

السياسات الغذائية للقمح والذرة في السودان

Wheat and Sorghum Food Policy in Sudan

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الملخص: يعتبر القمح والذرة من المحاصيل الزراعية الرائدة في السودان لما لها من دور مهم من ناحية الأمن الغذائي والعائدات المزرعية حيث يعتبر المحصولان الغذاء الرئيسي لسكان السودان. في مواجهة ارتفاع أسعار الغذاء العالمية في بداية الألفية الثالثة اضطرت الدول إلى تجميد سياسات التحرير الاقتصادي جزئياً بالنسبة لمحاصيل الغذاء الرئيسية حتى تتيح للسكان إمكانية الحصول على الغذاء. حيث قامت الدول بوضع سياسة تتضمن دعم المستهلك وتحفيز المنتجين. تهدف هذه الورقة إلى تضمين الآثار المترتبة على سياسة الدعم بالنسبة لمحصول القمح بجانب سياسة فرض ضرائب على محصول الذرة وما يترتب على ذلك على الأمن الغذائي إجمالاً. استخدمت هذه الدراسة نموذج الأسواق المتعددة لتحليل وضع الأمن الغذائي في السودان. حيث أن النموذج يعتبر من النماذج الساكنة ويفترض المنافسة الكاملة بين أسواق المحاصيل وتجانس السلع. يتيح النموذج دراسة التداخل بين الأسواق وذلك من خلال المرونة السعرية والتقاطعية للسلع. يتضمن النموذج سلع الأمن الغذائي الرئيسية وهي القمح والذرة كما يتضمن تحليل مؤشرات الأمن الغذائي القومية مثل الاكتفاء الذاتي ومعدل استهلاك الفرد وذلك حتى نعطي نظرة متكاملة لوضع الأمن الغذائي بالبلاد تحت مختلف السيناريوهات. كما يقوم النموذج بتحليل الرفاهية لكل السياسات المدروسة. نتائج المحاكاة بالنموذج أوضحت أن الأثر العام لسياسة دعم المستهلكين وتحفيز المنتجين للقمح بجانب فرض ضريبة على منتجي الذرة يؤدي إلى آثار إيجابية على منتجي القمح كما أنه يؤدي إلى انخفاض في جانب عرض الذرة. أما من ناحية الطلب فإن السياسة تؤدي إلى زيادة في استهلاك القمح وبالتالي زيادة في واردات القمح مما يؤثر سلباً على الميزان التجاري تؤدي السياسة الحالية أجمالاً إلى انخفاض في مؤشر الإكتفاء الذاتي وزيادة في معدل استهلاك الفرد من الحبوب. خلصت الدراسة إلى أن سياسة الدولة يجب أن تتسم بالحذر في سوق الحبوب حيث أن السياسة الحالية تؤدي إلى خسائر في معدل الرفاه العام كما أنها تؤدي إلى عدم كفاءة في استخدام الموارد كما يجب على الدولة أن تراقب التطورات في الأسواق العالمية حتى تتوصل إلى سياسات مرنة.

كلمات مفتاحية: الأمن الغذائي، السياسات، السودان

Abstract :

Wheat and sorghum crops have prominent roles in the Sudan agricultural sector as important sources of food security and farm income. They are the main staple food crops in the Sudan. In the face of increasing world food prices during the 2000s, the country was obliged to abandon liberalization policies partially for food main crops and to subsidize wheat consumers in order to improve their accessibility to food and fix price ceilings for farmers as an incentive to increase food availability. The aim of this paper is to assess and quantify the consequences of domestic price policy of the two main food crops, wheat and sorghum on the food security of the country. This study applies a multi-market model approach to analyze Sudan's food security policies. The model is static and assumes perfect competitive crop markets and homogeneity of goods. It allows the study of interaction between commodity

markets through own and cross price elasticities. The model involves major food security crop markets in Sudan, namely wheat and sorghum and extends to provide analysis of national food security indicators of food self-sufficiency and per capita consumption ratios to provide an overview of national food policy implications under different policy scenarios. The model also runs welfare analysis about the distributional impact of the adopted price policies. The simulation results reveal that the total effect of subsidizing both wheat producers and consumers, while taxing sorghum producers' show in general a small positive change in the supply of wheat and a decrease in sorghum supply. On the demand side, wheat demand would considerably increase induced by the subsidized consumer prices. The subsidy policy would result in an increase in wheat consumption and consequently wheat imports which will aggravate the deficit in the balance of trade. The current policy reduces the self-sufficiency ratio while increases per capita consumption of cereals in the country. The paper concludes that the government policy should manage carefully the intervention in wheat and sorghum markets in terms of subsidies and taxes which would distort prices and result in welfare losses and inefficient resource allocation. The policy need to consider the developments in the world market prices and adopt flexible subsidy polic

