Potential impacts of the Production of Liquid Biofuels on Food Security in Botswana

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1) Introduction

Biofuels are fuels produced from biomass either in a solid, liquid or gaseous form and they may be used in a primary (unprocessed) or secondary (processed) form (UNIDO, 2007.,FAO, 2008). This paper focuses on the potential for the production of liquid biofuels for transportation use (bioethanol and biodiesel). These fuels are classified as first or second generation, depending on type of technology and feedstock used (UNIDO, 2007). First generation bioethanol is produced from food crops such as sugarcane or corn, whereas second generation bioethanol is produced from ligno-cellulosic feedstocks such as wood, energy crops, residues or wastes. However, first generation biodiesel is produced from vegetable oils such as *Jatropha curcas*, sunflower, soya and palm. There is also second generation biodiesel which is produced by synthetic process from ligno-cellulosic biomass feedstocks such as forest residues and perennial grasses and straw (Bridgwater, 2007). These feedstocks are more abundant and diverse than those of first generation biofuels, and their use for biofuel production is still at the stage of research and development (FAO, 2008).

The major drivers of biofuel development are concerns about the energy security, climate change and rural development (Dufey, 2006). Biofuel development is thus perceived to be part of the rapidly emerging bioeconomy (Royal Society, 2007). The global production of bioethanol has doubled to over 40 billion litres during the period 2000 to 2007; while that of biodiesel significantly increased to 10 billion litres in 2007. The leading producers of bioethanol are USA and Brazil which use maize and sugarcane as feedstocks, respectively. Biodiesel production is dominated by the European Union, with Germany accounting for 54% of the total production (Birur *et al*., 20007). In Africa, biofuel development is still at an early stage as most countries are still drawing up their energy policies. Production of liquid biofuels is limited to a few countries such as Malawi and Zimbabwe. Countries such South Africa, Namibia, Mali, Zimbabwe and Zambia have already developed strategies for biofuel development. It is therefore clear that biofuel development will continue to be a critical development strategy in Africa in the foreseeable future as it promises to offer many opportunities for sustainable development. Notwithstanding these benefits, there is a growing concern that its pattern of development is not always consistent with the principles of sustainable development (FAO, 2008).

Botswana is currently finalising its policy programme on biofuel development; and once this is accomplished, the programme will be implemented. It is therefore necessary to assess the potential impacts of the production and use of biofuels on food security, particularly because Botswana has a high dependency on imports of cereals and petroleum products. It is one of the 22 countries in Sub-Saharan Africa classified by the FAO (2008) as being very vulnerable to food insecurity, despite the fact that its per capita gross national income is among the highest in Africa, estimated at USA $ 5 900 in 2006 (World Bank, 2008). In 2006/7, the national demand for cereals in Botswana was 191 000 metric tonnes as compared to the national production of only 27 000 metric tonnes or 14% of the total national cereal requirements. The proportional contribution of the agricultural sector to GDP also declined overtime from 40% in 1966 to 1.7% in 2006/7, partly due to the relative increase in the output of the mining sector and the decrease in the output of the agricultural sector. However, agriculture still remains a key sector of the economy since 70% of the rural

households still derive much of their livelihoods from it. The improvement of food security is therefore one of the key policy objectives of the agricultural sector in Botswana (MFDP, 2009).

This paper examines the impacts of biofuel development on food security in Botswana. The following research questions are therefore critical in understanding this general research objective: 1) what is the status of the development of biofuel policies and strategies in Botswana? 2) What are the main ways in which adverse impacts of biofuel development on food availability could be reduced 3) How do trends in national food prices compare with global food prices; and to what extent could these trends be attributed to biofuel development? 4) and finally, what is the potential impact of national food prices on food security and in particular, how does the change in prices compare with the change in incomes? It is intended that by assessing the potential impacts associated with biofuel development in Botswana, an awareness of decision-makers on the opportunities and risks associated with the implementation of these fuels will be raised.

2.0 Conceptual Framework

2.1 Biofuel development and sustainability

There are concerns that the development of biofuels is associated with risks that may threaten sustainable development (Naylor *et al*., 2007). According to Yang *et al* (2009), scientific literature on the impact of biofuel development on sustainability is still lacking. There has been a lot of media attention and grey literature on the sustainability of biofuels, and the coverage mainly highlighting the negative rather than the positive aspects of their production and use. The main issues of concern revolve around the environmental, economic, and social social impacts of biofuel production and use (Royal Society, 2008;Smeets, 2008;Yang *et al*., 2009;Eickhout *et al*; 2008);Goldemberg *et al*., 2008). More relevant to this paper is the concern that biofuel development is responsible for the soar ing of commodity prices which have aggravated the problem of food insecurity in developing countries (Mitchell, 2008; FAO, 2008). In order to ensure that biofuels are produced in a sustainable way, a number of countries are now introducing sustainability certification systems, whereby the buyers of biofuels ensure that their production complies with certain standards or sustainability criteria (Smeets, 2007.

According to Naylor *et al*., 2007), the use of agricultural products for biofuel development is overriding the famous economic principle of Engels Law, which states that the proportion of income spent on food decreases when income increases, *ceteris paribus.* While in the past, the increase in food production and rising incomes have been associated with a decline in real food prices, this trend seems to be changing as food prices have been rising in real terms, particularly between 2005 and 2008, despite a general rise in incomes. This is mainly because energy markets now determine the value of agricultural products (FAO, 2008; Naylor *et al*., 2007). The increase in commodity food prices tends to cause what is called the “food–price dilemma” because it affects net-food buyers negatively and net food sellers positively (Lustig, 2009). Since most people in urban and rural areas in Botswana are net food buyers,

the rise in food prices will tend to adversely affect net-buyers of food, particularly the poor as their expenditure on food accounts for large proportion (55% to 75%) of their income (Naylor, *et al.*, 2007).

