

## CATTLE MILK AND MEAT RESEARCH AND DEVELOPMENT IN BOTSWANA<sup>1</sup>

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### Introduction

Botswana, covering an area of 582,000 km<sup>2</sup>, is situated in the middle of the southern African plateau with a mean altitude of 1000 m above sea level. The country may be divided into three main ecological zones: the better-watered Okavango of the northwest, the main Kalahari system, and the eastern Hardveld. The Hardveld is further subdivided into the northern deciduous forests, the north and central Mophane veld, and the southern Acacia/Combretum complex, where soils capable of supporting crop production in favorable rainfall years are found.

Rainfall averages 475 mm/year, but varies in total by as much as 50-70% from year to year. The rainfall is highest in the northeast at 650-700 mm (varies from 400-1200), falling through the central areas to 400-550 mm (200-850), and a minimum of 150-200 mm (0-400) in the southwest. Monthly precipitation gives little guide to effective rainfall as it is considered that 10 mm or less, unless following good previous rains, never effectively penetrates the soil. Thus, 50% of monthly precipitation or more may be ineffective.

Evapotranspiration is high from December to March. Seasonal commencement and end of rains are equally unreliable, and early planted crops are just as likely to suffer from a drought period as late planted crops. There are basically two seasons; the wet season which extends from October to April, and the dry season from May to September. Temperatures range widely with a maximum of 38°C during the summer and a minimum of 5°C during the winter period.



<sup>1</sup> Paper presented at ILCA Workshop on Collaborative Cattle Milk and Meat Research in East and Southern Africa, Harare, Zimbabwe, 12-15 June, 1989.

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## Population and Economy

The population of Botswana is estimated at 1.13 million, of which 245,300 people live in urban areas and 882,600 live in the rural areas. Annual growth rate for urban and rural areas is 10.6% and 3.7%, respectively.

Botswana is essentially an agricultural country; despite progressive structural changes in its economy since independence in 1966. The economy is based on exports of minerals and livestock products. Total GDP increased from P36.8 M in 1966 to P997.1 M in 1982/83 (Table 1). Income per capita was estimated at P982.6 in 1983. Mining in 1966 was insignificant, however, the discovery of diamonds in the early 1970's has had the most dramatic impact on Botswana's total GDP. Of the total GDP the agricultural sector accounted for 7.4% in 1983 compared to 39.4 in 1966, despite agricultural increase from P14.4 M in 1966 to P73.5 M in 1983. More than 75% of this contribution to the GDP is derived from beef exports.

Livestock statistics during the period from 1979 to 1986 are shown in Table 2. An increase in cattle and chicken numbers occurred from 1979, reaching a peak of 3.0 million and 1,146 million, respectively, in 1982. The drought which occurred between 1982 to 1987 affected cattle grazing areas and watering points causing an increase in cattle mortality, and reducing calving percentages. Subsequently, the cattle population decreased to 2,3 million in 1986. In contrast to the cattle subsector, the number of small stock (sheep and goats) increased significantly over the same period. The reasons for this increase in small stock numbers was due, in part, to the availability of feed provided by indigenous browse plants and low incidence of diseases. The population of chickens and pigs showed a similar trend to that of sheep and goats during that period.

The distribution of cattle in terms of commercial vs traditional Production Systems, regions, and cattle ownership is shown in Tables 3 and 4. About 84% of the national herd is kept on communal areas which comprise 71% of the country's land area, while the 16% of cattle in the commercial sector is kept on 5% of Botswana's land area. Of the six regions, the central region, which is the largest in size, had the highest cattle population (32.5%) in 1986. The vegetation of this region is classified as the hard and sweetveld area with Panicum maximum, Eragrostis regidior and Digitaria species being the dominant grass species. Though the vegetation and land area for the Southern, Gaborone, Francistown and Maun regions differ, similar cattle numbers were obtained in these areas. The smallest cattle population was in the Western region, which is classified as the sandveld area receiving the lowest seasonal rainfall, hence the lowest carrying capacity even in normal rainfall years. However, farmers in this area are dependent on livestock since crops cannot be grown.

