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Abstract

The agricultural trade of the Sudan is expected to develop under the recent dramatic increase of world food prices. Sudan as one of the developing countries and as price taker on the world agricultural market has been affected greatly by the world price increase. This paper aims at studying the impact of the increasing world food prices on developments of the agricultural crops trade sector of Sudan. In this paper a multi-market model is used as the main tool to estimate the increase of the world food prices on the crop trade sector. Multi-market analysis is a tool for simulating the effects of agricultural price policies on outcomes considered of interest to policy makers. The model under consideration takes the normal specification of a standard partial equilibrium model; it is static and consists of a set of demand and supply equations for each commodity with the level of production and demand determined by factors including prices, income, and demand and supply-shift variables, in addition to various other assumptions about policies. Price transmission equations in the model establish links between the domestic price, the producer price (for producers of exportable products and of import-substitute products), the consumer price and the world market price. The model has been developed to calculate the impact of high food prices on the main economy variables including supply and demand of the major agricultural commodities. The scenario of high world food prices showed on one hand, an increase in farmers' incentives resulting in higher levels of production of agricultural commodities, on the other hand, consumers demand has decreased significantly, and trade indicators reflect a positive effect on the agricultural crop trade sector.

Keywords: Trade, Multi-market model, Sudan

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1. Introduction

The agriculture sector is the most important economic sector in the country. It contributes on average about 43% of the country Gross Domestic Product (GDP) during the period 1999-2006 (table1). The sector provides employment for about 70 percent of the country's population, and provides inputs to many major manufacturing industries (e.g., edibles oils, leather, and sugar).

Agriculture historically generated the bulk of Sudan's foreign exchange earnings through a diversified basket of exports which can be broadly classified into three categories that includes field crops exports, animal and forest exports. The major field crops include sorghum, millet, cotton, sesame and ground nut, while animal exports include sheep, camels and cattle, and, gum arabic represents the major forest exports. Although several of these have enjoyed strong growth, agricultural exports are now lower than they were in the late 1960s and early 1970s. Table one show that agricultural exports were the main source of foreign currency before oil exploitation in 1999, agriculture exports share represented on average 20.6% of the total country's exports during the period 1999-2006, this share has declined to only 10% in 2006. Wheat is the major imported food in Sudan, the value of imported wheat has increased from 83.8 million US$ in 1999 to 286.9 million US$ in 2007 (Bank of Sudan, 2006)

During the last two years the world market prices of food has reached unprecedented levels. In 2007 the international food price index rose by nearly 40%, compared with 9% the year before, and in the first three months of 2008 prices increased further, by about 50% (von Braun et al 2008). Between January 2007 and January 2008 wheat nominal prices rose by 240% and real prices by 172%. Wheat export prices from USA climbed from $375/ton in January to $425/ton in February 2008. This comes on top of a 63% increase in global wheat prices over the past three years and a 33% increase in overall global food prices (World Bank 2008). The FAO Food Price Index (FAO Website 2008) has been steadily rising on monthly basis since 2006 to reach a record of 219 points in June 2008.

The Food and Agriculture Organization (FAO) has pointed out that; the dramatic increase in food world market prices is caused by factors related to both supply and demand of food in the world. Regarding the supply side, weather related production short falls, the declining stock levels and the increasing fuel costs arises as main factors that have negatively affected the supply of food in the world. On the demand side, the increasing demand for agricultural commodities for biofuels production and the changing structure of food demand in emerging economies are considered as major factors that has increased world food prices (FAO, 2008).

Table (1) Contribution of agriculture to the GDP and exports share in total exports in Sudan 1999-2006

Year	Share of Agriculture in GDP (%)	Agriculture Exports (Million US$)	Share of Agriculture Exports in Total Exports (%)
1999	49.8	432.0	55.4
2000	46.4	372.0	21.3
2001	45.6	240.6	14.9
2002	46.0	356.2	18.8
2003	45.6	410.3	16.1
2004	39.2	590.7	16.5
2005	38.6	578.8	12.0
2006	39.2	569.4	10.0
Average	43.8	443.8	20.6

Source: Bank of Sudan, Annual reports

2. THE STUDY OBJECTIVE

Higher food prices have radically different effects across countries. At the country level, countries that are net food exporters will benefit from improved terms of trade, although some of them are missing out on this opportunity by banning exports to protect their consumers. Net food importers, however, will fight to meet domestic food demand. Given that almost all countries in Africa are net importers of cereals, they will be hard hit by rising prices. At the household level, surging and volatile food prices hit those who can afford it the least the poor and food insecure. The few poor households that are net sellers of food will benefit from higher prices, but households

that are net buyers of food which represent the large majority of the world's poor will be harmed (von Braun et al, 2008).