2.2 Biofuel development and food security

FAO (1998) defines food security as a situation whereby "all people, at all times, have physical, social, and economic access to sufficient amounts of safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". The thinking about the concept of food security has evolved over a long period of time, and can be categorised into three generations. The first generation focus was mainly on the supply side, emphasizing the importance of food availability to food security. The second generation focus was on the demand side conceptualising issues on individual and household access to food, and the discussion was to a large extent influenced by the work of Sen (1981) on entitlement and deprivation (Barrett, 2002). The third generation focus looks at food security in a broader perspective, bringing on board issues such as "uncertainty, vulnerability and non-food complementary inputs like health services, sanitation, education and public infrastructure" (Barret, 2002, p73).

Figure 1: Four dimensions of food security

Source: Adapted from FAO (1998).

There are four main dimensions of food security: 1) availability, 2) access, 3) stability, and 4) safe and healthy utilization of food (FAO, 2008). Biofuel development is known to have linkages with these dimensions of food security. The production of biofuels may adversely

affect food availability, as the productive resources of land, labour, water and other resources may be used for the production of biofuels instead of food. Biofuel production may also hinder access to food as it is one of the drivers of food commodity prices (Mitchell, 2008; FAO, 2008., RFA, 2008).

The food security dimension of healthy utilization of food may be positively or negatively affected by biofuel development. For instance, the production of biofuel crops such as *Jatropha curcas* may enhance the production of modern forms of energy in rural areas such as bio-electricity which may lead to an improvement of the safe and healthy utilization of food, and hence improve the health and nutrition of rural households (FAO, 2008). However, if biofuels lead to scarcity or pollution of water resources, there is likely to be an adverse impact on the safe utilization of food. Finally, biofuels are likely to increase the pressure on food stability or increase the risk of chronic food insecurity (FAO, 2008).

3.0 Methodology

3.1 Data collection

Data and information for this study were obtained from secondary data and informal interviews. Although data collection and analysis for this study was spread over a period of six months (February to July, 2009), most of the work was done in the three months of March April, and May.

3.1.1 Secondary data collection

Secondary data were obtained from library and internet searches as well as from conferences and networks in which the authors are participants. Through membership in the EU-funded coordination project called "Competence Platform on Energy crop and agro-forestry Systems for Arid and Semi-arid Ecosystems in Africa (COMPETE)," it was possible to obtain substantial information, including that on trends in bioenergy development in the global environment. This included information on biofuel development in the EU, Africa and other countries of the South with advanced bioenergy technologies, notably Brazil, Mexico, India and China. The COMPETE project promotes cooperation between partners in these countries and those in Africa in order to promote information exchange and technology transfer on bioenergy technologies (Janssen *et al*., 2009).

3.1.2 Informal interviews

Informal interviews formed an important part of data collection for this study. These interviews did not solicit opinions of policy-makers about biofuel development, but rather attempted to identify sources of data for this study and to understand the general issues on biofuel development and policy in Botswana. Those interviewed were ten officers from the following departments and agencies: Department of Agriculture, Department of Energy, Central Statistics Office (CSO), and the Botswana Agricultural Marketing Board (BAMB).

At the Department of Energy, the focus was on energy policy, energy balances, and status of development of biofuels in Botswana, including proposals for biodiesel development. At the Ministry of Agriculture, the interviews focussed on food security issues, availability of land for biofuel production, and amounts of idle and marginal land. At CSO and BAMB the focus was on trends in food commodity consumer price indices and cereal prices, respectively.

3.2 Data Analysis

Data collected was on consumer price indices (base year = 2006) for selected food commodities (cereals and oils and fats) and non-food commodities (e.g.clothing and footwear). From data collected, trends in food commodity prices and rates of inflation for these commodities were estimated. The analysed information was utilised to make comparisons between the inflation rates of food and non-food commodities. In addition, data on the nominal prices of major food commodities of white maize, sunflower and groundnuts was summarised in order to determine their trends over a period of nine years (from 1999 to 2008). Using consumer price indices for all commodities, the real prices of the major food commodities were estimated. In addition, data for the prices of the selected commodities of sunflower, maize, and groundnuts were deflated by an index of the Botswana GDP, normalised to the year 2006. The aim was to compare the rate at which prices and incomes grew.

4.0 Botswana's Energy Balance and Policy

The energy sector is mainly the responsibility of the Ministry of Minerals, Enegy and Water Affairs, which has been given the mandate to formulate, direct and coordinate national energy policy since 1982. As in other parts of Africa, the structure of the energy sector reflects the dualistic economy of Botswana since the main sources of household energy in rural areas are fuelwood and other forms of biomass energy, while in urban areas the sources of energy are electricity and petroleum-based products. Electricity is generated from coal produced from Morupule Colliery which operates a 120 MW power station. Local electricity production is far below the national demand of 500 MW and does not meet the shortfall of 80%. Electricity is imported from the Southern African Power Pool (SAPP), and a large proportion is from South Africa. The 2005 energy balance of Botswana shows that the contribution of renewable energy to final energy supply is insignificant. Petroleum was the most important source of energy (34%), followed by coal (29%), traditional biomass energy (27.5%) and electricity (8.8%) (Department of Energy, 2009). Botswana has large resources of coal, estimated at 212 billion tons. There are currently no known petroleum reserves and Botswana is therefore a net importer of petroleum resources (MFDP, 2009). As already stated, a combination of dependence on petroleum and major cereal imports makes the economy of Botswana very vulnerable to external shocks (FAO, 2008).

