The Feasibility of Mandatory Fortification of Cereals in Botswana

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BOTSWANA INSTITUTE FOR DEVELOPMENT POLICY ANALYSIS

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Abbreviations

ACBF	African Capacity Building Foundation
AIDS	Acquired Immune Deficiency Syndrome
BAMB	Botswana Agricultural Marketing Board
BIDPA	Botswana Institute for Development Policy Analysis
BOBS	Botswana Bureau of Standards
BP	British Pharmacopoeia
CEDA	Citizen Entrepreneurial Development Agency
CHBC	Community Home Based Care
EPMM	Enriched Precooked Maize Meal
FAO	Food and Agriculture Organization
FCC	Food Chemicals Codex
HIV	Human Immune Virus
IDD	Iodine Deficiency Disorder
kg	Kilogram
KW	Kilowatt
MIS	Multiple Indicator Survey
MoA	Ministry of Agriculture
MoH	Ministry of Health
MoLG	Ministry of Local Government
MTCT	Mother to Child Transmission
NACA	National AIDS Coordinating Agency
NFTRC	National Food Technology Research Centre
NFA	National Fortification Alliance
NFCB	National Food Control Board
OCP	Orphan Care Programme
ORD	Office of Research and Development
PEM	Protein Energy Malnutrition
PLWHA	People Living with HIV/AIDS
PSFP	Primary School Feeding Programme
QA	Quality Assurance
QC	Quality Control
QA & C	Quality Assurance and Control
RAD	Remote Area Dweller
RDA	Recommended Daily Allowances
RIIC	Rural Industries Innovation Centre
RoB	Republic of Botswana
RSA	Republic of South Africa
SA1	Super A1 maize meal
SADC	Southern African Development Community

SC	Standards Council
SNN	Social Safety Net
STPA	Short Term Plan of Action
TB	Tuberculosis
TC	Technical Committee
UB	University of Botswana
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
USP	United States Pharmacopeia
USAID	United States Agency for International Development
VAT	Value Added Tax
VGFP	Vulnerable Group Feeding Programme
WHO	World Health Organization
WSS	White Star Super maize meal

CHAPTER 1 INTRODUCTION

WHAT IS FORTIFICATION?

Fortification is broadly defined as addition of specific amounts of one or more nutrients (vitamins and/or minerals and/or other nutrients such as protein) absent or present in low amounts into the food item. The purpose of fortification is to improve the nutritional quality of the food item, and to further combat the problems of macronutrient and/or micronutrient deficiencies. Thus, fortification has the following advantages (Department of Health, n.d.)

- It prevents or reduces the risk of the occurrence of micronutrient/macronutrient deficiencies in a population or specific population groups.
- It corrects a demonstrated micronutrient/macronutrient deficiency in a population. This can be realised through lower rates of mortality and promotion of normal growth, as well as improved school performance if children were initially affected.
- It improves the productivity of labour. That is, it increases workers' strength and their ability to work, resulting in better productivity.
- It reduces the expenses borne by the public health sector in taking care of illnesses related to micronutrient/macronutrient deficiency.

Fortification may be either voluntary or mandatory. Table 1.1 distinguishes between these two types of fortification. *Voluntary fortification* allows food manufacturers to decide on whether or not to add nutrients to foods, and the type and quantity of nutrients to add. Hence, voluntary fortification neither limits consumer choice nor forces unwilling companies to bear the financial costs of fortifying their products. In countries where consumer demand for fortified products is lacking, companies are generally unwilling to take the financial risks of fortifying their products. This is because any company venturing into product development, market research, and advertising runs the risks that its product may not be viewed by consumers as being superior to unfortified products from rival firms, leading to low or negative returns on investment in fortification. There is also likely a free-rider problem, in that in the event that the first entrant succeeds, companies that come in later may benefit without having invested in product development, research and advertising – if patenting laws are nonexistent or weak. A totally different response may emerge, depending on the country and consumer situation. A company

fortifying first may distinguish itself as supplying a differentiated product with appeal to the most educated and high income consumers, leading to its success. However, low income consumers will be left out as they cannot afford fortified products.

Mandatory fortification is required by law and, hence, all food manufacturers are required by law to comply. Its implementation is the responsibility of government. Mandatory fortification is commonly implemented in response to a significant public health problem related to nutrition, or the deficiency of a particular micronutrient/ macronutrient (Department of Health, n.d.; Health Systems Trust, 1996). Thus, it is justified on the basis of public health concerns, including, (i) the high prevalence of particular micronutrient/macronutrient deficiencies, and (ii) the high cost of treating illnesses associated with such deficiencies. The 1993 World Development Report reported that mandatory fortification is one of the most cost effective public health interventions, as fortification increased the unit cost of the product by no more than one percent (Health Systems Trust, 1996).

Table 1.1: Mandatory versus Voluntary Fortification

Criteria for Comparison	Mandatory Fortification	Voluntary Fortification
Definition	• Food producers are legally obliged to fortify products. • Most often used nutrients include iodine, iron, vitamin A and folic acid. • It can be of the following types: *Mass Fortification,* which entails adding nutrients to foods that are commonly consumed by the public in general; or *Target Fortification,* which involves adding nutrients to foods for specific groups of population (for example, government feeding programs).	• Food manufacturer chooses to fortify products through a permission given in law or encouraged to do so by the government.
Significance of public health need or risk of deficiency	• Likely to be instituted when there is a serious public health need or risk.	• Likely to be implemented in situations where there is lower public health risk.
Structure of the proposed industry (number of firms, capacity and geographical distribution).	• Likely where the industry is large, in terms of firm size. Where there are few small scattered firms, its implementation may become possible when such firms merge.	• Does not necessarily need to take into account the structure of the proposed industry, as it depends on the willingness and ability of an individual firm to fortify its product(s).

Criteria for Comparison	Mandatory Fortification	Voluntary Fortification
Level of knowledge about the benefits of fortification and interest in the fortified commodity.	• Likely when consumer knowledge is poor, and when there are slim opportunities for consumer education on the benefits of fortification.	• Generally dependent on the consumers' interest in, and knowledge about, the fortified product.
Level of government intervention.	• The government has to ensure the programme meets its objectives.	• Government has to exercise control to a limited extent.
The food consumption pattern and the technical suitability of food vehicles.	• Food vehicles should be those widely and regularly consumed by the majority of the population.	• Depends on commercial interests of the food producers/processors /manufacturers.
Level of certainty	• Delivers a higher level of certainty that the selected fortified food will be in constant supply, and this perhaps in a way guarantees positive public health impacts.	• Public health impacts may be negligible.

Source: Allen, et al., 2006

There are several factors that require close scrutiny before a policy decision is made regarding mandatory fortification. Firstly, the choice of the food vehicle should depend on the share of the population consuming the product, the technological feasibility of fortifying the products, and the economic sustainability of fortifying the product. Secondly, in order to promote success in supervising and monitoring the fortification process, and to ensure compliance with set quality standards, the food vehicle should be produced by a limited number of manufacturing firms. However, the selection of several food items to serve as vehicles may have to be done if consumption patterns vary greatly across the target population. Thirdly, effective support systems need to be put in place to support mandatory fortification. They include advocacy and social communication, regulations, and quality control and monitoring (at different levels from production to final consumption).

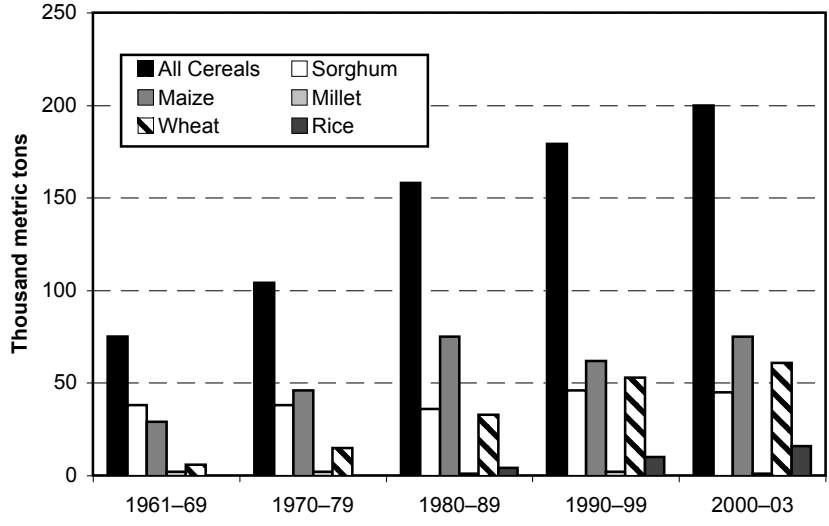
CEREAL CONSUMPTION PATTERNS

The 1994 micronutrient survey indicated that most households in Botswana consumed cereals every day, regardless of the season and social status (Belbase *et al.,* 1996). Therefore, cereals play a fundamental role as a source of nutrients for the majority of households, particularly poor households which cannot afford other products. To analyse trends in cereal consumption, data from the Food and Agriculture Organization

(FAO) was used (FAO, 2006). The analysis covered sorghum, maize, millet, wheat, and rice. Consumption of each commodity was estimated from the food balance sheet as domestic utilization.

Figure 1.1 plots average annual consumption for all cereals combined, sorghum, maize, millet, wheat, and rice. Cereal consumption has grown steadily over time. Maize has generally been the leading consumption commodity, followed by sorghum. However, wheat consumption has risen steadily over time and surpassed sorghum consumption in the 1990s. While rice consumption has also risen over time, its consumption levels are still much lower than those for the three leading cereals of maize, sorghum and wheat. Thus, the data show a slight change in consumption patterns towards increased consumption of wheat and rice, while the consumption of the major staples of sorghum and maize has remained more-or-less stagnant.

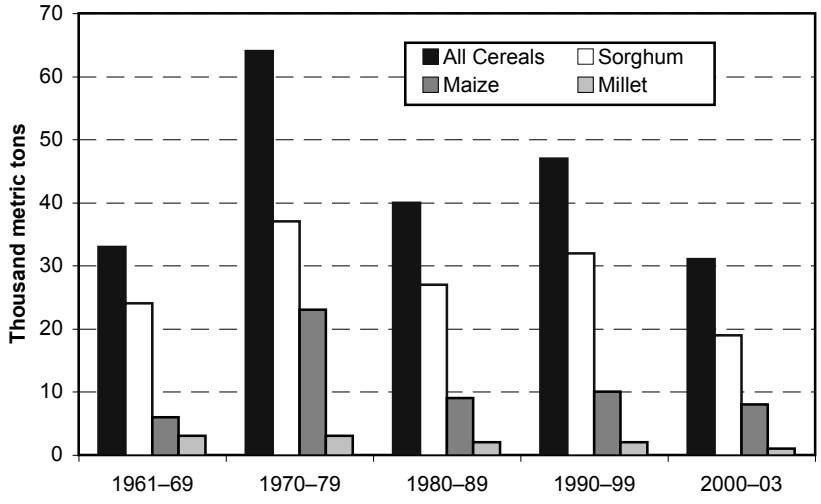
Figure 1.1: Average Annual Consumption of Cereals



Source: Author computed from FAO (2006)

Figure 1.2 plots average annual production figures for all cereals combined, sorghum, maize, and millet.[1] Total cereal production steadily declined after the 1970s. Sorghum has consistently been the leading production commodity, followed by maize. However, sorghum and maize production has steadily declined over time. Millet production is insignificant and has also declined over time. While sorghum has not always been the leading consumption commodity, it still remains the major production commodity. It is, therefore, the leading consumption commodity for subsistent households, followed by maize. Sorghum and maize are also the most consumed staples by poor rural and urban households. Hence, the two commodities are the most important for rural household food security. Fortification efforts should therefore target sorghum and/or maize to help improve the nutritional status of the poor who do not have diverse diets.

Figure 1.2: Annual Average Production of Cereals



Source: Author computed from FAO (2006)

SCOPE AND PURPOSE

The purpose of this publication is to examine the feasibility of mandatory fortification of cereals in Botswana. The rest of the publication is organised as follows. Chapter 2 briefly reviews existing literature on the state of malnutrition in Botswana. Specifically, it examines the extent, nature and causes of malnutrition in Botswana. While this subject has not been well researched in the context of Botswana, the chapter serves to provide a consolidated review of existing, albeit inadequate, literature on the subject. In Chapter 3, the state of cereal fortification in Botswana is examined. It becomes evident in this chapter that, with the exception of some of the government feeding programmes, cereal fortification activities are limited because of the lack of legal instruments on this subject.

Chapter 4 shows that the milling industry is characterised by the existence of small firms. It is argued that this situation may make mandatory fortification difficult to implement due to the likelihood that small firms would lack the capacity to fortify their products. Thus, for a mandatory fortification programme to be embraced in the industry, it should be simple and affordable to existing small-scale firms. It is further noted that since some firms also engage in service milling where they process raw grain for consumers at a fee, mandatory fortification may be difficult to comprehensively implement.

Chapter 4 also examines the cost of fortification for small-, medium- and large-scale firms, assuming that existing firms adopt the NFTRC/RIIC technology, where a ribbon mixer developed by the Rural Industries Innovation Centre (RIIC) is being recommended by the National Food Technology Research Centre (NFTRC). The technology was

designed for small- to medium-scale firms and the recommended premix is imported from South Africa. As expected the unit cost of fortification is inversely related to firm size, implying that fortification would be more costly to small-scale firms. Therefore, while mandatory fortification would be feasible for a typical (average) firm, it might be difficult for smaller firms given cost considerations.

Chapter 5 examines institutional issues such as advocacy and promotion, legislation and regulations, and quality assurance and control. It shows that regulations for mandatory cereal fortification are missing, and hence there would be need to develop such regulations as a key step towards devising a programme on mandatory fortification in Botswana. While the Botswana Bureau of Standards (BOBS) has been set up to oversee and enforce food standards, including fortification standards, the agency does not currently oversee any fortification programme. It is argued that BOBS needs to develop standards and strengthen/improve its capacity to handle all the activities of a mandatory fortification programme, including inspection and certification. Chapter 6 provides a summary and recommendations.

CHAPTER 2 THE STATE OF MALNUTRITION

INTRODUCTION

The extent and nature of malnutrition in Botswana has not been well researched and documented. The most recent study on malnutrition was conducted by the Ministry of Health in 1994 (Belbase *et al.,* 1996). This study was however not comprehensive in population coverage as it was restricted to women of child bearing age and children. The study established that, as is the case for many developing countries, Botswana experienced the nutritional problem of Protein-Energy Malnutrition (PEM) and deficiencies in micronutrients such as Vitamin A, Iodine and Iron. Since the 1994 study, there have been a number of developments regarding government intervention to combat malnutrition, and the nature of malnutrition has taken different forms. Firstly, due to publicly provided supplementary feeding programmes, malnutrition among children has been drastically reduced since the 1990s. Secondly, there are new nutritional challenges from the emergence of communicable diseases such as Tuberculosis (TB) and HIV/AIDS and non-communicable diet-related diseases such as diabetes, cardiovascular diseases, hypertension, gout and obesity.

These new health conditions may cause malnutrition in that they dictate the intake of additional foods and monitored special diets, which often are unaffordable. In addition, many of these diseases weaken the immune system of the patients, leading to the need for specialised diets. These new challenges have posed serious health threats to affected individuals, particularly the poor who cannot afford the diets required to address the health conditions. For example, it has been reported that hypertension, heart and other diseases affecting the circulatory system account for about seven percent of outpatient health attendance in Botswana. Thus, these health conditions are associated with high medical costs to both the affected individuals and government, and they cause premature death and various disabilities.