Sudan as one of the developing countries with the agricultural sector as the main sector of economy, is characterized by its small open economy, and as price taker in the world market of agriculture; the country is more vulnerable to changes in international agricultural prices and markets. This paper aims at studying the impact of the increasing world food prices on the production, consumption and trade of agricultural crops of the Sudan.

3. MATERIALS AND METHODS
3.1 A Multi-market Model for Sudan Agricultural Crop Markets: General Features and Equations

In this paper a multi-market model is used as a main tool to assess the price impact on the agricultural crop markets. Multi-market analysis is a tool for simulating the effects of agricultural price policies on outcomes considered of interest to policy makers (Braverman and Hammer 1987).

Sudan economy is modeled as a small open economy on both the import and export side of the agricultural commodities. The model under consideration takes the normal specification of a standard partial equilibrium model; it is static and consists of a set of demand and supply equations for each commodity with the level of supply and demand determined by factors including prices, income, demand and supply shift variables and various other assumptions about policies (see Jechlitschka *et al*, 2007). In specifying supply and demand functions for each product market, domestic prices for one market help to determine the quantity supplied and demanded not only in that market but also in the other markets through cross-market price linkages. Price transmission equations in the model establish links between producer price (for producers of exportable products and of import-substitute products) and the consumer price and the world market price.

Six key agricultural crop markets of the Sudanese agriculture are considered in the model. The major agricultural crop exports are sorghum, millet, sesame, ground nut

and cotton, while wheat is the main import substitute. The model has been extended to calculate the impact of high world food prices on the economy variables which mainly include supply, demand, exports and imports.

3.1.1 The Supply Equations

The supply of each commodity is represented by the quantity produced which is function of its own price and the prices of the competing commodities. The product supply equations represented as follows:

$$q_i^s = c_i * (p_i^s)^{\varepsilon_{ii}} * \prod_{j \neq i} (p_j^s)^{\varepsilon_{ij}}, \qquad\qquad i, j = 1,.... 6 \qquad (1)$$

Where

q_i^s denotes the amount of the ith commodity supplied

c_i is the supply calibration coefficient of the ith commodity

p_i^s is the supply price of the ith commodity

p_j^s is the supply price of the jth commodity

ε_{ii} is the supply price elasticity of the ith commodity

ε_{ij} is the supply cross price elasticity of the products j[th] that are

    competing the ith commodity

j is the set of relevant competing substitutes of the ith commodity

3.1.2 The Demand Equations

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

$$q_i^d = b_i * (p_i^c)^{\eta_{ii}} * \prod_{j \neq i} (p_i^c)^{\eta_{ij}} * I^{\mu_i}, \qquad\qquad i, j = 1,.... 6 \qquad (2)$$

Where,

q_i^d denotes the amount of the ith commodity demanded

b_i is the demand calibration coefficient of the ith commodity

p_i^c is the demand price of the ith commodity

I is per capita income

η_{ii} is the demand price elasticity

η_{ij} is the cross price elasticity of the ith commodities that are

   complementary or substitutes for the jth commodities.

μ_i is the income elasticity of the ith commodity.