Among cattle farms in the traditional sector, 70.5% own less than 30 cattle comprising 26% of cattle in the traditional sector. In the Commercial sector, 66% of farms own less than 500 cattle constituting 15.9% of cattle in this sector.

## Cattle Production

Cattle production in Botswana is based on the use of extensive rangeland. There are three major production systems: i) Tribal Grazing Land Policy (TGLP), which is a fenced range system, 2) the traditional "cattle post" system where cattle are grazed on

unfenced communal areas, and 3) the commercial freehold system.

Cattle in the traditional sector depend on natural pastures for feed during both the wet and dry seasons. Supplementary feeding using locally available feed resources (Tables 4 and 5), is not a common practice among the traditional farmers unlike the commercial livestock producers. Crop residues available after grain harvest are grazed in situ rather than harvested as feed for livestock during the dry season, when natural pastures deteriorate in both quantity and quality.

On average, commercial farms have more cattle than the traditional farms. During the 1985/86 cropping seasons, cattle numbers were 36.5 per farm in the traditional sector compared to 740.8 cattle in the commercial sector (Table 7). Studies conducted by the Animal Production Research Unit (APRU) during 1970-75 showed a calving percentage and mortality rate of 74% and 8%, respectively, for cattle kept in the ranch system compared to 46% and 10% in the traditional cattle post. It must be emphasized that the period from 1970-75 were favorable rainfall years and therefore the natural grazing areas and watering points were in a better condition. During the drought (1982-87) the average calving percentage, mortality rate and offtake (sales) were 54%, 20% and 8%, respectively, in the traditional sector compared to 60%, 8% and 36% for the commercial sector. From these figures it can be seen that the mortality rate of cattle in the traditional sector was double that of the commercial sector. Lack of capital to buy locally available feed resources, coupled with poor management practices among the traditional farmers contributed significantly towards the increased death rate of cattle during the drought period.

Even though the livestock sector is affected by the frequent drought, it still continues to play a vital role in the economy of the country. A majority of farming households still depend on cattle for their subsistence needs. Beside, cattle providing income, food and employment opportunities to Botswana, they contribute the largest foreign exchange earnings in the agricultural sector. Foreign exchange earnings derived largely from the export of beef and by-products have enabled the Government to undertake several development projects which would have otherwise depended on foreign aid or investment. In addition to the provision of foreign exchange earnings, cattle farming also plays a key role in creating investment capital. Money from cattle sales is also used to finance the development of social services such as schools, transport and health centres.

#### Major constraints affecting cattle milk and meat production

Faced with endemic drought, erratic rainfall, and limited supply of both underground and surface water, the development of the agricultural sector in general and in attaining self-sufficiency in particular, poses several problems.

Though quite a lot of progress has been made in the establishment of the beef production industry, very little has been achieved in the development of the dairy production industry. Dairy production, in Botswana, is still in its infant stage compared to the well established beef industry. In 1988, the total registered commercial dairy herd in Botswana was 2,750 cows, of which 1,340 cows produced an average of 4.1 million liters of milk per year. This milk production meets only 25% of the National milk demand. The other 75% is imported from South Africa. Of the 2,750 dairy

cows, the Friesian and Jersey breeds constitute 50% and 30%, respectively, followed by a small number of Brown Swiss, Ayrshire, Guernsey, Simmental and crossbreds. Most of the dairy farms are located around the urban centers in South Eastern Botswana where the milk produced is processed and distributed by the Gaborone Dairy Cooperative Pasteurization Plant.

The development of both beef and dairy production industries in Botswana is affected by both technical and non-technical factors. The technical constraints can be divided into four broad categories: 1) Feeding and management, 2) breed and breeding improvement, 3) reproductive wastage, mortalities and animal health and 4) products processing and marketing.