Nutritional problems in Botswana are a result of a variety of causes, including inadequate food intake, pre-disposal to diseases such as TB and HIV/AIDS, inadequate maternal and child caring practices, poverty and food insecurity, ignorance, taboo and lifestyle (Ministry of Health, 2005b). Population groups which are more vulnerable to micronutrient deficiencies include women, particularly those of child-bearing age, children under five years old and HIV/AIDS infected people (Belbase *et al.,* 1996; Ministry of Health, 2005b). Several government initiatives have been launched to combat malnutri-

tion and its causes, both directly and indirectly. Some of the programmes have involved direct food transfers to the needy segments of the population. The rest of this chapter reviews, in much greater detail, nutritional problems facing Botswana. Public interventions for addressing malnutrition will be discussed in chapter 3.

Nature and Extent of Malnutrition

The most common type of malnutrition in Botswana is known as Protein-Energy Malnutrition (PEM). However, the 1994 micronutrient study also reported iron, vitamin A and iodine deficiencies (Belbase *et al.*, 1996).

Protein Energy Malnutrition

Protein-Energy Malnutrition (PEM), which relates to clinical conditions ranging from mild underweight (low weight-for-age) to severe stunting (low height-for-age), is the most common type of malnutrition in Botswana. It may affect both children and adults if their consumption of protein and energy is below their nutritional needs. Table 2.1 reports the extent of PEM in children aged five years and under, for 1993 and 2000. The heights and weights of the children were measured using standard methods, and underweight and stunting was determined based on the WHO standard for children of the same age. About 26 percent of the children experienced stunting in 1993, compared to 23 percent in 2000. Thus, there was a marginal improvement from 1993 to 2000. When the rates are decomposed according to the extent of stunting, it becomes apparent that 18 and 8 percent of the children were moderately and severely stunted (respectively) in 1993, compared to 15 and 8 percent in 2000. Thus, the proportion of children experiencing severe stunting remained more-or-less unchanged between the two periods, whereas moderate forms of stunting were reduced, albeit only marginally. The incidence of wasting (low weight-for-height) fell from 6 percent in 1993 to 5 percent in 2000, a marginal improvement. The slight improvement in total wasting was due mainly to the improvement in moderate wasting. Thus, severe wasting was not considerably reduced between the two periods. The incidence of total underweight was also reduced slightly from 15 percent in 1993 to 12 percent in 2000. Decomposition into moderate and severe underweight shows that both incidences were reduced by about only one percentage point.

Table 2.1: Stunting, Wasting, and Underweight in Children Aged 0–5 Years

Year	Percent Stunted			Percent Wasted			Percent Underweight		
	Mod.	Sev.	Total	Mod.	Sev.	Total	Mod.	Sev.	Total
1993	17.7	8. 2	25. 9	5.1	0. 9	6.0	11.3	3. 3	14.6
2000	15.1	7. 9	23. 0	3. 9	1.1	5.0	10.0	2.4	12.4

Note: Mod. = Moderate, Sev. = Severe

Source: Ministry of Health (2005)

Table 2.2 reports June 2005 child malnutrition estimates by district, to reveal regional disparities in malnutrition status. The highest malnutrition rates, of about 12 percent, were recorded for Kgalagadi North and Mabutsane. These were followed by Good Hope, Kweneng West, Kgalagadi South, Kanye/Moshupa and Kweneng East, which recorded malnutrition rates ranging from 6 to 8 percent. This is somewhat consistent with national poverty statistics which indicate that Kgalagadi and Kweneng West have higher incidences of poverty, as measured by the income poverty headcount index, compared to the rest of the country (BIDPA, 1997). The lowest malnutrition rates were for Selebi Phikwe (1.1%), Lobatse (1.2%), Ngamiland (1.2%) and Gaborone (1.3%). What emerges, although with some exceptions, is that malnutrition is more predominant in rural areas, particularly in remote areas such as Kgalagadi and Kweneng West. With the exception of Francistown, cities/towns tend to record the lowest rates of malnutrition. The highest growth failure rates were recorded in Kgalagadi North and South. Interestingly, the spatial pattern of growth failure rates is not necessarily the same as that for total malnutrition rates, except for the fact that Kgalagadi records the highest malnutrition and growth failure rates.

Table 2.2: National Nutritional Status of Children Aged 0–5 Years, June 2005

District	No of Under Fives	No. in Attend-ance	Malnutrition (percent)			Growth Failure (%)	Percent Receiving Ration
			Mod.	Sev.	Total		
Bobirwa	9858	7079	4.0	0.7	4.7	6.1	93.8
Boteti	7692	6188	3.8	0.8	4.6	8.4	56.4
Chobe	2035	1652	1.9	0.3	2.2	2.4	77.4
Francistown	9183	6717	4.3	0.5	4.8	7.2	73.0
Gaborone	15780	8095	1.0	0.3	1.3	5.0	60.2
Good Hope	6132	5187	6.4	1.1	7.5	7.7	83.8
Jwaneng	1356	1015	2.1	0.1	2.2	1.9	16.3
Kanye/Moshupa	14734	11376	5.9	0.8	6.7	11.0	78.5
Kgalagadi North	1915	1744	9.6	2.2	11.8	15.1	86.9
Kgalagadi South	3437	3276	5.8	1.1	6.9	11.5	90.8
Kgatleng	8129	7657	4.0	0.7	4.7	4.0	88.1
Kweneng East	22022	17549	5.1	0.6	5.7	6.2	75.6
Kweneng West	5464	5785	6.2	1.1	7.3	4.8	90.4
Lobatse	2994	2651	0.9	0.3	1.2	4.7	88.6
Mabutsane	1371	1986	9.6	2.0	11.6	5.7	83.8
Mahalapye	15487	13302	4.1	0.9	5.0	2.7	78.6
Ngamiland	8646	7024	0.9	0.3	1.2	1.9	86.3
North East	6504	6910	2.3	0.6	2.9	6.0	77.5
Okavango	7173	6206	1.5	0.6	2.1	1.4	89.6
Selebi Phikwe	4980	3047	0.9	0.2	1.1	6.7	88.0
Serowe/Palapye	20758	15905	4.6	0.8	5.4	7.6	79.7
South East	6039	4558	2.0	0.2	2.2	2.6	78.9

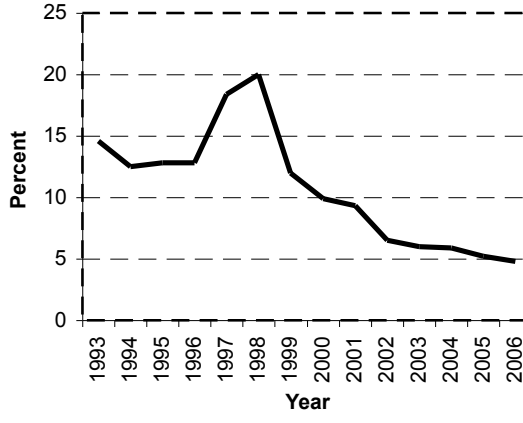
Note: Mod. = Moderate, Sev. = Severe

Source: Ministry of Health, 2005a

With the exception of Jwaneng, the proportions of children receiving rations through a publicly provided supplementary feeding programme were high in June 2005. Thus, both malnutrition and growth failure rates may have been much higher in the absence of the government feeding programme.

Child malnutrition rates have declined over time. A plot of malnutrition rates for under-five children indicates a declining trend over time (RoB and UNDP, 2004). During 1978 to 1984 child malnutrition rates ranged from 24 to 30 percent. From 1985 to 1998, malnutrition rates ranged from 12 to 20 percent. From 1999 to 2000, malnutrition rates ranged from 6.5 to 12 percent. The decline was partly caused by the government feeding programme being targeted at under-five children. Figure 2.1, which plots child malnutrition rates for 1993 to 2006, demonstrates the impact that the government feeding programme for the under-fives had. A consistently declining trend was evidenced during the period, with the exception of 1997 and 1998, where the highest malnutrition rates occurred. The substantial increase in malnutrition rates in 1997 and 1998 was due to the termination of the blanket feeding of under-five children in these years. Beginning in 1999, the government reinstated the blanket feeding of under-five children, and malnutrition rates were significantly reduced.

Figure 2.1: Malnutrition Rates, 1993-2006



Source: Food and Nutrition Unit (2006)

Iron Deficiency (Anaemia)

Iron deficiency is a common nutritional problem in developing countries. The prevalence rate of iron deficiency was estimated to be 30 percent for the entire world and 50 to 60 percent for developing countries (Belbase *et al.,* 1996). While no survey/study has been conducted recently in Botswana, it has been observed that there has been a rise in anaemia in adults, especially women. Generally, to estimate iron deficiency at the global, regional, or national level, anaemia prevalence is used as a proxy indicator. This assumption – namely that iron deficiency is the main cause of anaemia – is likely to hold true in industrialised countries but this is less certain in some regions of the developing world where other factors play an important role. These other factors include, for example, malaria and some other parasitic infections, current infectious diseases such as HIV/AIDS, and other pathologies, as well as other nutrient inadequacies that may limit haemoglobin formation. Any estimate of iron deficiency based on anaemia data can thus only be an approximation (UN, 2000).

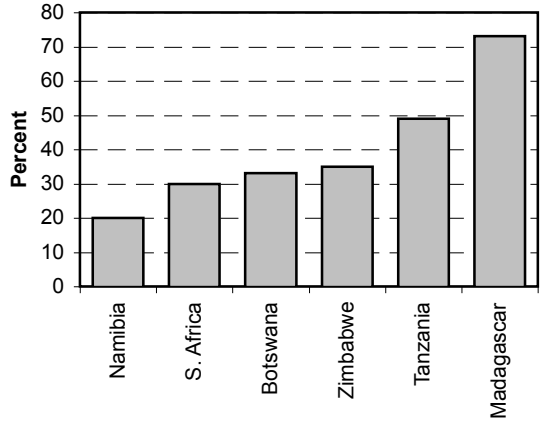
The 1986 epidemiological survey revealed that about 17 percent of the population was anaemic, and that the most affected group was children aged 3 to 36 months, followed by those aged 4 to 15 years (Belbase *et al.*, 1996). According to the micronutrient survey of 1994, about 38 percent of the surveyed children aged less than six years had anaemia (Belbase *et al.,* 1996). This figure is comparable to what occurs for developing countries in general. The figure for women was estimated to be slightly lower at 33 percent, surpassed by the developing country average of about 40 percent. Due to the increase in the prevalence of HIV/AIDS since 1994, the incidence of anaemia may now be higher than the 1994 estimates.

Vitamin A Deficiency

The 1994 micronutrient study showed that only two percent of the children surveyed had deficient (severe) vitamin A status, and about 35 percent had marginal vitamin A status.[2] Vitamin A deficiency was due primarily to the low consumption of leafy vegetables and fruits. The study further ascertained that only 27 percent of the children who were on the Tsabana ration recorded marginal or deficient status of Vitamin A, compared to 38 percent of those who were not benefiting from the programme.[3] While those children receiving Tsabana recorded lower prevalence rates of Vitamin A deficiency, the figure of 27 percent is still high when considering the fact that the Tsabana ration was formulated to primarily address Vitamin A deficiency. It is however unknown as to how much progress has been made since then, for children benefiting from the supplementary feeding programme.

According to Johnson and Philar (2005), the incidence of Vitamin A deficiency in Botswana stands at 33 percent. Figure 2.2 compares the incidence of Vitamin A deficiency for selected SADC countries, reflecting percentages of the population with less than 20 mg/dL retinol (Johnson and Phillar, 2005). While Botswana is surpassed by some of the southern African counties such as Madagascar (73 percent), Tanzania (49 percent), Zambia (66 percent) and Zimbabwe (35 percent), it fell above the WHO cutoff point of 20 percent. Moreover, Botswana surpasses some of its neighbouring countries such as Namibia (20 percent) and South Africa (30 percent). Hence, vitamin A deficiency remains a nutritional concern for Botswana and the wider SADC.

Figure 2.2: Vitamin A Deficiency for Selected SADC Countries



Source: Johnson and Philar (2005)

Iodine Deficiency

Iodine Deficiency Disorder (IDD) is reported to be generally low in Botswana. Total goitre rate in the country is estimated to be 16 percent (Ministry of Health, 2005b). The 1994 micronutrient study reported severe forms of IDD only for the Serowe/Palapye Sub-district with a total goitre rate of about 41 percent. Moderate levels of IDD were reported for Selebi Phikwe (22 percent) and North East District (25 percent). The low levels of iodine deficiency in Botswana may be due to the distribution of iodised salt through retails stores, most of which is imported from South Africa.

Causes of Malnutrition[4]

The causes of malnutrition in Botswana have not been systematically studied. According to the Ministry of Health (2005b), there are three broad categories of factors causing malnutrition: (1) immediate factors, (2) underlying factors and (3) basic factors. Immediate factors are those that account for the poor health status of an individual, and they include inadequate dietary intake and the prevalence of diseases. They are the main cause of child mortality and morbidity in developing countries. Underlying factors include household food insecurity, inadequate maternal and child caring practices, poor health services and unhealthy environment. Basic factors relate to the quantity and quality of human, economic and organizational resources available and the way they are controlled in the society (UNICEF, 2002).

Immediate Factors

Decline in the Prevalence and Duration of Breast Feeding: Breastfeeding is widely practiced in Botswana. According to the Family Health Surveys of the 1980s, the prevalence of breastfeeding was estimated at 98 and 91 percent in 1984 and 1988, respectively. The 1993 national study on the determinants of child nutritional status and the 1993 multiple indicator survey (MIS) reported breastfeeding prevalence rates of 96 and 90 percent, respectively. However, the duration period of breastfeeding appears to have declined over time. For example, it declined from 19 months in 1988 to 15 months in 1993. The 1993 data also indicates that 25 percent of children aged 12 to 15 months received breast milk together with semi-solid or solid foods, and that by the age of 20 to 23 months the prevalence of breastfeeding had fallen to 10 percent. The foregoing data, though not clearly conclusive on the dynamics of the prevalence of breastfeeding, appears to suggest that breastfeeding may have somewhat declined over time. Plausible reasons for this include participation of mothers in formal employment, HIV/AIDS infection, and the dilemma surrounding the issue of mother to child transmission (MTCT), cultural barriers, urban lifestyle, and the inadequate capacity of the health sector to give necessary advice and support to mothers (Ministry of Health, 2005b).

Early weaning of babies, or the complete absence of breastfeeding, contribute to malnutrition in that the alternative foodstuffs fed to babies do not generally provide all essential nutrients provided through breastfeeding (Kuzwayo, 1991). This is particularly

worrisome if mothers either lack nutritional knowledge or cannot afford to purchase infant formula and other nutritional foods that can help the baby to grow healthily. Thus, the affected children end up being given foods such as soft porridge made from sorghum or maize meal (flour) throughout the day, without regard to the nutritional composition of such foods and the nutritional requirements of the child. In this case, the food given to the child may supply excessive amounts of one particular nutrient (especially carbohydrates) and insufficient amounts of other essential nutrients, leading to malnutrition.

Improper and Unhygienic Preparation of Infant Formula: Although it is a good alternative to breastfeeding, infant formula feeding has some disadvantages. While, in certain cases, the milk contains pre-biotic agents that protect the infant from infection, it is easily contaminated and can be an excellent medium for the growth of microorganisms, which cause infection and contribute to malnutrition (Kuzwayo, 1991). Other disadvantages, such as those that concern cleanliness and proper preparation of the milk are controllable. The improper preparation of the milk and unhygienic conditions mainly cause diarrhoea, which further leads to loss of nutrients and dehydration. This is why infant-formula fed babies have higher morbidity or mortality rate, and are admitted into hospital very often.

