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Processing and Utilization of Sorghum and Maize in Botswana: Current Status and Opportunities

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Abstract

The study reviews the current sorghum and maize production, processing and utilization in Botswana. Most of the grains produced in Botswana are used for home consumption, while processing of commercial and export commodities are limited both in terms of quantity and extent of processing. The major processing activity by both small scale and large scale firms is grain milling into maize and sorghum flours. There is limited value-added commercial processing. This creates an opportunity for development and marketing of traditional and new value-added products. Opportunities for expanding and diversifying industrial or semi-industrial processing of maize and sorghum beyond grain milling are suggested.

Keywords: Maize, Sorghum, milling, value-added processing, food security

Introduction

Cereals have a long history of use by humans as staple foods and important sources of nutrients in both developed and developing countries. Cereals and cereal products are an important source of energy, carbohydrate, protein and fiber, as well as containing a range of micronutrients such as vitamin E, some of the B vitamins, magnesium and zinc (McKevith, 2004). Cereal grains form a major portion of the diet of the people of Botswana, and are widely grown throughout the country. Many different processing activities are utilized to turn coarse cereal grains into products ready for human consumption. Food processing contributes to food security by reducing postharvest food losses and contributing to diversity of the diet. Food processing absorbs the surplus agricultural products that may otherwise be lost by using them as raw materials that are converted into intermediate or finished consumer products. The Food and Agriculture Organization of the United Nations (FAO) estimated world food losses at 33% or 1.3 billion tons per year (FAO, 2011). The FAO report stated that food losses in the developing world tend to be related to financial, managerial and technical limitations of food distribution between the farmer and the consumer. Proper processing and packaging of foods can minimize this waste by offering foods with extended shelf life that provides more time for sale, thus saving food that is normally lost. Food processing also ensures higher value addition to agricultural production, generates employment, improves farmer income and creates markets for domestic consumption and export of foods. It has

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been estimated that high-income countries add over US$200 per ton of value by processing agricultural products while developing countries add less than US$50 (UNIDO, 2013). Furthermore, while 98% of agricultural production in high-income countries undergoes industrial processing, in developing countries, barely 30% is processed. A dynamic food processing sector provides strong linkages and synergies between agricultural production and the consumers and hence plays significant role in the overall economic setup of a country.

While it is widely recognized that processing provides a strong backward linkage to agricultural production, the potential of the cereal processing industry in Botswana is not fully utilized to achieve this purpose. In general, a relatively small amount of agricultural products in Botswana are industrially processed. The main objective of this study is to review literature on the production and utilization of maize and sorghum in Botswana. The study make use of existing secondary data from the Ministry of Agriculture, Statistics Botswana, Ministry of Trade and Industry and other relevant government and non-government agencies (both local and international). The secondary data were complemented by extensive survey of literature relating to maize and sorghum utilization in Botswana.

Cereal production trends in Botswana

Cereal production in Botswana is based on rain-fed farming. However, the low and erratic rainfall coupled with relatively poor soils, makes crop production in general a high risk system with low productivity. Arable crop production is carried out by both commercial farmers and subsistence smallholder farmers. The arable sector is dominated by small traditional farms with an average farm size of 5 hectares. Farm size estimates for the year 2011 showed that about 63,000 arable farms were 5 hectares or less and only 112 farms were larger than 150 hectares (Statistics Botswana, 2013). Sorghum and maize are two of the major crops grown in terms of area planted. Sorghum is traditionally the most important crop and the one best suited to Botswana's agro-climatic conditions. However, the share of maize production has grown over years in response to increasing demand, despite it being a more risky crop (Stockbridge, 2006).

Data shows that maize is the predominant crop under the traditional sub-sector, while sorghum is the more popular crop in the commercial sub-sector. Production estimates for 2011 as presented in Figure 1 show that 29,070 metric tons of maize was produced by traditional farmers as opposed to only 6,252 metric tons by commercial farmers (Statistics Botswana, 2013). During the same period, traditional farmers produced only 5,946 metric tons of sorghum while commercial farmers produced 26,645 metric tons of sorghum. As one would expect, crop yields in the commercial sub-sector is far superior to that in the traditional sector. In 2011, the yield for sorghum was 4,100 kg/ha in the commercial sub-sector, whiles it was only 100 kg/ha in the traditional sub-sectors (Statistics Botswana, 2013). Likewise, the yield for maize in the commercial sub-sector was 19,200 kg/ha and 190 kg/ha for commercial and traditional sub-sector, respectively. These results indicate that commercial farmers are achieving much better yields per hectare compared to the traditional subsistence farmers.