#### 1) Feeding and management

Livestock production depends on the availability of adequate feed supplies and good management. Due to the endemic drought, unreliable rainfall and poor soil fertility, natural feed fluctuates in both quantity and quality. Protein and mineral content of the natural pastures is generally low, especially during the dry season. Conservation and storage of feed from the time of its maximum availability to the time of its use is a critical issue. Though crop residues are available after grain harvest, the use of these plant material as livestock feed by the small scale farmers in Botswana is constrained by lack of transport, labor and long distances between the homestead and the plowing areas.

In the traditional sector high stocking rates which result in range overgrazing and degradation are the major management factors contributing to low productivity, increased mortality and reproductive wastage among cattle.

#### 2). Breed and breeding improvement

Improvement of the Tswana breed for beef production is being undertaken through crossbreeding, using performance tested exotic bull breeds (Brahman, Simmental, Bonsmara, Tuli) and selected Tswana bulls. Genetic improvement in the national herd is further provided by the establishment of artificial insemination centers (A1) where semen from high quality bulls is used and the sale of bulls to farmers through the Bull Subsidy Scheme. Major problems affecting the provision of this service to livestock producers are: inadequate A1 facilities, insufficient number of selected bulls for interested farmers, and shortage of qualified personnel at both technical and professional levels. Improvement of indigenous types to increase their productivity without losing adaptational characteristics is important particularly in communal areas like the Western Region. This has not yet been done. However, Tswana cattle, sheep and goats selection programmes have already started.

#### 3). Animal health and diseases

Five major strategies have been set up by the Department of Veterinary Services for the control of livestock diseases in Botswana. These strategies are: 1) mass immunization through vaccination, 2) movement restriction, 3) vector control, 4) buffalo "cordon" fences and 5) mass communication and education. Despite the effort made in the control of livestock diseases, constraints such as lack of veterinary requisites, capital, transport and qualified human resources to conduct research and do field work poses

problems in the control of livestock diseases. The incidence of low productivity among cattle in the traditional sector is therefore, due to the interaction between nutrition, diseases and poor reproductive performance. The export of beef to Europe, which is a major market depend on keeping the National herd free of foot and mouth disease (FMD). The system of cordon fences and vaccination has been steadily strengthened, and there has not been an outbreak of FMD since 1981. Important cattle diseases in Botswana are tick borne (heartwater) and botulism due to low phosphorus content in soils and forages. Dicalcium phosphate and bone meal are the sources of phosphorus supplement available to livestock producers in Botswana. Other diseases are under control due to regular vaccination programmes.

#### 4) Product processing and marketing

Presently there are no major constraints in the processing and marketing of products and by-products produced by the Botswana Meat Commission (BMC).

In contrast to the beef sector, surplus milk produced in the traditional sector during the wet season is fermented to make madila as distances, lack of transport and lack of proper cooling facilities among farmers generally preclude the sale of the surplus milk in urban areas.

### Cattle Milk and Meat Research

The Animal Production Research Unit (APRU), Department of Agricultural Research, was established in 1970 with the responsibility of conducting research in animal production. APRU is currently conducting research in animal breeding, animal nutrition, small stock (sheep and goats), range management, fodder/forage and dairy production. Animal cross breeding and Tswana selection and up-grading studies are conducted in 20 ranches located in the three main ecological zones of Botswana. Fodder/forage multilocational trials as well as range management (stocking rate trials, bush control and grazing trials) are also undertaken in these ranches. Overall, APRU research objectives are to assist traditional communal farmers in improving livestock production through the introduction of adaptable genotypes, selection and breeding, range management and controlled stocking rates and increased offtake.

