MULTI-MARKET ANALYSIS OF SUDAN'S WHEAT POLICIES: IMPLICATIONS FOR FISCAL DEFICITS, SELF-SUFFICIENCY AND THE EXTERNAL BALANCE

RASHID M. HASSAN, W. MWANGI, AND B. D'SILVA (1)

ABSTRACT

Highly subsidized bread prices financed partially through wheat aid and over valued currency, have stimulated rapid growth in wheat consumption in Sudan at the expense of other staple grains such as sorghum and millet. Due to inefficient production methods and the resultant low wheat yields, domestic supply has lagged behind demand. Faced by serious foreign exchange shortages, severe internal and external imbalances and reduced availability of food aid, Sudan could not sustain dependence on external sources to bridge the growing wheat gap. Given the political difficulties associated with managing demand,, the government has chosen to promote local production. Research results which have shown high potential gains in wheat yield under improved crop management was another factor behind choosing the supply strategy.

A dynamic multi-market model was developed and used to evaluate alternative supply promoting and demand control strategies. Competition with alternative productive uses of the country's scarce agricultural resources , as well as substitution between wheat and other cereal grains in consumption were analyzed. Impacts of the various policies on net exports, food security and the budget are measured and compared. Policy analysis results indicate the significant contribution of production efficiency, reduced consumer subsidies and elimination of relative price distortions, to higher self-sufficiency and lower internal and external deficits.

Key Words:

Sudan, wheat policy, multi-market

---

(1) CIMMYT, Nairobi, Kenya, CIMMYT, Addis Ababa, Ethiopia, and USDA Washington D.C., USA.

MULTI-MARKET ANALYSIS OF SUDAN'S WHEAT POLICIES: IMPLICATIONS FOR FISCAL DEFICITS, SELF-SUFFICIENCY AND THE EXTERNAL BALANCE

INTRODUCTION:

A recent history of highly subsidized bread prices financed partially through wheat aid and an overvalued currency, has trapped Sudan into rapidly growing demand for wheat at the expense of traditional food staples such as sorghum and millet. Per capita annual consumption of wheat in Sudan has risen from around 20 kg to 40 Kg over the last two decades, whereas growth in domestic production lagged far behind demand. The result has been steady deteriorating in self-sufficiency and increased importation of wheat. For instance in 1988 only 20% of the total wheat consumed in Sudan was locally produced compared to a self-sufficiency ratio of about 70% in 1971. The gap was filled by imports with more than 80% of these received as food aid[1] in 1988 that is, food aid accounted for 65% of total wheat consumption (Hassan 1990). Another consequence of the aid supported subsidies was the development of a large milling industry in Sudan, adding one more interest group to lobby for increased consumption and subsidization of wheat.

With reduced availability of food aid and mounting internal and external deficits facing the country, the current wheat gap is increasingly unsustainable. Given demand management options such as lifting consumer subsidies are politically difficult to implement, the government has chosen to rely on a crash program promoting local wheat production in order to bridge the wheat gap. While this strategy will reduce reliance on external wheat supplies and ease the pressure on the already strained sources of foreign exchange, it will lead to greater competition with high value crops such as cotton and faba beans for the country's agricultural resources. Moreover, the capital-intensive and highly mechanized systems of wheat production in Sudan make the foreign exchange component in local wheat production relatively high, leaving a narrow margin for potential saving of foreign resources from wheat production.

The objective of this study is to evaluate the contributions of alternative wheat production and consumption strategies to macro-economic improvement in Sudan. The impact of various supply promoting and demand reducing wheat policies on net imports, food security and the budget are analyzed within a multi-market framework. This allows for substitution effects in the production and consumption of wheat and competitive products. The model developed in this study extends the static multi-market framework of Braverman and Hammer (1986) to incorporate short-run (partial) adjustment dynamics to modelling supply.

1. SUDAN WHEAT SECTOR AND POLICIES:

Production structure: All wheat produced in Sudan receives regular irrigation during a short winter season. There are two distinct regions of wheat production representing different technologies and institutional environments. These are the private pump schemes of the North and the public irrigation schemes in the central clay plains of Sudan.