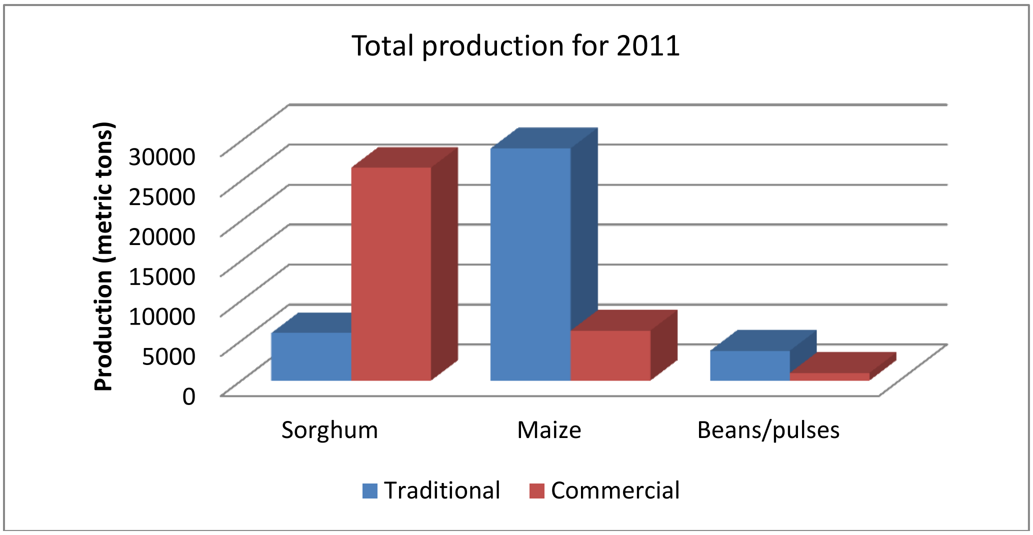
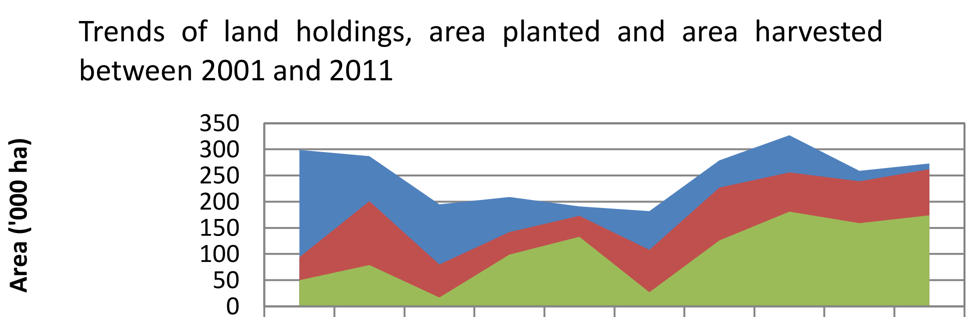


Figure 1: **Total production of major crops in Botswana during 2011**
Source: Statistics Botswana, 2013

The land area available for crop cultivation, as well as the actual area planted and the actual area harvested after planting, vary considerably from year to year, as shown in Figure 2. From the figure, the average land area available for crop production was about 250,000 ha during the period between 2001 and 2011 (Statistics Botswana, 2013). However, only 178,000 ha, or about 70%, of this available land area were actually planted with crops during this period. Of the area planted, only about 60% was actually harvested. This data shows that much of the land is being underutilized, or not used at all.



	2001	2002	2003	2004	2006	2007	2008	2009	2010	2011
Available Land Area	299	287	195	209	191	182	279	327	259	273
Area Planted	94	201	80	142	173	108	227	256	239	262
Area Harvested	50	79	17	99	133	27	126	181	159	174

Figure 2: **Land area, area planted and harvested during 2001-2011. Data for 2005 is missing.**
Source: Statistics Botswana 2013