3.1.3 Price Transmission in the Model

The illustration of the price-linkage equations assumes that the government could control the domestic price through price policy measures. 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). Therefore, price transmission in the model is represented as follow:

Producer and consumer prices of the export and import-substitute commodities are shown by the following equation:

(i) Producer price

$$p_i^s = p_i^w (1 + r_i) * (1 - t^p) \qquad (3)$$

(ii) Consumer price

$$p_i^c = p_i^w (1 + r_i) * (1 + t^c) \qquad (4)$$

Where,

p_i^s is the producer price for the commodity i

p_h^c is the consumer price for the commodity i

p^w is the world price of the commodity i

t^p is domestic rate of producer's tax

t^c is domestic rate of consumer's tax

r_i is the protection rate of the commodity

3.1.4 Trade indicators

In order to assess the effect of the high world food prices on the major agricultural crop markets of the Sudan, a selected trade indicators used by the United Nations are implemented. Simple and composite indices are established as recognized approaches in monitoring progress in achieving various policy goals or in benchmarking various policy options. The indicators include Growth Rate of Exports, Export Propensity, Import Penetration, Marginal Propensity to Import and Export/Import Coverage.

3.14.1 Growth Rate of Exports

The growth rate of is one of the most common indicators used when assessing the progress of an economy in any area of economic activity. Often the rate is calculated at level of product groups to identify 'dynamic sectors.' The growth rate calculates the annual compound percentage change in the value of exports between two periods, it is a percentage, and can take a value between -100 per cent (if trade ceases) and $+\infty$. A value of zero indicates that the value of trade has remained constant.

$$\text{Growth Rate of Exports} = \left[\left(\frac{\sum X_j^1}{\sum X_j^0} \right)^{\frac{1}{n}} - 1 \right] * 100 \qquad j = 1,\dots, 5 \qquad (5)$$

Where,

$\sum X_j^0$ is the bilateral total export flow of the commodities in the start period,

$\sum X_j^1$ is the bilateral total export flow of the commodities in the end period, and n is the number of periods (not including the start).

3.1.4.2 Export Propensity

The index shows the overall degree of reliance of domestic producers on foreign markets. The index provides an indicator of vulnerability to certain types of external shocks (e.g., increase or falls in export prices or changes in exchange rates). The ratio is expressed as a percentage and it ranges from zero (with no exports) to 100 (with all domestic production exported).

$$\text{Export Propensity} = \frac{\sum X_j}{GDP} *100 \qquad j = 1,\ldots, 5 \qquad\qquad (6)$$

Where,

$\sum X_j$ are total bilateral exports of (Cotton, sorghum, sesame and ground nut and millet) the markets under study, and

GDP is agricultural gross domestic product of country (the covered commodities in the model).

3.1.4.3 Import Penetration

The import penetration rate shows to what degree domestic demand (the difference between GDP and net exports) is satisfied by imports. Calculated at the sectoral level it is termed the self-sufficiency ratio. The ratio ranges from zero (with no imports) to 100 percent when whole domestic demand is satisfied by imports only (no domestic production and no exports).

$$\text{Import Penetration} = \frac{\sum M_i}{GDP - \sum X_j + \sum M_i} *100 \quad j = 1,\ldots, 5 \text{ and } i=1 \qquad (7)$$

Where,

$\sum X_j$ is total bilateral exports of the country under study,

$\sum M_i$ is total bilateral imports of wheat and

GDP is agricultural gross domestic product of country (the covered commodities in the model).

3.1.4.4 Marginal Propensity to Import

The marginal propensity to import (MPM) is measure of the extent to which imports are induced by a change in incomes. With higher MPM, in an economic downturn with a fall in GDP, there will also be a significant fall in imports as compared with lower MPM. More generally, higher MPM reduces the multiplier effect of an increase in GDP. The ratio ranges between 0 (with no part of extra GDP spent on additional imports) to 1 when the whole extra GDP created is spent on imports.

Marginal Propensity to Import = $\dfrac{\Delta \sum M_i}{\Delta GDP}$ (8)

Where,

$\Delta \sum M_i$ is change in imports (Wheat) to the country under study, and

$\Delta \sum GDP$ is change in agricultural gross domestic product of the country (for the covered commodity markets in the study) .

3.1.4.5 Export/Import Coverage

This index is an alternative to the normalized trade balance. It tells whether or not a country's imports are fully paid for by exports in a given year. In general, economists expect that the trade balance will be zero in the long run, thus imports are financed by exports, but it may vary considerably over shorter periods. The values for this index range from 0 when there are no exports to $+\infty$ when there are no imports. A ratio of 1 signals full coverage of imports with exports (trade balance).