Despite the foregoing disadvantages, particularly hygiene concerns, infant formula may be used to supply the nutrients required by children. However, the problem is that poor mothers have limited access to this alternative source of essential nutrients due to cost factors. Some mothers have gone to the extent of over-diluting the milk, a practice which gradually leads to under-nutrition (Kuzwayo, 1991). In Botswana, HIV positive mothers are supplied free infant formula for a period of one year. However, most of these mothers need adequate counselling on proper methods of formula preparation, good hygiene practices and proper frequency of feeding in order to prevent infant malnutrition and illness (Ministry of Health, 2005b).

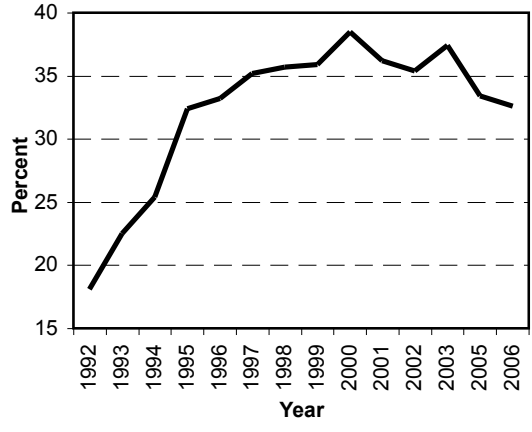
Lack of Product and Nutrient Diversity in Complementary Foods: Complementary feeding is the introduction of solid foods to the baby to diversify the diet from milk. Its main purpose is to provide the baby with nutrients that are insufficiently provided by breast or formula milk. These nutrients are protein, iron, zinc, carbohydrates, and vitamins A and D. Complementary foods differ from one community to the other. However, local staple cereals in the form of soft porridge are usually introduced first. Vegetables, fruits, pulse purees and dairy products like yoghurt are then introduced. As the baby becomes accustomed to these foods other foods high in protein, such as minced meat, fish and soft cheese, can be given. As chewing ability develops, finger foods can be introduced. The main aim of complementary feeding should be to provide required nutrients in sufficient quantities (Barasi, 1997). The ideal time to start giving solid foods to babies is when they are six months old. However, since infants grow differently, some mothers start feeding solid foods to their babies as early as four months.

There are three important elements that need to be considered when introducing

these foods: the age of an infant, the type of complementary foods and the frequency of feeding. The MIS study of 1993 showed that 57 percent of the children aged six to nine months were receiving breast milk and solid foods. The study further revealed that traditional complementary foods based on starchy cereals made into porridge, usually low in nutrient density and bulky in starch, were commonly given to babies, and that the consumption of fruits and vegetables was very low. Furthermore, children were given these foods three times instead of the recommended five times per day. The 1993 survey results showed that the prevalence of stunting was estimated to be 32 percent among children fed one to two meals a day, compared to 23 percent for those fed three times or more daily. This nature of feeding whereby the baby is given insufficient food, deficient of necessary nutrients for healthy growth, mainly contributes to under-nutrition of babies.

Prevalence of Diseases and Infections: Acute respiratory infections and diarrhoea are the leading causes of childhood morbidity in Botswana among children aged 12 to 24 months. These infections account for about 37 percent of all diagnoses and 15 percent of deaths in children under the age of 5 years (Ministry of Health, 2005b). Diarrhoea, which leads to malnutrition, is more prevalent among children aged 12 to 24 months. Since this age cohort coincides with the weaning period, the diarrhoea may be caused by feeding the children with contaminated foods introduced to wean the children from breast feeding (Belbase *et al*., 1996). HIV/AIDS is a serious health concern in Botswana, and has increased the rates of tuberculosis. These two health conditions have complex interactions with malnutrition. Mothers who are HIV positive are advised against breast-feeding and their babies are instead provided with infant formulas for a period of one year. HIV/AIDS itself leads to malnutrition as it destroys or weakens the immune system, and hence, creates a doorway for opportunistic infections. Furthermore, it increases nutritional requirements and reduces appetite. The Botswana annual sentinel surveys of pregnant women in all health districts indicated that the prevalence of HIV/AIDS increased from 18 percent in 1992 to 38.5 percent in 2000 (NACA, 2000). However, recent figures indicate a downward, though not substantial, trend to 35.4 percent in 2002 and 32.4 percent in 2006 (Figure 2.3). In more than half of the country, the prevalence was over 30 percent (NACA, 2002; NACA, 2006).

Figure 2.3: HIV Prevalence in Pregnant Women



Source: NACA (2000, 2002, 2006)

TB is also increasing at an alarming rate. Pulmonary TB cases for all ages during the six years from 1996 to 1999 and 2002 to 2003 were estimated to be 6636, 7287, 7960, 8647, 10823 and 10407, respectively. As previously noted, HIV/AIDS and TB contribute to malnutrition by increasing nutritional requirements, reducing food intake due to lack of appetite and interfering with nutrient utilization. These infections, therefore, demand too much of nutritional foods to boost the immune system. But not everyone can afford the type of foods required, leading to insufficient food intake and, hence, malnutrition (Ministry of Health, 2005b).

Underlying Factors

Household Food Insecurity: Food security is the ability of all people to have access to sufficient food to meet their dietary needs for a productive and healthy life at all times. Household food security depends on the availability and accessibility of safe and affordable food in adequate quantity, variety and quality. The groups that are vulnerable to food insecurity in the country include, poor people living in rural and urban areas, the disabled, the elderly, orphans, people living with HIV/AIDS (PLWHA), and female-headed households. Drought, unemployment and low agricultural productivity are the main causes of food insecurity in Botswana. Food insecurity leads to insufficient food both at family and country level, and hence is an underlying cause of malnutrition (Ministry of Health, 2005b).

Childcare Practices: Childcare is one of the factors that contribute to malnutrition in the country because most mothers or child caretakers often think that it is all about the provision of food to fill the stomach. Childcare is overlooked and not well understood. Most mothers and caretakers do not have proper knowledge, means required and sufficient time for proper childcare. Childcare includes providing the child sufficient food to meet his/her nutritional requirements, giving love, and supporting the child psychologically. Therefore, childcare goes beyond the provision of food. Foods must be purchased, well prepared and served in good condition. Poor childcare practices may occur where food is available but there is no one prepared to cook for the child. It might also involve the lack of supervision to ensure that the child eats the food once it has been prepared. These poor child care practices may lead to the baby being malnourished because of inadequate food intake (Ministry of Health, 2005b).

Basic Factors

Increase in Food Prices: The prices of foods and other commodities in Botswana have increased. These price increases have been generally due to inflation, caused by, among others, the devaluation of the Pula and the introduction of Value Added Tax (VAT) (Ministry of Health, 2005b).[5] Some segments of the population cannot afford to purchase some of the food that can help to develop or improve the nutritional status of individuals.

Chapter 3 The State of Cereal Fortification

Government Feeding Programmes[6]

Government implements a number of supplementary feeding programmes to combat hunger and malnutrition. They include the Vulnerable Group Feeding Programme (VGFP), Primary School Feeding Programme (PSFP), Community Home Based Care (CHBC) Programme, and Orphan Care Programme (OCP). In addition to providing food packages to the beneficiaries, some of these programmes also supply non-food support to the same beneficiaries. This section only discusses food packages provided under these programmes, placing concentration on fortified sorghum and maize products. We therefore only discuss the VGFP and CHBC programme since they include fortified cereal products in menus provided to beneficiaries.

Vulnerable Group Feeding Programme (VGFP)

Government provides fortified sorghum and maize products through the VGFP. This programme provides: (i) Soya weaning food (Tsabana) to all children aged 4 to 36 months as a take home package, (ii) enriched (fortified) precooked maize meal to all children aged 37 to 60 months, and to medically selected expectant and lactating mothers and TB patients, and (iii) dried skim milk to all children aged 37 to 60 months and medically selected expectant and lactating mothers and TB and leprosy patients, and (iv) vegetable oil for all beneficiaries.[7]

In general, the food items are provided to meet additional requirements of vulnerable groups. The provision of Tsabana and precooked maize meal to children under five years old and to pregnant and lactating mothers is intended to improve the growth and development of infants and foetuses, through improving their nutritional status. Tsabana is made from mixing sorghum meal with soybeans, and adding a premix predominant in vitamin A.[8] The reason for adding soybeans to sorghum meal is to increase the nutritive value of the meal, especially with proteins and some micronutrients like vitamin A, B complex, C, D and folic acid. Minerals such as iron, calcium, iodine, which are contained in the premix, are there to aid in the healthy growth of an infant. Enriched precooked maize meal supplies vitamins and minerals. The two products are precooked during the production process to reduce the consumer's cooking time which, if prolonged, can

destroy some of the unstable vitamins like vitamins C and B complex. Fermentation is not recommended as that can lead to loss of nutrients. Table 3.1 provides nutritional information for Tsabana and Enriched Precooked Maize Meal (EPMM). As is evident, the nutrient composition of the two products is similar, notable differences being with protein, vitamin B12, calcium, phosphorous and iron.

Table 3.1: Nutritional Information of Tsabana and Enriched Pre-Cooked Maize Meal (EMM)

			Percentage Recommended Daily Allowance		
	Per 100 g		Tsabana†	EPMM	
Type of Nutrient	Tsabana	EPMM	Child	Child*	Person**
Energy (kJ)	1470.000	1430.000	19	26	13
Protein (g)	15.000	7.500	49	35	14
Vitamin A (iu)	1650.000	1650.000	62	82	41
Vitamin D (iu)	200.000	200.000	37	50	50
Vitamin E (iu)	7.500	7.500	75	100	72
Vitamin C (mg)	80.000	80.000	133	177	133
Thiamine (B1) (mg)	0.800	0.800	86	114	67
Riboflavin (B2) (mg)	0.500	0.500	47	63	36
Pyridoxine (B6) (mg)	0.130	0.130	11	14	6.5
Vitamin B12 (mg)	0.002	0.020	75	100	66
Folacin (mg)	0.200	0.200	150	200	50
Pantothenic Acid (mg)	2.400	2.400	60	80	48
Niacin (mg)	8.000	8.000	67	88	50
Calcium (mg)	630.000	400.000	59	50	50
Phosphorus (mg)	600.000	400.000	56	50	50
Zinc (mg)	1.650	1.650	12	17	11
Iodine (mg)	0.050	0.050	54	71	33
Iron (mg)	6.500	6.000	40	40	33

†: Percent RDA for a child serving of 75g.

* Percent RDA for a child aged 4-6 years per Serving of 100g.

** Percent RDA for an Individual aged 10 years or more per serving of 100g.

Source: Foods Botswana (n.d.).

The effectiveness of the VGFP is monitored through regular assessments that are done on the under-five target group. Given existing resource constraints, the assessments are currently targeted only at this particular group since the under-five children are at the most critical stage of growth and development. Information is collected monthly from all the clinics providing rations for the under fives. The assessments focus on growth monitoring of under five children attending clinics and cover the following aspects: nutritional status, attendance rate and ration coverage. The report for September 2005

indicates that attendance has remained stable at 81 percent; total malnutrition decreased from 5.6 percent in July to 4.7 percent in September; growth failure also decreased from 7.4 percent in July to 6.1 percent in September and ration coverage increased by 4 percent from 79 percent in July to 83 percent by September.

The challenge regarding the effectiveness of the Tsabana programme is that some of the rations intended for children get consumed by other family members. For example, it is reported that fathers like Tsabana and in some cases get to consume their children's rations. In order to combat this problem, the Food and Control Unit in the Ministry of Health (MoH) responded by requiring that Tsabana powder be modified by reducing the particle size as this would make it smoother and less preferred by older family members. The extent to which this has reduced the problem has yet to be determined.

Community Home Based Care (CHBC)

The CHBC Programme was established in 1995 to give care to terminally ill individuals in their natural environments (their homes). The patients are looked after by their families, with support from social welfare officers and communities. The programme is intended to meet the spiritual, material and psycho-social needs of patients. The food basket provided under this programme is determined by a doctor or dietician and it is only provided to needy patients.

Patients are classified into five categories: (1) relatively healthy; (2) terminally ill but not on tube feeding, (3) terminally ill, and on tube feeding, (4) children aged 4 to 24 months not on tube feeding and (5) children aged 4 to 24 months on tube feeding. Patients classified as relatively healthy and terminally ill, but not on tube feeding are fed fortified pre-cooked maize meal (also called enriched maize meal), in addition to other recommended non-cereal products. Children aged 4 to 24 months and not on tube feeding receive Tsabana, and other non-cereal products. Thus, in addition to being provided under the VGFP, enriched maize meal and Tsabana are provided under the CHBC programme for patients who are not on tube feeding.

VOLUNTARY FORTIFICATION

Only large-scale milling firms engage in commercial sorghum and maize fortification on a voluntary basis. Table 3.2 provides a list of firms that have been engaged in voluntary fortification of sorghum and maize. In addition to producing Tsabana and Pre-Cooked Maize Meal (enriched maize meal) for government programmes, Foods Botswana has also been producing a fortified soya/sorghum blend (Tsabotlhe) for adults, which is sold outside the government contract. This is the only fortified sorghum meal produced on a commercial basis in the country. In 2005, Foods Botswana reported that it produced 60 tons of Tsabotlhe per month, a small amount relative to what the company produced on government contract.[9] Thus, the fortified sorghum product does not appear to be commercially successful, as unfortified sorghum meal is the most commonly utilised in the country. Foods Botswana itself reported that it produced about 800 tons of unfortified sorghum meal (Sechaba) on a monthly basis, a huge amount compared to Tsabotlhe.

Certainly, the demand for Sechaba must be much higher than that for Tsabotlhe based on these production statistics.

Table 3.2: Extent of Voluntary Cereal Fortification

Company	Fortified Product(s)	Examples of Unfortified Product(s)
Foods Botswana	Soya/Sorghum Blend (Tsabotlhe)	Sorghum Meal (Sechaba)
Bokomo Milling	White Star Super Maize Meal	Special Maize Meal
Bolux Milling	Super A1 Maize Meal	None

Source: Author prepared

Bokomo milling manufactures flour, samp, special and super maize meal. These products are sold locally through wholesalers and retailers. Only the super maize meal under the brand name White Star Super Maize Meal (WSS) is fortified based on South African legislation (since Botswana has no laws that regulate cereal fortification). The premix that is used is called Vita Plus Maize. However, Bokomo also produces an unfortified maize meal product, special maize meal, which is of lower quality compared to the WSS (Table 3.2). Bolux milling company produces Super A1 maize meal (SA1), which is fortified with Vit IS 353 premix, also based on south African standards. Table 3.3 provides nutritional information for WSS (for Bokomo) and SA1 (Bolux).

Ongoing Research and Development Activities

The University of Botswana TSHOLOFELO Project

The University of Botswana (UB) is currently conducting research on a protein and micronutrient fortified sorghum extruded product. The product is prepared from sugar beans and dehulled sorghum grain, and a mineral/vitamin premix, with the beans supplying the additional protein to increase the protein content of the sorghum. The sugar beans and sorghum are either sourced locally or imported from South Africa, depending on availability, while the premix is from Roche in South Africa. The tentative name of the product is "TSHOLOFELO" for "HOPE", but it is not yet finalised as the product is still under development. The price of the product is not yet set but it is packaged into 11 kg polyethylene containers during the study. The product is being tested on HIV infected children between the ages of 6 and15 years, but it is likely to be recommended for all children in the age group, regardless of infection status.