Keywords: Food security, Policy, Sudan

1. Introduction

Wheat and sorghum crops have prominent roles in the Sudan agricultural sector as important sources of food and farm income. They are the main staple food in Sudan. Wheat is consumed mainly in urban centers while sorghum is the main food in rural areas. Food security is major concern in the country because of the instability of these two crops. The instability in wheat arises from that Sudan is a wheat net importer and small country in the world market; hence the country is exposed to world price variability and increasing trend of world market prices, in addition domestic wheat production is highly vulnerable to unstable temperature during winter season. While the uncertainty in sorghum production is attributed to that most of sorghum is produced under rain fed sector with rainfall usually differ from year to year and expose sorghum production to the risk and fluctuation in yield and production. Hassan (1988) (in Faki, 1996), defines the main sources of sorghum price instability are changing climate conditions, government intervention policies and speculations. A salient feature of Sudanese agriculture is the wide fluctuations in its contribution to economic growth. While being generally export orientated via cash crops, which have been an intrinsic characteristic of the agricultural sector (Faki and

Taha, 2010). In general because of these two factors, prices and rainfall; Sudan food security is fragile and normally falls in shortage. In the Sub Saharan Africa region about 180 million of food insecure people and had in the past experienced an increase in the number of the undernourished by 24 million people between 2003 and 2009 (Ackello-Ogututu et al, 2012). In Sudan only, the USAID have estimated 3.6 million in secure people, mainly in conflicts areas. Two characteristics are drawn from FAO data by Hertel et al 2002, the annual volatility is largely due to variation in yield. Yield variability is mainly attributed to uncontrollable events that play a fundamental role in agricultural production such as amount of rainfall, temperature and incidence of pests and diseases. Unstable supply of staple food in developing countries tends to increase domestic price variability which may lead to food insecurity problems for poor and increase uncertainty for farmers (Ibrahim, 2004).

