dissection of the underlying genetics of the crop and its evaluation across a range of environments for traits relating to abiotic factors that currently limit productivity, geographic range and farmer and consumer uptake. Collaborators will identify genes and QTL's for drought, heat and cold tolerance and photoperiodic control of podding and will link genetic and biochemical composition of seeds to quantify nutritional composition, nutritive value and processing potential of genotypes. The development of molecular markers and genetic maps for bambara groundnut, will be coupled with agronomic and physiological assessment across locations. Gaining an understanding of the genetic basis of these traits and the development and dissemination of tools for their exploitation will provide the foundation for subsequent focused breeding efforts in bambara groundnut. At all stages, end-users will guide researchers toward desirable traits.

For more information on Sorhum Entomology project, contact:

Professor D. C. Munthali at email: dmunthal@bca.bw

PIGEONPEA PROJECT

"Evaluation of pigeonpea (*Cajanus cajan*) as a potential legume for production under Botswana conditions"

This is a collaborative, multidisciplinary project involving agronomists, entomologists and nutrition specialists at the Botswana College of Agriculture (BCA). It is funded by the BCA's Research and Publications Committee. The main objective of the project is to investigate the potential of pigeonpea production in Botswana. This research is important because pigeonpea is a multipurpose crop that can improve soil fertility and is utilized as food and yet can also provide fuelwood for farmers and can be fed to livestock. The research has evaluated seven pigeonpea varieties obtained from the SADC Regional Pigeonpea Research and Development Programme based in Malawi. The studies conducted so far have included assessment of growth and yield characteristics of the varieties; determination of effects of planting dates on their growth and yield parameters; evaluation of relative susceptibilities of the varieties to major pests; assessment of yield yield losses caused by pests and assessment of the impact of indigenous natural enemies on major pests of the crop. The nutritional composition of seeds of each variety have also been estimated. Research has also been initiated on the potential use of pigeonpea as a livestock feed and as a source of fuelwood.

For more information on the Pigeonpea Project, contact:

D.C. Munthali (email: dmunthal@bca.bw)

Basic Science Research

The Department of Basic Sciences has two major research teams, the Biological Sciences Research Team (BSRT) and the Mathematical Sciences Research Team (MSRT), although the staff continues to do individual based research in areas of specialization and some collaborative research.

**BIOLOGICAL SCIENCES RESEARCH TEAM (BSRT)
COLLABORATIVE RESEARCH**

Mathematical Sciences Research Team (MSRT)

The Mathematical Sciences group is a multi-disciplinary group comprising of experts from the fields of Mathematics, Biometry, Physics and Computer studies. The following are the groups' key research areas:

a) Environmental Physics (or Modeling)

The research involves the use of naturally occurring (and anthropogenic) radionuclides as tracers of atmospheric aerosols (pollutants). The monitoring of Lead (Pb-210), Beryllium (Be-7) and Cesium (Cs-137) in the lower troposphere is of paramount importance. Lead and beryllium are continuously being produced and washed away from the atmosphere, hence the knowledge of their concentrations in the atmosphere may lead to proper quantification of load of pollutants that are being deposited, as the two do attach to the same accumulation mode as the sulphates and nitrates. Particular problems involve: (i) the investigation of water induced erosion or sedimentation, (ii) determining the quality of agricultural products to ensure that the products meet the bureau of standards settings, (iii) studies on urban and maritime aerosols under varying conditions of humidity and (iv) studies on environmental aerosol deposition on the plant leaves.

b) Mathematical Modeling

This is a very diverse area encompassing Mathematical epidemiology, Population studies, Biomechanics, Fluid dynamics, Heat transfer and Statistical modeling. Problems of variations in rainfall, extreme temperatures, solar radiation and sunshine radiation could be tackled. Real life problems exhibit complex behaviour and patterns, which sometimes follow certain probabilistic distributions. Statistical modeling is commonly applied to give more insights on the dynamics of the system or the problem that follow certain distributions.

i) Mathematical Epidemiology

The research involves modeling transmission dynamics of infectious diseases within a population with emphasis to HIV/AIDS. The evaluation and/or assessment of the impact of intervention programs such as vaccination and treatment on the spread of diseases are

vital in guiding policy formulation and implementation of intervention strategies. A clear understanding of immunology of diseases plays a vital role in designing and implementing intervention programs.

Real life problem solutions are urgently needed, but in most cases experimentation takes longer to provide insights in the behaviour of the phenomena. In this case Mathematical modeling becomes an alternative tool. Hence, the aspect of Mathematical modeling would through simulation provide insights on the behaviour of the problem, which would facilitate the formulation intervention strategies. Validation of such models once data is available is crucial. Particular areas of problems for research are: (i) the role of churches and traditional healers in the fight against HIV and AIDS, (ii) impact of community health care systems (home base care), (iii) long term effects of treatment and vertical transmission, (iv) contribution of tradition, economic status and behaviour on the spread of the disease and (v) effects of HIV/AIDS on population demographics.

ii) Biomechanics, Fluid Dynamics and Heat Transfer

Modeling of liquid flow through certain specified medium could be used to understand a number of health problems and real life problems, for instance heart mechanism, arteries, veins, and food absorption into blood streams. The research usually involve: (i) modeling flow of a polar fluid through a porous medium, subjected to magnetic field, (ii) heat transfer due to a combined action of radiation, magnetic field with variable suction, (iii) effect of temperature on catalytic reactor with heat source or sink.

c) Multivariate Analysis and Its Applications :

Applications to Student Performance at schools: Disparities between boys and girls performance

In order to provide a solution to any real life problem it is crucial for one to formulate a problem, prepare experimental designs, carry out data collection, analysis and interpretation. Appropriate application of statistical methods to different research data in determining patterns or relationships among variables and ways of interpreting the data is very important. The use of statistical software is essential in research, with most common being SAS, SPSS and Minitab. Particular research problems involve: (i) application of principal component and factor analysis in agriculture and educational research data and (ii) **experimental designs.**

d) Applications of Information Technology (e-learning) to Agriculture and Education

This area of research makes use of information technology to source information or data from available resources in the Internet, such as bioinformatics: - retrieval and analysis of DNA sequences from the DNA bank.

Ministry of Communications, Science and Technology (MCST)

The MCST's goal is to formulate relevant information and communications technologies (ICT) and science and research policies as well as coordinate their implementation through national, regional and global collaborative efforts that harness local resources, talent and innovation. Currently the ministry has two research institutions that fall under its portfolio: the National Food Technology Research Centre (NFTRC) and Botswana Technology Centre (BOTEC).

National Food Technology Research Centre (NFTRC)

NFTRC aims to generate knowledge and technologies to enhance food quality and safety through sustained research and development, communication and extension services, training and commercialization. The organization carries out its research activities through the units of Food Technology, Food Biochemistry, Microbiology and Biotechnology, Nutrition and Dietetics and Extension and Training. The organization has twelve Board of Directors appointed by the Ministry of Communication Science and Technology.

The Food Technology Unit (FTU) exists to promote food-processing activities from product formulation to finished products. The process involves identification of available raw materials, recipe development, and pilot plant process optimization for selected product formulations, sensory evaluation and consumer acceptance surveys. The goal is to promote the development of the food industry in Botswana, hence contributing to diversification in the local economy.

MAIN ACTIVITIES

- Research and development of food products from locally produced animal and plant resources
- Process design, optimization and technology transfer to entrepreneurs
- Technical support in process equipment sourcing and/or fabrication
- Technical assistance in process documentation and record keeping for SMEs in food processing on consultancy basis
- Provision of training in food processing technologies, nutrition, food hygiene and safety
- Preparation of technical business proposals for presentation to funding agencies

Development of Value-added Plant Products

The main objective of R & D in plant products is to enhance self-reliance in semi-processed and processed horticultural products. This will be result in job creation, income generation and a diversified economy, especially in marginalized areas that depend primarily on veldt (wild) products.