Botswana's energy is aimed at achieving the aspirations of national development plans and the Long Term Vision for Botswana (Vision 2016). The main objectives of the draft energy policy of Botswana could be summarised as follows: 1) To facilitate sustainable economic growth by promoting competition, economic efficiency and investment in the sector 2) To improve access and affordability of energy services to all sectors of the economy 3) to ensure environmental sustainability, 4) to ensure security of supply and diversified supply sources 5)

and to improve institutional arrangements and governance within the sector. The objective of economic efficiency implies that renewable energy sources should be supplied at a least cost to the economy. An efficient use of energy will promote its conservation. It is critical that energy should be accessible to households as it is a basic need. The Botswana energy policy has in the past put more emphasis on the production of solar energy, but now the interest in development modernised forms of biomass energy is growing. There are possibilities of producing synthetic biofuels from the abundant resources of coal, but the main problem is high financial costs, estimated at 90 to 110 USA cents per litre, which is three times higher than the cost of oil fuels and also because coal is carbon intensive (Royal Society, 2007). While the use of synthetic fuels will be consistent with the objective of energy security, it may be inconsistent with the objective of environmental sustainability.

5.0 Feasibility Study on biofuels

A feasibility study was undertaken in 2007 on behalf of the Ministry of Minerals, Energy and Water Resources to assess the potential for the production and use of liquid biofuels for transport in Botswana (EECG, 2007). The following crops were investigated as possible feedstocks: *Jatropha curcas,* palm oil, sunflower, sugarcane, maize, and sweet sorghum. The study revealed that there is a potential for the local production and use of biofuels in Botswana. The recommended feedstocks for biofuel production are *Jatropha curcas* for biodiesel and sweet sorghum and sugarcane for ethanol production (EECG, 2007) due to their lower production costs (EECG, 2007). The study recommended that bioethanol should be grown in Chobe District, where there will be a plant of 20 million litres per annum for processing the feedstock (EECG, 2007). It also recommended a farming system whereby bioethanol producers will be large scale farmers (100 ha) supported by small-scale farmers. For biodiesel, the model of the farming system recommended was that of contract farming, whereby farmers would be contracted by private companies to grow crops on their land. Due to a larger potential for biodiesel production in the country, a larger plant of 50 million litres/ year was recommended. The plant could produce biodiesel for blending with fossil diesel at ratios of B5 and B10 (EECG, 2007).

6.0 Biofuels Policy and Biodiesel Production

The Government is still developing a biofuels policy, including guidelines for investment in biofuel production. There are already some policy statements on biofuels in various official documents such as the Draft Energy Policy, The Botswana Energy Master Plan of 2004, and National Development Plan 10 (NDP10). In the draft NDP 10, it is stated that a plant of 50 million litres/year, using Jatropha as a feedstock, will be constructed by the Government during the plan period. The plant, which is estimated to cost 100 to 150 million Pula, will require about 50 000 ha to 75 000 ha of land for the production of the feedstock (MFDP, 2009). It will be located at Tshele Hills in Kgatleng District, where the Government is constructing a strategic oil reserve (Department of Energy, 2009). The Government intends to kick-start biodiesel production in order to demonstrate its feasibility to the private sector. It also wants to do so because the capital costs of the construction of the plant are high and could therefore discourage potential investors. In future therefore, there might be a

possibility to lease out the plant to the private sector (Wright, 2009, with my emphasis). Production of biodiesel is expected to commence in 2012 (MFDP, 2009).

It is anticipated that 20 000 ha of land will be identified near the plant within a radius of 100 km in order to enable production to start in 2012. The land will be divided into 50 paddocks of 400 ha, and will be leased to small-scale farmers who will produce the feedstock for sale to the Government. The private sector will be encouraged to plant *Jatropha curcas* in order to produce additional requirements for the processing plant, and 55 000 ha of land will be utilised for this purpose (Department of Energy, 2009).

Currently there is a lot of interest from investors to grow energy crops in Botswana, especially *Jatropha curcas* (Mabowe, 2009). One company known as General Biofuels, but trading as Hort and Cort, has a pilot project in Gaborone North, where it has a 1.5 ha Jatropha plantation and it has also acquired additional land (600 ha) for plantation of this crop in Hatsalatladi in Kweneng District (Department of Energy, 2009). The absence of a policy on biofuels greatly hinders the development of these fuels in Botswana. It is expected that the strategy for the development of biofuels will outline the vision of the Government on these fuels and also address future targets for the share of liquid biofuels. In addition, it is also expected that the strategy will determine blending ratios, prices, standards, financial incentives, and funding mechanisms of these fuels (EECG, 2007).

7.0 Potential Impacts on Food Availability

As already stated, the production of biofuels may adversely affect food availability if food crops or productive resources (land, labour, water, etc) are switched from the production of food to that of biofuels instead. The Botswana Government tries to reduce the adverse impacts on food availability by selecting feedstocks which are not used for food and by using marginal and idle land for biofuel production. This section of the paper assesses the risks and opportunities associated with these strategies.

7.1 Use of marginal and idle land

One of the recommendations of the "Gallagher Review of the Indirect Effects of Biofuel Production" is that marginal and idle land, rather than land used for food production, should be used for the production of feedstocks for biofuels (RFA, 2008). This report raises a valid point that there is need for an internationally agreed definition of the concepts of idle and marginal land as they tend to vary from place to place. According to this review, idle land is "former or current agricultural land that will not otherwise be used for food production" and "land that is potentially suitable for agricultural production". Marginal or degraded land refers to "land unsuited for food production, e.g. with poor soils or harsh weather environments; and areas that have been degraded, e.g. through deforestation" (RFA, 2008).

The Ministry of Agriculture in Botswana defines idle land as the difference between total area under arable fields on suitable land and the total area that is used for arable production and marginal land as land not suitable for cultivation of food crops (Mafoko, 2008).