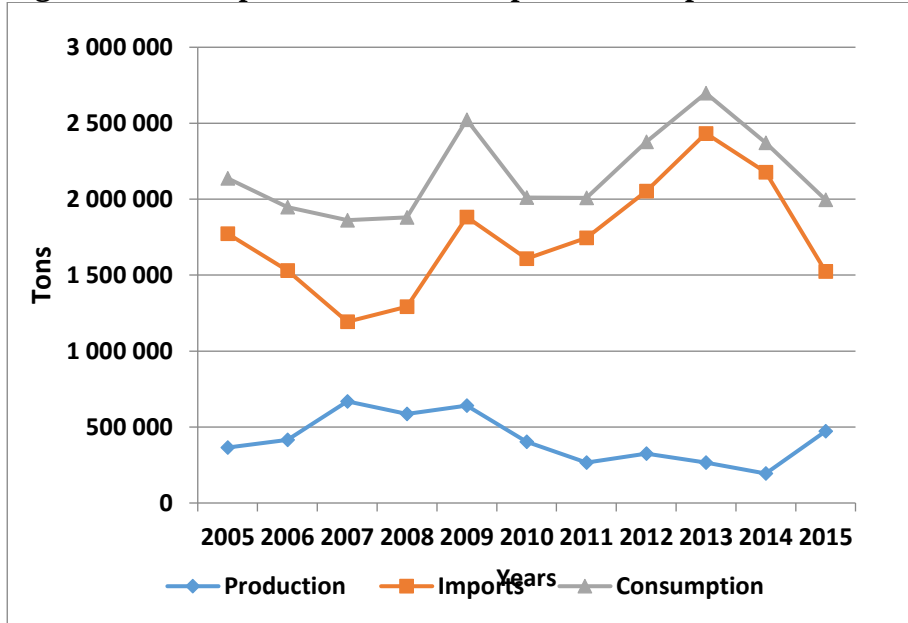
1.1 Food Policy in Sudan

In many African countries, policies are designed in order to induce changes in a society and its economy to achieve desired objectives. Most African countries, depend to a significant extent on the challenging agriculture sector to sustain economic growth and achieve food security (Angelucci et al, 2013). Economic policies in Sudan have provided government dominance over production, marketing and trade of agricultural products through a series of public-sector-led development plans, production and marketing parastatals, plus close control of foreign exchange transactions that, until recent years, had led to currency overvaluation (Faki and Taha, 2007). The Sudan agricultural policy shifted towards market economy through adoption of structural adjustment programs in early 1990s, the main reformers under this program revolve around agricultural products and include a wide abolition of subsidies (production and consumption) and restriction in interventions in output prices. Beside other measures including tax reduction and freeing exchange rate market. However, in the face of increasing world food prices in the 2000s, the country has obliged to abandon liberalization policies partially for food main crops and to subsidize wheat consumers in order to improve their accessibility to food and place price ceilings for farmers as an incentive to increase food availability. During the first decade of the 2000s, the government

financed these subsidies from budget surplus of oil returns; however, after succession of the south Sudan and losing of its oil returns the country has suffered to find financial resources for wheat subsidies. It has been the case that most African Governments have been taxing farmers and subsidizing urban consumers, while at the same time doing very little in terms of policy and investment to favor the rural sector (FAO, 2006).

1.2 Wheat production, consumption and imports

Wheat is grown totally under the permanent irrigated sector. The decreasing trends of local production and increasing demand have developed an increasing annual volume of imports which has exerted a heavy burden on the country budgetary. Over the past few decades' changes in dietary patterns and a rapid growth in wheat consumption have been noted across countries in Sub-Saharan Africa, (Morris and Byerlee, 1993 in Faki, 1996 and Jayne et al. 2010). Wheat demand in Sudan has increased substantially over time by scale that could not be satisfied by local production. The sharp increase trend in wheat consumption is shown in figure which describes the expansion of consumption from 504,106 tons in 1981 (Faki, 1996) to 2,698,000 tons in 2013 (figure 1). In addition to normal population growth, wheat consumption has been affected by other factors, during the 1980s; high growth in wheat consumption was maintained through low consumer prices induced by food aid, overvalued currency and direct subsidies (Faki, 1996). Moreover, much of that increase was derivative by raising per capita income, the social factor of change in consumer habits by switching from tradition food the sorghum to wheat consumption, coupled with demographic changes of the internal migration from rural areas to the urban centers where wheat is staple food. Wheat production has shown a decreasing trend since early 2000s. The production in 2014 was about 194,000 tons which represent only one tenth of the total country needs (figure 1).

Figure 1: Wheat production, consumption and imports 2005-2013

Source: Ministry of Agriculture and Forests

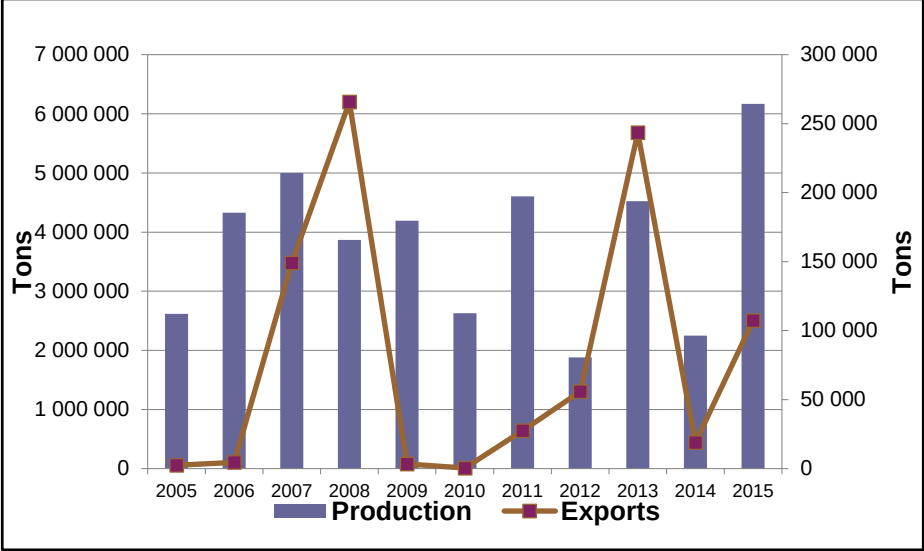
The low production trends in the 2000s are owed to liberalization policy under which the competitiveness of the other cash crops has increased. Another major reason was the unfavorable weather conditions that affect productivity, where relatively high temperatures prevail in Sudan during winter. Wheat yields have varied considerably, sometimes below 1 MT/ha but more often well above 2 MT/ha, especially in recent years. Nevertheless, they are below the average for developing countries as a whole by 25-30%. (Konardeas, 2009).