Lack of rainfall and poor soils have been cited as the main constraints for farm productivity in Botswana, but a broad comparison between commercial and subsistence farming indicates that climatic conditions cannot take the full blame for low land productivity within the traditional subsistence farming community. While climatic factors have been cited as constraints for improved yields in many countries, other factors have also been identified, such as preference of one crop over the other. For example, in Bangladesh, slowing yield growth of wheat was reported over the years, which was attributed to comparative advantage of cultivation of Boro rice over wheat (Poudel and Chen, 2012). Similar trends were also reported for maize cultivation in Pakistan, where land area previously used for sorghum production was being converted to cultivating other crops which yield higher profits in the market (Habib *et al*., 2013). In Botswana however, there are no alternative crops preferred over maize and sorghum to explain the trend. The traditional farming system is characterized by farmers who keep livestock in addition to crop cultivation. In some years, it is possible that these farmers may decide to concentrate more on livestock rearing at the expense of crop cultivation. Additionally poor agronomic practices and economic constraints might explain the underutilization of land. Increasing crop yields per unit of land can be achieved through use of new improved technologies, high yielding cereal varieties and improved production practices such as proper land preparation techniques and correct fertilizer use. Use of drought tolerant varieties can produce desirable effects in crops such as maize. The results of a study by Kiani (2013) indicated that there is a lot of genetic variation in maize varieties with regard to drought tolerance. This is particularly important to consider in a semi-arid country such as Botswana. The right type and accurate fertilizer application rates have been shown to satisfy crop requirements and produce higher crop yields. Ejuneke (2013) showed that organic manure from poultry and cow dung and an inorganic NPK fertilizer applied to three varieties of maize crop produced higher grain/cob.

The government of Botswana has been investing on subsidy schemes to provide smallholder producers with inputs such as seeds and fertilizers, draught power for tillage operations, and with assistance in land preparation and development in a bid to improve agricultural productivity and increase yields. These schemes, over the years, included the Arable Lands Development Program (ALDEP); the Accelerated Rain-fed Arable Program (ARAP); National Agricultural Master Plan for Arable Agriculture and Dairy Development (NAMPAAD) as well as the most recent Integrated Support Program for Arable Agriculture Development (ISPAAD). There have been some additional concerns that these schemes have failed to achieve the desired outcomes. A recent study for United Nations Development Program (UNDP) concluded that the ISPAAD program is not economically viable in its current form (UNDP, 2012). The study shows that the actual expenditure on the program exceeded its budget allocation, and constituted more than 80% of budget allocation for the Department of Crop Production (under which the program is managed) and more than half the budget allocation for the entire Ministry of Agriculture. Furthermore, it was found that the annual expenditure on ISPAAD operations exceeded annual proceeds in all the years reviewed. Data on domestic grain production and grain imports show that the ISPAAD program has not increased grain production beyond historical production levels prior to its inception (UNDP, 2012). The analysis showed that on average, traditional farmers were only able to achieve about 20% of the target yields while commercial farmers achieved 80%. This shows there is potential for traditional farmers to achieve improved yields under the existing rainfall and soil conditions, provided they improve their farming practices.

Cereal milling technologies in Botswana

Processing of sorghum and maize in Botswana is done by both traditional and commercial sectors. Whether at the traditional or industrial levels, milling is the main activity associated with cereal processing in Botswana. Hand pounding with mortar and pestle has been the primary processing technique used for milling maize and sorghum by traditional households. Traditional hand pounding is extremely labor-intensive, and the laborious task has traditionally been performed by women and children. Eastman (1980) established from several informal surveys that women can devote 2-5 hours a day to processing sorghum and millet grain for family daily grain needs. A study cited by Mmapatsi and Maleke (1996) revealed that using a mechanical dehuller instead of hand pounding saves 41% of women's time and 50% of children's time to engage in other productive activities. Hand pounding is still a major food preparation activity in some rural areas of Botswana, despite the widespread availability of mechanical milling.

Commercial sorghum milling in Botswana utilizes a technology consisting of a decorticator (commonly referred to as a dehuller) and hammer mills. The type of decorticator most common in Botswana is based on a prototype put out by Prairie Research Laboratory (PRL) in Canada (Bassey and Schmidt, 1989; Mmapatsi and Maleke, 1996). This decorticator has the advantage of being relatively inexpensive to install, operate and maintain. Bassey and Schmidt (1989) described the development of this type of decorticator and its use in Africa. A description of the machine used in Botswana, which was developed and introduced by Rural Industries Innovation Center (RIIC), was given by Mmapatsi and Maleke (1996).