In plant products, potential exists for exploitation of indigenous plant resources (especially fruits and vegetables), which are adapted to the local climatic conditions. With Government support in irrigated crop production, there is a need to develop plant products as a means of value-addition, and to accommodate surplus produce, while reducing reliance on imported processed food products. The selection of plant products for conversion to value-added products is based on several criteria, which include raw material availability; priority areas as per government policy, the potential for irrigated agricultural production, the current level of importation of the products, and the potential for transformation into high value export products.

The Unit also conducts research on products from other crops such as soybeans and cowpeas as alternative and healthier protein sources.

Development of Value-added Animal Products

Through the Botswana Meat Commission (BMC), the beef industry in Botswana is well developed, with exports of prime beef cuts to the EU. The beef industry is more advanced in Botswana than in most other African countries. Non-prime meat cuts can be processed into value-added products for export markets within Africa and beyond. For the local market, the potential still exists in the development of products based on traditional recipes, such as *seswaa* and *serobe*, among others. Diversification into long shelf life-type products for institutions (military, hospitals, schools, etc) and famine relief meat products requires evaluation, and is part of the current focus in the FTU.

The ostrich industry in Botswana offers an enormous opportunity, as only about 50% of meat from the ostrich is of export quality. With the current production level of 5,000 birds per year, each producing an extra 20 Kg of non-export quality meat, 100 MT would be available for processing into value-added ostrich meat products. For the Botswana ostrich abattoir to be economically viable, 12,000-15,000 birds are needed per year, providing over 360 MT of non-export quality ostrich meat for value-added products. Ostrich meat products provide an alternative and healthier choice, compared to beef.

The FTU also conducts product development and food safety training for dairy products, especially in support of SMEs.

Food Safety Management Systems

The FTU is involved in assessments and design of tools to promote food safety in food processing facilities, the hospitality industry, institutional kitchens, and allied industries such as in manufacturing of food packaging materials. Services in food safety management systems based on Hazard Analysis Critical Control Point (HACCP) are also offered on consultancy basis.

This Unit is charged with the responsibility of characterizing food materials for physical and chemical qualities and defects.

MAIN FUNCTION

The laboratory continues to assess, investigate and document physical, chemical and biochemical properties and reactions of foods and related products.

ACTIVITIES

In the previous year the lab procured and installed several major pieces of analytical equipment. During the period of reporting, much effort was focused on operational aspects of optimization and customization of the equipment and analytical procedures to specific needs and conditions. The work included experimental and proficiency testing and validation of analytical protocols, equipment operating conditions and optimization of sample preparation processes for various parameters and food matrices. Through this effort, the lab was able to adopt and optimize protocols for analysis of fatty acids in oil seeds, cholesterol in eggs, minerals and nutrients in cereals.

The laboratory continued working on training programs and documentation to develop and implement Laboratory Quality Management Systems in line with ISO 17025, including participation in the proficiency-testing programs coordinated by Botswana Bureau of Standard and the Swedish National Food Administration.

During the same period the laboratory analyzed more than 100 food samples. Most of the analyses focused on samples generated from internal R&D work involving a nutrition and food security assessment study in the Southern District. Some external client samples were also analyzed.

The laboratory also made efforts to improve procurement and inventory management of its accessories and consumables.

CONSTRAINTS

Major areas of constraint during the reporting period included inadequate staffing levels of analysts, insufficient preparatory and support equipment and the lack of planned and preventive maintenance for the equipment. Arrangements are also underway to secure resources for support and preparatory equipment and maintenance.

THE FUTURE

In the year 2003/04 optimization work is planned to cover other areas of testing including vitamins, amino acids, pesticides, mycotoxins and phytochemicals. Efforts are continuing to enhance staffing, and competence through on-job learning and training programs. This will go a long way to improving the laboratories performance and output.

NUTRITION AND DIETETICS

Evaluation of Dietary Quality and Adequacy of Botswana Dishes for Utilization in the Community Home Base Care Program - A pilot Study in the Southern District.

A study was conducted in the Southern District and the main objective of this study was to identify major traditional dishes and patterns in food combinations consumed at community/household level in . In addition, the extent to which these dietary patterns were compatible with nutritional adequacy and diversity to meet the requirements of the target population was also determined. A questionnaire was administered to establish the food security situation in the households and the main meal (lunch) was collected for chemical composition and nutritional quality analysis.

The findings indicated that 41% of the households visited live below the poverty datum line and 24% earn only marginal incomes, therefore, 65% of the population is at risk for food insecurity. In addition, the study findings considered indicate significant inadequacy in dietary protein and a major deficit in dietary energy on the basis of reference Estimated Average Requirements and Estimated Energy Requirement values respectively. Further, the study indicates significant inadequacy prevalence in dietary fat at 40% on the basis of . Moderate levels of inadequacy prevalence for protein carbohydrate at 10% and 25% respectively are indicated. This suggests that communities need to change their diets to reflect more adequate nutrition. Meals with adequate nutritional balance and diversity have been suggested. Further, education on appropriate dietary guidelines will be required to support this.

PURPOSE

Extension is a Subunit of the Food Technology Unit, and serves as link between the Organization and the general public.

Headed by the Senior Extension Officer, this department is responsible for Marketing, Extension services, Training and Publishing of activities of the Centre

Effective Publicity of the Centre's activities is generally achieved through the following:

Radio programmes which are broadcasted on RB1 through "Tsa Maranyane Programme" Btv to inform the public about NFTRC services and activities and how their benefit to society at large.

Efforts are made through the district councils to brief Councilors about activities of the Centre

Invitations for Councilors and dignitaries as well as Students to visit the Centre

ACTIVITIES

The main purpose of the R&D activities at the Centre is geared towards increasing food processing opportunities in the country. A number of training workshops for potential food processing entrepreneurs have been held in the following areas:

Peanut butter processing

Jam processing using a variety of raw materials including melons (lerotse), which have a lot of potential as an enterprise since they are drought tolerant and do well in Botswana.

Watermelon juice processing

Sweet reeds processing

Cereal Snack processing

Meat processing and on

Some NFTRC Extension activities

Food safety

FAIRS AND EXHIBITIONS

The Unit continues to use both local and international fairs and exhibitions to markets the Research outputs of the Centre and also benchmark against similar Institutions.

The most recent participations of the Organization were in:

Botswana International Trade Fair (BITF) and won a second price on user friendliness of our services

Africa Industrialisation Day

World Food Day celebrated at Sekoma and Mahalapye

Permaculture Industrialisation day at Paje

Botswana Horticultural Day and exhibition held in Kanye and

Career fair held at Mookami CJSS for Community Junior Secondary School in Kanye.

Food Processing and Quality Enhancement

This theme is concerned with the development of new food products and ingredients that meet consumer demands as well as requirements of quality and safety. It will encompass all the commodity areas (cereals / legumes / oilseeds, fruits and vegetables, meat / fish / poultry, and dairy) as well as under-utilized and indigenous raw materials (veld products), and utilize as far as possible those production, packaging and distribution processes that are environmentally responsible. The knowledge base from this area will be used for technology transfer in the development of sustainable food based enterprises.