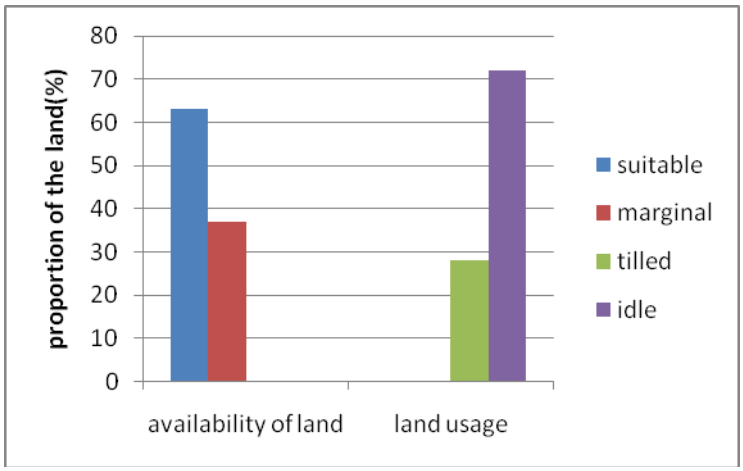

Fig 2: Proportions of idle and marginal land in eastern Botswana.

Source: Mafoko (2009).

Table 1: Agricultural area planted in Botswana.

Year	Area Planted (ha)
2004	106 755.4
2005	719 98.1
2006	137 824.0
2007	68 488.1
Average Area planted (ha)	96 266.4 (228 733.60)[a]

[a]The figure in parenthesis denotes the average area of idle land

Source: EECG (2007)

Personal communication with officers of the Ministry of Agriculture revealed that marginal and idle land are available for growing energy crops such as *Jatropha curcas* and sweet sorghum in Botswana. Out of a total of 682 000 ha of arable land in eastern Botswana in

2009, about 200 000 (29%) is marginal land and the rest (71%) is suitable land (Mafoko, 2008). In Chobe District, about 5 000 ha of land which is not suitable for arable agriculture in Pandamatenga area could be used for biofuel production (Modise, 2009). In addition, 72% of suitable land in eastern Botswana is idle land, and only 28% is utilised for arable agriculture (Mafoko, 2009). The feasibility study for the production and use of biofuels in Botswana also revealed that the four year mean (2004 to 2007) for the total area planted with crops in Botswana was 96 266 ha, whereas the total area which was fallow was 228 733 ha (Table 1). From the above figures, the proportion of idle land can be estimated to be 70% as compared to that of utilised land of 30% which is of the same order of magnitude with the figure for idle land in eastern Botswana of 72% mentioned above. A study undertaken in Gaborone and central regions on "Declining Interest in Arable Agriculture in Botswana" also revealed that 48% of the households did not plough their land because of a number of reasons such as HIV AIDS related ill health, lack of drought power, poor rainfall, and lack of funds (Fidzani, 2000, Cited in EECG (2007).

7.2 Feedstock selection and biofuel development.

Apart from the use of idle and marginal land, the type of feedstock used for the production of biofuels is a major factor which determines the extent to which biofuels impact on food availability (IRGC, 2008). As already stated, *Jatropha Curcas* and sweet sorghum are the recommended feedstocks for biofuel production in Botswana. One of the most important features of these plants is that they are drought resistant and can therefore be grown on marginal lands where most crops cannot be grown (UEMOA, 2008). Thus, the use of *Jatropha curcas* as feedstock for biofuel production may reduce the food-fuel conflict as the use of fertile land may be reserved for food production. However, the use of this feedstock may indirectly complete with food due to its competition with land and other productive resources. The use of sweet sorghum as feedstock will overcome the problem of food-fuel conflict as its new hybrids can produce fuel and animal feed from the stalks and food from its grains. In addition, the yield of grains is almost the same as that of sorghum (PATANCHERU, 2008).

8.0 Potential Impacts on Access to Food.

This section discusses the extent to which the global production of biofuels is linked with the recent rise in food commodity prices in Botswana. Production of biofuels is mentioned to be one of the main causes of the recent increase in global food prices (FAO, 2008). It is crucial to investigate this issue because the economy of Botswana is very vulnerable to food insecurity as it is a net importer of major cereals such as rice, wheat and maize (FAO, 2008).

8.1 Trends in consumer price indices

Fig 3 shows the consumer price indices for all food products and selected food products of cereals and oil and fats in Botswana normalized to the year 2006 (base year = 2006). The results reveal that the indices of food commodities have been rising during the period 1998 to 2008. Cereals increased by 135%, whereas oils and fats increased by 240%, suggesting that the annual rate of inflation was 14% for cereals and 24% for oils and fats (Fig. 4). The rate of

increase of the prices of these food commodities was of the same order of magnitude during the period 2002 to 2008; 13% for cereal products and 27% for oils and fats (Fig. 5). However, the increase in food commodity prices was greater during the period 2005 and 2008; as was the case globally (FAO, 2008). During this period, oils and fats registered an annual inflation of 37%, whereas cereals increased by 21% (Fig. 5). The index of operation of personal transport (includes petrol and diesel) also increased by a proportion of 23% during the periods of 2002 to 2008 and 2005 to 2008 (Fig. 5). This should be expected because the fossil fuels of petrol and diesel account for a large proportion of this index. The rise in the prices of these fuels is one of the factors which determined the rise in food commodity prices as already stated (FAO, 2008; Naylor *et al*., 2007). However, the trend in the indices for food prices significantly differs from that of the indices of clothing and footwear, a non-food commodity. The nominal price index for this commodity increased by only 2% and 1.5% during periods 2002 to 2008 and 2005 to 2008, respectively (Fig 5). In addition, health, another non-food item also increased by only 9% and 10% during these two periods, respectively (Fig. 5).