Export/Import Coverage = $\dfrac{\sum X_j}{\sum M_i}$ $j = 1, \ldots, 5$ (9)

Where,

$\sum X_j$ the bilateral total is export flow, and

$\sum M_i$ is the bilateral total import flow in the end period.

3.2 Assumptions of the Multi-market Model

1. Sudan has small open economy.
2. A competitive world market of agricultural crop markets.
3. Homogenous product that is no distinction is made between domestic and imported wheat.
4. There is no transportation cost included in the model.

3.3 Model Calibration and scenarios

The multi- market model is calibrated empirically by using the data of a baseline year of 2006; the data included are the quantities supplied and demanded, supply and demand prices, world market prices, and price and income elasticities for all crop markets. Data sources are obtained from different sources of databases, where, world prices are obtained from FAO statistical database (www.fao.org), local supply is obtained from Bank of Sudan annual statistics, and elasticities are drawn from Abdelkarim (2002). The major agricultural crop markets of the Sudanese agriculture are considered in the model, main exports are cotton, sorghum, millet, ground nut and sesame, while, wheat is the main import substitute. The model has been extended to calculate the impact of high world food prices on economy variables which include supply, demand exports and imports. Two scenarios were run in the model; each scenario is differentiated by the world food price for different years. The baseline scenario represents the point of reference for the simulated prices and developed by calibrating the model parameters to the world food prices of the year 2006, the second scenario is calibrated at the 2008 world prices.

4. Results
4.1 Supply and Demand Responses

Figure one and two provide outlay of the possible responses of supply and demand to the simulated increase in the world market prices of 2008. With regard to the supply, the simulation results show an increase in the supplies of wheat, sorghum, sesame and ground nut, while the result show a fall of the supply of millet and cotton. In general, the supply increase is attributed to the increase of the producer prices and the relatively higher own and cross price elasticities of the certain commodity.

The supply of wheat could possibly increase by 4.5% resulting from the higher increase of its producer price in compare to the other competing crops especially cotton which accordingly records a decrease of 2.3% in supply.

Sorghum, the main staple food grain in Sudan could increase by 4.4%; this is mainly due to the higher increase of the domestic sorghum price in compare to the increase of millet price the primary competitive crop for sorghum. Sesame and groundnut supplies could increase by the rate 10% and 5.5% respectively at the expense of millet

supply which will fall by 5.6%. Millet and cotton did not reflect a significant increase of their world prices as high as of wheat, sorghum, sesame and groundnut prices, that is shown in the fall of millet and cotton supplies.

On the demand side, the simulation results show a fall in demand of the entire agricultural commodity markets covered in the model; this is down to the increase in consumer prices. The fall in the demand is varied across the covered commodity markets according to the degree of increase of consumer price and the crop's own and cross price elasticity, reflecting the adverse effect of the world prices on the food accessibility in Sudan.
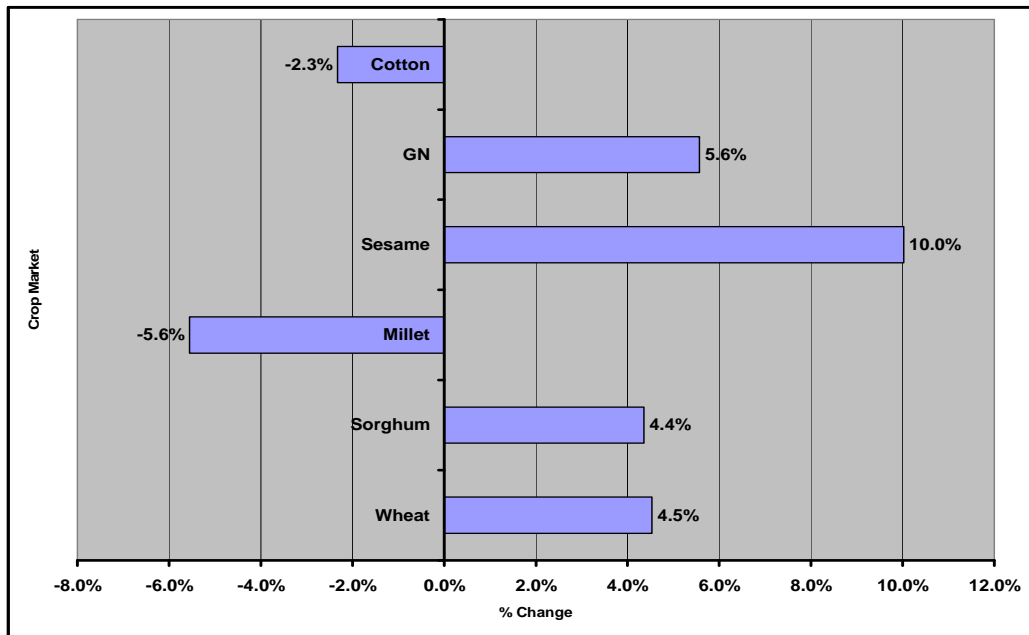