· Improving Process Efficiency, Product Quality and Nutrient Composition of Fruit and Vegetable products

- Quality and Nutritional Evaluation of tomatoes, potatoes, cabbage, and garlic grown in Botswana (Botswana Horticultural Council)

- Sweet Potato Products Development

- Improved Utilization of Sorghum Varieties

- Carbohydrate Composition of Sorghum and its role in Consumer Preference for selected Varieties in Botswana (PhD project)

- Health Benefits of selected Sorghum Varieties

- Development, quality and safety of value-added dairy and dairy-based products

- Plain and Flavoured Yoghurt Development

- Flavour profile of selected Dairy-based products

- Utilization of Madila Whey

- Development of soy-based food products for the local market

- Development and quality of value-added meat / poultry / fish-based products

- Quality of value-added meat products in Botswana

- Sensory Profile of Processed Meats in Botswana

- Novel foods development from Veld products

- Flavour profile and Shelf-life studies of fresh and preserved Truffles

Food Safety and Biotechnology

The quality and safety of food products and ingredients, in particular genetically modified foods, is under ever increasing pressure from both the government and consumers globally. NFTRC aims to strengthen the food safety system in Botswana by building expertise that can be used to develop quick and reliable methods for assessment and control as well as to guide in food safety policy development.

Fate and behaviour of environmental contaminants including pesticides, heavy metals, pollutants (SO₂) and other contaminants in soil, water, air and food

Risk Assessment of Acrylamide in the Botswana Diet

Profile of microorganisms and enzymes involved in deterioration of the baobab fruit

Genetic modification of foods - safety, health and environment.

Perception of GM foods in Botswana

Surveillance of the market for GM foods

Empower The Food Chain in Botswana to Handle Food Safely

KAP of the Botswana Food Chain to Food Safety

Current status of the food safety system in Botswana and recommendations for the National Food Safety Work plan

Impact of training on food safety KAP of the food chain in Kanye

Exploiting food product / ingredient development using biotechnology

Carotene from halophilic algae (MS Project)

Improving the Safety of Value-Added Meat and Poultry Products

Biochemical and Community Nutrition

Research is aimed at better defining factors which play a role in food health levels and acceptability in Botswana. This knowledge will be used to assess the relationship between nutrition and health and to advise on nutritional choices, and to develop foodstuffs that promote health and prevent illness.

- Nutritional Assessment of Botswana Traditional Dishes.
- Food Composition Tables for Botswana.
- Relationship of Diet, Physical Activity and Health.
- Behavioural and Health Factors that influence the health of Botswana.

- Environmental contaminants and health.
- Nutrition and HIV/AIDS
- Vitamin A fortification of sorghum meal and its use in HIV/AIDS feeding trials.

Botswana Technology Centre (BOTEC)

BOTEC is responsible for the adaptation, research, development and application of technologies appropriate to the needs of Botswana. Our aim is to contribute to employment creation, research, and development, and growth of small and medium industries through technology transfer. Through our annual report, clients, stakeholders and key players are informed about our products and services. They also get to know what to expect from us in the future. This enables them to provide feedback that should help improve our operations, products and services.

Ministry of Education (MoE)

The University of Botswana (UB) under MoE has a small proportion of their research and training with direct relevance to agriculture through the Department of Environmental Science and the National Institute of Development Research and Documentation (NIR). MoE does not have a direct policy for agricultural research or training.

University of Botswana (UB)

UB is the only national university in Botswana. In 1990, a major review of the organization, management, structure, and statutes of the UB was initiated. Since 1995, 3 new faculties of engineering and technology, business, and the school of graduate studies, have been created to supplement the existing faculties of education, science, and humanities and social sciences. In addition, the Botswana College of Agriculture, which awards degrees through UB, functions as an 8th autonomous faculty. A special pre-medical program was launched in 2000-01. UB obtains both its capital and recurrent budgets through the rolling national development plans and the annual budget cycle. Approximately 20% of the university's annual budget has been raised from tuition fees

and other revenue (mainly from the refectory, residences, and bookstore). In 2000, UB's assets were valued at approximately \$150 million. A new UB Foundation has been established to seek funds from the private sector to support new initiatives at the university

The National Institute for Development Research and Documentation (NIR) was established in 1975 and during its first decade earned an international reputation with more than 80 publications. It had a focus on land and environment; education and society; health and nutrition; issues of migration and settlement; and rural development. It was changed in the late 1990s to the Directorate of Research and Development and then in 2001 to the Department of Research and Development, with only a few staff members. The demise of the NIR has been accompanied by the rapid growth of a major research center in northern Botswana. At the end of February 2000, the UB officially launched the Harry Oppenheimer Okavango Research Center (HOORC). The Okavango Research Center has been operating since late 1994. In 2000, the Center had 8 academic staff and 10 support staff and planned to build up to 24 academic staff and 30 support staff over the next 5 years. In addition, graduate students and post-doctoral researchers from UB and universities around the world are attached to the HOORC and participate in its research programs.

Like most Departments at the University of Botswana, the bulk of time and resources in Environmental Science is devoted to teaching rather than research. However, despite this many staff still find time to do applied research (Environmental Science publication). Recently a large number of staff was involved in two major externally funded 3-year multi-disciplinary research projects linked to the Botswana Global Environmental Change Committee based in the Department. One of these was funded by the European Union and aimed at finding policy options and environmental management strategies for sustainable livelihoods and rangeland utilization in the Kgalagadi region of Botswana (budget = 168 000 Euros). The second project was funded by UNEP/GEF and START and investigated possible impacts of, vulnerability and adaptation to, climate change on

the Botswana side of the Limpopo Basin (budget = US\$195 000).

Ministry of Environment, Wildlife and Tourism

The overall responsibility of the Ministry of Environment, Wildlife and Tourism is to enhance the environment policy and Management, Forestry, Meteorological services, Tourism development and conservation of the wildlife. The following Statutory authorities are also supervised by the ministry and other organisations with portfolio responsibilities related to it:

- Department of Forestry and Range Resources
- Botswana Wildlife Training Institute
- Department of Environmental Affairs
- National Conservation Strategy Board

Department of Environment affairs (DEA)

Department of (DEA) exist to:

- Pressure on water resources
- Degradation of rangeland pasture resources
- Depletion of wood resources
- Exploitation of veld products
- Pollution
- The need to improve environmental awareness
- Depletion and conservation of wildlife resources
- Resource pressure due to growth in human population

The primary goals in formulating the National Conservation Strategy were to pursue policies and measures which:

- Increase the effectiveness with natural resources are used and managed, so that beneficial interactions are optimized and harmful environmental side-effects are minimized.

- Integrate the work of the many sectoral ministries and interest groups throughout Botswana, thereby improving the development of natural resources through conservation, vice versa.

The NCS recommended among others, the establishment of the NCS Advisory Board and the NCS Coordination Agency within the then Ministry of Local Government, Lands and Housing. These came into being in 1991 and 1992 respectively. The Agency services the Board by coordinating the execution of its decisions and liaising with other organizations to ensure that the NCS goals and objectives are achieved. To perform its duties, the NCS Coordinating Agency has three professional divisions, namely Environmental Education (EE), Environmental Research and Monitoring (ERM), and Programmes and Projects (PP). An additional division is the Administrative Support Services division

Botswana Institute for Development Policy Analysis (BIDPA)

BIDPA is an independent trust, which started operations in 1995 as a non-governmental policy research institution. BIDPA's objectives include, among others, to promote and conduct research, analysis and publication on development policy issues relevant to Botswana and the Southern African region; to monitor the performance of the Botswana economy and the management of public policy implementation, especially with regard to the implications for economic and social development; to offer advice and consultancy services to agencies of government and other clients under suitable contractual and other arrangements; to provide technical and financial assistance, directly and indirectly, to individuals and organizations in Botswana as deemed desirable for purposes of facilitating policy analysis; to assist professional training and public education of Botswana citizens in matters relating to policy analysis and encourage collaboration between expatriates and local professionals in these matters in ways which build, or augment, national capacities for performance and understanding of policy analysis.

The Executive Director is responsible for the day to day management of activities of the Institute. The Program Coordinator assists the Executive Director in matters relating to general management and administration of the Institute and servicing of the Board of Trustees. Other management staff consists of the Financial Administrator, the Information Systems Manager and the Chief Librarian. In addition to these, BIDPA has an additional team of nine support staff deployed in finance, administration and library.