The decorticator is an abrasive disc type that removes mainly the outer pericarp layers of sorghum during a dry milling operation. Evenly spaced abrasive wheels (carborundum stones) rotate clockwise against the grain inside a horizontal barrel, enabling a progressive abrasion and decortication of the outer layers of grains along the length of a barrel. A suction aspiration fan and ducting system removes the husks and bran, while the decorticated grain is discharged after sufficient decortication. This can be done as either a batch or a continuous process where several decorticators are used in series (Mmapatsi and Maleke, 1996). The development of sorghum milling technology through RIIC and the continued support of the industry by government has produced business opportunities that created jobs, generated income to business owners and improved livelihoods of many. Rohrbach et al. (2000) stated that initially machine processing of sorghum was viewed primarily as a means to encourage growth of sorghum production and consumption in rural areas. However, over the years sorghum milling has grown into a commercial enterprise. The rapid growth of the milling industry was attributed to financial support from the government through programs such as the former Financial Assistance Policy (FAP) which provided grants for land, buildings, machinery, labor and packaging.

Grain milling products

The main product from grain milling is flour (i.e., sorghum meal and maize meal). Products from sorghum milling include fortified or enriched sorghum meal, soya-sorghum weaning food and malts used for sorghum beer brewing. Maize milling products include maize meal, samp, maize grit and maize rice. The flour produced in traditional households mainly goes to self-consumption within the producing household. The quantity and quality of the flour is popular and highly accepted for home consumption, but have little latitude for marketing in a large scale. Flour from hand pounding comprise a mixture of different size granules of the endosperm, but may also contain particles from the germ and pericarp fractions of the grain. The moisture content of flour is a very important quality factor for shelf life purposes. Due to the semi-wet milling process, the flour produced from the traditional milling process is moist; hence it has a shelf life of about three days (Kebakile, 2008).

All grain milling techniques, manual or mechanical, result in some loss of nutrients in the grain. However, the nutrient content of manually produced flour is generally higher than that of highly refined industrially produced flours. Eastman (1980) revealed that more nutrients were lost from grains processed with the PRL/ RIIC dehuller compared to grains processed manually because the traditional wet process removes very little of the grain germ, which happens to contain many of the high quality nutrients. It was reported that mechanical processing removes more of the germ and resulted in flour that has, on average, 25% less fat, 10% less crude fiber, 15% less ash, and slightly less protein than does manually processed sorghum flour (Eastman, 1980). Pedersen and Eggum (1983a, 1983b) studied the influence of milling on the nutritive value of flour from maize and sorghum. Pedersen and Eggum (1983a) reported that milling of maize reduced the fat content and minerals to approximately 28% of corresponding levels in whole maize. The composition of amino acids in maize flour was also significantly affected by milling. The effect of degerming was most pronounced in the reduction of lysine and tryptophan, which were reduced to 63% and 69%, respectively, of corresponding levels in whole maize. Starch and protein are less affected by processing as these are concentrated in the endosperm of the grain (Goldberg, 2003, Inglett, 1970). A reduction in the fat and ash content of sorghum flours was reported, despite higher contents of these components being retained as compared to hand dissected endosperm (Pedersen and Eggum, 1983b). The authors speculated that a considerable proportion of the germ is retained during milling even at an extraction rate of 64%. It was also found that the content of lysine was significantly decreased by milling, while the content of leucine, which is naturally present in excessive amounts in sorghum, was further increased. The lysine content of whole sorghum meal (i.e., 100% extraction rate) was 2.02% which reduced to 1.3% at 64% extraction rate (Pedersen and Eggum, 1983b). On the other hand, leucine content was 13.9% at 100% extraction rate and increased to 15.7% at 64% extraction rate.

The maize meal categories available in the retail market in Botswana are generally identified as '*Super*', '*Special*', '*Sifted*' or '*Unsifted*', based on the composition and particle size index as shown in Table 1. Also shown in Table 1 are the compositions of other maize milling products such as samp, maize rice and grits. Some of the maize meal grades are fortified to improve the nutrient reductions during milling.