The consumer acceptance study was done on a group of children from Serowe who are in the same age group as those involved in the study, as well as a group of adults living in Gaborone, as they will be the ones buying the product for their children in the long run. The product was rated highly by both groups and the adults indicated that they would be willing to purchase it for their families. During the clinical trial of the product, information on preparation and portion sizes is provided to caregivers who would then prepare the porridge for the children on a daily basis. This is monitored through random home visits, particularly for problem clients. The product is provided in sufficient

Table 3.3: Nutritional Information of the Bokomo and Bolux Fortified Products

	Per 100g		Percentage RDA			
			WSS		SA1	
Type of Nutrient	WSS	SA1	Child *	Child/ Adult**	Child *	Child/ Adult**
Energy (kj)	1480.00	1430.00	–	–	–	
Protein (g)	8.60	6.80	25	15	12	20
Glycemic Carbohydrate (g)	74.20	72.20	–	–	–	–
Total fat (g)	1.30	1.60	–	–	–	–
Saturated Fat		*0.20*				
Trans fatty acids		*0.00*				
Dietary fibre (g)	2.90	3.20	–	–	–	–
Sodium (mg)	2.00	2.00	–	–	–	–
Vitamin A (mg RE)	188.00	188.00	31	21	31	21
Vit B1(Thiamine) (mg)	0.31	0.31	34	26	34	26
Vit B2 (Riboflavin) (mg)	0.18	0.18	20	14	20	14
Vit B3 (Niacin) (mg)	2.97	2.97	25	19	25	19
Vit B6 (Pyridoxine) (mg)	0.39	0.39	39	30	39	30
Folic acid (50%) (mg)	189	189	63	47	63	47
Iron (mg)	3.73	3.73	47	21	47	21
Zinc (mg)	1.89	1.89	17	17	24	17

*Source: Bokomo Milling Co. (nd); Bolux Milling Co. (nd). *: 4-13 years. **: age ≥13 years. WSS: White Star Super Maize Meal; SA1: Super A1 Maize Meal; RDA = Recommended Daily Allowance.*

quantity for a household of about five persons on a monthly basis, and assessments of blood and other tests such as anthropometric and biochemical indicators are conducted at baseline and quarterly during a 12-month feeding period. The product does not have any known health risks as pathogens and other microorganisms were tested for and found to be within standard acceptable limits. Prior to release of the product for clinical testing, samples are analysed for specific microbiological parameters by the laboratory at Foods Botswana. The nutrient composition (macro- and micro-nutrient) of the flour and cooked porridge is also evaluated by the Analytical Laboratory of the Department of Chemistry at the University of Botswana and the Chemistry Laboratory at NFTRC.

The HIV/AIDS epidemic has had a devastating impact on nutrition in countries that have been greatly affected by the disease. Despite this, the scientific evidence to support nutrition's role in disease prevention, care and treatment and to formulate recommendations is still not clear. WHO (2003) recommends that adequate nutrition is best achieved through consumption of a balanced healthy diet, and is vital for health and survival for all individuals, regardless of HIV status. Energy intakes need to be increased by 50% to 100% over normal requirements in children experiencing weight loss. However, the data are insufficient to support an increase in protein or fat requirements due to HIV infection. To ensure micronutrient intakes at RDA levels, HIV-infected adults and children are encouraged to consume healthy food. Tables 3.4 and 3.5 show the

proximate and micronutrient composition of the products that are used in the nutrition intervention for HIV+ children. They suggest that given the intake recommendation of 2–5 cups of porridge per day, the products can provide the daily requirements for most nutrients for children between 6 and 14 years of age.

Table 3.4: Proximate composition of Tsholofelo sorghum flour and porridge

	Flour		Porridge	
Nutrient	**Experimental**	**Control**	**Experimental**	**Control**
Protein (%)	13.22 ± 1.5	7.53 ± 1.2	3.57 ± 0.54	2.03 ± 0.43
Fat (%)	8.10 ± 0.55	10 ± 0.23	1.48 ± 0.34	0.97 ± 0.21
Moisture (%)	8.30 0.14	7.39 ± 0.28	75.52 ± 3.2	77.24 ± 4.1
Ash (%)	3.48 ± 0.13	1.78 ± 0.25	0.98 ± 0.11	0.68 ± 0.15
Carbohydrate (%)**	66.90	73.30	18.45	19.08
Crude Fibre (%)	2.48 ± 0.09	2.1 ± 0.56	0.67 ± 0.12	0.57 ± 0.09

*** determined by difference*

Source: Jackson et al., 2006

Table 3.5: Micronutrient composition of Tsholofelo sorghum porridge

Nutrient	**Experimental**	**Control**
Retinol (A)	0.033 ± 0.002	0.015 ± 0.003
Thiamine (B1)	0.128 ± 0.016	0.094 ± 0.005
Riboflavin (B2)	0.052 ± 0.006	0.042 ± 0.003
Niacin (B3)	0.049 ± 0.002	0.038 ± 0.004
Pyridoxine (B5)	0.050 ± 0.001	0.051 ± 0.003
Folic acid (B9)	0.052 ± 0.003	0.047 ± 0.003
Cyanocobalamin (B12)	0.023 ± 0.003	0.017 ± 0.002
Ascorbic acid (C)	1.461 ± 0.510	1.261 ± 0.285
Cholecalciferol (D)	2.463 ± 0.553	3.598 ± 1.397
Tocopherol (E)	6.888 ± 0.672	3.381 ± 0.719
Se (mg/g)	0.438 ± 0.035	0.481 ± 0.067
Zn (mg/g)	0.053 ± 0.000	0.039 ± 0.000
Fe (mg/g)	0.279 ± 0.014	0.204 ± 0.009
Ca (mg/g)	0.401 ± 0.022	0.378 ± 0.012
Mn (mg/g)	0.010 ± 0.000	0.010 ± 0.001
Cu (mg/g)	0.004 ± 0.001	ND
Mg (mg/g)	1.413 ± 0.015	1.054 ± 0.008
K (mg/g)	7.397 ± 0.371	3.554 ± 0.227
Na (mg/g)	1.739 ± 0.063	1.505 ± 0.072

ND = not detectable

Source: Jackson et al., 2006

NFTRC/RIIC Technology

The National Food Technology Research Centre (NFTRC) is currently conducting research on micronutrient sorghum meal fortification in Botswana. Sorghum was selected as the right food vehicle because research in selected areas in the country indicated that it is consumed by a significant proportion of households. The sorghum is fortified with a premix containing mostly Vitamin A. The project was divided into two phases. Phase 1 comprised of trials to determine the mixing efficiency of the mixer commissioned by RIIC, microbial quality analysis and shelf life studies of the fortified sorghum meal. Phase 2, on the other hand, will involve the feeding trials of the fortified sorghum meal to adult HIV positive persons. The project came about as a result of the findings of the 1994 Botswana Micronutrient study which indicated that Vitamin A malnutrition was a problem in Botswana.

The milling equipment that is currently being used by most of the millers in the country is fabricated by the Rural Industries Innovation Centre (RIIC). Hence, NFTRC approached RIIC to request them to fabricate a ribbon mixer for them. The ribbon mixer whose capacity is 150 kg is suitable for small scale millers. The equipment was specifically developed for sorghum fortification trials for NFTRC. For the trials at NFTRC, it was found out that, to fortify sorghum, 3kg of diluted premix (which is bought from South Africa) was needed to fortify 150kg of sorghum. The trials also showed that efficient mixing was achieved in between 5 and 10 minutes. The fortified samples are packaged in opaque plastic bags to avoid sunlight.[10] For commercialization of the ribbon mixer, RIIC will deliver, install and train the millers on the usage of the mixer at a cost. Efforts are currently underway to reduce the cost of the mixer so that it is affordable to small scale millers.

EXISTING GAPS

Limited Extent of Commercial Fortification

As noted earlier, there are only two broad forms of cereal fortification that take place in Botswana. The first involves the production of Tsabana (sorghum-soy blend) and Enriched Maize Meal by a commercial miller on Government contract. These products are provided to beneficiaries under the VGFP and the CHBC programme. Besides Tsabana, sorghum porridge consumed in the country is prepared from unfortified flour produced by local millers. Even the sorghum flour going through the food retail chain is unfortified. Thus, except for the publicly provided food rations to vulnerable groups and the needy terminally ill, sorghum meal going through the commercial distribution system is unfortified. As will be seen from Chapter 4, sorghum milling is generally in the purview of small milling firms, who individually may have no capacity to engage in fortification.

Moreover, beneficiaries from those government programmes whereby rations are procured from or provided through local retail stores also receive unfortified products. Examples are the Orphans Care Programme (OCP) and the Primary School Feeding Programme (PSFP). Food baskets for orphans are provided by the Department of Social Services through local retailers.[11] The food basket is based on the nutritional requirement of the child, which varies with the age of the child. The menu is drawn to ensure that each child gets a healthy diet. While the menus provide balanced diets for orphans, it is worth noting that children aged four months to 18 years are fed sorghum porridge prepared from unfortified sorghum meal distributed through the food retail chain. The PSFP provides varying menus from Monday to Friday. Products in the menus include unfortified sorghum or *voluntarily fortified* maize meal, vegetable oil, beans, jam, peanut butter, fruit drink and stewed beef steak. Since the menus do not meet the child's daily requirements of nutrients, they could be enhanced if the porridge is prepared from fortified sorghum meal, rather than from unfortified meal procured through the retail chain. The same concern arises for the destitute package, where beneficiaries receive unfortified sorghum meal through local retail stores.

Lack of Fortification Legislation and Regulations

As previously noted, progress has been made with regard to voluntary fortification of maize flour going through the retail chain. This is because maize milling is generally in the purview of large scale firms with the capacity to engage in fortification at low cost. The firms have adopted South Africa's standards (see earlier discussion), which might have been introduced to minimise competition with imported fortified maize meal from South Africa. While this is commendable, the challenge is that not all the products are fortified since there is no legislation requiring millers to comply. Moreover, there are no enforcement mechanisms in place to ensure that millers reach standards. Thus, it cannot be ascertained that firms that have voluntarily fortified their maize do actually comply with the South African standards that they are supposedly emulating.

CHAPTER 4 INDUSTRY STRUCTURE AND FORTIFICATION COSTS

INTRODUCTION

A survey of millers was conducted from November to December 2005, to gather information on the structure of the milling industry. A list of registered millers, obtained from the Ministry of Agriculture, showed that there were 57 sorghum, maize and millet millers countrywide. Since the number was small, it was decided to administer the survey instrument to all of them. However, 13 millers were excluded since they had collapsed or declined the interview. Of the remaining 44, three were excluded as they did service milling only, leaving a total of 41 firms that participated in the survey. Data analysis covered only 40 firms because the largest firm in the sample was an outlier in terms of the volume of output and the milling technology used. Moreover, this firm was already involved in fortification activities through government contracts.

INDUSTRY STRUCTURE

Number and size of firms

Table 4.1 categorises firms according to the business activity they were engaged in. The majority of the firms, 70 percent, did sorghum milling as a sole activity. About 15 percent were engaged in sorghum and millet milling, 8 percent in sorghum and maize milling, and another 8 percent in sorghum, maize and millet milling. All the firms were either involved in sorghum milling as a sole activity or jointly with other activities. Thus, sorghum milling was a major activity in terms of the number of firms involved. It is also evident that only sorghum milling occurred as a sole activity for

Table 4.1: Business Activities

Activity	No of Firms	Per cent
Sorghum milling only	28	70.0
Maize milling only	0	0.0
Millet milling only	0	0.0
Sorghum and Maize	3	7.5
Sorghum and millet	6	15.0
Maize and millet	0	0.0
Sorghum, Maize and Millet	3	7.5
Total	**40**	**100**

Source: Author computed from miller survey.

the firms interviewed, and maize and millet were undertaken together with sorghum milling.

The importance of sorghum milling is also highlighted in Table 4.2, which shows that 95 percent of the 40 firms ranked it (sorghum) as the leading business activity. This is in contrast to maize milling, which was ranked as the leading activity by only 33 percent of the 6 firms engaged in maize milling.

Table 4.2: Firm Ranking of Cereal Milling Activities

	Rank†				Average quantity processed monthly (metric tons)
Activity	1	2	3	Total	
Sorghum milling	38 (95.0)	2 (5.0)	0 (0)	40 (100)	80.9
Maize milling	2 (33.3)	2 (33.3)	2 (33.3)	6 (100)	85.5
Millet milling	0 (0)	8 (88.9)	1 (11.1)	9 (100)	0.53

Source: Author computed from miller survey. †: 1; 2; 3 = most important, second most important, and third most important business activity, respectively; figures in parentheses are percentages of the total number of millers engaged in each business activity.

Table 4.3 provides a summary of total monthly output by firm size. For sorghum, small-, medium-, and large-scale firms collectively produced about 146, 666 and 873 metric tons per month. Thus, most of the sorghum was produced by the 7 large-scale firms, followed by the 14 medium-scale firms and finally the 19 small-scale firms. For maize, there were only small-scale firms, who collectively produced about 32 metric tons of flour per month. Existing large-scale maize millers, who are few in the industry, did not respond to the survey. While their inclusion would have substantially increased total maize output, it would not have affected fortification cost analysis as these millers are already engaged in fortification activities using South African standards. The millet results indicate that all the firms were small-scale and that they collectively produced about 3 tons of flour per month, which is marginal. The key emerging conclusion is that sorghum milling is characterised by the existence of numerous small firms, whereas maize milling is dominated by a few large firms (although the latter did not respond to the survey). Millet milling is insignificant and it is generally in the hands of a few small millers who also engage in non-millet milling activities – it was not cited as a leading activity by any of the millers interviewed (see also Table 4.2).

Table 4.3: Total Monthly Output in Metric Tons by Firm Size†

Activity	Small	Medium	Large	Total
Sorghum	145.7 (19)	666.3 (14)	873.4 (7)	1685.3 (40)
Maize	32. 3 (6)	0.0 (0)	0.0 (0)	32.3 (6)
Millet	3.3 (9)	0.0 (0)	0.0 (0)	3.3 (9)
Total	**181.3 (19)**	**666.3 (14)**	**873.4 (7)**	**1720.9 (40)**

Source: Author computed from miller survey. †Firm size is based on monthly output: small= 0 to 20 metric tons per firm; medium = 20 to 100 metric tons per firm; large = over 100 metric tons; figures in parentheses represent the number of firm.

Table 4.4 shows that on average, a small-scale sorghum miller produced about 8 metric tons of flour per month. Output for small-scale sorghum firms ranged from 1 to 19 metric tons per month. A medium-scale firm produced an average of 48 metric tons of sorghum per month. Output for medium-scale firms ranged from 21 to 90 metric tons per month. Large-scale millers produced an average of 125 metric tons of sorghum per month, with output ranging from 105 to 151 metric tons per month. The figures for maize and millet can be interpreted along similar lines.

Table 4.4: Minimum, maximum and mean monthly production per firm in metric tons

	Small			Medium			Large		
Activity	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Sorghum	0.9	19.4	7.7	20.9	90.1	47.6	105.0	151.0	124.8
Maize	0.5	15.8	5.4	–	–	–	0.0	0.0	0.0
Millet	0.3	1.0	0.4	–	–	–	–	–	–
All Products	**0.9**	**19.4**	**9.5**	**21.2**	**90.1**	**47.6**	**105.0**	**151.0**	**124.8**

Min = minimum, Max = maximum

Source: Author computed from miller survey

Table 4.5 reports total employment levels by business activity. In total, all firms employed 570 people, or 14 people per firm. The 28 firms which specialised in sorghum milling accounted for a total workforce of 234 people, which averaged 8 people per firm. Those producing sorghum and maize and sorghum and millet had much higher average employment levels. This is due to the fact that most of these firms are relatively larger, in terms of output, than the ones producing sorghum as a sole activity.