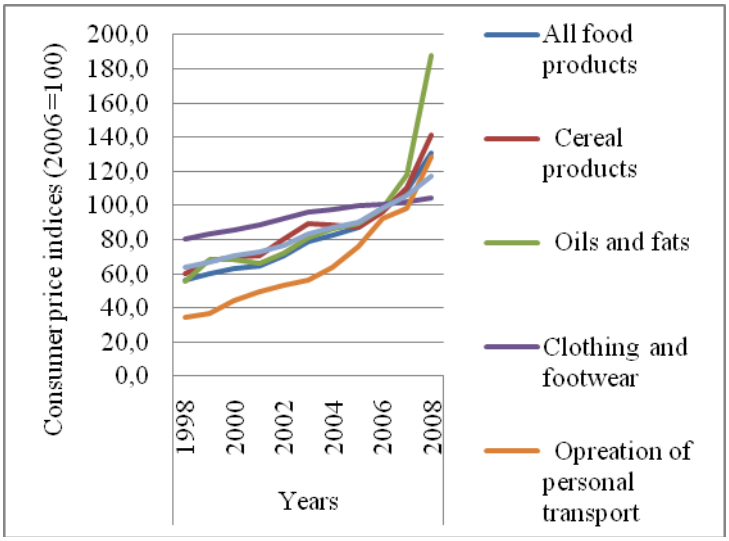

Fig. 3: Botswana consumer price indices (1998 to 2008).

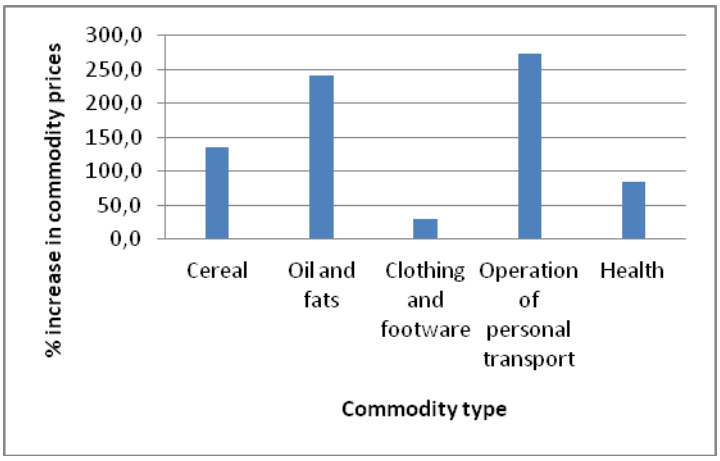

Fig. 4: Increase in commodity prices, 1998 to 2008.

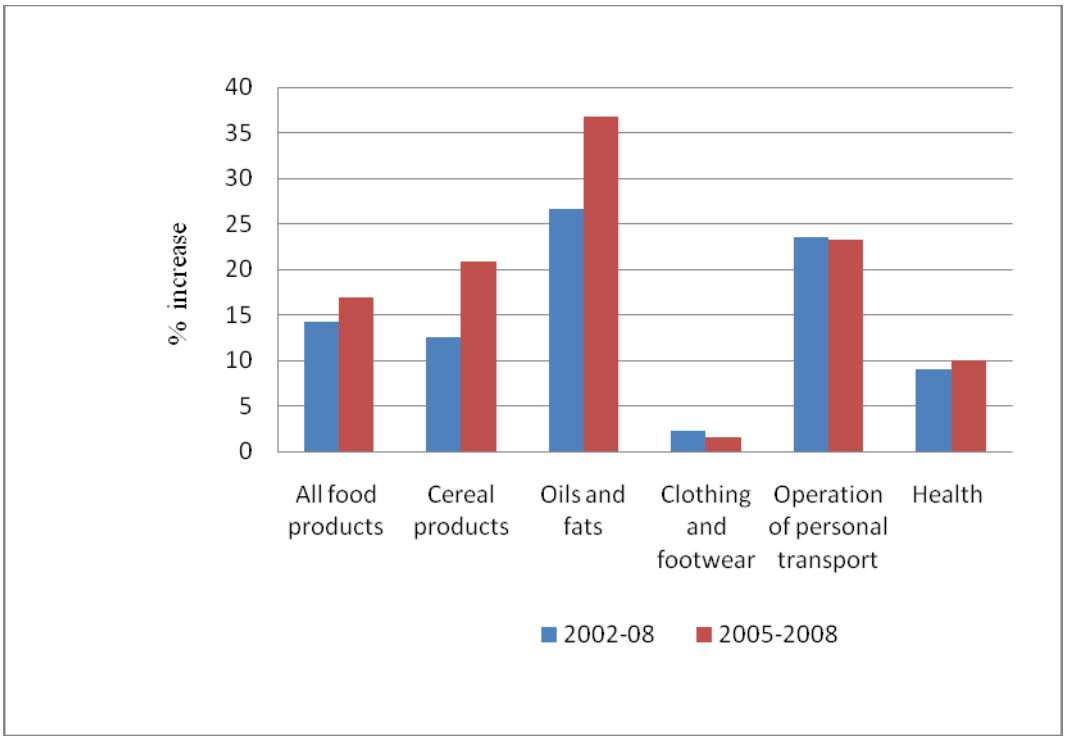

Fig. 5 Increase in prices of food and non-food commodities, 2002-08 and 2005-2008

8.2 Trends in Selected Prices of cereals

This section discusses trends in the nominal and real producer prices of selected commodities of white maize, sunflower, and groundnuts. The nominal prices were deflated by the

Botswana consumer price index (2006 as base year) to change the prices to real terms or constant prices of 2006. In other words, the nominal prices were expressed in terms of the purchasing power of the Botswana currency of the year 2006. Fig. 6 and 7 present the trends in the nominal and real producer prices of these commodities from 1999 to 2008. It can be revealed that both nominal and real prices of these commodities increased rapidly during the period 2005 and 2008. There was, however, a decline in the prices of maize (-140%) and sunflower (-49%) between 2002 and 2005. Of the three food commodities, the real prices of groundnuts increased much faster than those of maize and sunflower which increased by 140% and 6%, respectively, during the period 2005 to 2008. The above results are consistent with the trends in the nominal prices of the consumer price indices in that the prices of food commodities soared during this period.