In the year 2014 Sudan imports reached 2.4 million tons (figure1) of value \$ billion 1.046 (Bank of Sudan, 2015). Starting from the beginning of the 1980s, Sudan became a net importer of wheat. Sudan's wheat supply and consumption directions have resulted in a continuous and variable deficit between domestic needs and local production (Faki, 1995).

1.3 Sorghum production and exports

Sorghum is grown throughout Sudan; more than 80 percent of sorghumis grown in the rain fed subsector, however its production is concentrated in few states. Six states jointly contribute about 72% of thenational sorghum production.

Figure 2: Sorghum production and exports 2005-2013



Source: Ministry of Agriculture and Forests

The most important sorghum producing states include: Gedarif with 18.8% share of annual sorghum production, Gezira (16.6%), South Kordofan (12.9%), Kassala (8.4%), Sennar (8.2%), and White Nile (7.6%). Blue Nile and South Darfur also contribute 5.4% and 4.8% ofttotal sorghum production, respectively (SIFSIA, 2010).

Sorghum production is quite volatile from year to year as its production follows rain fall fluctuations, the country produces surplus in good rain seasons and some years fail in produce enough for all (El-Dukheri, 2011). In good seasons the production could reach more than 4 million tons such as in years 2006, 2007, 2009, 2011 and 2013. While, in low production years the production might fall to less than 3million tons such as the years 2005, 2008, 2010 and 2012 (figure 2). Sudan exports a relatively small amounts of sorghum at times of good production, in 2008 the exports reached around 250 thousand tons, while there is no exports in 2009 because of the bad season of 2008 (Figure 2).

1.4 Study objectives

The study aims at analyzing the current main food crop markets and related to food security situation in the country, more specifically:

- i) To discuss recent trends in wheat and sorghum production and trade as the two main food crops.
- ii) To analyze and to quantify the likely impacts of the Sudan's food security domestic policy in the face of increasing world market prices, more particularly on supply, demand, welfare, food import bill and food security indicators.

A multi-market model for wheat and sorghum issued to address these questions.

The next section reviews trends of wheat and sorghum economic variables. Section 3 discusses the underlying multi-market model. Section 4 outlays the simulation model used to test the domestic policy. Finally, Section 5 gives a summary and discussion.

2. MATERIALS AND METHODS

2.1 A Multi-market Model for Food Crops: general features and equations

In this paper a multi-market model of two crops markets is used to assess and quantifies the consequences of domestic price policy of the two main food crops, wheat and sorghum on food security of the Sudan. A standard partial equilibrium model is used for this analysis; it comprises a set of demand and supply equations for each crop market with a level of supply and demand that calibrated from variables including prices, income, supply and demand elasticities which are working as a shifting variables (Jechlitschka et al, 2007). Supply and demand functions for each product market are specified through cross-market price linkages; domestic prices for one market help to determine the quantity supplied and demanded of markets under consideration. Price transmission equations in the model set links between world market price, producer price (for producers of exportable products and of import-substitute products) and the consumer price. The two agricultural crop markets of the Sudanese food considered in the model are wheat which is the major import substitute and sorghum a major cereal export. The model has been extended to calculate the impact food

policy prices on the economy variables which include supply, demand exports and imports. Also, the model is calculating the effects on the national food security indicators.

2.2 The Supply Equations

A set of equations is used to represent the relationships between supply and demand in the model for both wheat and sorghum. The interaction between the two crops is captured through cross price elasticities. For each market a Cobb-Douglas iso-elastic function is used to represent supply and demand system for both markets (Kirschke and Jechlitschke, 2002). The supply of each commodity is indicated by the quantity produced which is function of its own price and the prices of the competing commodities. The crop market supply equation is represented as follows:

$$q_i^s = c_i * (p_i^s)^{\varepsilon_{ii}} * \prod_{j \neq i} (p_j^s)^{\varepsilon_{ij}}, \quad i, j = 1, \dots, 2 \quad (1)$$

Where

q_i^s denotes the amount of the i^{th} commodity supplied

c_i is the supply calibration coefficient of the i^{th} commodity

p_i^s is the supply price of the i^{th} commodity

p_j^s is the supply price of the j^{th} product

ε_{ii} is the supply price elasticity of the i^{th} product

ε_{ij} is the supply cross price elasticity of the products j^{th} that are competing the i^{th} product

j is the set of relevant competing substitutes of the i^{th} product.