On-station and on-farm dairy comparative performance studies using dual purpose Simmental crossbreds, crossbred Friesians, Tswana and Tuli breeds fed crop residues supplemented with either lablab or groundnut haulms are currently being undertaken by APRU. Technical and management interventions include: 1) improved animal feeding, 2) animal breeding using natural and artificial insemination (on-farm and on-station), 3) fodder production, 4) animal health control, 5) conservation of crop residues for dry season feeding, 6) calf rearing and 7) rural milk collection, cooling and marketing. Results have shown that dual purpose Simmental crossbreds are adaptable to small scale communal farmer management and feeding conditions.

The Department of Veterinary Services is responsible for animal disease research and control such as diseases prevention, tsetse fly control, construction and administration of cattle trek routes, administration of quarantine camps, the administration of the National Veterinary Laboratory and the Livestock Advisory Services. Moreover, the Veterinary Services Department is responsible for meat inspection at the two Botswana Meat

Services Department is responsible for meat inspection at the two Botswana Meat Commission (BMC Lobatse and Maun) prior to meat export to both the EEC and non-EEC markets.

Farmers Cooperative societies are the main supplies of cattle from the traditional farm sector to the main slaughter plants at Maun and Lobatse.

The Animal Production Division (APD), Department of Field Services, is responsible for extension services. Its activities include the execution of the Tribal Grazing Land Policy (TGLP) group commercial ranches, communal grazing areas, implementation of the Bull Subsidy Schemes, dairy production, and coordinates artificial insemination activities. APD assists farmers in gaining access to 1) credit facilities such as those provided by the National Development Bank for TGLP commercial ranches 2) the Services to Livestock Owners in Communal areas (SLOCA), and 3) the Financial Assistance Policy (FAP) loans for small scale farmers.

The Animal Production Division (Extension) collaborates with APRU in disseminating results and information to farmers. In addition, extension staff at the district and headquarters level are involved in the design, implementation and evaluation of on-going livestock projects. Currently, dairy extension staff are actively involved in a small scale dairy project, animal breeding and the establishment of a SADCC assisted Dairy Cross-bred Multiplication Unit and on-farm evaluation of the role of crop residues in animal feeding.

Research results recommended to farms are published in "Agrinews and Agrifacts" by the Agricultural Information Services of the Ministry of Agriculture, and distributed to rural extension staff.

The Division of Planning and Statistics undertakes research in sociological and economic aspects of different livestock production systems, and policy formulation and analysis relating to livestock production and marketing.

### Research Priorities and Strategies

APRU research strategies are based on the recommendations as outlined in the National Development Plan (1985-1991). The summary of the research priorities is as follows:

1) Animal Nutrition

- Crop residue evaluation, conservation and utilization.
- Browse plant species utilization.
- Agro-industrial by-product utilization.
- Introduction of fodder crops to communal farm areas.

2) Fodder crop production

- Multilocational fodder crop yield trials in collaboration with PANESA-ILCA and ICRISAT.

3) Range management

- Stocking rate trials.
- Grazing trials.
- Bush control trials.
- Mineral supplementation trials.

4) Animal breeding

- Selection and breeding of Tswana cattle.
- Composite breed development using multiple crossbreeds.
- Crossbreeding Tswana with Simmental for extensive small scale dairy production.
- Crossbred evaluations using local and imported breeds.

5) Small stock

- Effect of dipping frequency on external parasites and mortality in goat and sheep.
- Effect of season of breeding on sheep mortality and growth and Lambing rate.

6) Small scale dairy

- Introduction of dual purpose Simmental-Tswana crossbreeds into small scale peri-urban communal farmers.
- Fodder production and crop residue conservation and utilization.
- On-farm and on-station cross breeding using Simmental semen.
- Animal disease control and vaccinations.
- Basic dairy feeding stalls and housing.
- Calf rearing, management and record keeping.
- Milk and madila "sour milk" collection and marketing.
- Economic evaluation of the small scale dairy production systems.

## Summary

Livestock is the most important agricultural sector for both domestic and export income in Botswana. In 1983, agricultural products contributed to P73.5 M of the P997.1 M total GDP. Of the 7.4% agricultural GDP's contribution, 75% was from beef exports to the EEC and non EEC countries.