Table 1: Composition of maize milling products

Product name	Particle size distribution (mm)	Fat (%)	Protein (%)	Starch (%)	Moisture (%)
Samp	3.4-5.8	0.8	9.0	84	12
Maize rice	1.4-2.0	0.8	9.0	84	12.5
Grits	0.65-1.4	0.7	9.0	82	12
Super maize meal	0.3-0.65	1.0	9.0	80	13
Special maize meal	0.17-0.3	2.3	9.2	80	13.5

Adapted from Erasmus (2003)

The major cereal milling companies in Botswana include Bolux Milling, Foods Botswana and Bokomo Botswana. These are all large scale companies manufacturing maize- and sorghum-based milling products under different brand names found in the local market. Bokomo Milling manufactures and markets a fortified maize meal (under brand name '*White Star*') locally through wholesalers and retailers. Bokomo also produces an unfortified maize meal product, special maize meal, which is of lower quality in terms of nutrients. Bolux milling company also produces fortified and unfortified maize meal under '*A1*' brand. According to Seleka *et al*. (2008) the fortification used by these companies is based on South African standards as Botswana does not have laws to regulate cereal fortification. Another company, Foods Botswana, is a major producer of sorghum meal under the brand name '*Sechaba*', sorghum beer powder or malt under the brand name '*Tholo'*, and samp under the brand name '*Sarona*' (Sefalana Holding Company Limited, 2011). Foods Botswana also produces fortified pre-cooked maize meal product used for supplementary feeding of older children and adults ('*Tsabotlhe'*) and a soya-sorghum weaning food ('*Tsabana'*). According to Seleka *et al*. (2008) *Tsabotlhe* was the only fortified sorghum meal produced on a commercial basis in Botswana. The soya-sorghum weaning food brand '*Tsabana*' is a product specifically made for Botswana government to be used as a weaning food for supplementary feeding of children aged between 6 to 36 months (Ohiokpehai *et al*., 1998). *Tsabana* is made out of a combination of red sorghum and soya beans. It is pre-cooked using extrusion cooking and fortified with vitamins and minerals. In addition to maize- and sorghum-based products, these companies manufacture and/or distribute other cereal products, especially wheat-based products (wheat flour, pasta products, and biscuits). Bokomo also distributes other food products manufactured by its sister companies in South Africa or elsewhere, such as breakfast cereal products, dried fruits and vegetables, poultry products, etc.

Value-added products

Apart from use in local staple porridge dishes, sorghum and maize flours can be further processed in a variety of ways and combined with many other ingredients to produce a vast range of value-added products. These value-added products use a variety of food preservation methods such as fermentation, pasteurization, etc., and products may be non-alcoholic or alcoholic. Botswana Breweries Limited is a major company engaged in production of alcoholic and non-alcoholic beverages based on sorghum and maize. The company produces a non-alcoholic maize meal based beverage known as ***Mageu*** under the brand '*Keone Mooka*'. Mageu is prepared by cooking maize meal in boiling water to obtain a final product containing about 8-10% solids. Upon cooling a small amount wheat meal (0.1-0.2%) and sugar (1-2%) are added to initiate lactic acid fermentation (Holzapfel and Taljaard, 2004). Preservatives such as sodium benzoate, potassium sorbate, or calcium propionate are often added. The product may be pasteurized in order to obtain a reasonable shelf life for retail distribution. The final product usually has acidity of about 0.4-0.5% lactic acid (Holzapfel and Taljaard, 2004). Mageu is packaged in 500 mL and 1 Liter cartons and various flavors are available in the retail market, such as 'plain', 'banana', 'cream' and others.

Botswana Breweries Limited is also the main manufacturer and distributor of a low alcohol content sorghum opaque beer called '***Chibuku***'. The product is also consumed in Zimbabwe, South Africa and other countries where it may be marketed under different brand names. Industrial production of sorghum beers is well described by Haggblade and Holzapfel (2004). The general process involves an alcoholic fermentation using yeast and spontaneous lactic acid fermentation (Haggblade and Holzapfel, 2004). Chibuku is packaged in 1-liter cartons and is actively fermenting when sold, with alcohol strength increasing from 0.5% on the first day to about 4% in five days before expiry. Recently Botswana Breweries Limited also started producing '*Phafana*' brand of premium opaque beer. According to the company, this brand is targeted to non-consumers of Chibuku who prefer to drink in the formal channel.

Role of cereals in the economy

As of 2012, the contribution of agriculture to GDP of Botswana was very minimal at 2.7% compared to 5.8% contributed by manufacturing and 20% by mining (Statistics Botswana, 2013). The contribution of agriculture comes from the beef industry, which is the only sub-sector of agriculture that has constantly remained a significant contributor to the national GDP over the years. Meat and meat products contributed 2.7% of the BWP[1] 951.6 million worth of total exports in January 2009, (CSO, 2009). While Botswana is a net exporter of beef, it has always been a net importer of the staple commodities of sorghum and maize.