Table 4.5: Total employment levels by business activity

Activity	Total Employees	Total Firms	Employees per Firm
Sorghum only	234	28	8
Sorghum and maize	130	3	43
Sorghum and millet	175	6	29
Sorghum, maize and millet	28	3	9
Total	**570**	**40**	**14**

Source: Author computed from miller survey

Table 4.6 conducts a further analysis of employment levels. Most of the firms were small. If we consider those engaged in sorghum milling alone, 11 out of the 28 firms (39 percent) employed only 1 to 4 people. Thus, the majority of the firms engaged in sorghum milling were small. A similar picture emerges when examining employment levels for all firms. In total, about 16 of the 40 firms (40 percent) employed 1 to 4 people per firm and 9 firms (22.5 percent) employed 5 to 8 persons per firm. Thus, about 63 percent of the firms employ

8 or less people per firm. These results indicate that the cereal milling industry, particularly sorghum milling, is dominated by numerous small-sized firms.

Table 4.6: Employment levels by business activity

Business	Employment range									
Activity†	1-4	5-8	9-12	13-16	17-20	21-24	25-30	31-35	119-167	All
Sg only	11	6	2	4	1	2	1	1	0	28
Sg & Mz	1	1							1	3
Sg & Ml	2	2	1						1	6
Sg, Mz & Ml	2					1				3
All firms‡	**16 (40.0)**	**9 (22.5)**	**3 (7.5)**	**4 (10.0)**	**1 (2.5)**	**3 (7.5)**	**1 (2.5)**	**1 (2.5)**	**2 (5.0)**	**40 (100)**

Source: Author computed from miller survey. †: Sg= sorghum; Mz = maize and Ml= millet. ‡: Figures reported in parentheses are percentages of millers for each employment range.

Firm Technology

It has been demonstrated that sorghum milling is the major economic activity in terms of the number of firms involved. With the exception of fortification activities carried out on government contracts, sorghum milling products going through the food chain are unfortified.[12] Thus, the sorghum milling process is simple. It involves dehulling, milling and packaging. Table 4.7 shows that the majority of firms own one or two dehullers, hammer mills and packaging (sealing) equipment: about 77.5, 67.5 and 95.0 percent of the millers own one to two hammer mills, dehullers and packaging (sealing) equipment, respectively. Thus, most of the firms are small, as they own little milling equipment.[13]

Table 4.7: Equipment Ownership

Type of	Number of Pieces of Equipment Owned						
Equipment	1	2	3	4	5	6	Total
Hammer mill	19 (47.5)	12 (30.0)	5 (12.5)	2 (5.0)	0 (0)	2 (5.0)	40 (100)
Dehuller	17 (42.5)	10 (25.0)	5 (12.5)	4 (10)	4 (10)	0 (0)	40 (100)
Packaging (Sealing)	32 (80.0)	6 (15.0)	2 (5.0)	0 (0)	0 (0)	0 (0)	40 (100)

Source: Author computed from miller survey

Three kinds of millers can be distinguished, based on the milling activities performed: (1) those involved in purchasing raw grain, milling and packaging it and selling flour through wholesalers and retailers, (2) those doing only service milling to process raw grain for consumers at a fee, and (3) those engaged in both (1) and (2). Of the 40 firms interviewed, ten (25 percent) belonged to category one and 30 (75 percent) belonged to category three. As noted previously, three firms were excluded from the survey as they did only service milling. Including the three firms would not have significantly altered the results.

Cost of Fortification

Identification and Quantification of Fortification Costs

Fortification programmes are implemented at a cost. This section examines the miller cost of fortification. An attempt is made to capture all fortification costs that will be incurred by the milling industry. Since progress has been made with respect to maize milling, based on South African standards, this section is primarily relevant for sorghum fortification. Our assumption is that existing firms would adopt the RIIC/NFTRC technology since it has been designed for small- to medium-scale firms. We used partial budgeting, looking at only the cost side rather than both the cost and income sides. Partial budgeting is used "in analyzing the relatively small changes in the business such as the purchase of a piece of equipment …" (Boehlje and Eidman, 1984; p237).

Since we are only examining the cost side, we need to identify additional expenses to millers, associated with the introduction of mandatory fortification. Additional expenses include depreciation, interest, premix, electricity, packaging, labelling, and repairs and maintenance. We also included contingency to account for price changes and any underestimations of costs. Unit cost computations adopt two scenarios. For scenario 1, we assumed that each firm produces its own diluted premix. For scenario 2, we assumed that the production of the diluted premix is centralised in the hands of a few large-scale commercial millers, who then sell in required quantities to other millers. Individual fortification cost items are discussed below.

Depreciation Cost: The RIIC plug-on ribbon mixer, with the capacity to hold 150kg of flour per run, costs P23 000. RIIC charges P2.75 per kilometre to deliver the equipment to the firm. In computing delivery costs to the miller, we assumed a distance of 120km, which is equivalent to delivering the equipment from Kanye (where RIIC is located) to Gaborone (the capital city). Thus, delivery costs amount to P330.[14] RIIC charges a fixed amount of P833 to train the operator on how to use the equipment. It is assumed that only initial training is required and that subsequent training will be on-the-job. It is further assumed that only one person is trained per firm, who would subsequently train other employees on the job. Total equipment cost at the mill was computed by summing ribbon mixer, training and delivery costs. We assumed that each firm, irrespective of its size, would require only one ribbon mixer – based on prevailing output levels. The largest firm, for example, would require 6.85 hours of mixing time per day, given its output level.[15] Thus, the total cost of the equipment per firm stands at P24,163. RIIC estimated the lifespan of the equipment to be 10 years. We used the straight-line method to compute depreciation.

Interest Charges*:* Two interest rate scenarios were considered. In the first one, we assume that each firm will acquire a loan from a commercial bank to purchase the equipment (ribbon mixer). Thus, the interest charge on the ribbon mixer will be fully borne by the firm. The prime rate was reported to be 16.5 percent by seven commercial banks in Gaborone. The same banks charged additional interest, over the prime rate, ranging

from 4 to 16.5 percent. Thus, total interest rates ranged from 20.5 to 33 percent. We adopted the average of the seven banks, which was estimated at 26.5 percent. In the second scenario, we assumed that firms would be eligible for grants under the Citizen Entrepreneurial Development Agency (CEDA), a public support programme tasked with issuing loans at subsidised interest rates. CEDA interest rate on the purchase of the ribbon mixer would stand at only 5 percent.[16]

Labour Expenses: Introducing fortification will require additional labour as it involves an additional step in the milling process. Additional labour will be required, for example, to operate and monitor the fortification equipment and to add the micronutrient premix to the ribbon mixer. Moreover, where the firm produces its own diluted premix, some additional labour will be required. For each additional unskilled worker that will be needed a wage rate of P3.10 per hour, which is the rate for the manufacturing sector, was assumed. It was further assumed that a month has 25 working days and that a standard day has 8 work-hours. It is further assumed that small-, medium- and large-scale firms require one, two and three additional workers, respectively.

Cost of Premix: According to NFTRC, a two-step process is required to fortify flour. In the first stage, a diluted premix is formulated by mixing 29.85kg of unfortified flour with 0.15kg of premix concentrate. The diluted premix is then packaged into 3kg bags. Therefore, each 3kg bag of diluted premix contains a premix-concentrate of 0.015kg. In the second stage, the 3kg diluted premix is mixed with 147kg of unfortified flour to yield 150kg of the final product. Thus, technically, a 0.015kg of concentrate is mixed with 149.985kg of unfortified flour. It follows that the quantity of the premix-concentrate required is computed as: *annual quantity of concentrate = 0.015*(annual firm output)/149.985*. According to information from NFTRC, the cost of the concentrate was estimated at R342.06 per kg, which is expressed in South African Rand.[17] Thus, we computed the cost of the premix as: *annual cost of premix = (342.06*annual quantity of concentrate)/(rand per pula exchange rate)*. To arrive at a final figure we added a mark-up of 20 percent, to account for transportation costs from South Africa to Botswana.

Electricity Expenses: NFTRC trials indicated that it takes between 5 and 10 minutes for the ribbon mixer to bring about a uniform mixture to the product. Taking the upper bound limit as the rule of thumb, it follows that it takes 10 minutes to produce 150kg of the final product. Therefore, *total annual mixing hours = (annual firm output + annual quantity of concentrate)/(6*150)*. The motor used in the ribbon mixer is of 5.5 kilowatts (KW). Botswana Power Corporation (BPC) charges P0.35/KW.Hr, P0.18/KW.Hr and P0.16/KW.Hr, respectively, for small-scale, medium-scale and large-scale firms. Therefore, *annual electricity expense in Pula = 5.5 KW*(Pula/KW.Hr)*total annual mixing hours*. The categorization of firms according to size based on electricity consumption was not possible given available data. Therefore, to avoid underestimation of costs, we adopted the charge of P0.35/KW.Hr for all firms, irrespective of size.[18] Electricity costs were separately computed for diluted premix

preparation and for final fortification. In scenario 2, only the latter is applicable.

Packaging Expenses: Two packaging processes will take place. In the first stage, the premix is prepared and packaged into 3kg bags. In the second stage, the premix is mixed with unfortified flour to prepare a fortified product, which is then packaged into 10kg bags and sold to retailers for further resale to final consumers. A leading plastics manufacturer charges P500 per one thousand 3.5kg regular bags and P750 per one thousand 5kg bags. If we interpolate linearly, one thousand 3kg bags would cost P550, or P0.55 per bag. The firm estimated that an opaque bag would cost 40 percent extra, which leads to P0.77 per 3kg premix bag. The same firm currently charges P1.10 for a regular 10kg sorghum flour packaging bag. The firm estimated that an opaque bag, which would be suitable for packaging fortified sorghum flour, would cost 40 percent extra, implying an estimated additional cost of P0.44 per bag. In Scenario 2, where the diluted premix is purchased, the 3kg bag is not required, and, hence, its cost is not applicable.

Labelling Expenses: A leading plastics manufacturer pointed out that an additional labelling plate, for nutritional information, would be required in addition to the current plate used by existing firms. Each labelling plate would cost P1000.00, and can be used to label (stamp) up to 300,000 bags. We computed labelling cost as: *annual labelling cost = (cost of labelling plate/no of bags per stamp)*(annual output)/10*. For simplicity a standard quantity of 10kg is assumed.

Repairs and Maintenance: We assumed that the annual maintenance costs stand at 10 percent of equipment cost. Although this may be a high figure, reducing it to zero, for example, did not alter the estimated fortification costs per kg, when rounded to two decimal places.

Results

Scenario 1: Decentralised Production of Diluted Premix: Table 4.8 (overleaf) presents key statistics that were used to compute cost of fortification for typical firms. The second column presents the data for an average firm. This is a hypothetical firm producing an average output of all the 40 firms included in the analysis. The third, fourth and fifth columns present summary statistics for average small-, medium-, and large-scale firms, respectively.

Table 4.9 (overleaf) reports fortification costs for "typical" firms. The results depict additional firm costs for the first year of introducing a fortification programme. Assuming prevailing prices hold in subsequent years up to the lifespan of the ribbon mixer, the only cost item that would change is interest. Over time, interest payments would go down following principal repayments, and would not exist after all of the loan amount had been repaid. However, this would not substantially alter (reduce) unit fortification costs, in subsequent years, since interest is not a major cost item. The major cost items across firm sizes are labour, packaging and premix. An average firm, producing about 516 metric tons of fortified flour per year, would incur about P0.15/kg

of flour produced. Similarly, average small-, medium-, and large-scale firms would incur unit costs of P0.26/kg, P0.15/kg and P0.12/kg, respectively.

Table 4.8: Summary Statistics for Computing Fortification Costs

		Typical (average) firm			
		All firms	**Small**	**Medium**	**Large**
Annual Output:	Unfortified (kg)	516,000.00	114,000.00	571,200.00	1,497,600.00
	Fortified (kg)	516,051.61	114,011.40	571,257.13	1,497,749.78
Premix:	Concentrate (kg)	51.61	11.41	57.13	149.78
Packaging:	No of 3kg bags (premix)	3,440.34	760.08	3,803.38	9,985.00
	No of 10kg bags (flour)	51,605.16	11,401.14	57,125.71	149,774.98
Packaging cost:	Pula/3kg bag	0.77	0.77	0.77	0.77
	Pula/10kg bag†	0.44	0.44	0.44	0.44
Additional workers (number)		2	1	2	3
Hours of mixing:	Premix	11.47	2.53	12.69	33.28
	Flour	573.39	126.68	634.73	1,664.17
	Total	584.86	129.21	647.42	1,697.45
	Per day	1.95	0.43	2.16	5.66
Ribbon mixers (number)		1	1	1	1
Cost of premix concentrate:					
	SA rands/25 kg	342.06	342.06	342.06	342.06
	SA rands/kg	13.68	13.68	13.68	13.68
Months of use of 25 kg premix concentrate		5.81	26.92	5.25	2.00

†: *reflects additional costs associated with replacing an ordinary plastic bag with an opaque plastic bag.*
Source: Author computed

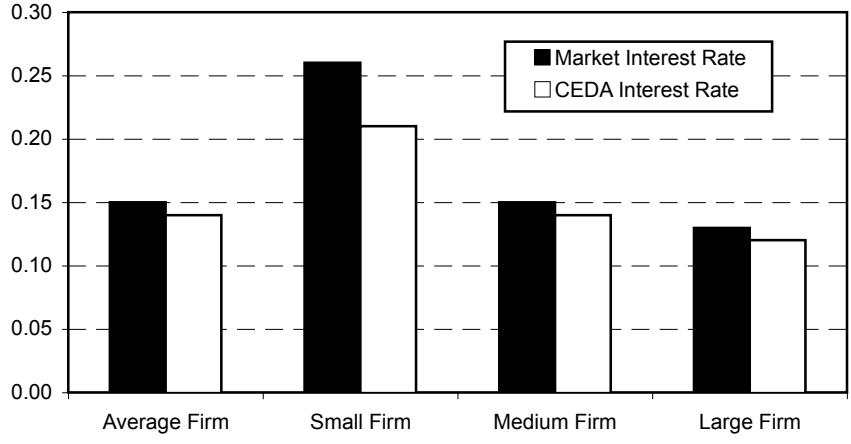
Table 4.9: Estimates of annual fortification costs for year one by firm-size in Pula

	Typical (average) firm			
Cost item	**All firms**	**Small**	**Medium**	**Large**
Depreciation	2,421.30	2,421.30	2,421.30	2,421.30
Interest	6,416.45	6,416.45	6,416.45	6,416.45
Labour	14,880.00	7,440.00	14,880.00	22,320.00
Premix	20,861.53	4,608.94	23,093.23	60,546.94
Electricity: Premix	22.08	4.88	24.44	64.07
Final Product	1,103.78	243.86	1,222.86	3,203.52
Packaging: Premix	2,649.06	585.26	2,932.45	7,688.45
Final Product	22,706.27	5,016.50	25,135.31	65,900.99
Labelling	172.02	38.00	190.42	499.25
Maintenance and Repair	2,300	2,300.00	2,300.00	2,300.00
Sub-total	71,232.48	26,775.19	76,315.45	169,060.97
Contingency (10 percent)	5,948.45	2,677.53	6,241.26	16,906.10
Total cost	78,355.72	29,452.10	83,946.99	185,967.06
Firm output (kg)	516,051.62	114,011.40	571,257.13	1,497,749.78
Unit Cost (Pula/Kg)				
With 10% contingency	0.15	0.26	0.15	0.12
Without 10% contingency	0.14	0.23	0.13	0.11

Source: Author computed

When assuming that the purchase of the ribbon mixer is financed through a CEDA loan, with an interest rate of 5 percent, interest expenses for each firm category go down from P6,416 to P1,211. The unit cost of fortification, for an average firm, is then reduced from P0.15/kg to P0.14/kg. Similarly, the unit cost of fortification for small-, medium-, and large-scale firms (with a 10 percent contingency included) goes down to P0.23/kg, P0.13/kg and P0.11/kg, respectively. Figure 4.1 compares unit costs for the two interest rate scenarios by firm-size. Evidently, acquiring a subsidised CEDA loan would reduce unit cost substantially for small-scale firms. While medium- and large-scale firms would benefit, the savings made from the reductions in unit costs are not as substantial as for small-scale firms.