Botswana is divided into three ecological zones comprising of: 1) the Northwest wet Okavango swamp region, 2) the central kalahari region and 3) the eastern hardveld region where the largest cattle and small stock population are found.

There are three livestock production systems: 1) the Tribal Land Grazing Policy System (TGLP), 2) the "cattle post" communal area and 3) the commercial freehold system. The TGLP and cattle post systems are in the traditional sector. About 84% of the cattle herd are in the traditional sector and 16% in the commercial sector. Cattle population in 1983 was estimated at 3.0 million. However, severe drought condition between 1982-1987 drastically decreased forage availability, causing a high mortality rate and decreased calving rate among cattle in the traditional sector. Consequently, cattle numbers decreased to 2.3 million in 1986. The number of small stock (sheep and goats) was not affected by drought mainly because of the availability of browse plants as feed for sheep and goats. Furthermore, disease incidences of sheep and goats was low during the drought period.

There are few commercial dairy farms located mainly around the south eastern urban areas of the country. These farms own a total of 2,750 dairy cows of which 1,350 cows produce 4.1 million liters of milk per year. This amount of milk only meets 25% of local fresh milk demand, and the other 75% is imported from South Africa.

The major constraints to cattle milk and meat production in Botswana are: 1) lack of adequate feed supplies particularly during the dry season and drought years, 2) uncontrolled stocking rate in the communal areas resulting in overgrazing and range degradation, 3) lack of adaptable genotypes for dairy production, 4) skilled management and farm labour problems and 5) inadequate infrastructural development especially for transporting and processing milk.

Animal Production Research Unit (APRU), Department of Agricultural Research is responsible for livestock production and range utilization research. APRU conducts beef cattle crossbreeding and Tswana cattle selection studies in 20 ranches located in the three ecological zones. Other research areas being undertaken by the department include: 1) animal nutrition, 2) fodder crop production, 3) range management and 4) small stock production. A small scale dairy production research project using Simmental crossbred cows is also implemented in the communal areas around Gaborone region.

APRU collaborates with the Animal Production Division (Extension) of the Department of Field Services in the dissemination of research results as well as in the initial design and implementation of livestock projects. Research results are published in "Agrinews and Agrifacts" by the Agricultural Information Services Unit, of the Ministry of Agriculture and distributed to rural extension staff.



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TABLE 1. GROSS DOMESTIC PRODUCT 1966-1983  
(MILLION)

| ITEM              | 1966 |      | 1971-72 |      | 1975-76 |      | 1982-83 |      |
|-------------------|------|------|---------|------|---------|------|---------|------|
|                   | PM   | %    | PM      | %    | PM      | %    | PM      | %    |
| AGRICULTURE       | 14.5 | 39.4 | 33.1    | 32.3 | 65.5    | 31.5 | 73.5    | 7.4  |
| MINING            | -    | -    | 11.2    | 10.9 | 33.6    | 16.1 | 286.3   | 28.7 |
| MANUFACTURING     | 2.9  | 7.9  | 5.1     | 5.0  | 20.9    | 10.0 | 81.7    | 8.2  |
| WATER/ELECTRICITY | 0.3  | 0.8  | 1.3     | 1.3  | 11.1    | 5.3  | 29.5    | 3.0  |
| CONSTRUCTION      | 2.1  | 5.7  | 10.0    | 9.7  | 18.8    | 9.0  | 43.2    | 4.3  |
| TRADE/HOTELS      | 6.8  | 18.5 | 17.5    | 17.0 | 42.5    | 20.4 | 223.5   | 22.4 |
| TRANSPORT         | 3.0  | 8.1  | 3.8     | 3.7  | 12.5    | 6.0  | 29.8    | 3.0  |
| SERVICES          | 2.4  | 6.5  | 8.8     | 8.6  | 28.6    | 13.7 | 82.2    | 8.2  |
| GOVERNMENT        | 4.9  | 13.3 | 11.8    | 11.5 | 36.1    | 17.3 | 147.4   | 14.8 |
| TOTAL GDP         | 36.8 | 100  | 102.6   | 100  | 269.8   | 100  | 997.1   | 100  |

National Development Plan. Ministry of Finance and Development Planning 1985-91. Botswana.