The research department consists of twenty one (21) research staff at the levels of Senior Research Fellow, Research Fellow, Associate Researcher and Research Assistant. Research staff is specialized in the broad areas of agricultural economics, national development planning, econometrics and statistics, public administration, environmental economics, public finance, financial economics, public policy analysis, labor market analysis, social development, macro economics, trade and international economics, micro economics/enterprise analysis. Research activities are in areas of incomes, welfare and poverty research and consultancy, macro economic forecasting, projections policy advice and planning, capacity building and training, structural change in Botswana, information and library service, international trade, communication services, public sector reforms, promotion of development policy issues.

BIDPA has modern and fully computerized office environment comprising seminar rooms and a research library, audio visual equipment, full Internet access and electronic catalogues. Through its library and information technology resources, BIDPA has been able to extend its information services to audiences beyond the borders. BIDPA's library has materials in the areas of Economics, Trade, Statistics, Public Administration, Public Finance, Welfare, Incomes, Poverty and related subjects. The BIDPA website is an important reference site for students and researchers, both locally and abroad.

Forestry Association of Botswana (FAB)

FAB promotes ecologically sound indigenous forest management practices through research and extension work. The organization also promotes public awareness and education on the importance of tree planting, with emphasis on indigenous species. It also encourages sustainable utilization of natural woodlands and maintenance of biological diversity among communities. FAB co-operates with government, private sector, and non-governmental organizations involved in forestry and environmental management and lobby as the need arises.

Veld Products Research and Development (VPR&D)

VPR&D is a Non-Governmental Organization (NGO), established to research and develop veld products and to investigate suitable management systems for natural resources in order to ensure sustainable utilization. A Board of Directors comprised of individuals who are farmers in the Gabane community as well as senior people in Government and in other NGOs governs VPR&D.

The Community Based Management of Indigenous Forests (CBMIF) Project

Objectives and strategy

The Community Based Management of Indigenous Forest Project is a collaborative effort of SNV Botswana, GTZ through the SADC/FSTCU in Malawi and VPR&D.

It started in 1996 in the villages of Motokwe, Khekhenye and Tshwaane, Western Kweneng Sub-District, with the objective:

"To improve the living standard of rural communities in Botswana through sustainable and equitable utilisation of veld products."

The project strategy is based on two assumptions:

People will only be interested in management of veld resources if they can derive a reasonable and sustainable income from it.

Most veld products are found in communal lands and therefore should be managed by the relevant communities.

In order to maximise benefits for the people from veld products, the project has chosen to address issues related to four aspects of veld product management: management of the indigenous vegetation, domestication, processing and preservation and marketing. While working on these more technical issues, the project attempts to establish mechanisms at community level in which the different uses of natural resources are discussed and decisions are made with sustainability, equity and gender integration as major guiding principles.

Communal management of veld products for commercial gain, as opposed to random utilisation for subsistence, is a relatively new concept, for VPR&D well as for the communities. In order to make sure that lessons are learned, the project uses an annual consultation cycle. Every year the project plans activities together with the communities, monitors progress and provides support to the communities in the course of the year, and, at the end of each year, evaluates progress and problems, again together with the communities.

Most progress in the initial phase of the project has been made on domestication and sustainable utilisation of veld products. Through subsidised provision of seedlings and nursery materials and training sessions, the project has succeeded in developing awareness and a keen interest among the communities in cultivation of indigenous fruit trees and veld products, agroforestry and bee-keeping. To date almost 4,500 seedlings of fruit trees and veld products have been distributed. Survival rates of the indigenous tree species are 60 - 70 %, which is encouraging given the harsh environment. Also, through

involving other projects and organisations in this activity, this activity can now be sustained with a minimum of effort on part of the project. One weakness associated to this activity is that sometimes, because of the low intensity of the follow-up from the project, people do not always adhere to guidelines. Another weakness is that, unlike the activities under the other project components, there is no clear prospect of income generation potential of the species used. The interest of the communities shows however that they are willing to take the risk.

The project has approached the issue of management of the veld products in the wild, processing and marketing, through organising activities around the products which are currently available in the wild and which are being commercially exploited. In an early stage of project implementation the communities identified the four most potential veld products for income generation:

Moretlwa (*Grewia flava*; Raisin Bush)

Sengaparile (*Harpagophytum procumbens*, Devils Claw)

Mahupu (*Terfezia pfeilii*, Kalahari Truffles)

Motsikiri (*Eragrostis pallens*, Thatching grass)

Although the specific activities for the different products differed a similar strategy was used. Main steps in the process were raising awareness on availability and ecology through participatory resource assessments, community meetings to agree on harvest areas and quota and working on community organisation for the purpose of quality control and marketing. Participation levels in these discussions ranged between 40 and 70 % of all households, depending on the product and community.

The activities under this component were implemented in close collaboration with the Agricultural Resources Board, the government body responsible for regulating the extraction of indigenous plants, which gave legal backing to community decisions. A local NGO was asked to assist with community organisation and institution building.

Although the products we are dealing with are indigenous, the yields still depend on the rainfall, which is highly variable. Last year, 1997, showed high yields of e.g. thatching

grass and grapple, whereas this year the yields were far less, both in terms of quality and quantity. The raisin bush did not give any significant yields in 1996 and 1997, because of unfavourable timing of rainfall. Because of these limitations income generated through these products has been relatively low.

Another problem is that traditional utilisation of the veld products was geared towards subsistence in stead of commerce.

People know the plants and the properties of those species, which they have used, but do not have a real notion of quantities available and market dynamics. In 1997 for instance the project asked the communities whether they had truffles in the area. All three communities reported back that this year was a bumper year and they would be able to supply large quantities. In the end the project was only able to collect 200kg, which hardly paid for the expenses of the trip. On several occasions the project and the communities had tough discussions on issues such as prices, handling and transport cost and quality. Communities are slowly learning, but it takes time.

In 1998 a marketing study was conducted to identify additional marketable products and markets. The results of the study indicate that only a few products have potential for income generation, mainly because the limited quantities available of most species does not warrant commercial exploitation. Also, especially for the medicinal plants and wild foods, sophisticated tests and quality control are required, which reduce the possibilities of community based processing. Together with three other NGO's, the project intends to test market indigenous teas, which seem to be available in abundance and the processing of which is fairly simple. Hopefully this collaboration will contribute to the establishment of a marketing network, which will improve the transparency of the market demands and the supply.

One of the reasons why veld products were selected as the main focus of the project was that it was assumed that veld products were important especially for the more marginalised groups, such as Bushmen and female headed households. The project has

monitored participation levels of the different socio-economic groups and discussed the issue with the community groups found that especially these groups are active in the project: Apparently the work involved and the relatively low returns make veld products a last resort. In terms of equity, the project is therefore more focusing on the internal dynamics of the veld products groups.

These groups were established already in an early phase of the project around the management of group plots. Later the groups became active in other areas as well, such as tree planting and resource assessments.

The project has supported these groups through regular workshops and training sessions. However, probably mainly because of the variety of activities engaged in and the marginal returns generated so far, these groups have not developed into strong entities. Hopefully the herbal teas will prove to be a viable and profitable enterprise, which would contribute to a stronger organisation. However, if this would prove to be wishful thinking, we may have to draw the conclusion that veld products are not the most appropriate resource around which to build a strong community organisation.

A more informal community consultation mechanism may be more appropriate for the management of resources with limited income generation potential.

The project currently is preparing a second phase project document. The lessons above will be incorporated in the process. Several rounds have been planned to properly consult with the communities and other stakeholders. Also the project is looking into the feasibility of alternative natural resource management activities, such as eco-tourism and, crafts production. The results of these assessments combined with the experiences of the first phase will help to make deliberate choices. However, there still are a big number of unknowns and uncertainties regarding the resources and its management, and the

communities and the project will have to continue the process of learning by doing which started in the first phase of the project.