Figure 4.1: Scenario 1 fortification cost per kilogram of flour



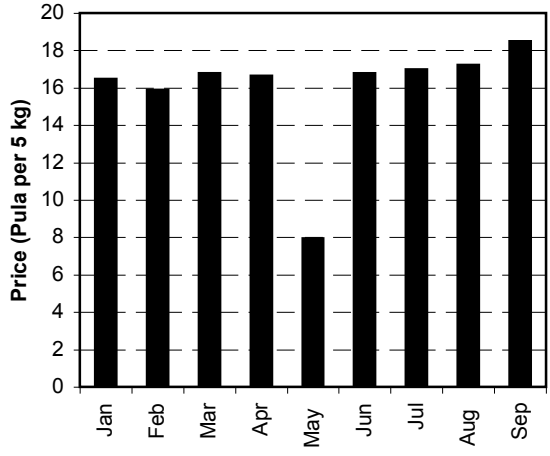
Source: Author computed

Scenario 2: Centralised Commercial Production of Premix: Scenario 1 assumed that each firm produced its own diluted premix from the premix-concentrate. Table 4.8 shows that an average firm requires only 51.61kg of premix concentrate per year. Average small-, medium-, and large-scale firms require 11.41kg, 57.13kg and 149.79kg of concentrate premix per year, respectively. The minimum quantity of concentrate premix supplied by the manufacturer in South Africa stands at 25kg. Therefore, an average firm would utilise the 25kg bag over 5.81 months. An average small-, medium-, and large-scale firm requires 26.92 months, 5.25 months, and 2.00 months to use all of the 25kg premix concentrate (Table 4.8). However, the shelf-life of the premix imposes a constraint with respect to the time over which a single bag can be used. NFTRC estimates that the time between opening the premix concentrate and consumption of the final product should not exceed 6 months. Given this criterion, it would be feasible for only large-scale firms to produce their own diluted premix. Even then, the two-month period required for an average large-scale firm, would place a constraint on the maxi-

mum amount of time the product can stay in supermarket shelves and, ultimately, be used by final consumers.

Given the above considerations, it would be more technically feasible for small- to medium-scale firms to participate in a mandatory fortification programme if the diluted premix is centrally produced and supplied to these firms in 3kg bags. This section examines fortification costs where it is assumed that diluted-premix production is centralised. The cost of the diluted premix was approximated using retail prices of sorghum for Gaborone. Figure 4.2 plots retail prices of sorghum for Gaborone for the period from January to September 2006. Data for October 2006 to the current time were unavailable. Therefore, we assumed that the average price for 2007 was P20 per 5kg bag, implying that a 3kg bag would cost P12.00. Assuming that the diluted premix is produced by a medium-scale firm, it would cost an additional P0.15 per kilogram, or P0.45 per 3kg. Adding fortification cost to the retail price yields P12.45 per 3kg of diluted premix.

Figure 4.2: Monthly Retail Price of Sorghum for January to September, 2006



Source: Central Statistics Office (various)

Table 4.10 reports the results for typical firms. The unit cost of fortification for an average firm is now estimated at P0.19/kg, a significant increase from P0.15kg in Scenario 1. Unit fortification costs for average small-, medium-, and large-scale firms are now estimated at P0.30/kg, P0.19/kg and P0.17/kg, respectively. Figure 4.3 compares unit fortification costs for the two scenarios. Scenario 2 is costlier, although it is the most technically feasible for small- to medium-scale firms, given the minimum quantity of the premix of 25kg.[19] Therefore, these firms can only participate in a mandatory fortification programme if diluted premix production is centralised and they are supplied in 3 kg bags. Even some of the large-scale firms (those smaller than the average large-scale firm) may find it difficult to handle the premix concentrate of 25kg.

If we apply CEDA interest rate on the equipment loan, the unit cost of fortification for an average firm is estimated at P0.18/kg. For average small-, medium-, and large-scale firms, the unit costs are, respectively, estimated at P0.25/kg, P0.18/kg and P0.16/kg. Therefore, CEDA financing for acquisition of the ribbon mixer would cut the costs substantially for small-scale firms. However, it does not appear that such financing would

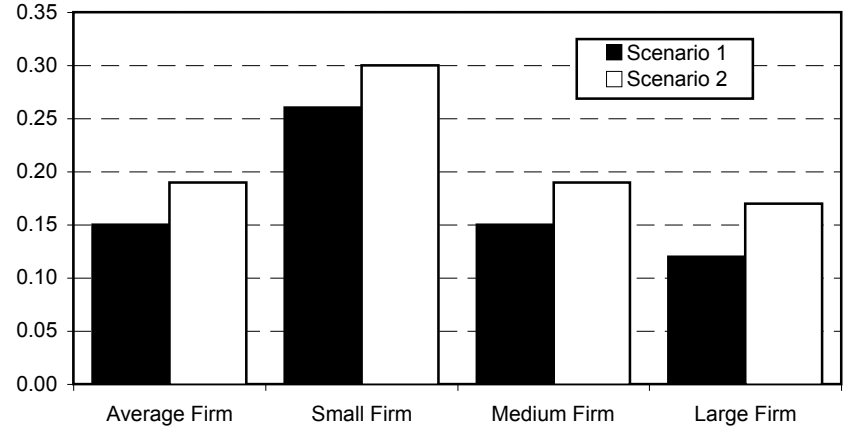
be sufficient to ensure that small-scale firms are sustained once a mandatory fortification programme is introduced.

Table 4.10: Estimates of annual fortification costs for year one by firm-size (Pula)

	Typical (average) firm			
Cost item	**All firms**	**Small**	**Medium**	**Large**
Depreciation	2,421.30	2,421.30	2,421.30	2,421.30
Interest	6,416.45	6,416.45	6,416.45	6,416.45
Labour	14,880.00	7,440.00	14,880.00	22,320.00
Premix	43,832.28	9,462.95	47,414.34	124,313.23
Electricity	1,103.78	243.86	1,222.86	3,203.52
Packaging	22,706.27	5,016.50	25,135.31	65,900.99
Labelling	172.02	38.00	190.42	499.25
Maintenance and Repair	2,300.00	2,300.00	2,300.00	2,300.00
Sub-total	42,832.28	31,039.05	97,679.67	225,074.74
Contingency (10 per cent)	4,283.23	3,103.91	9,767.97	22,507.47
Total cost	90,532.09	34,142.96	107,447.64	247,582.21
Firm output (kg)	516,051.62	114,011.40	571,257.13	1,497,749.78
Unit Cost (Pula/Kg)				
With 10% contingency	0.19	0.30	0.19	0.17
Without 10% contingency	0.18	0.27	0.17	0.1

Source: Author computed.

Figure 4.3: Comparison of Unit Costs under Scenarios 1 and 2



Source: Author computed

IMPLICATIONS FOR MANDATORY FORTIFICATION

We can draw a number of implications on the feasibility of mandatory fortification from the findings of the survey and the cost analysis. Firstly, if mandatory fortification of cere-

als, such as sorghum is implemented, the additional equipment recommended should be suitable for small-scale firms. The technology should be simple, inexpensive and thus affordable, to enhance adoption by existing millers, who are predominantly small. Thus, the new technology should be readily accommodated by the current milling industry structure. If not, and a mandatory fortification programme is launched, most of the existing millers will collapse, and will be replaced by a few large-scale firms with the capacity to operate more efficiently with sophisticated and expensive technology.

Secondly, since some sorghum milling firms also engage in service milling, mandatory fortification would be difficult, if not impossible, to comprehensively implement. This situation would be compounded by the fact that most of the domestic output of cereals does not go through the formal food chain (wholesale and retail markets), and hence it is not packaged.[20] Thus, if statutory requirements on fortification were imposed on grain destined for service milling, this is likely to be viewed as an unfair practice to poor households if the costs are perceived to be prohibitive. Besides, the implementation of such a programme, including quality assurance and control, would be highly cumbersome and administratively burdensome. It would also be impossible to regulate the processing of raw cereals by farm-households for own consumption.

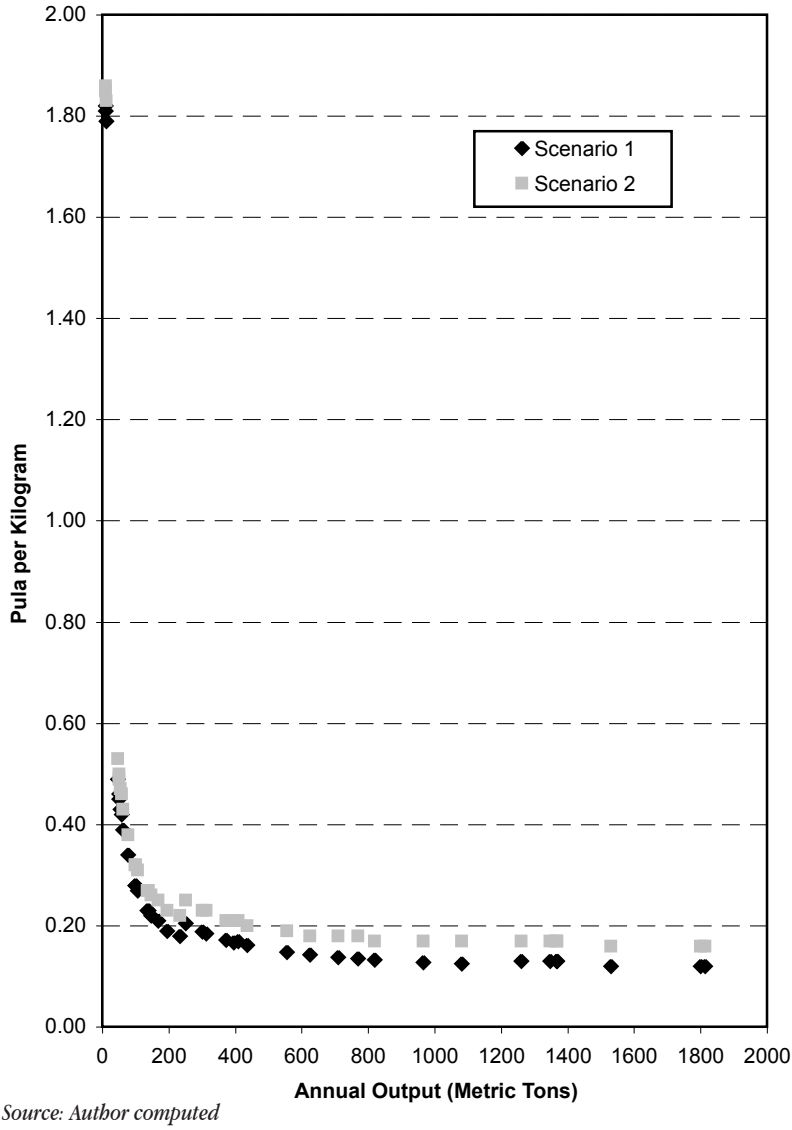
Figure 4.4 plots unit fortification costs for all the 40 firms included in the analysis. As seen, there are three firms with unit costs exceeding P1.70/kg. These firms cannot participate in a mandatory fortification programme. Thus, if mandatory fortification is introduced they will have to exit the industry. The remaining firms have unit costs ranging from P0.12 to about P0.50 per kg. It appears, from Figure 4.4 that those firms producing less than 500 metric tons per year may experience difficulties if mandatory fortification is introduced. The largest of these firms, which produces 435 metric tons per year, would incur fortification costs of P0.16/kg in scenario 1, or P0.20/kg in scenario 2.

If we accept the criterion that only those firms producing over 500 metric tons of flour per year are able to fortify, 25 firms would exit the industry if mandatory fortification is launched, and only 15 would remain in business. Thus, about 63 percent of the firms would exit the milling business – they would collapse. However, firms producing between 500 and 900 metric tons per year may also face difficulties once a mandatory fortification programme is introduced, as shown in Figure 4.4. Only firms producing more than 1200 metric tons per year would have a greater chance of surviving.

It should also be recognised that firms may face cash flow problems once a mandatory fortification programme is introduced. For example, additional operating costs for an average small-scale firm stand at over P110 thousand. Similarly, an average medium-scale firm would incur operating expenses of over P550 thousand, and an average large-scale firm about P1.5 million. Although operating expenses should be well spread-out throughout the year, some firms may face problems if they cannot access operating credit, since they may not have enough equity to implement the programme. Thus, whether or not a mandatory fortification programme would be feasible is not only dependent on the unit cost of fortification, but also on the effect of the programme on the cash flow position of existing firms.

Notwithstanding the foregoing conclusions, it should be noted that some of the

Figure 4.4: Unit cost of fortification for individual firms in the industry



Source: Author computed

costs of fortification would be passed to consumers through increased retail prices.[21] The extent to which this would happen depends on market supply and demand conditions. Introducing mandatory fortification would shift marginal costs of individual firms upwards, leading to a decrease in market supply of the final product. This would lead to an increase in the retail price of the product, and, hence, pass some of the costs of fortification to ultimate consumers. If, in addition to this, the final consumers perceive the fortified product to be superior in quality, compared to the unfortified product, the

market demand for this product would increase, reinforcing the original market price increase due to the supply-side. However, the extent to which the latter would occur appears limited, since mandatory fortification is a result of government policy rather than industry response to changes in consumer tastes and preferences.

Chapter 5 Institutional Issues

For a mandatory fortification programme to be successful, all relevant institutions on the ground have to be fully engaged and committed to the programme. Several tasks need to be undertaken to ensure that the programme takes off, and that once it has taken off it is sustainable. These tasks include the interrelated issues of advocacy and promotion, legislation and regulations (legal instruments), and quality assurance and control. This section discusses these factors within the context of cereal fortification in Botswana.

Advocacy and Promotion

Advocacy and promotion is important to ensure that the malnutrition problem is put on the agenda, solutions to the problem are devised, and that appropriate interventions are adopted to arrest the problem. It involves several interrelated activities, amongst which are, information, education and communication, and lobbying, which are meant to ensure that all actors – millers, policymakers and the food industry – are taken on board. A multi-sectoral committee would have to be set up, and be tasked with the advocacy and promotion mandate. Its responsibility would be to promote awareness on the benefits of food fortification to the general public. In order to be effective, the committee should have the capacity to articulate the scope, severity, distribution and characteristics of the malnutrition problem, and identify ways, such as food fortification, to address the problem (Mora, *et al.,* 2000).

The other role of this committee would be to ensure that information on the potential benefits of fortification is disseminated, particularly to policymakers, industry players and consumers, to promote the likelihood of policy intervention/reform, and acceptance of the programme. Therefore, it is important to involve food processors/producers, and other relevant industry players in the early stages of the development of the envisaged programme. The motive here is to create a strategic alliance between the food industry and the public sector to ensure further commitment to the course by industry players. This would ensure that stakeholders representing diverse interests are taken on board and are a part of the fortification programme (Sharma, 2005).

Legislation and Regulations (Legal Instruments)

Before introducing mandatory fortification, legal instruments have to be developed to regulate the programme. Mandatory fortification can be established either through presidential decree or through other legislative instruments. The formulation of fortification law and regulations should allow inputs from all the different actors. Since fortification involves several matters like technology and nutrition, the inputs of the various players would ensure that a realistic approach is adopted. The law would have to be clear to the firms and to those who would enforce it (Nathan, 1999). The ability of government institutions to enforce the law and regulations is fundamental for the success of the programme. It is through regulations that the government sets specific requirements such as food composition standards and quality assurance procedures.