Wheat is a traditional crop and the major food staple in the north. Over the last 20 years an average yield of 2.3 ton/ha has been realized in the Northern Region compared to 1.3 ton/ha on the central plains. This yield advantage is mainly due to the relatively cooler and longer winters in the north coupled with farmers familiarity with the crop. Other factors critical to the horizontal (area) and vertical (yield) expansions in wheat production in both regions include high irrigation costs and water shortages, plus poor crop management practices. Land is, however, more limiting in the Northern region.

About 75% of Sudan's wheat is produced on the public irrigation schemes where land allocations are determined according to a fixed crop rotation. Procurement and distribution of other critical inputs are also controlled by the schemes' administration. Cotton is the only crop that stays on the land during winter to compete with wheat for irrigation water. Farmers are required to deliver the produce of both crops to marketing boards at government set prices. The other crops in the rotation (groundnuts

and sorghum) are harvested before wheat planting and sold in the free market. Although wheat yields are low, there is considerable potential for improvement. A potential gain of more than 100% in wheat yield has been demonstrated through the adoption of a new wheat technology package, released by the Agricultural Research Corporation (ARC) of Sudan and tested by the ARC and the Sasakawa Global 2000 (a Non-governmental Organization) on a large number of on-farm trials and demonstrations over the past four years (Ageeb et. al. 1989; Global 2000, 1990).

In the Northern Region, allocation of land, water and other inputs is decentralized. Farmers buy all inputs from and sell their product to private traders. Faba beans is the main crop competing with wheat for land and water in the Northern Region.

Consumption: Sorghum, wheat, and millet are the main source of cereal calories to the Sudanese people. Inspite of the rapidly growing demand for wheat, it remains largely a food of the urban population. Sorghum and millet on the other hand, are still the basic food staples for the vast majority, particularly in rural areas where more than 70% of the population reside (Ministry of Finance 1988). The preference for wheat bread by urban consumers is in large part because of the high bread subsidy (see below). Wheat bread is also a convenience food that is easy to prepare and that uses less time and baking energy compared to the popular sorghum breads such as Kisra and Asida. Apart from the relative price effects, accelerating rural-urban migration and increased participation of women in the urban labor force were identified as important forces behind rising wheat consumption in Sudan (Damous 1986; Salih 1985). Sudan is currently experimenting with the alternative of using composite flours that mix wheat with other grains for flour for bread making.

Pricing policies: Sorghum and millet prices are determined in the free market whereas, the price of wheat is regulated by the government which controls its marketing and importation. In 1989 the producer price of wheat was set based on parallel exchange rate of Ls. 12.5 per 1 US$[(2)], whereas the effective exchange rate applied to cotton exports was Ls 6.5. Both cotton and wheat however, receive an indirect subsidy

on the price of imported inputs especially fertilizer, whose price is set at the official exchange rate.

A free market price that is higher than the import parity cost of wheat has been reported. This price differential indicates an unsatisfied demand for wheat at the official price, reflecting the effect of a quota system on wheat imports in Sudan. Due to the discrepancy between the official producer and free market prices, farmers in the public irrigation schemes under-report their true wheat yield levels and sell the difference in the free market (Salih 1989; Damous 1986; Hassan et. al. 1991). Consumers on the other hand, enjoyed a high price subsidy on wheat as they paid less than 25% of the actual cost to the government of buying and processing wheat in 1989 (Hassan 1990). Revenues collected from selling concessional wheat imports enabled the government to support the high subsidy on bread prices.

2. A MULTI-MARKET MODEL FOR THE WHEAT ECONOMY OF SUDAN

For the proper evaluation of Sudan's wheat policy options it is essential to develop a comprehensive representation of the structure of the production, consumption and marketing of wheat in Sudan. The multi-market (MM) approach to modelling supply-demand interactions and their macro implications is adopted in this study. This framework has mainly been used by the World Bank to analyze the impacts of agricultural pricing and marketing policies on the level and composition of agricultural output, farmers' incomes, the government budget and foreign trade (Braverman 1985, 1986 and 1987). Supply and demand decisions are modelled on the basis of the neo-classical theory of the firm and consumer behaviour. Substitution possibilities in the production and consumption of goods competing for domestic resources and consumer budgets are allowed. The model also specifies the institutional arrangements within which agents interact and that define equilibrium conditions. Detailed discussions of the MM approach are found in Singh, Squire and Krichna (1984) and Braverman and Hammer (1986). The Sudan wheat model is developed on this basis.