Data from FAO on cereal demand/supply balances estimates as of early June 2013 indicate that Botswana would need 230,000 tons of coarse grain cereals for food use during 2013/14 period (FAO, 2013). During 2012, only 30,000 tons of grains were produced in Botswana, hence 215,000 tons will be imported to cover both food and non-food uses, which is over 90% of national grain requirements. Despite the lack of measurable contribution to GDP, the cereal sub-sector contributes to employment through both crop production and grain milling and processing. There is a wide geographical distribution of grain mills, mostly sorghum mills, throughout Botswana, and a corresponding widespread availability of locally produced sorghum meal brands in the local retail market. A survey conducted by Seleka *et al*. (2008) showed that commercial sorghum milling in Botswana is characterized by existence of numerous small firms, whereas maize milling is dominated by a few large firms. The authors identified three categories of millers: those who mill and package flour for sale through formal retail markets; those who do only service milling (also known as 'contract' milling) where customers bring their grain to a mill and have it ground for either a small fee or a proportion of the flour, and; those who do both service milling and produce packaged product for the retail market.

Opportunities for expanding industrial utilization of sorghum and maize

Despite agriculture's declining share of the GDP, it remains vitally important to the economy and achievement of food security. Processing of cereals produces foods that are considered staples in Botswana and worldwide; hence the industry is poised to remain relevant in the years to come. Furthermore, agro-based industries, including cereal processing, have great significance to the rural population as they can be instrumental in fostering strong linkages between the agricultural and industrial sectors and in enhancing the employment potential.

There is considerable opportunity to increase the contribution of the agriculture to the economic activities of Botswana, and especially by small scale producers, through diversification of cereal processing beyond grain milling to manufacturing of value-added products. There is an urgent need for a national agricultural policy that places more focus on food processing as a vital component of the value chain, especially in the rural areas, where business ownership is lower and unemployment rates higher. This will require action from all stakeholders, including government, industry and academic institutions in terms of policy

[1] BWP means Botswana Pula, which is the currency of Botswana (BWP1 is currently approximately US$8.50)

support, capacity building, and market information to producers, applied research and overall investment in the supply chain. Some of the opportunities in improving grain production and supply, and promotion of small scale food processing businesses are discussed below.

Use of contract farming to improve grain supplies

A major limiting factor for value-added processing of sorghum and maize in Botswana is the limited and inconsistent supply of good quality grain. The low productivity and associated low incomes make it difficult to attract the next generation of farmers. Increasing productivity of smallholder farmers is essential, but has been a challenge so far. Apart from increasing the land area available for agricultural production, productivity can also be improved by increasing yields from the land already in use. The use of contract farming can provide an opportunity to promote production and ensure grain of specific quality depending on the end-use industry.

Contract farming has been discussed by various authors as having the potential to incorporate low-income growers into the modern sector (Glover, 1984; Goldsmith, 1985; Williams and Karen, 1985). In contract farming, agro-processing firms can provide, via contracts, the credit, inputs, information, and services smallholders need to cultivate and market traditional and lucrative nontraditional crops while the firm has greater control over the production process and final product quality. Contracting has been used in countries like Zambia, Zimbabwe and South Africa, especially in the opaque beer industry, where farmers are issued with seeds at the beginning of the planting season to ensure varieties with good malting qualities (Rohrbach and Kiriwaggulu, 2007). However, contract farming has not been widely used in Botswana. Recently, Botswana Breweries Limited initiated a sort of contract farming project called Project Thusanang to promote sourcing of bitter sorghum for use in production of Chibuku beer from local small scale subsistence farmers (Sechaba Breweries Holdings Limited, 2012). This program benefits farmers by enhancing land productivity and promoting use of scientific farming methods. As noted earlier, crop production in Botswana is characterized by numerous small scale farms and low production and yields, which might make it difficult to administer and manage contract farming projects. To resolve this problem, Project Thusanang has implemented a Hub and Spoke model where a lead farmer oversees, assists and encourages farmers in a cluster to help drive the objectives of the project (Sechaba Breweries Holdings Limited, 2012). Promotion of similar projects for other end-use specific industries can go a long way in encouraging more productive use of available farm lands.