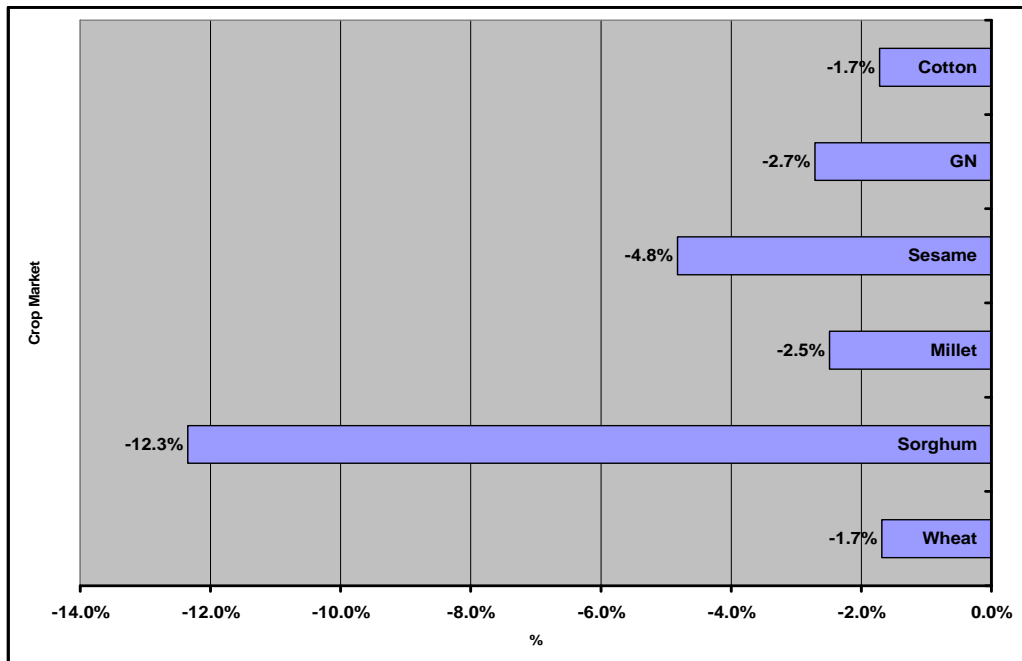**Figure (1) Changes in Supply, effect of high world food prices**

Figure (2) Changes in demand, effect of high world food prices

4.2 Trade Response

Table 2 summaries the outlay of the simulated information of the main economic variables for the basic model at the 2006 prices and the scenario model of the 2008 world prices. The basic model information shows that the agricultural GDP would increase by 75.3% in response to 2008 prices, that is from 1163.2 $US million in 2006 to 2040.2 $US million. While, total crop exports could increase by 123%, that is from the amount of 261.1 $US million at 2006 prices to 582.4 $US million at 2008 world prices. Finally, total imports would also increase by 72.5 % from 214.9 to 370.9 $US million.

Table (2) Simulated Agricultural GDP, Exports and Imports of the Two Scenarios in $US Million

Economic variables In the model	2006 Prices Basic Model	2008 Prices Scenario Model	% Change
Total Agriculture GDP	1163.2	2040.2	75.3
Total crop exports ($\sum X_j$)	261.1	582.4	123
Total crop imports ($\sum M_i$)	214.9	370.9	72.5

Table (3) depicts the simulation results of trade indicators for the basic model of the 2006 world market prices and the scenario model of 2008 prices. In general the increasing world market food prices reflect a positive effect on the trade sector of the Sudanese agricultural crop markets.