2.3 The Demand Equations

Regarding demand, the quantity of a commodity demanded is set to depend on its own price, the prices of close consumption substitutes or complementary commodities and the consumer per capita income. Therefore, the system of the demand function can be expressed as follows:

Where,

q_i^d denotes the amount of the i^{th} commodity demanded

b_i is the demand calibration coefficient of the i^{th} commodity

p_i^c is the demand price of the i^{th} commodity

I is per capita income

η_{ii} is the demand price elasticity

η_{ij} is the cross price elasticity of the i^{th} commodities that are complementary or substitutes for the j^{th} commodities.

μ_i is the income elasticity of the i^{th} commodity.

2.4 Price Transmission in the Model

Price-linkages are essential in the model. The equations assume that the government could control the domestic price through price policy measures which affects producer and consumer prices. Also, it assumes that the movements in producer and consumer prices are connected to the world price movements. (for exportable products and import-substitute products). Price transmission in the model is represented through a common approach which computes the difference between a domestic price and international reference price to attribute the difference to the effect of policies (Blandford, 1990). The policies considered in the model are wheat producer and consumer subsidies and, sorghum producer tax. Producer and consumer prices of the export and import-substitute commodities are shown by the following equation:

(i) Producer price

$$P_i^s = P_i^w (1 + r_i) * (1 + s^p) \quad (3)$$

$$P_i^s = P_i^w (1 + s^p) \quad (4)$$

(ii) Consumer price

$$P_i^c = P_i^w (1 + r_i) * (1 - s^c) \quad (5)$$

$$P_i^c = P_i^w (1 - s^c) \quad (6)$$

Where,

P_i^s is the producer price for the commodity i

P_i^c is the consumer price for the commodity i

P^w is the world price of the commodity i

s^p is domestic rate of producer's subsidy

s^c is domestic rate of consumer's subsidy

r_i is the protection rate of the commodity

2.5 Government Budget

By this term it is meant to assess the gains and losses of the government treasury resulting from applying a certain policy. The calculation of the government budget is shown in the following equation; the components of the government are export taxes, import tariffs and domestic taxes or subsidies.

$$\begin{aligned}
 GB_i &= (q_i^s - q_i^d)(p_i^w - p_i^d) + q_i^s(p_i^d - p_i^s) + q_i^d(p_i^c - p_i^d) \\
 &= q_i^s \cdot p_i^w - q_i^s \cdot p_i^s + q_i^d \cdot p_i^c - q_i^d \cdot p_i^w \\
 &= q_i^s(p_i^w - p_i^s) + q_i^d(p_i^c - p_i^w) \quad i=1,2 \quad (7)
 \end{aligned}$$

Foreign exchange can be calculated through the following equation

$$F_i = (q_i^s - q_i^d)p_i^w, \quad i = 1,2 \quad (8)$$

The above mentioned economic variables are the major variables to be tested by the multi-market model, but we could make use of these variables to extend the model and study the effect of the domestic policy on other indicators such as food security and food imports and exports.

2.6 Food security indicators

Wheat and sorghum are the major staple food for the population used as the food security component in the model. National macroeconomic indicators of food availability used in the model are self-sufficiency ratio (SSR) of cereals, and per capita consumption (PCC) of cereals.

(i) Self-sufficiency ratio (SSR)

$$SSR = \sum q_i^s / q_i^d \quad (9)$$

(ii) Per Capita Consumption (PPC)

$$PPC = q_i^d / N \quad (10)$$

Where, N denotes the population number.

2.7 Model scenarios

2.7.1 Base scenario

The base scenario is obtained by running base simulation model with the base period data of the year 2013. The base scenario simulation results show how main food crop markets (wheat and sorghum) perform under the current international prices.