TABLE 2. LIVESTOCK STATISTICS (NUMBERS 000)  
YEAR 1979-1986

| LIVESTOCK | 1979  | 1980  | 1981  | 1982  | 1983  | 1984  | 1985  | 1986  |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|
| CATTLE    | 2,840 | 2,911 | 2,967 | 2,979 | 2,818 | 2,685 | 2,459 | 2,332 |
| GOAT      | 616   | 638   | 621   | 636   | 783   | 889   | 1,138 | 1,332 |
| SHEEP     | 152   | 149   | 140   | 140   | 165   | 167   | 200   | 229   |
| CHICKENS  | 740   | 833   | 1,046 | 1,146 | 961   | 715   | 1,020 | 1,179 |
| PIGS      | 6     | 6     | 5     | 5     | 5     | 7     | 9     | 11    |

1986 - AGRICULTURAL STATISTICS, MINISTRY OF AGRICULTURE, BOTSWANA.

TABLE 3. CATTLE: FARMS, ANIMALS AND AVERAGE SIZE BY  
SUBSECTOR AND REGIONS

| REGION            | CATTLE---FARMS |       | TOTAL---CATTLE |       | AVERAGE SIZE<br>NUMBER |
|-------------------|----------------|-------|----------------|-------|------------------------|
|                   | NUMBER         | %     | NUMBER (000)   | %     |                        |
| SOUTHERN          | 8,600          | 16.1  | 247.5          | 10.6  | 28.8                   |
| GABORONE          | 11,200         | 21.0  | 281.8          | 12.1  | 25.2                   |
| CENTRAL           | 16,300         | 30.5  | 755.2          | 32.4  | 46.3                   |
| FRANCISTOWN       | 8,700          | 16.3  | 311.8          | 13.4  | 35.8                   |
| MAUN              | 6,400          | 12.0  | 279.1          | 11.9  | 43.6                   |
| WESTERN           | 1,700          | 3.2   | 79.0           | 3.4   | 46.5                   |
| TOTAL TRADITIONAL | 52,900         | 99.1  | 1954.4         | 83.8  | 36.9                   |
| TOTAL COMMERCIAL  | 510            | 0.9   | 377.8          | 16.2  | 740.8                  |
| OVERALL TOTAL     | 53,410         | 100.0 | 2332.2         | 100.0 | 43.7                   |

1986-AGRICULTURAL STATISTICS. MINISTRY OF AGRICULTURE, BOTSWANA.