In Botswana, it is expected that the Ministry of Health, through its Food Control Unit, in consultation with other stakeholders (like the Attorney General Chambers and Consumer Affairs Department), would lead the process towards the development of legal instruments. The National Food Control Board (NFCB) is the body charged with formulating and ensuring that all legislation stipulated as law governing food is implemented. However, in performing its functions, the NFCB faces several challenges. The most critical challenge is that it has no powers to fully enforce approved food regulations. In certain cases, the Food Control Act of 1993 stipulates penalties for non-compliance which are so low that they do not deter defaulters or deviators from repeatedly defaulting from set standards. Therefore, the powers of the Board need to be increased and the Food Control Act revised to include stiffer penalties for those who default.

To ensure the protection of public health, regulations should cover aspects of labelling and packaging, level of fortification, licensing requirements, and quality assurance and control and enforcement (Nestel, *et al.,* 2002). All these aspects are important and fulfil crucial functions in ensuring that mandatory food fortification is achieved in a desirable way. For instance, labelling is important because it enables the consumer or inspector to be able to tell what is in the food package. Correct packaging is also essential to preserve micronutrients and, hence, to prevent decomposition or degeneration due to exposure to sunlight. The level of fortificant in the product is also a key element to ensure that the product is not poisonous. Licensing of firms is also important to ensure that they meet minimum standards. To this end a quality assurance and control mechanism must be established and put in place as part of the fortification programme. The next section examines quality assurance and control issues in greater detail.

Quality Assurance and Control (QA&C)

The Need for QA&C

Quality assurance (QA) encompasses all organised activities undertaken to ensure that fortified foods meet the standards of quality and the criteria stipulated in relevant food regulations. It includes all matters and activities that individually and severally influence the quality of the product, including equipment, supplies, logistics, product

design, processing, labelling and packaging, premix/preblends, sampling plans, and management and human resources used in the manufacture of food (Nestel, *et al.,* 2002). Quality control (QC) involves the techniques, and assessments used to document compliance with established performance standards through the use of objective and measurable indicators. QC is an essential part of QA.

Effective quality assurance and conrol (QA&C) systems are those that are designed to allow quick and timely corrections to be carried out when deviations from performance standards are identified. The QA&C mechanism must be a proactive and continuous system that monitors reproducibility and reliability of performance. It must have three critical stages. First, there has to be a QA&C process established for cereal fortification for which the millers will be responsible. Second, there must be a quality inspection and auditing process of the fortified food at the miller's stage to ensure that proper procedures have been followed. Third, there must be a product monitoring process established at the retail end to ensure that consumers get what they are paying for (Mora, *et al.,* 2000).

For the Botswana case, it is suggested that millers be responsible for QA&C at the milling stage as it is at this point where the cereal will be fortified. The responsibility for quality inspection and auditing of the fortified food at the miller's stage would have to be given to the Food Control Unit in the Ministry of Health. This is important as it ensures that the flour that leaves the miller is actually fortified to the stated levels. The responsibility for the product monitoring process at the retail end could also be given to, and supervised by, the Food Control Unit together with the Consumer Protection Unit and Botswana Bureau of Standards (BOBS).

According to Nestel, *et al.,* (2002) a good QA&C system involves (1) control over the quality of the raw materials used, (2) production control, and (3) fortified food control. All raw materials used including the fortificant must meet certain specifications, and all ingredients must be inspected to ensure that they meet those specifications. Under production control all quality factors and hazards relating to the production process must be identified. Any critical control points must be identified and monitored. The fortified food product must be unadulterated and properly labelled. It must be properly packaged so that it maintains its integrity and the stability of its micronutrient content throughout its shelf-life.

The essential elements of a good QA&C system for a food fortification programme, as in Nestel *et al.* (2002) are as follows:

Rapid, simple analytical assays: Micronutrient assays must be done quickly using easy laboratory methods. The method must be good enough to establish a range for the level of the nutrients being added.

Packaging in labelled bags: The fortified food must be appropriately repackaged for retail sale. Food labels on the package must provide information pertaining to the name of the food, ingredients and level of micronutrients.

Inspection, technical auditing and monitoring: This must be based on quantitative methods to allow the inspector to determine if the product complies with set standards and specifications. Technical expertise will be required for this exercise.

Documentation and general supervision: An inter-institutional group encompassing a broad range of stakeholders from academia, industry, the standards agency and government departments must be given the mandate and full powers to run the QA&C system. It is crucial that all monitoring activities are well documented and enforced by the group to ensure that all stakeholders take it seriously.

The Role of Government in QA&C

It is every individual's right to expect their food to be safe, of good quality and suitable for consumption. To this end, the 1985 United Nations General Assembly adopted guidelines for consumer protection. Since then governments all over the world have become increasingly aware that food quality and safety are essential and that they as governments have the responsibility of protecting and promoting public health.

Nestel *et al.,* (2002) identify the following activities as requiring government involvement in QA&C:

Developing regulations and standards: This must involve all stakeholders, and must be spearheaded by an inter-ministerial food control board or agency.

Inspection and certification: This must be done by an agency appointed to perform this function with the assistance of technical experts from industry, academia, and government departments. Nevertheless, it should be Government's overall responsibility to perform official inspection and certification.

Identification of substandard products: Procedures and guidelines to be followed in order to comply with policies must be published to enhance compliance with food fortification regulations. These must be readily understood by the manufacturers.

Product recalls: All defective products must be recalled or removed from retail shops. This must be adequately enforced and the retailer selling such products must be penalised for non-compliance. Penalties should be high enough to deter the retailer from repeating the action.

QA&C in Botswana[22]

Institutional Arrangements for Standardization: The Botswana Bureau of Standards (BOBS) was established to formulate Botswana standards and to coordinate quality assurance activities in the country. BOBS was established by the Standards Act of 1995 and began operating as a parastatal organization in 1997. It is headed by a 12 member Standards Council (SC). BOBS is the official body responsible for all issues related to the International Organization for Standardization and the national

contact point for all SADC programmes on Standardization and Quality Assurance.

In Botswana a standard is prepared when there is a need to solve recurring problems. Standards are prepared by committees of experts drawn from industry, representing a cross-section of stakeholders of the subject under consideration. When members of the Technical Committee (TC) discuss the standards, they are required to solve substantial technical objections through consensus principle which requires that resolutions are reached through discussions and negotiations. Experts develop standards taking into consideration the cultural, technical, commercial and environmental conditions of the country. The process of preparing standards has six different stages, namely, proposal, drafting, committee, public comments, approval and publication.

Standardization projects are initiated based on requests received from interested parties. Requests may come from technical committee members, government departments, consumers, manufacturers, BOBS, individuals, and so on. BOBS receives these requests, compiles, evaluates and makes recommendations regarding priority areas to the SC for approval. Then annual work programmes are prepared based on approved priority areas. The secretary of the TC or a small working group (two or three people) then drafts or prepares the first draft to be submitted to the TC for discussions. A meeting of TC is then held to discuss the draft standard. The draft standard is then circulated for public comments where interested parties are given the opportunity to provide comments.[23] This stage is concluded by consideration of the comments from the public by the TC, which may accept or reject any comment based on technical arguments reached upon by consensus. Accepted comments are then incorporated into the standard.

The draft standard is then sent to the SC for approval. In cases where the draft is approved as a mandatory standard, the public is informed and given two months to raise objections. If after two months there are no objections then the Minister of Trade and Industry publishes the standard in the government gazette. Lastly, the standard is printed, circulated to relevant bodies, and sold to interested parties. Botswana standards are revised periodically.

Once a company or miller is BOBS certified it is issued with a BOBS certificate. This certificate lasts for three years at which stage the manufacturer must apply for a renewal. Monitoring and inspection of its products can then begin. This does not necessarily entail the inspectors going to the production site. Inspection and surveillance and the sampling of the product are done at least every three months. Ideally, this activity should be done more frequently. Inspection, sampling and testing can be done from a wide variety of identified critical control points, which can include the production level as well as retail shops. This is because if the food products are properly labelled they can be traced back to the manufacturer.

BOBS' QA&C for Existing Fortified Food Imports:[24] At the moment BOBS is involved in maintaining the QA&C for the following fortified food products imported into the country: animal and poultry feed stuffs, cereals, pulses and food drinks. However, BOBS' involvement in QA&C for animal feed stuff and other commodities such as building materials is slightly more mature and advanced than its involvement in fortified food

products. This is a limitation because fortified food products are regularly imported into the country and, in certain cases, are produced locally. It is envisaged that the cereal and pulses technical committee will eventually consider developing standards for fortified foods produced in Botswana, particularly infant foods.

With regard to cereals and pulses, BOBS' involvement is at early stages. The agency is currently directly involved in developing standards for sorghum grains and products, maize meal, wheat flour and bakery products. However, these are basic standards to ensure the food products are of good quality and are safe for consumption. At the present time BOBS has not yet done anything pertaining to the development of standards for the QA&C of fortified foods. Thus, fortified maize meal produced domestically based on South African standards is not currently subjected to any QA&C rules. This is a serious omission because it is unknown whether or not the concerned millers do actually comply with SA standards.

BOBS' Human, Physical and Technical Capacity: The nature of the tasks performed by BOBS requires a team of inspectors with multidisciplinary expertise relevant for the product under consideration. Informal interviews with BOBS indicate that BOBS primarily uses its own manpower to conduct inspections. In the event that there is a shortage of inspectors the Minister of Trade and Industry can appoint additional inspectors from outside BOBS to assist. BOBS has involved inspectors from the University of Botswana, NFTRC and relevant government departments.

As far as the physical capacity to conduct the necessary laboratory tests is concerned, BOBS has completed the construction of modern chemistry and microbiology laboratories, which are yet to be fully equipped with the instruments for food testing and other relevant tasks. The labs will be equipped pending the outcome of the tendering process which is already underway.

Implications for Mandatory Fortification

From the above discussion, it appears that BOBS may not currently have the human, physical and technical capacity to mount a QA&C system for a food fortification programme. Thus, much still needs to be done if Botswana is to mount a successful mandatory food fortification programme. It is clear that the benefits of fortification still need to be clearly articulated to all stakeholders (policymakers, industry players and consumers) so that there is a general buy in and true sense of ownership of the fortification programme. This means that a lot has to be done in the way of advocacy and promotion for the programme. The participation of all stakeholders early on in the devlopment of the programme is vital to get industry support for and commitment to the programme via the establishment of mutually rewarding public and private partnerships. Consumer awareness of their rights regarding the food products that they purchase needs to be increased as they can also assist in the enhancement of the effectiveness of the QA&C mechanism by identifying and alerting the NCFB or BOBS of the retailers selling food beyond its expiry date.[25]

While the relevant institutions to implement, monitor, regulate and evaluate the fortification programme exist, they clearly do not have the technical expertise and capacity to perform all the necessary functions. Standards for fortified food are still yet to be either developed locally or adopted from neighbouring countries such as South Africa where these standards already exist. In the area of QA&C more qualified manpower and fully equipped facilities are needed to ensure that inspectors are able to effectively test and monitor the fortified food product more frequently than is currently the case. From the onset, it is important that a positive and collaborative attitude towards those who will be doing the fortification (the millers), rather than a punitive regulatory stance, is adopted by government. Similarly, the millers must be encouraged to take responsibility for ensuring that their products meet set standards. Since food fortification will be a new thing in Botswana, government may need to provide training and guidance in QA to the millers in the initial stages of the programme.

In the area of legislation and regulation, adequate legal instruments such as a fortification law, standards of identity, technical regulations, and universal labelling should be in place to support fortification. The revision of the Food Control Act of 1993 which is more than ten years old is long overdue. For example, one of the amendments to the Act could include the imposition of stiffer penalties for non-compliance to deter potential violators.

Finally, role clarity amongst the various industry players is necessary to avoid confusion and duplication of activities. This is vital if the QA&C mechanism is to function effectively, and to facilitate the delivery of a good quality and safely fortified product to the consumer. For example, it is important to clearly define the role and activities of the Food Control Unit at the Ministry of Health and those of BOBS when it comes to QA&C so that the most suitable entity is given the responsibility to perform the tasks it is best able and most suited to do.

CHAPTER 6 SUMMARY AND RECOMMENDATIONS

INTRODUCTION AND PURPOSE

Fortification is broadly defined as the addition of specific amounts of one or more nutrients (vitamins and/or minerals) absent or present in low amounts in the food item in question. The purpose of fortification is to improve the nutritional quality of the food item, and to further combat the problem of micronutrient deficiencies. Thus, fortification has the following advantages: (1) it prevents or reduces the risk of the occurrence of micronutrient/macronutrient deficiencies in a population or specific population groups; (2) it corrects a demonstrated micronutrient/macronutrient deficiency in a population (this can be realised through lower rates of mortality and promotion of normal growth as well as improved school performance if children were initially affected); (3) it improves the productivity of labour (it increases workers' strength and their ability to work, resulting in better productivity); and (4) it reduces the expenses borne by the public health sector in treating illnesses related to micronutrient/macronutrient deficiencies.

Fortification may be either voluntary or mandatory. *Voluntary fortification* allows food manufacturers to decide on whether or not to add nutrients to foods, and the type and quantity of nutrients to add. It neither limits consumer choice nor forces unwilling companies to bear the financial costs of fortifying their products. *Mandatory fortification* is required by law and, hence, all food manufacturers are required by law to comply. Its implementation is the responsibility of government. Mandatory fortification is commonly implemented in response to a significant public health problem related to nutrition, or the deficiency of a particular micronutrient.

The purpose of this publication was to assess the feasibility of mandatory fortification of cereals in Botswana. Based on available literature, the paper examined the extent and nature of malnutrition in Botswana. Next, the paper examined the state of cereal fortification in Botswana, following which an analysis on the feasibility of mandatory cereal fortification was carried out (through a detailed assessment of industry structure and unit cost analysis for existing firms). Finally, the publication examined institutional issues and arrangements to assess their capacity and readiness to implement a mandatory fortification programme. In sum, the paper identifies the existing gaps *vis-à-vis* cereal fortification and recommends a way forward to move towards mandatory fortification.

Key Findings

State of Malnutrition

The most recent study on malnutrition was conducted by the Ministry of Health in 1994. This study was restricted to women of child-bearing age and children. According to the study, nutritional problems in Botswana are a result of a variety of causes, including inadequate food intake, pre-disposal to diseases such as TB and HIV/AIDS, inadequate maternal and child caring practices, poverty and food insecurity, ignorance, taboo and lifestyle. The population groups which are more vulnerable to micronutrient deficiencies include women, particularly those of child-bearing age, children under five years old and HIV/AIDS infected people.

The most common type of malnutrition in Botswana is known as Protein-Energy Malnutrition (PEM). However, the 1994 micronutrient study also reported iron, vitamin A and iodine deficiencies. PEM relates to clinical conditions ranging from mild underweight (low weight-for-age) to severe stunting (low height-for-age). PEM may affect both children and adults if their consumption of protein and energy is below their nutritional needs. The causes of malnutrition in Botswana have not been systematically studied. According to the Ministry of Health, there are three broad categories of factors causing malnutrition; immediate factors, underlying factors, and basic factors. *Immediate factors* are those that account for the poor health status of an individual, and they include inadequate dietary intake and the prevalence of diseases. They are the main causes of child mortality and morbidity in developing countries. *Underlying factors* include household food insecurity, inadequate maternal and child caring practices, poor health services and an unhealthy environment. *Basic factors* relate to the quantity and quality of human, economic and organizational structures available and the way they are controlled in the society. Given that this first major study is over 10-years old, this suggests that a comprehensive research study that evaluates both macro- and micro-nutrient deficiencies is needed to document the current nutritional status of children and adults in Botswana.