2.7.2 Domestic policy scenario

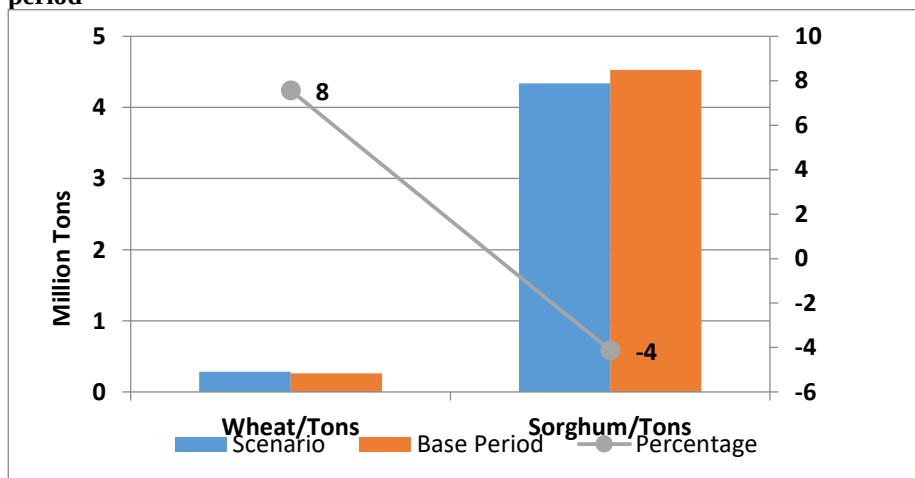
In this scenario we study how the change in domestic policy of wheat producer's and consumer's subsidy and sorghum producer's tax will affect the performance of food crop markets, including supply, demand, imports, welfare, and government budget, in addition to the national food indicators.

3. RESULTS AND DISCUSSION

3.1 The Supply effect

Figure (3) highlights the supply effect of the simulated policy on the supply of wheat and sorghum. The expected total effect of subsidizing both wheat producers and consumers, while taxing sorghum producers show in general a small positive change in supply quantity of wheat to increase by 8 percent from the base period of 265,000 tons to about 285,000 tons, this is clearly due to the incentives of wheat minimum prices set by the government a head the growing season. If the market prices are set above the equilibrium price level, marketed food production will increase and the supply deficit will diminish. Regarding sorghum supply, the scenario of taxing sorghum producers by ten percent reveals a 4 percent decrease in its supply. That the supply might decrease from 4,524,000 tons in the base period to 4,337,301 tons induced by the low producer's price.

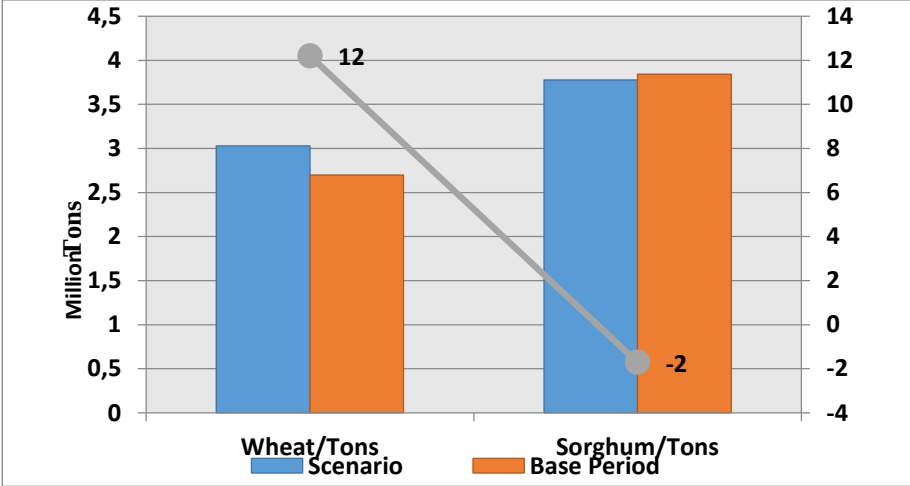
Figure (3): The supply effect on wheat and sorghum, scenario relative to base period



3.2 The Demand effect

Figure (4) outlines the demand effect of the simulated policy on the demand of wheat and sorghum. Wheat demand would increase by 12 percent from the base level to reach 3.027 million tons induced by the subsidized consumer prices. However, at lower prices, more people will be able to afford the food they need, effective demand will go up and the overall demand deficit increased. As a result of the increased supplies and increase demand, market deficit would emerge. This increase in consumption would affect negatively the balance of trade by increase imports of wheat and hence the country needs more sources of foreign currency. Findings indicated that consumers were more likely to increase their food consumption if food was subsidized directly. Sorghum demand would decrease slightly by 2 percent to reach 3.8 million tons due to the increasing competitiveness of wheat prices that will attract more wheat consumption.