Training

Propagation of Indigenous and Naturalised Fruit Trees in Southern Africa

VPR&D is offering a two week course on basic indigenous fruit tree propagation studies, with special reference to the production practices for producing potentially high quality seedlings that produce fruit early.

All participants will learn how to set-up and implement a proper plant management programme. Participants will be led through the whole process, hands-on, starting from germplasm collection, seed germination, vegetative propagation, to site selection, preparation and planting as well as water harvesting techniques for trees.

The course will be a mix of basic theory and application and will focus on indigenous and naturalised fruit trees and herbal teas commonly found in Southern Africa.

This 10-day course will include theory and practical on:

- Selection of superior phenotypes in the wild
- Germplasm selection
- Basics of germplasm storage and transportation
- Techniques for root stock preparation
- Techniques for seed propagation
- Techniques for grafting and budding
- Seedling planting and management
- Plant management (thinning, pruning, tree shaping)

Thusano Lefatsheng

Thusano Lefatsheng is a rural development organization engaged in the introduction of new cash crops to local farmers through research and extension and product processing and marketing (both locally and abroad). It is also concerned with the conservation of indigenous plants and strives to ensure that the commercialization of these plants does not lead to their overexploitation in the wild. The organization is particularly interested in the traditional medicinal plants of Botswana. Dissemination of research technologies is achieved through visits and workshops and demonstration plots. Thusano Lefatsheng has undertaken some ecological studies through a collaboration involving the National Institute of Research of the University of Botswana and universities in the Netherlands.

COORDINATION NARS

Monitoring Mechanism

The Department of Research Science and Technology (DRST) was established in 2004 ,its mandate is to coordinates and provide and enabling environment for research in science and technology. One key responsibility has been to define what research products and services the ministry is actually funding and why it is funding them. Another has been to create a planning and reporting system for the research institutions that reassures government that institutions will be scientifically and financially viable in the long term.

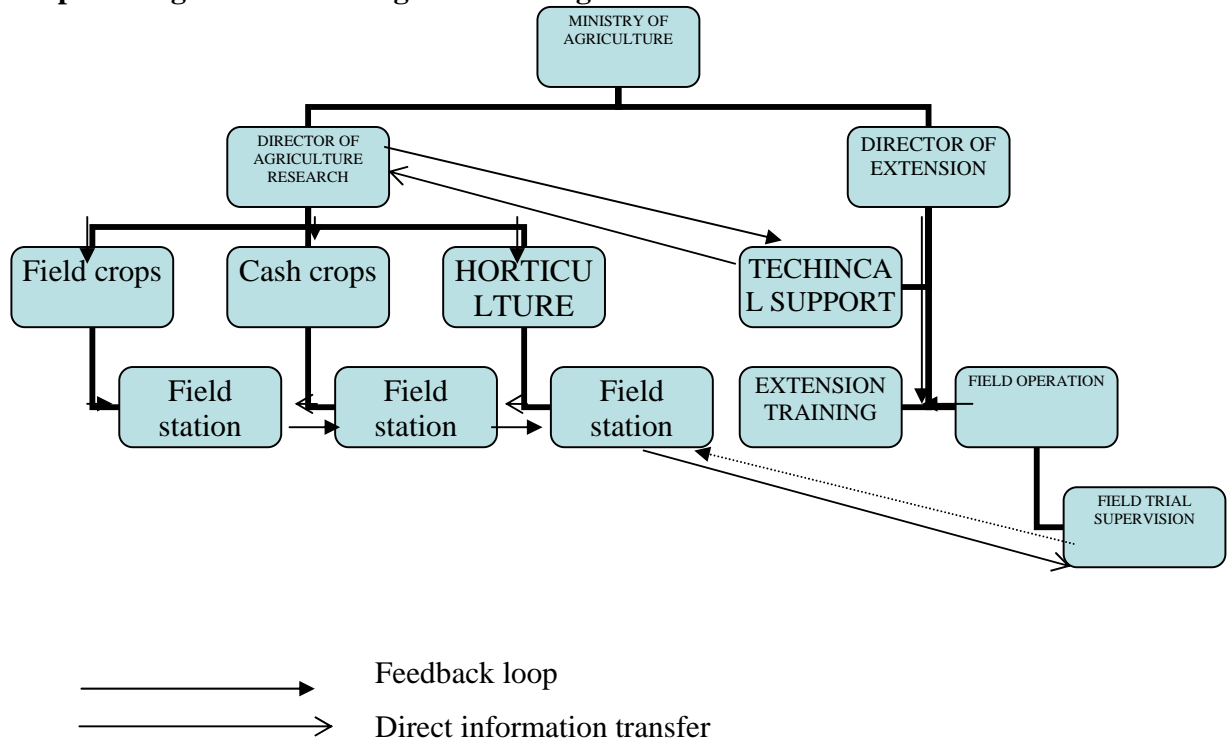
Coordinated agricultural research at all levels of the NARS involving all the stakeholders of the NARS is far much lacking at the present time since individual institutions are used to pursuing their own agricultural research agendas that often result in duplication of efforts and wastages of scarce resources both in terms of human and financial resources and some times even in terms infrastructure and equipment resources.

Existing agricultural research and extension systems are organized mostly under separate administrative units. The linkage between research and extension institutions is weak, especially in transferring feedback from farmers to researchers. The top-down models followed in these institutions do not especially suit agriculture characterized by poor and diverse endowments and ecological conditions.

Several approaches have been adopted in order to integrate these two functions. Case studies have shown that variations of farming systems approaches have been successful in integrating research and extension to a great extent. Some managerial approaches have also been quite successful in strengthening the linkage between research and extension in many organizations.

Some of the recently proposed models have examined the research and extension linkage problem in a systems perspective, where linkage forms a part of the system.

Proposed organization arrangement linking research and extension



WORKING METHODOLOGY FOR RESEARCH

A research organization must decide where to focus its work and how to allocate resources between commodities, species and research areas, including policy to fulfill its mandate. It must decide how important Agriculture is, and where and for which section of society research could have the most impact. The first stage in deciding on the allocation of resources is to consider the following elements: the estimated value of production, adjusted by modifying factors to allow for national research objectives; the probability of research success; efficiency in the use of research resources; and distribution of impact.

In Botswana majority of the institutions in NARI in Botswana uses , Vision 2016,MDG and they also carry out needs assessment which is then included in NDP as a priority.