8.3 Global food commodity prices

As stated earlier, a number of studies reveal that production of biofuels was among the factors that contributed to the rise in commodity food prices since 2002. The rise in these commodity prices was sharper between 2005 and 2008. According to Mitchell (2008) the IMF's index of internationally traded food commodity prices increased by 130% and 56% during the periods of 2002 (January) to 2008 (June) and 2007 (January) to 2008 (June), respectively. The FAO index of nominal commodity prices also doubled between 2002 and 2008. In real terms, there was also a high increase in food commodity prices as the 2008 prices were 64% higher than those of 2002 (FAO, 2008). A number of studies also reveal that this increase in commodity prices was led by vegetable oil prices and cereals (FAO, 2008; Mitchell, 2008).

According to a number of studies, biofuel development has significantly made a contribution to this rise in food commodity prices. The rapid global expansion of biofuel production in recent years was due to incentives, mandates, and tax exemptions on these fuels. Article 3.3 of the EU Directive 2009/28/EC of the European Parliament and of the Council, which repeals directives 2001/77/EC and 2003/30/EC, expects Member states to ensure that "the share of energy from renewable sources in all forms of transport in 2020 is at least 10% of the final consumption of energy in transport in that Member State" (EPCEU, 2009). There is no enough land in the EU to meet the requirements of this directive, and according to the COMPETE (2009), Europe will have to import biofuels from other countries. In the USA, it is also expected that fuel distributors will increase the volume of biofuels to 30 billion per annum by 2012 (OECD/IEA, 2007). In order to achieve biofuel targets and mandates, generous subsidies are usually provided by countries in order to stimulate production of biofuels (RFA,2008).

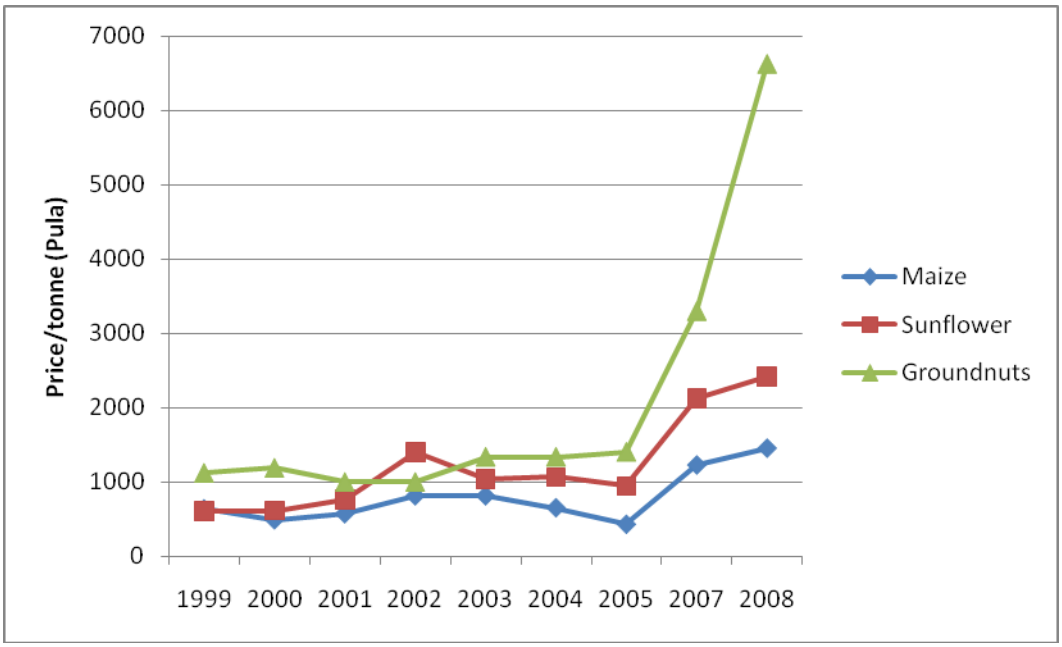

Fig: 6 Trends in nominal producer prices of selected food crops in Botswana.

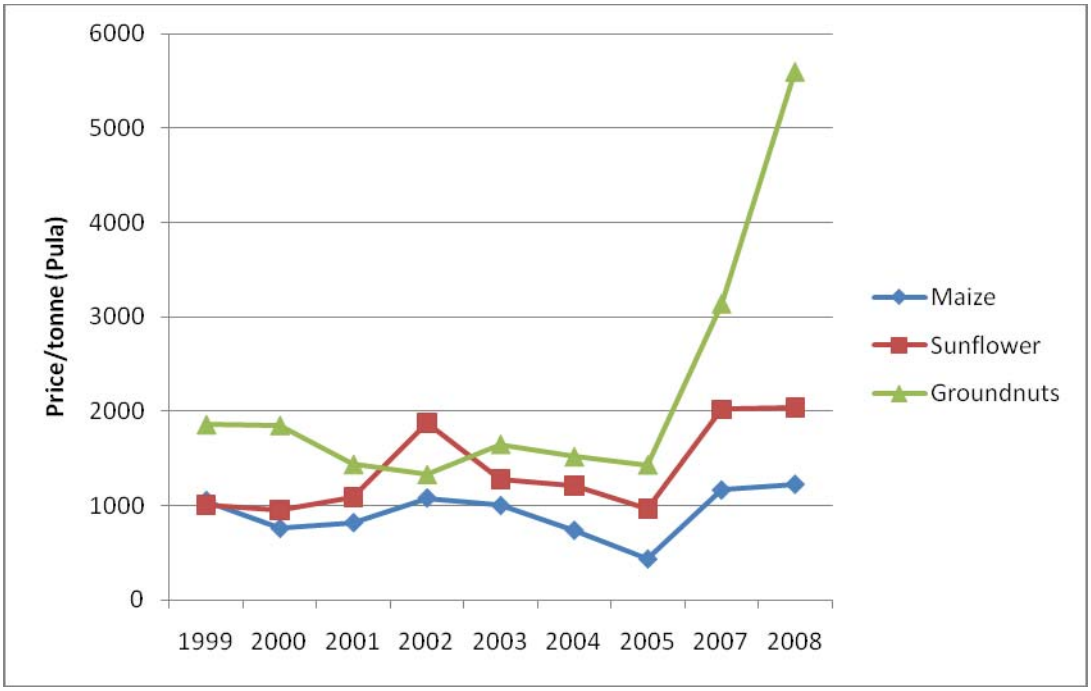

Fig 7: Trends in real producer prices of selected food commodities in Botswana.