Processing and packaging of traditional and new value-added products

Promotion of small scale enterprises involved in value-added food processing is crucial to rural development. Traditional food processing and preservation techniques are used mainly in the rural areas to produce foods consumed within households. The techniques are mainly rudimentary, are not standardized, are not based on scientific principles, and hence not suitable for commercial production. The development of appropriate processing technologies aimed at upgrading the quality of indigenous/ traditional foods will be indispensable for the growth of agro-industries and economic development in rural areas. Appropriate packaging is required to assure quality and shelf life as well as make the products appealing to the consumer. In Botswana, traditional fermented products such as ting and sorghum beer can be modernized and developed for small scale commercial processing. These products are not currently available in the commercial market. ***Ting*** is a fermented gruel made by mixing sorghum meal with water, which is then allowed to spontaneously ferment in a warm place for two to three days. After fermentation the gruel is cooked in boiling water and consumed as thin or thick porridge with sugar, meat or vegetables. Traditional opaque beers are brewed with tastes that differ from the industrially produced Chibuku beer. Brewing procedures vary from place to place or even from brewer to brewer within the same locality. Fermentation is known to improve bioavailability of nutrients of cereal products containing antinutritional factors such as phytates, polyphenols and tannins (Steinkruss, 1995). Hence, proper fermentation of maize and sorghum-based products can change a diet which generally has low nutrient availability to one of high nutrient availability. Research is needed to isolate the microflora responsible for natural fermentation of these traditional products. One notable study was carried out by Sekwati-Monang (2011) to characterize the microorganisms responsible for fermentation of ***ting***. For both ***ting*** and sorghum beer, the development and commercialization of a bulk starter medium for fermentation processes is prerequisite for improving these indigenous fermentation technologies and commercially produce products which closely resemble the traditional ones.

In addition to the traditional products, small scale processors can be supported in developing new and exotic cereal-based, high value products. For example, there is a growing demand for gluten free foods and beverages for people with celiac disease who cannot consume wheat based products. Celiac disease is characterized by damage of the mucosa of the small intestine caused by gluten in wheat and other grains (Fasano and Catassi, 2001). Sorghum has been recommended as a safe food for celiac patients (Kasarda, 2001) and can be used an alternative breads and other naked goods such as cakes, cookies (biscuits) and snacks. Apart from targeting celiac patients, development of sorghum-based baked products might replace some of the wheat-based products, thereby reducing wheat imports and associated costs.

Support of SMEs through Business Incubation

In both developed and developing economies, policies supporting small and medium enterprises (SMEs) are widely promoted as their role for economic and social development is universally recognized. Support programs for SMEs usually range from technical assistance to tax incentives, from direct supply of capital to regulatory provisions, training, support to innovation and other types of incentives. One of the mechanisms employed to nurture small firms is "business incubation". Business incubation has been used successfully in Brazil, China, Israel and other countries. According to the National Business Incubators Association (NBIA), "business incubation catalyzes the process of starting and growing companies, providing entrepreneurs with the expertise, networks and tools they need to make their ventures successful. In supporting entrepreneurs with a 'one-stop' style service and reducing their overhead cost by sharing facilities, business incubators are able to significantly improve the survival and growth prospects of new start-up companies (Scaramuzzi, 2002). In food processing, incubator facilities can provide a wide range of services from product concept to commercialization for both start-up businesses and existing businesses. New start-up companies in need of basic small scale processing capacity can gain access to equipment and services they could not likely afford on their own, and have their products produced in state-of-the-art food processing facilities that meet regulatory standards. On the other hand, larger processors can use these facilities to minimize capital risks that are associated with new products and processes in test markets and with scale up and commercialization stages. These facilities would be located in strategic agricultural production districts where producers and processors can have easy access. Research and academic institutions such as the National Food Technology Research Center, Botswana College of Agriculture, University of Botswana and Department of Agricultural Research, can be engaged in providing the technical support and business assistance to start-up companies.

Conclusions

Cereal grain production is very limited in Botswana, partly due to the agro-ecological conditions, but also due to human related problems that can be resolved. Increased production of good quality grains is a prerequisite for successful development of commercial cereal processing. Currently, primary milling is the main cereal processing activity carried out in the country, with very limited value-added processing. Commercial processing of locally grown grains such as sorghum and maize into value-added food and beverage products can be an important driver for economic development. However, this requires policy, financial and technical support from the government, industry and academic institutions. Efforts from the government should promote food processing as one of the ways to achieve food security at both the household and national levels. Strong links should be developed between grain producers, research and development institutions and the food manufacturing industry.

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