The table below gives an over view f the policy documents

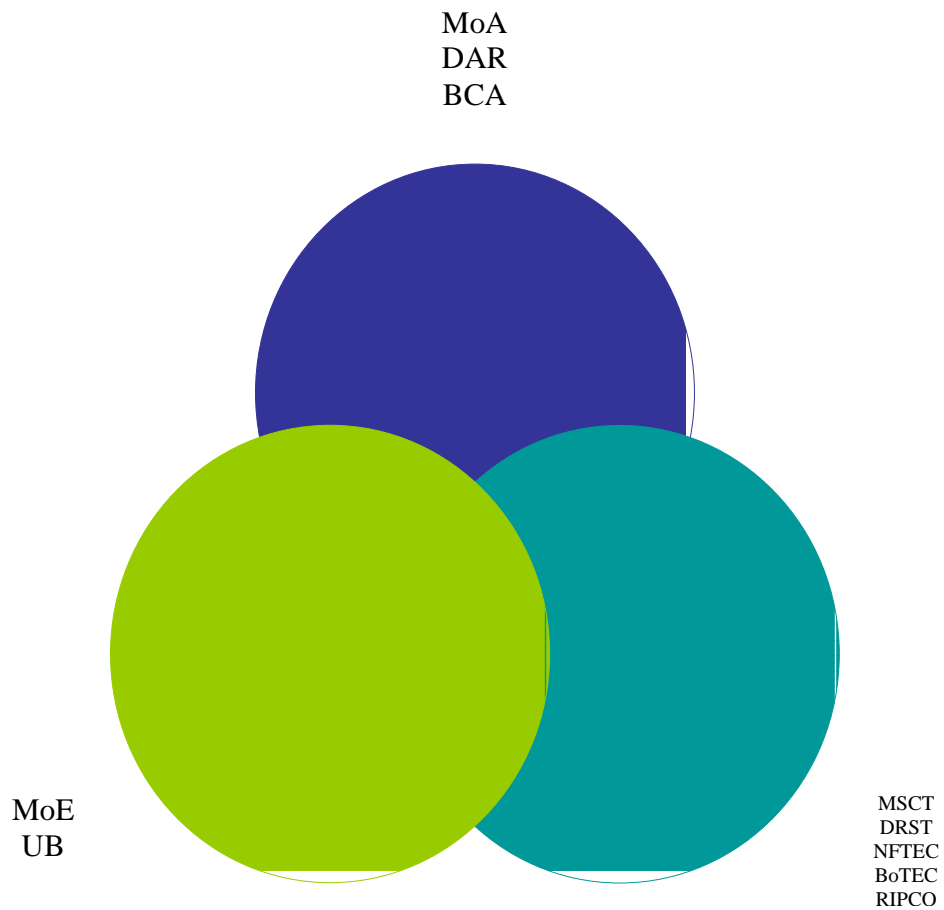
The policy context of agricultural research

Millennium Development Goals	Vision 2016 Botswana will be a	National Development Plan (NDP9)	Agricultural policy in 1991	The Revised National Food Strategy (2000)	The National Master Plan for Arable Agriculture and Dairy Development
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<p>(MDG) The MDG's aim at, by 2015: Reducing by half the proportion of people living on less than a dollar a day; Reducing by half the proportion of people who suffer from hunger.</p>	<p>prosperous, productive and innovative nation with a diversified economy with agriculture, absolute poverty will have been eradicated country-wide.</p>	<p>The plan sets out the objectives of the development of the agricultural sector as being to: Improve food security at household and national levels; Diversify the agricultural production base; Increase agricultural output and productivity; Increase employment opportunities; Provide a secure and productive environment for agricultural producers; Conserve the scarce agricultural and land resources.</p>	<p>The following objectives: (1) to provide adequate and secure livelihoods for those involved in agriculture; (2) increase agricultural output; (3) increase food self-sufficiency; (4) conserve agricultural land resources; and (5) meet the employment demands of a growing labour force</p>	<p>The specific objectives of the strategy are:- To achieve a two percentage points reduction per year in the proportion of households, which are food insecure, and below the poverty datum line for the next 20 years; To contribute to the reduction of the proportion of children underweight for their age from the current 15-7% by year 2015; To reduce the poverty rate among the people in remote areas, settlements and cattle-posts especially in the western regions by approximately 3 – 4% points per annum till 2015.</p>	<p>(NAMPAADD) The plan mainly addresses rain-fed crop production (focusing on smallholder farmers); irrigated agriculture (to alleviate impact of droughts); and dairy development (to remove the constraints that have arrested the growth of the subsector).</p>
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NETWORKING FOR AGRICULTURE RESEARCH, TRAINING AND DEVELOPMENT

The graph below shows the interrelationship of ministries and their departments.



In Country Research Alliances

Although, the institutions have linkages (e.g., representation on the executive boards, provision of lab services), the survey has revealed that almost none of the agricultural research institutions are presently engaged in any kind of collaborative joint research programmes. For example, although there are research programmes in biotechnology none of the 3 institutions (BCA,DAR , NFTEC) have developed formal links or network in this particular area

The collaboration exists mainly among scientists who have common interest in some areas. In fact, there is a lot of willingness at the level of the scientists and genuine interest for cooperation. However, one of the key reasons that may have deterred the development of such cooperation is the bureaucracy that is involved before such projects are approved. Another crucial point that came out of the discussion is that institutions are unwilling to share funds and resources. It is expected that the formalization of their working relationships via MoA may solve partly this problem.

Potential networking of Main National agricultural research institution

DAR	BCA	NFTEC
<p>1. Arable research division conducting research on crops of importance to the farming system of Botswana as well as those with potential for diversifying the production base, with focus on agronomic and breeding aspects</p> <p>2. Animal Production and Range Research Division undertakes research, development and technology transfer to the benefit of the livestock industry in Botswana, research in farm machinery, soil fertility, weed research and irrigation, oil seeds improvement (covering crops such as groundnuts, soybeans, sunflower, mungbeans, watermelons, etc.), grain legume improvement and horticultural improvement</p> <p>3. Division of Animal Production and Range Research Identifying the Best Combination of Breeds in Crossbreeding Programme Composite Breed Improving the Production potential of the Indigenous Tswana breed through a structured selection programme</p> <p>4. <i>Dairy Research Program</i> is to increase milk production at minimal cost, develop</p>	<p>1. Marketing of non-traditional cash products An understanding of the barriers that prevent smallholders to participate and increase their level of participation in agricultural markets is important if they are to be developed and integrated in to the agricultural marketing system.</p> <p>2. Market participation by smallholder farmers In order to increase smallholder farmers' participation in the markets we therefore need to identify these transaction costs factors and try to eliminate or minimize them.</p> <p>3. Demand Analysis of Food Products in Botswana Knowledge of the demand patterns and elasticities will also provide useful information to policy makers.</p> <p>4. Production and supply response of agricultural products to identify factors that influence production and supply response in various sub sectors of the agricultural sector in order to come up with appropriate policy advice for each sub sector.</p> <p>5. The effects of land</p>	<p>1. Development of Value-added Plant Products The main objective of R & D in plant products is to enhance self-reliance in semi-processed and processed horticultural products.</p> <p>2. Development of Value-added Animal Products Development of products based on traditional recipes, such as <i>seswaa</i> and <i>serobe</i>, among others. Diversification into long shelf life-type products for institutions (military, hospitals, schools, etc) and famine relief meat products requires evaluation,</p>