Cereal Consumption Patterns

The 1994 micronutrient survey indicated that most households in Botswana consumed cereals every day regardless of the season and social status of the individual. Time series data for the period from 1961 to 2003 indicate that cereal consumption has increased markedly over the years. During the 1960s, sorghum was the most consumed cereal, followed by maize and wheat. However, since the 1970s maize has become the leading consumption commodity, and sorghum held the second position until the 1980s, after which it was overtaken by wheat. The data show that wheat consumption rose consistently over time since the 1960s. Millet and rice are the least consumed cereals, although rice consumption outstrips millet consumption. Rice consumption has also increased steadily over time. Thus, while maize and sorghum are still important consumption commodities, consumption patterns at national level have slightly changed towards increased wheat and rice consumption.

While consumption patterns may have slightly changed over time, the major staples of sorghum and maize still remain the key traditional cereals produced by smallholder farming households. Production data indicate that sorghum has been consistently the leading production commodity since the 1960s, followed by maize and millet. The data indicate that the production of all the three commodities has declined steadily since the 1970s, mainly due to poor rainfall. Thus, from the standpoint of subsistence and poor households, sorghum and maize remain the most consumed commodity. For a cereal fortification programme to be effective, it must necessarily have sorghum and maize as food vehicles, particularly if the target population is the poor, who lack flexibility in diet diversification.

State of Cereal Fortification

Cereal fortification in Botswana is not mandatory. Therefore, it is not widely practiced in the commercial milling industry. However, in the case of maize milling, which is done by large-scale companies, fortification is currently done on a voluntary basis. The companies involved in maize flour fortification include Foods Botswana Company, Bokomo Botswana Milling Company and Bolux Milling Company. However, there is no legislation, nor are there regulations or institutional arrangements to govern and monitor the operations of these firms. The bulk of the sorghum flour going through the retail market is not fortified.

Some of the publicly provided food rations are also fortified. The Vulnerable Group Feeding Programme provides Tsabana (soya weaning food) to all children aged 4 to 36 months as a take home package, and precooked maize meal to all children aged 37 to 60 months, and medically selected expectant and lactating mothers and TB patients, in addition to other non-cereal products provided as part of the food ration. These products provide nutrients such as protein, vitamins A, B complex and C, folate, iron, calcium, and energy from carbohydrates and fat. However, sorghum meal provided through other public programs such as the primary school feeding programme, the destitute person programme, the orphan care programme and the community home-based care programme is not fortified since the rations for these programs are provided through contractual agreements with local retail stores.

On the research side, efforts are advanced in developing an appropriate technology for sorghum fortification. The National Food and Technology Research Centre (NFTRC) is currently conducting research on sorghum fortification with Vitamin A. The project came about as a result of the findings of the 1994 Botswana Micronutrient Study which indicated that Vitamin A malnutrition was a problem in Botswana. According to NFTRC, the project is divided into two phases. Phase 1 of the study consisted of trials to determine the mixing efficiency of the mixer commissioned by Rural Industries Innovation Centre (RIIC), microbial quality analysis, and shelf-life studies of the fortified sorghum meal. Phase 2, by contrast, will involve feeding trials of adult HIV-positive persons.

The milling equipment that is currently being used by most of the millers in the country was fabricated by the Rural Industries Innovation Centre (RIIC). Hence, NFTRC

approached RIIC to request them to fabricate a ribbon mixer for them. The ribbon mixer, whose capacity is 150kg is said to be suitable for small-scale millers. The trials of the equipment at NFTRC showed that efficient mixing was achieved between 5 to 10 minutes. For commercialization of the ribbon mixer, RIIC will deliver, install and train the millers on the usage of the mixer at a cost. Efforts are currently underway to reduce the cost of the mixer so that it is affordable to small-scale millers.

Feasibility of Mandatory Cereal Fortification

The feasibility of mandatory fortification in Botswana would depend on a number of factors, including, but not limited to, the cost of the fortificant, the structure of the milling industry, institutional and regulatory arrangements, and so on. Of the millers interviewed, 70 percent did sorghum milling as a sole activity, 15 percent engaged in sorghum and millet milling, 8 percent in sorghum and maize milling, and another 8 percent in sorghum, maize and millet milling. Thus, sorghum milling is a major activity in terms of the number of firms involved, as all the firms are either involved in it as a sole activity or with other activities.

With the exception of the fortification activities of Foods Botswana, which are mainly carried out on government contracts, sorghum milling products going through the retail food chain are unfortified. The exception is that Foods Botswana also produces a soya/sorghum blend (Tsabotlhe) for adults, which is sold outside government contract. Sorghum milling is characterised by numerous small-, medium-, and large-scale firms. The sample for this study contained 19 small-, 14 medium-, and 7 large-scale firm, each producing monthly outputs of 0-20, 21-100 and over 100 metric tons of flour per month, respectively. An average small-, medium-, and large-scale firm, respectively, produced 9.5, 47.6, and 124.8 metric tons of flour per month. Thus, the milling industry is dominated by small-scale firms, each producing no more than 20 metric tons of flour per month, followed by medium- scale firms producing 21 to 100 metric tons of flour per month. However, in terms of total output, large-scale firms produce more (873 metric tons per month), followed by medium-scale (666 metric tons per month) and lastly small- scale (181 metric tons per month).

For sorghum, mandatory fortification would be feasible if additional equipment required is suitable for a typical small-scale firm. Thus, the technology should be simple, inexpensive and thus affordable, to enhance adoption by existing millers, who are predominantly small. The new technology should be readily accommodated by the current milling structure. If not, and mandatory fortification is launched, most of the existing small-scale millers would collapse, and are likely to be replaced by large-scale firms who can operate more efficiently with sophisticated and expensive technology. Thus, efforts should go into introducing technologies that are appropriate for the existing firms before mandatory sorghum fortification has to take off. This will include not only the additional fortification equipment required, but also the accessibility of the fortification premix, packaged in the right quantities (sizes) for small- to medium-scale millers (the size of the premix packages should be appropriate for small-scale firms).

For millers, the costs of implementing a fortification programme include additional

capital costs (equipment and machinery) and additional recurrent costs (personnel, utilities and fortificant). If the acquired fortification equipment and machinery was made available through the provision of a loan by financial institutions like banks, interest is incorporated as part of the cost.

The analysis indicated that the probability of millers being able to afford to fortify increases with firm size. The unit cost of fortification ranged from P0.26 to P0.30, P0.15 to P0.19 and P0.12 to P0.17 per kilogram of sorghum flour for average small-, medium- and large-scale millers, respectively. The implication is that it is feasible for large- and perhaps medium-scale sorghum millers to adopt mandatory fortification. However, the prospects diminish when it comes to small-scale millers who do not have adequate economies of scale. Since most of the sorghum flour going through the retail system is produced by medium- to large-scale firms, this study concludes that mandatory fortification of sorghum is feasible for large-scale firms. However, it might move numerous small-scale, and some medium-scale millers out of business if they do not receive grants to acquire the required technology. This conclusion is based on the assumption that sorghum millers will adopt the RIIC ribbon mixer, which is less costly and is suitable for the sorghum milling industry. However, there would be need to develop legislation and regulations, including quality standards, before any fortification programme can be introduced. Even where mandatory fortification is feasible from the perspective of the millers, the complication that would arise is that most of the sorghum produced locally goes into home consumption, where service milling plays a key role. It would be technically cumbersome, if not impossible, to come up with practical, enforceable and effective procedures and regulations for introducing mandatory fortification for service milling.

For maize, where the milling industry is predominantly characterised by large-scale firms and where some voluntary fortification is currently being done, mandatory fortification is highly feasible. What is required is to develop legislation and regulations and a monitoring system to ensure that firms (and the products they produce) comply with set quality standards and procedures. Therefore, the government needs to develop legislation and regulations, and strengthen institutional arrangements to enable the introduction of mandatory maize fortification, as existing firms are already engaged in voluntary fortification.

RECOMMENDATIONS

Set up a National Fortification Alliance (NFA): The first logical step is to form a National Fortification Alliance (NFA), a multi-sectoral committee tasked with advocacy and promotion of the fortification programme. Its mandate will be to promote awareness and increased appreciation of fortification by stakeholders. The NFA should have the capacity to bring various stakeholders together. Information disseminated by the NFA should spell-out the potential benefits as well as limitations of the proposed programme in addressing the micronutrient/macronutrient deficiency problem. Efforts

should be directed to the people with decision-making power as well as to those expected to consume the fortified food products. This information should be shared with the public through such means as the media. The NFA should ensure that the fortification programme has both political and industry-level support. Thus, the role of the NFA should be to facilitate an alliance between the food industry and the public sector, to ensure that the process towards developing a successful and sustainable fortification programme takes off.

Develop Legislation and Regulations (legal instruments): Once the NFA has been set up, it should facilitate the development of legal instruments to regulate the programme. The mandatory fortification programme can be established either through presidential decree or through other legislative instruments. The formulation of fortification law and regulations should allow inputs from different actors since fortification involves several diverse matters such as technology, nutrition, and so on. What the law requires should be clear to both the producers and those who will enforce it. The ability of the government to enforce the law and regulations is very important for the success of the programme. It is through the regulations that the government sets the specific requirements (food composition standards, quality assurance procedures, etc). Most importantly the law should give a reflection of the stakeholders' will and interests, as they are more likely to comply when they feel the law is in their best interests. The Ministry of Health, through its Food Control Unit, in consultation with other stakeholders (such as the Attorney General Chambers and the Consumer Affairs Department), shall be expected to lead the process. To ensure the protection of public health, regulations should be developed on the following aspects: labelling and packaging; level of fortification; licensing requirements; and quality assurance and control and enforcement.

Introduce Mandatory Fortification: From the standpoint of milling firms, maize fortification can easily be introduced since the existing firms already practice voluntary fortification. Therefore, for maize, it is recommended that institutional arrangements needed to carry out a successful fortification programme be put in place. This would involve the development of legislation and regulation (legal instruments), and setting of quality standards and mechanisms for monitoring the programme. For sorghum more work needs to be done, beginning with advocacy and promotion through to the development of legal instruments.

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NOTES

1 Note that wheat and rice are not produced domestically.

2 The WHO classification for vitamin A status indicates that normal status is for levels of serum retinol >30 μg/dL; adequate status is $20 - 29.9$ μg/dL; marginal (low or moderately deficient) status is $10 - 19.9$ μg/dL; and deficient status is < 10 μg/dL of serum retinol.

3 Tsabana is a fortified sorghum meal (flour) fed to children five years and under, through a publicly provided supplementary feeding programme.

4 This section draws heavily from Ministry of Health (2005b).

5 This is not to suggest that devaluation and VAT are bad policy instruments, and that they were introduced to hurt the poor and exacerbate poverty and malnutrition. They were introduced for other reasons beyond the scope of this study.

6 Some of the information contained in this section was drawn from Ministry of Local Government and Lands (2002a, 2002b, 2003a, 2003b).

7 The extent of distribution of food supplements under the Vulnerable Groups Feeding Programme is determined by whether a drought has been declared. Therefore, district-based drought committees such as the Inter-Ministerial Drought Committee and the Early Warning Technical Committee in the Ministry of Finance and Development Planning are critical in determining coverage. In non- drought years the programme covers: medically selected under-five children, pregnant and lactating women, nursing mothers feeding multiple births, teenagers aged 13 to 18 years and TB outpatients. In drought years recipients are not medically selected and blanket coverage is applied. The programme is administered by the Ministry of Health (MoH) and MoLG through local primary health facilities including clinics and health posts.

8 Tsabana is a fortified food product, which is given to children between the ages of 4 and 36 months. The Ministry of Local Government (MoLG) procures Tsabana from a manufacturing company after a tender process. The company winning the tender is charged with the responsibility of producing Tsabana and delivering the product to the food relief depots of the MoLG, which then distributes the Tsabana to the clinics. Technical expertise in terms of product specification, testing, analysis, quality assurance and control is provided by the Food Control Unit in the Ministry of Health (MoH). This function ensures that the product that reaches beneficiaries adheres strictly to nutritional requirements and that its quality is of the required standard. All testing is done at the national food laboratory.

9 On a monthly basis, the company manufactures and supplies 900 tons of Tsabana and 550 tons of enriched pre-cooked maize meal, compared to only 60 tons of Tsabotlhe.

10 Vitamin A is destroyed by sunlight.

11 It is estimated that about 90 percent of all orphans benefit from the programme.

12 The exception is Tsabotlhe, which was produced by Foods Botswana independent of the government contract. However, this product has not seen much success since its commercial demand appears much smaller than that for unfortified products.

13 It has to be noted that the dehuller and hammer mills used in the sorghum milling industry, in particular, were supplied by the Rural Industries Innovation Centre (RIIC), and therefore are of standard capacity. Therefore, the number of pieces of equipment owned by a firm should be related to the size of the firm, assuming that there is no idle capacity.

14 Delivery costs are not a significant item. Therefore, even if the distance was to be quadrupled, unit fortification costs would have remained unchanged, if rounded to two decimal places.

15 As shown in Table 4.8, an average small-scale, medium-scale, and large-scale firm requires 0.43, 2.16 and 5.66 hours of mixing per day, revealing that most firms would have excess capacity if they bought their own ribbon mixer. Thus, one ribbon mixer per firm would be more than adequate.

16 CEDA charges interest of 5 percent for loans ranging from P500 to P150,000 and 7.5 percent for those ranging from P150,001 to P2,000,000 (CEDA, nd).

17 The concentrate is packaged in 25kg, 100kg, 250kg, 500kg and 1000kg bags, at costs per kg of R342.06, R291.74, R281.42, R276.54 and R 274.54, respectively. The concentrate expires in approximately 6 months. NFTRC estimates that the fortified flour should be consumed in 6 months from the time the concentrate has been opened. We assumed that firms will use the 25kg package to avoid having to reuse the concentrate several times after it has been opened. Still, this might be too large for small-scale to medium-scale firms.

18 Note that our classification of millers into small, medium and large was arbitrary and, hence, it is not necessarily consistent with the BPC classification which is based on usage.

19 Note that scenario 1 computations had assumed that the premix concentrate is readily divisible, when sold, implying that even small-scale firms could acquire the small quantities they need to prepare the diluted premix. However, as we discussed above, this would not be feasible because the minimum quantity that can be procured from the manufacturer in South Africa stands at 25kg.

20 The bulk of domestic production goes into home consumption or informal sales where service milling plays an important role.

21 This is highly likely since there are no competing imports for domestically produced sorghum meal. If imports existed, and Botswana was a price taker, the prospects for increased retail prices would be limited.

22 This entire section draws heavily from the *Information Guide of the BOBS Products and Services* (2005) pp. 1–2.

23 The public, in the context of writing standards, is a group of interested parties (organizations, government departments, associations, consumers, manufacturers, etc) who are directly or indirectly affected by the standard. At this stage the standard is circulated to all SADC member states, selected known stakeholders, and an advert is published in the popular newspapers to request comments from any other interested parties. Members of the public are given three months to comment.

24 This entire section is based on personal communication with Mr. Bannyaditse of the Food and Agriculture Division at BOBS.

25 To this end BOBS regularly conducts consumer awareness campaigns countrywide. These campaigns cover the BOS 9 labelling of chicken, cattle feed and so on. BOBS has also just recently launched its website (www.bobstandards.bw) to acquaint members of the general public with its functions and approved standards.