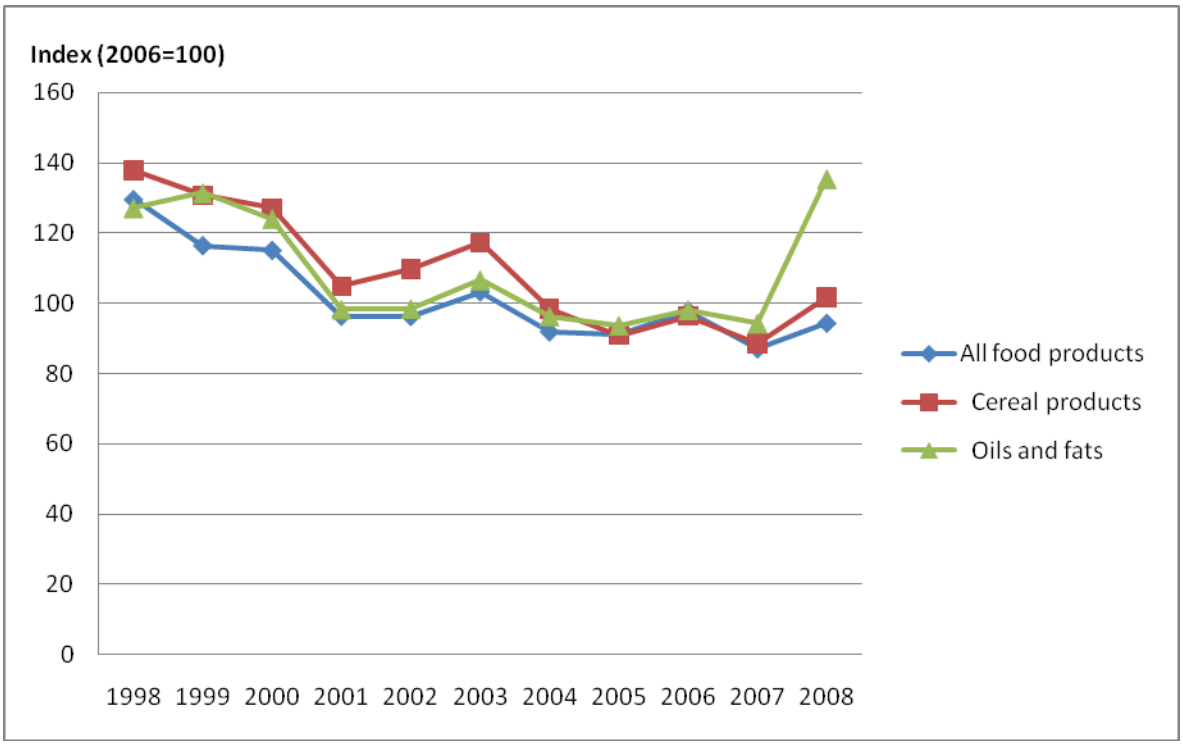

Fig 8: Food Prices Relative to Income

As already stated, a rapid increase in food commodity prices has an adverse effect on incomes and poverty, particularly if prices are rising faster than incomes. The Botswana indices of all food items and sub-indices of cereals and oils and fats for the years 1998 to 2008 (base year, 2006) were deflated by the Botswana GDP index (base year, 2006). Fig. 8 summarises the results which reveal that the deflated indices declined for all food items, cereals, and oils and fats during the period 1998 to 2007. However, these indices were rising during the period 2007 to 2008. These results suggest that during the period 2008 to 2007, average incomes were rising faster than all food commodity prices, suggesting that on average purchasing power was not being eroded. However, there was a loss in purchasing power during the period 2007 to 2008 as the prices for these commodities were rising faster than incomes on average. The prices of cereals and oils and fats rose faster than those of cereal products and all food products during this period. It is crucial to mention that the above calculations are based on average figures which mask the high variation of incomes among different households in Botswana, and the actual impacts of rising commodity prices on the poor households. The rapid economic growth of Botswana, for example, has not resulted in substantial reductions in poverty as 50% of the population lives below USA $2 a day (World Bank, 2005). According to the 2007/2008 Human Development Report, Botswana had a human development index of 0.654 and it was ranked 124th out of 177 countries in terms of human development. Its GDP per capita (PPP USA$) rank minus HDI rank was negative at (-70), suggesting a lower performance in human development as compared to economic growth (UNDP, 2005).

9.0 Discussion

9.1 Food availability

The use of idle and marginal land for growing biofuel crops has positive implications for food security. The displacement of food crops from fertile agricultural land is avoided and this reduces the associated negative impacts of land use change (FAO, 2008). There is need to make careful assessments of the food security implications of the use of the land classified as marginal or idle in Botswana. Regarding marginal land, there is need for an assessment of the current use of the land and to determine how it is currently used by local communities, and whether its use for biofuels will indeed not compete with land for food production. The assessment should also ensure that its use will not displace local communities, and whether it will improve the restoration of degraded areas, and provide the poor households with new sources of income.