Figure (4): The demand effect on wheat and sorghum, scenario relative to base period



3.3 Welfare effects

The distributional impact of the subsidy tax scenario is shown in table (1). In terms of welfare the effect of the policy is a gain to wheat producers and consumers a loss to sorghum producers and consumers. Government losses from wheat subsidies are compensated partially by sorghum tax, with total losses of US \$ 168.9 million. However, the policy ends with total welfare losses of US \$224.9 million.

Table (1) welfare effect of the subsidy tax policy scenario

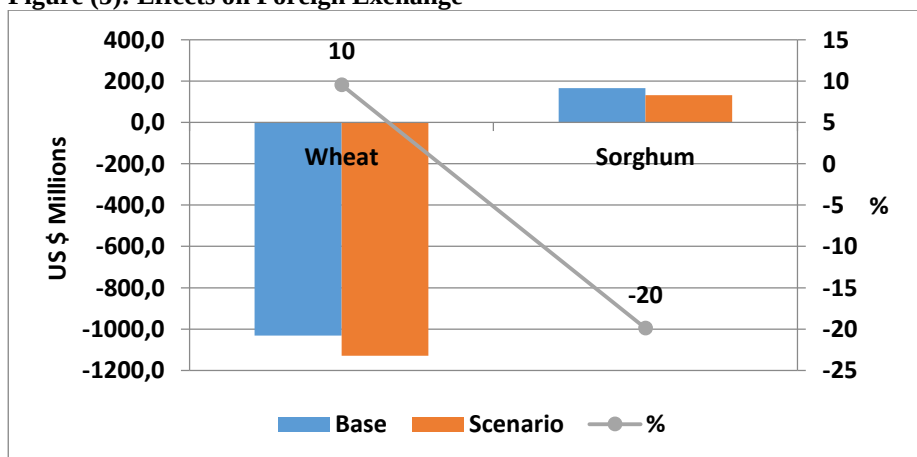
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Market	Producer's surplus	Consumer's surplus	Govt. Budget	Welfare
	Million US \$	Million US \$	Million US \$	Million US \$
Wheat	23.3	238.9	-274.3	-12.1
Sorghum	-107.7	-210.5	105.4	-212.8
Aggregate	-84.4	28.4	168.9	-224.9

3.4 Foreign exchange effect

The effect of policies under consideration on foreign exchange is depicted on figure (5). The subsidy of wheat would secure low prices for consumers; resulted in more wheat consumption and imports. Therefore, under this scenario, wheat import bill would increase by 10% to reach US\$ 1.2 billion. Sorghum producer's tax would negatively affect sorghum exports to decrease by 20% from the base period to reach US\$ 150 million. Under this set of policies foreign exchange situation would aggravated by wheat import bill increase and the decrease in sorghum exports.

Figure (5): Effects on Foreign Exchange

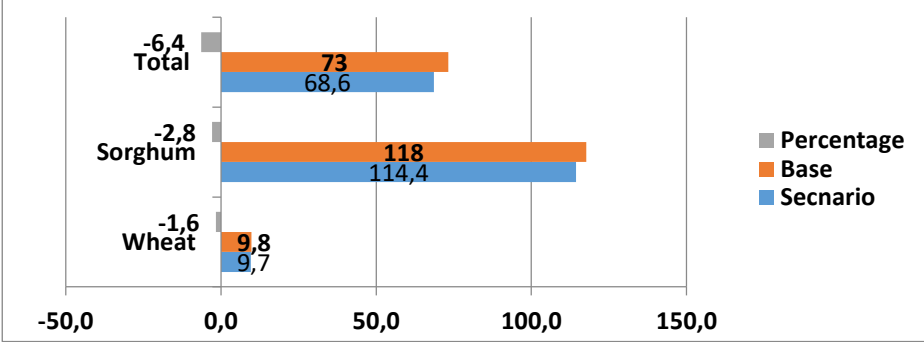


3.5 National food security effects

3.51 Self-Sufficiency Ratio (SSR)

The core target of the policy under study revolves around increasing food availability and accessibility in the country. Figure (6) show an indication of the possible effect on self-sufficiency ratio SSR for wheat and sorghum. Although the main objective of the policy is improve food availability, however, the policy has resulted in a reduction in total SSR by 6.4%. This is due to the double effect of wheat consumption increase which seems outweighing supply increase to result in 1.6% reduction in wheat SSR. In addition, taxing sorghum producers has resulted in a reduction of 2.8% of sorghum SSR. In spite of sorghum taxing policy, the country is still maintains its self-sufficiency of sorghum with 114.4 % ratio.