With regard to export indicators, total exports of the agricultural crops covered by the model would increase considerably in response to the price increase of 2008, the growth rate of exports show an increase of 123% of agricultural crop exports. The increase in total exports is attributed to the remarkable increase of exports of sorghum, millet, sesame and ground nut. The export propensity index shows that domestic farmers earn about 22% of their income from foreign trade in 2006; this ratio could increase to 29% in response to the high world prices of 2008.

On the side of import indicators, the import propensity index is used as the basis of specific policy objectives targeting self-sufficiency. It provides an indication of the degree of vulnerability to certain types of external shocks. The index shows that 31.3% of domestic demand is satisfied by imports at the 2006 world prices, while, this ratio could increase at the 2008 simulated prices to reach 34%.

The marginal propensity to import index explains that changes in imports between the 2006 and 2008 prices represent 18% of the counterpart GDP changes. Finally, the Export import coverage index show that exports could cover 1.21 of imports at the simulated basic model of 2006 prices and the coverage could increase to 1.57 at the simulated 2008 prices.

Table (3) Basic and Scenario model trade indicators

Trade Indicators	2006 Prices Basic Model	2008 Prices Scenario Model
Growth Rate of Exports	-	123%
Export Propensity	22%	25%
Import Penetration	31.3%	34%
Marginal Propensity to Import	-	18%
Export/Import Coverage	1.21	1.57

5. Conclusion

The multi market model for the responses of the agricultural crop markets to the high world market prices show that, the supply of wheat, sorghum, sesame and ground nut would increase remarkably, while, millet and cotton supplies would fall because of the relatively low price increase and the effect of their competing crops. On the demand side, the simulation results show a fall in demand of the entire agricultural crop markets; this is down to the increase in consumer prices. Trade indicators of the simulated model show a positive response that the trade growth in the export quantity and value for the covered agricultural crops is positive and significant in response to the higher world market prices, while, that for food imports reflects a low reduction in import quantity and high increase in import value. The export indicators of Export growth Rate and Export Propensity show appositive and significant response. The import indicators of Import Penetration and Import Propensity reflect an increase of the amount of imports. Finally, the Export Import coverage shows an increase of the rate of export coverage to imports.

References

Abdelkarim, I. E., 2002. **The Impact of Uruguay Round Agreement on Agriculture on Sudan's agricultural Trade**. Humboldt University, Berlin. Shaker Verlag.

Bank of Sudan, 1996-2006. Annual Report

Braverman, A., Hammer J., and Morduch J., 1987, **Wheat and Maize Price Policy in Hungary: Tradeoffs between Foreign Exchange and Government Revenue**, Agricultural Economics,1

FAO, 2008, **Soaring Food Prices: Facts, Perspectives, Impacts and Actions Required, High-Level Conference on World Food Security: The Challenges of Climate Change and Bioenergy**, Rome, 3-5 June 2008, HLC/08/INF/1

Jechlitschka, K., Kirschke, D., and Schwartz, G., 2007. **Microeconomics Using Excell: Integrating Economic Theory, Policy Analysis and Spreadsheet Modeling**. Routledge, Oxon, Great Britain.

Mikic, M., and Gilbert, J., 2007. **Trade Statistics in Policy Making**, A HANDBOOK OF COMMONLY USED TRADE INDECES AND INDICATORS- ECONOMIC AND SOCIAL COMMISSION FOR ASSIA AND THE PACIFIC- UN

von Braun, J., Ahmed, A., Okyere, A., Fan, S., Gulati, A., Hoddinott , J., Lorch, R., Rosegrant, M., Ruel, M., Torero, M., van Rheenen, T., and von Grebmer, K., 2008. **High Food Prices: The What, Who, and How of Proposed Policy Actions**. IFPRI Policy Brief

World Bank, 2008. **Rising food prices: policy options and World Bank response Key messages**. A brief prepared by Hassan Zaman, Tahrat Shahid, Louise Cord and Ana Revenga based on inputs from all regions, DEC and all three networks.