9.2 Access to food

The increase in the demand for biofuels is one of the contributory factors to the increase in food prices, an important indicator of access to food. Even though Botswana does not as yet produce biofuels, there are indications that it is already being affected by the implementation of biofuel policies in other countries. The pattern of the local food commodity prices is similar to that of the global food prices, which also soared faster than other commodity prices, particularly since 2005. This suggests that there is a high degree of transmission of world prices into local prices in Botswana, mainly due to trade openness and the policy of import parity. The above information suggests that the recent price trends in food commodity prices in Botswana could also be due partly to the implementation of biofuel policies in other countries. The increase in biofuel production in the USA and the EU resulting from biofuel policies in these countries is one of the contributory factors to the increase in global food commodity prices. This is partly because of the rapid expansion of biofuel development in these countries due to incentives, mandates, and tax exemptions on these fuels, and also because of the type of feedstocks used for biofuel production which compete with resources used for the production of food commodities. The costs of producing biofuels are still high in most countries. According to the Royal Society (2008), these costs are higher than those of petroleum-based fuels, with the exception of those of bioethanol produced from “sugarcane in the tropics and sub-tropics”.

The contribution of biofuels to the recent global increase in food prices (2002 to 20008) is estimated to range from 3% to 30% and even higher (FAO, 2008). Other contributory factors to the increase in commodity prices include some of the following factors: 1) high costs of food production resulting from high prices of petroleum products, 2) decline in food production in major exporting countries such as Australia due to weather-related shocks, and 3) strong demand of meat and dairy products due to high population and improved living standards in emerging economies of Asia and Latin America (FAO, 2008; Lustig, 2009). Recent studies attribute the rise in the price of food commodities such as maize and soybeans to their use for biofuel production. According to Mitchell (2008), the Chief economist of the

USDA informed the Joint Economic Committee of Congress that biofuels were largely the cause of the recent rise in the prices of maize and soybeans. Like in Botswana, the increase in global food prices was mainly led by grains and oilseeds. This is mainly because these commodities are used for ethanol production and also because of changes in landuse associated with a reduction in the supplies of commodities such as wheat and rice which compete with those used for the production of biofuels (Mitchell, 2008).

These soaring commodity prices, not only caused by an increase in biofuel development, have caused civil unrest and sometimes violence in a number of developing countries (FAO, 2008). Although higher food prices may give farmers an incentive to produce more food in the medium and long term, the benefits may be limited in Botswana since the country is a net importer of food. In the long run, the net food buyers, who are mainly the poorer households are likely to be adversely affected and this may increase the risk of chronic food insecurity in Botswana.

10.0 Conclusion and policy implications

This study has revealed that the Government of Botswana is currently working on a policy for biofuel development. It is intended that by the year 2012, the country will be producing biodiesel using *Jatropha curcas* as a feedstock. This crop was among those recommended by the consultancy on the feasibility of biofuel production and use in Botswana (EECG, 2007). In order to reduce adverse impacts on food security, the following strategies will be adopted by the Government of Botswana: 1) use of idle and marginal land for biofuel production, 2) use of drought resistant feedstocks of *Jatropha curcas* and sweet sorghum. About 70% of the land in eastern Botswana is idle, whereas the proportion of marginal land is 29%. Although, land availability is currently not a problem, there is need to ensure that the growth of the production of biofuels will not have an adverse impact on food security in the future. Farmers may easily switch from the planting of food crops to fuel, depending on the magnitude of relative prices of the crops. It is therefore necessary to do monitoring of land-use over-time in order to avoid adverse effects on food production.

It was also revealed that food commodity prices increased during the period 2002 and 2008 and the rise was much faster during 2005 to 2008. Even though Botswana does not yet produce biofuels, there are indications that the implementation of biofuel policies in other countries is already contributing to food insecurity in Botswana. The pattern of the local food prices is similar to that of the global food prices, which also soared faster than other commodity prices, particularly since 2005. This suggests that there is a high degree of transmission of world prices into local prices in Botswana, mainly due to trade openness and the policy of import parity. The increase in the demand for biofuels is one of the contributory factors to the increase in food prices, an important indicator of access to food.

The use of *Jatropha curcas* as feedstock for biofuel production may reduce the food-fuel conflict as it can be grown on marginal land. This will reserve the use of fertile land for food

production. In addition, it is also possible to produce both food and energy on the same land in Botswana using agro-forestry practices as is currently the case in Zambia where small-scale farmers are producing *Jatropha curcas* and food crops in their fields. In addition, the restoration of degraded agricultural lands by growing *Jatropha curcas* may also have a positive impact on the local economy and food security in the area. The use of sweet sorghum as feedstock is also associated with a number of advantages such as reducing the adverse impacts of the food-fuel conflict as there are now new hybrids which can produce fuel (from stalks), animal feed (from stalks), and food (from grains).

In conclusion, measures should be taken to ensure that the production of biofuels in Botswana is sustainable in social, economic and environmental terms. The failure to do so may result in adverse consequences for viability of achieving the Millennium Development Goals, particularly those of poverty alleviation and environmental sustainability (UNDP, 2005). To achieve the sustainability of biofuel development, it is necessary to develop criteria for their production and use in Botswana and food security should be one of the parameters which should be included. Other parameters should include greenhouse gas and energy balances, biodiversity, environment, and the wider socio-economic and political issues. The recent research evidence attributing the development of biofuels to the increase in food prices leads us to support the view of the Gallagher report that the targets for biofuel development should not be too ambitious (RFA, 2008). Globally, it might be necessary to slow down the development of first generation biofuels and speed up research and development on second generation biofuels produced from ligno-cellulosic biomass feedstocks as they are likely to be more compatible with sustainable development. The Department of Energy in Botswana should join the global research efforts on the production of second generation biofuels from ligno-cellulosic biomass feedstocks as they are very promising (Royal Society, 2008).

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