<p>small scale processing technologies and marketing systems for milk and milk products in the rural areas.</p> <p>5. <i>Evaluation of Tswana crosses for milk production under semi-intensive system at Sunnyside Ranch.</i></p> <p>6. <i>Milk Processing and Marketing systems</i></p> <p>The project identifies socio-economic factors and constraints governing milk consumption and marketing in the rural areas and to plan a local marketing strategy</p> <p>7. <i>Breeding and Selection of Indigenous Sheep and Goats</i></p> <p>The objective of improving the efficiency of these breeds for meat production, while at the same time encouraging the Batswana communities to harness them into their farming systems.</p> <p>8. <i>Characterization of livestock feed resources and identification of nutrient deficiencies through laboratory analysis and animal experiments</i></p> <p>9. <i>Develop supplementary feeding for improved livestock reproduction and growth</i></p> <p>10. <i>Selection and Conservation Programme.</i></p> <p>The indigenous Tswana cattle, sheep and goats selection and conservation</p>	<p>reforms on agricultural performance</p> <p>study to identify the constraints of such institutional arrangement on livestock productivity is necessary to provide some insight to policy makers</p> <p>6. Diagnostic Research</p> <p>Incidences of cryptosporidiosis in calves, lambs and kids (S. P. Sharma - Team leader)</p> <p>Improvement of indigenous chicken (E. Z. Mushi – Team leader)</p> <p>Diseases of Ostriches (E. Z. Mushi – Team leader)</p> <p>Heat increment of feeding in Tswana goats (J. M. Kamau - Team leader)</p> <p>Effects of rerouting blood in the facial and angularis oculi veins (J. M. Kamau - Team leader)</p> <p>7. Nutrition Research</p> <p>Utilisation of key forage plants in two desert margin areas of Botswana. DMP/GEF research project.</p> <p>Diet selection and influence of tannin containing browses in the nutrition of Tswana goats.</p> <p>Study of the adaptive responses of the gastro-intestinal tract (GIT) of the ostrich (Struthio camelus) to variation in dietary intake and implications for health and general performance of the bird.</p> <p>Evaluation of Imbrasia belina</p>	<p>processing into value-added ostrich meat products</p> <p>3. Food Safety Management Systems</p> <p>assessments and design of tools to promote food safety in food processing facilities, the hospitality industry, institutional kitchens, and allied industries such as in manufacturing of food packaging materials</p> <p>4. NUTRITION AND DIETETICS</p> <p>Evaluation of Dietary Quality and Adequacy of Botswana Dishes</p> <p>5. Food Processing and Quality Enhancement</p> <p>development of new food products and ingredients that meet consumer demands as</p>
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<p>programs are going well</p> <p>11. Lablab processing. Investigations on the processing on lablab as hay using the RIIC chaff cutter.</p> <p>12. Selection and Conservation Programme. The indigenous Tswana cattle, sheep and goats selection and conservation programs are going well. Selection is based on survival, mothering ability, growth rate and structural boundless</p>	<p>(Phane worms) as a livestock feed.</p> <p>8. Field Research Involved in research project on Cryptosporidiosis with Dr Sharma Selecting Tswana goat for parasite resistance and increased productivity with Dr Nsoso .</p> <p>9. Range Science Evaluation of rangeland responses to various management practices, environmental factors, restoration attempts as well as range animal behaviour and interactions for sustainable range and animal production</p> <p>10. Restoration of degraded rangelands Investigation in restoration of these rangelands is essential to improve their productivity.</p> <p>11. Resource use and partitioning by domestic and wild herbivores Management practices can promote or destroy habitat diversity, depending on their application. For instance livestock affect wildlife habitat directly by removal and/or trampling of vegetation that would otherwise be used for food and cover. Different types of livestock</p> <p>12. Animal Production Evaluation and utilization of resources in the development of sustainable livestock production in Botswana</p> <p>13. Intensification of sheep</p>	<p>well as requirements of quality and safety</p> <p>6. Food Safety and Biotechnology To strengthen the food safety system in Botswana by building expertise that can be used to develop quick and reliable methods for assessment and control as well as to guide in food safety policy development.</p> <p>7. Biochemical and Community Nutrition Research is aimed at better defining factors which play a role in food health levels and acceptability in Botswana.</p>
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	<p style="text-align: center;">and goat production</p> <p>promoting productivity of this sub-sector is to develop niche products and find niche markets.</p> <p style="text-align: center;">14. Forage production, processing and evaluation</p> <p>Processing and evaluation these forages are needed to improve on utilization by livestock.</p> <p style="text-align: center;">15. Sustainable ostrich production</p> <p>Ostrich farming will diversify the agriculture form the traditional cattle sub-sector.</p> <p style="text-align: center;">16. Animal Biotechnology</p> <p>The application of Biotechnology in DNA marking and fertility studies, disease resistance and carcass characteristics.</p> <p style="text-align: center;">17. Evaluation of beef production systems</p> <p>To diversify the beef industry and empower other section of the farming community it is important to promote various production systems</p> <p style="text-align: center;">18. CSP Research Projects</p> <p>(Molecular, Environmental and Nutritional Evaluation of bambara groundnut (<i>Vigna subterranea</i> L. Verdc.) for Food Production in Semi-Arid Africa and India</p> <p style="text-align: center;">19. PEANUT PROJECT</p> <p>"Basic and applied studies on aflatoxin and <i>Aspergillus flavus</i> management and interaction with</p>	
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	<p>peanut in the field" is a collaborative project with University of Georgia, USA, University of Wisconsin-Madison, USA, University of Botswana and Botswana College of Agriculture (Department of Crop Science and Production).</p> <p>20. MAHUPU PROJECT</p> <p>Propagation and processing of the desert truffle (<i>Kalahari tuber (Terfezia pfeilii)</i>)</p> <p>The project aims at addressing the dwindling yields of the Kalahari desert truffle due to drought, overgrazing and overexploitation.</p> <p>21. BREEDING OF BLACKEYE COWPEA FOR ALECTRA VOGELII RESISTANCE</p> <p>breeding program to insert the genes for <i>Alectra</i> resistance into Blackeye cowpea. With <i>Alectra vogelii</i> resistant Blackeye, all cowpea farmers will be able to grow and obtain high yields even in fields with high seed banks of the weed.</p> <p>22. MORAMA PROJECT</p> <p>The aim of the marama project was to develop an understanding of morama bean (<i>Tylosema esculentum</i> (Burch) A. Schreb.), its</p>	
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	<p>distribution, biology and socio-economic potential as a crop.</p> <p>23. PIGEONPEA PROJECT</p> <p>"Evaluation of pigeonpea (<i>Cajanus cajan</i>) as a potential legume for production under Botswana conditions"</p> <p>24. SORGHUM ENTOMOLOGY PROJECT</p> <p>Molecular, Environmental and Nutritional Evaluation of bambara groundnut (<i>Vigna subterranea</i> L. Verdc.) for Food Production in Semi-Arid Africa and India)</p>	
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Training

BCA is a parastatal under the Ministry of Agriculture and an associate institution of the University of Botswana. offers training at certificate, diploma, bachelor and Masters level through five academic departments of Agricultural Economics, Extension and Education, Agricultural Engineering and Land Planning, Basic Sciences, Crop Sciences and Production and Animals Sciences and Production. The College Farm also has facilities such as the center pivot irrigation system, various farm implements and animals for supporting staff research.

Cooperation with Foreign International Research Institution

Wildlife Conservation and Management Programme (€15 million) started in November 2001 and will end in December 2007. It is the third European Commission's support programme to Botswana's wildlife sector since the early 1990s.

The programme purpose is the strengthening of parks and reserves management trough improved capacity of the Department of Wildlife and National Parks, increasing the

capacity of local communities to participate in management planning and resource management within and outside parks and reserves.

- Management Plans for the Central Kalahari Game Reserve, the Moremi Game Reserve and the Makgadikgadi National Park have been or are being revised and technical assistance to support the management of these areas has been provided.

- In the tourism sector, the programme has computerised the manual booking system for the reserves and park, and at present tourism and staff facility infrastructure such as the parks' entrances and camping sites is being upgraded.

- Local communities have benefited from the programme in different ways. In early 2004, it was recognised that communities needed to improve the monitoring of their wildlife and natural resources within their community areas. In a pilot phase, monitoring kits were developed and training workshops were held. The monitoring is now up and running and being further developed to include coordination of regional inputs,

- Examples of other programme results are capacity building at the Department of Wildlife and National Parks, training and awareness rising concerning wildlife/humans conflict, research and monitoring activities.

Education and Training Sector Policy Support Programme (€1.7M, including €0.06M from FLEX), which started in February 2006 and will end in December 2009

The specific objective of the programme is to assist Government in adequate financing and effective management of the E&T sector, and expanding equitable access to quality education and training, with special emphasis on primary and secondary levels.

This programme is the first EDF intervention in Botswana using the Sector-Wide Approach (SWAp), with resources channelled through sector budget support. This support is provided in four annual tranches on the basis of progress in the sector performance as assessed through targets set for process and output/outcome indicators (focusing on access, quality and equity issues), forming the basis for policy dialogue between the EC and the Government of Botswana.