TABLE 4. CATTLE: FARMS, ANIMALS AND AVERAGE SIZE BY SIZE OF CATTLE HOLDING

| HERD SIZE            | CATTLE----FARM<br>NUMBER | %            | TOTAL----CATTLE<br>NUMBER(000) | %            | AVERAGE SIZE<br>NUMBER |
|----------------------|--------------------------|--------------|--------------------------------|--------------|------------------------|
| <b>TRADITIONAL</b>   |                          |              |                                |              |                        |
| 1-10                 | 18,300                   | 34.6         | 119.2                          | 6.1          | 6.5                    |
| 11-20                | 11,800                   | 22.3         | 192.3                          | 9.8          | 16.3                   |
| 21-30                | 7,200                    | 13.6         | 197.6                          | 10.1         | 27.4                   |
| 31-40                | 4,000                    | 7.6          | 154.4                          | 7.9          | 38.6                   |
| 41-50                | 3,400                    | 6.4          | 168.5                          | 8.6          | 49.6                   |
| 51-60                | 1,300                    | 2.5          | 77.6                           | 4.0          | 59.7                   |
| 61-100               | 3,500                    | 6.6          | 299.0                          | 15.3         | 85.4                   |
| 101-150              | 1,600                    | 3.0          | 209.3                          | 10.7         | 130.8                  |
| 151+                 | 1,800                    | 3.4          | 536.5                          | 27.5         | 298.1                  |
| <b>TOTAL</b>         | <b>52,900</b>            | <b>100.0</b> | <b>1954.4</b>                  | <b>100.0</b> | <b>36.9</b>            |
| <b>COMMERCIAL</b>    |                          |              |                                |              |                        |
| 1-100                | 120                      | 23.5         | 5.8                            | 1.5          | 48.3                   |
| 101-500              | 220                      | 43.1         | 54.4                           | 14.4         | 247.3                  |
| 501-1000             | 60                       | 1.1          | 47.1                           | 12.5         | 785.0                  |
| 1001-5000            | 100                      | 19.6         | 194.9                          | 51.6         | 1949.0                 |
| 5001+                | 10                       | 2.0          | 75.6                           | 20.0         | 7560.0                 |
| <b>TOTAL</b>         | <b>510</b>               | <b>100.0</b> | <b>377.8</b>                   | <b>100.0</b> | <b>740.0</b>           |
| <b>OVERALL TOTAL</b> | <b>53,410</b>            | <b>0.0</b>   | <b>2332.2</b>                  | <b>0.0</b>   | <b>43.7</b>            |

1986-AGRICULTURAL STATISTICS. MINISTRY OF AGRICULTURE, BOTSWANA.

TABLE 5. ANNUAL PRODUCTION OF DIFFERENT CROP RESIDUES OBTAINED DURING FAVOURABLE RAINFALL AND DROUGHT YEARS IN BOTSWANA

| CROP RESIDUES  | FAVOURABLE RAINFALL<br>(1980-1981) |                        | DROUGHT YEARS<br>(1982-1986)    |                        |
|----------------|------------------------------------|------------------------|---------------------------------|------------------------|
|                | AREA HARVESTED<br>(HA)<br>(000)    | PRODN<br>(MT)<br>(000) | AREA HARVESTED<br>(HA)<br>(000) | PRODN<br>(MT)<br>(000) |
| SORGHUM STOVER | 127                                | 57.0                   | 60                              | 18.4                   |
| MAIZE STOVER   | 53                                 | 34.0                   | 13                              | 11.0                   |
| MILLET STOVER  | 14                                 | 5.0                    | 8                               | 1.9                    |
| PULSES (BEANS) | 14                                 | 5.0                    | 4                               | 0.9                    |
| GROUNDNUTS     | 4                                  | 3.4                    | 1                               | 1.1                    |

SOURCE: 1986 AGRICULTURAL STATISTICS MINISTRY OF AGRICULTURE, BOTSWANA.

TABLE 6: ANNUAL PRODUCTION OF DIFFERENT AGRO-INDUSTRIAL BY-PRODUCTS IN BOTSWANA.

| BY-PRODUCTS  | PRODUCTION (MT, DM) |
|--|---------------------|
| SORGHUM BRAN   | 14,800              |
| BREWERS GRAIN <sup>1</sup> (BARLEY SPENT GRAIN)        | 780                 |
| BREWERS GRAIN <sup>2</sup> (SORGHUM/MAIZE SPENT GRAIN) | 2,128               |
| WHEAT BRAN   | 5,544               |
| HOMINY CHOP  | 10,000              |
| MEAT MEAL  | 2,949               |
| BLOOD MEAL   | 318                 |
| BONE MEAL  | 1,031               |

SOURCE: 1986 AGRICULTURAL STATISTICS MINISTRY OF AGRICULTURE, BOTSWANA.

<sup>1</sup> spent grain from beer malt brewing

<sup>2</sup> spent grain from "chibuku" malt brewing