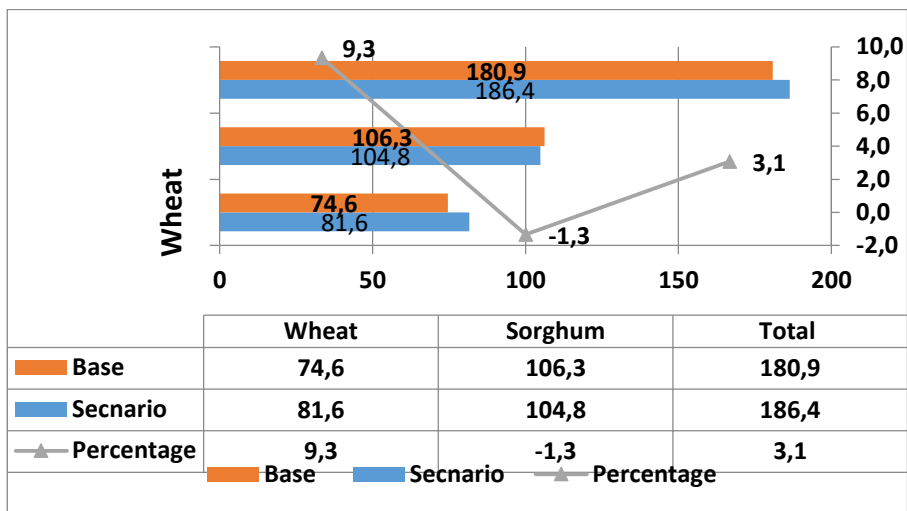
Figure (6): The effect on SSR of wheat and sorghum, scenario relative to base period



3.5.2 Per Capita Consumption PCC

Figure (7) explains how PCC would response to the food policy under investigation .In general total per capita consumption of cereals would increase by 3.1% to reach 186.4 kg per person, although sorghum PPC shows a decrease of 1.3% in compare to the base period in response to the production tax, which is highly above east African countries average of 72 kg/person/year (Mkumbwa, 2011).

Figure (7): The effect on PPC of wheat and sorghum, scenario relative to base period



This increase is due to 9.3 percent increase in the wheat PPC; which has increased from 74.6 in the base period to 81.6 kg/person/year. The subsidy policy has resulted in an increase in wheat consumption and consequently wheat imports which aggravate the trade balance deficit.

4. CONCLUSION AND POLICY RECOMMENDATIONS

The study has applied a multi-market model to analyze the impact of domestic policy in the face of the increasing world market prices on the two main food crops wheat and sorghum and food security of the country. The study has concluded that the expected total effect of subsidizing both wheat producers and consumers, while taxing sorghum producers show in general a small positive change in supply quantity of wheat and a decrease in sorghum supplies. On the demand side, Wheat demand has considerably increased induced by the subsidized consumer prices. The subsidy policy has resulted in an increase in wheat consumption and consequently wheat imports which aggravate the trade balance deficit. Under this set of policies, foreign exchange situation would aggravated by wheat import bill increase and the decrease in sorghum exports. Regarding total food security indicators, the simulation of the policy has shown a reduction in total self-sufficiency ratio, this is due to the double effect of wheat consumption increase which seems outweighing supply increase to result in a reduction in wheat self-sufficiency ratio. Despite taxing sorghum producers has resulted in a slight reduction of sorghum self-

sufficiency ratio sorghum self-sufficiency is still maintained. The government policy should manage carefully the intervention in wheat and sorghum markets as they are the main food crops and substitutes in consumption. The policy need to consider the developments in the world market prices and adopt flexible subsidy policy. More attention is needed for supporting inputs and infrastructure to affect positively the production of wheat and sorghum and hence food security of the country.

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