Food and agriculture organization Support to NEPAD–CAADP Implementation

- Pandamatenga Commercial Arable Farms Infrastructure Development
- Establishment of Plant Quarantine Facility and Phytosanitary Services
- Establishment of an Enabling Environment for Agro–Chemicals

- Management and Control
- Management & Control of Quelea Birds
- Beekeeping Development
- Improvement of Tsetse Fly Control Surveillance

DISCUSSION

Botswana national research, science and technology plan has identified anticipated outcomes as a results of investment in the priority research areas and a key measure of the success of research in agriculture is optimal allocation and use of agricultural resources , improved food production, increased diversity of agricultural base and improved marketing and processing strategies creating sustainable jobs, profits and agro-ecosystem.

The effectiveness and efficiency in developing, adapting and disseminating improved agricultural technologies depends on the existence of a strong research base comprising personnel, infrastructure and financial resources. For constructive regional collaboration, national system requirements need to be distinguished at their different stages of institutional development and strategies developed which will evolve as NARS grow in strength. The current arrangement of agricultural research in Botswana is largely incapable of addressing the issues of NARS in a coherent manner. This study identified, among others, the following research and development (R&D) related constraints which are separated into national level and institutional level.

National Level

There is lack of a specific and coherent agricultural research policy and long-term strategic management of research. Currently agricultural research in the country is guided by the national agricultural policy which covers all other departments of the MoA. There is also no NARS in existence in Botswana presently. Due to the lack of a specific policy and a NARS, the following constraints have been observed:

Inadequate mechanisms to establish priorities.

The general agricultural policy does not provide an adequate guide for setting priorities in agricultural research. The policy objectives are largely production oriented. There is no specific reference to problems of marketing and post-harvest processing. Therefore not much research is being done in the areas of marketing and post-harvest processes. The policy also lacks means to transmit changes in priorities (if any) from the political and agricultural establishments (farmers) to agricultural research. For example many of the programmes introduced to farmers (ARAP, ALDEP, etc.) do not necessarily involve thorough research, and many of them do not provide the intended outputs either because they are incorrect to begin with or their implementation is not appropriate. Unless priorities are set many institutions will continue to carry out irrelevant projects.

Lack of a coordinating mechanism at national level.

The government is the biggest funder of most research, yet there is no mechanism existing for government to know how the funds are expended. There are no evaluation, impact assessments and monitoring of how institutions utilize research funds, and therefore government is not able to carry out a cost-benefit-analysis. Efficient planning, effective coordination of national programs and accountability mechanisms are required to ensure that key institutions, policies and stakeholders effectively address poverty and food and nutrition security at national level. This will also encourage integrity and transparency in decision making process and resource Allocation;

Lack of linkage mechanisms between institutions.

There are poor partnerships between stakeholders (public-private, public-public, private-private). Effective institutional linkages (collaboration) will support effective coordination, prioritization and optimization of existing resources at all levels (i.e. research farms, personnel, equipment, etc) for implementing national research agenda and priorities). These will solve the problem of overlapping mandates of role players and lack of trust among stakeholders. In general the international linkages are also inadequate.

Lack of clear farmer - extension- research linkages

Because the policy used is not specifically for research, there is lack of an effective system for passing on whatever research results found by research (knowledge and information generators) to the extension workers who are in constant contact with farmers (users).

Non-existence of investment in agricultural research by organizations other than government.

There is a negative perception of agriculture as being 'rural', associated with unskilled labour and poverty, the latter makes agriculture unattractive to youth and potential students whom may contribute to the broader research and development.

Institutional Level

Within organizations research activities are generally constrained by the following factors:

- Limited specialized expertise in some disciplines and support staff (technicians) for research. For example, in academic institutions such as BCA the technical staff is mainly mobilized for teaching activities rather than for research purposes.
- Inadequate research physical resources: insufficient laboratory space and equipment; insufficient farm machinery; experimental farms/stations or laboratories with insufficient human and financial resources.
- Poor access to information: insufficient library and computer resources; lack of information sharing between (and even within) institutions.
- Inadequate research funding: majority of the funds comes from government and is shared among all other components (salaries, infrastructure building and maintenance, training, etc.)
- Poor institutional research management: research is not guided to a particular need (no research programs) and so research is based on an individual conducting research and not necessarily on national need. There is no follow-up on research progress. In most cases the committees responsible only deal with the initial approval of research funds.

Other constraints

- Concentration of the scientific potential in and around the capital of Gaborone.
- Extensive bureaucratic financial procedures.

CONCLUSION

In conclusion the contribution of the agricultural research to agriculture and the economy in general (improving contribution to GDP) will require focused efforts on tackling and responding to the identified set of challenges. The challenges, weaknesses and opportunities identified within the agricultural research system provide a compelling basis for developing an effective and well-supported agricultural research and development strategy for Botswana.

RECOMMENDATIONS

The recommendations from this study include the following:

- There is a need for a proper **agricultural research policy** that will guide research development and training taking into account national development needs.
- There is a need to set up a **national agricultural research system (NARS)** that will facilitate:
 - Development of national research strategies and plans.

It is recommended that a coordinating agency be created to administer, facilitate, implement, prioritize agricultural research operations and activities, solicit and fund agricultural research projects, appraise and prioritize agricultural research proposals, monitor agricultural research projects, establish linkages, partnerships, alliances, cooperatives and networks with necessary and appropriate stakeholders locally, regionally and internationally. The enabling institutions exist currently in the country.

- It is recommended that the Agricultural Research Council be adopted as the choice model to follow and that it should be a parastatal body housed under MoA with an autonomous status.

The NARS institutional framework should actively encompass public, private and civil society organizations in order to promote both horizontal and vertical linkages in the implementation of the agricultural research and development strategy.

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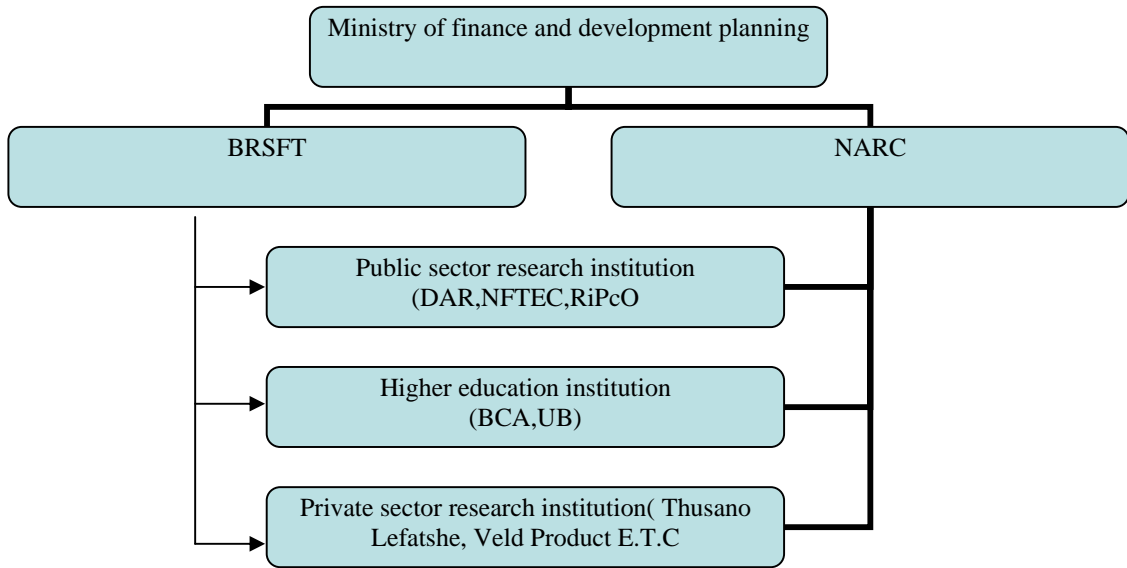
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Financial flow within the NARS with National agriculture research system



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