Income and final Demand: Due to data limitations on modelling agricultural factor markets, this model does not derive the functional distribution of income. Consumer demand for the three grain substitutes (sorghum, wheat and millet) is therefore measured for aggregate spending and not classified by income groups. Total aggregate spending on cereals is accordingly allocated among the three goods using the Almost Ideal Demand System (AIDS) of Deaton and Mullbauer (1980)

$$(1) \qquad D_{it} = D_i (I_t, P_{it})$$

where D_i and P_i refer to the final consumption and price of commodity i (wheat, sorghum and millet) in time t, respectively. I_t denotes total consumer spending on cereals which is set exogenously in this model. The consumer price of wheat is fixed by the government whereas sorghum and millet prices are market determined.

Output supply and factor demand: In this model wheat is produced in two regions as discussed earlier. Area allocations to wheat and cotton are set by the government agency in the public irrigation schemes. Farmers decisions are therefore assumed to influence yield rather than production. Agricultural supply is consequently modelled by using area and yield response instead of output supply functions.

$$(2) \quad (A_{it}, Y_{it}) = F (ENP_t, W_{kt}, Z_t) \qquad i = 1,2, ---,n \qquad k = 1,2, ---,m$$

Yield (Y) and area (A) of crop i (except for cotton and wheat in public schemes) at period t are assumed to vary with the expected net price (ENP) of all competing crops in the region, factor prices (W) and a vector of other fixed factors (Z) which includes, among others, climatic variables and diesel fuel allocations and prices.

As mentioned earlier, wheat competes with faba beans in the Northern region and with cotton in public schemes. Sorghum is produced on the central irrigated plains and in the traditional and mechanized dryland farming systems of the Sudan. Groundnuts under irrigation plus sesame and millet in the rainfed sectors compete with sorghum for land.

Naive price expectations are used where last years' realization is used as the expected price. This specification reflects partial adjustments in domestic production. Prices are defined net of intermediate costs and indirect taxes (t_i) using fixed input-output coefficients.

(3) $NP_i = P_i(1-t_i) - \sum_j a_{ji}P_j$

Prices of all tradables are determined in the world market.

(4) $P_{it} = e_{it} \cdot P^*_{it}$

Where the nominal exchange rate (e_i) converts world price (P^*_i) into local currency prices (P_i). Wheat, faba beans and intermediate inputs are imported while cotton, groundnuts and sorghum are exported. The small country assumption is used where Sudan exports face an infinitely elastic demand and imports are supplied in unlimited amounts.

The fixed coefficient technology derives demand for intermediate inputs. Demand for land is obtained from area response functions in equation 2. Upper bounds on total acreage and regional land supply functions are specified. Demand for labor, on the other hand, is obtained from the dual representation of the specified supply structure. The nominal wage rate is fixed to define an infinite supply of labor by region. There is only one type of labor in the model, namely unskilled labor. Due to data limitations, the capital market is not modelled.

Equilibrium conditions: At equilibrium, total supply is equated to total demand in the product and factor markets. Total output supply is obtained by adding imports to domestic production. Exports, intermediate use and final consumption constitute total demand. In addition to solving for equilibrium quantity and price flows, the model also computes wheat self-sufficiency ratios and traces implications for nominal macro aggregates such as the budget deficit, and net foreign exchange.

Subsystem estimation is employed to econometrically generate parameter values for this study. Supply and demand side parameters were estimated separately using Seemingly Unrelated Regressions. The Jacobian algorithm GAMS/MINOS was used

to solve the model. Clearing of the product market, is employed as the solution strategy for model validation and policy simulations.

3. POLICY ANALYSIS AND SIMULATION RESULTS:

The following policy scenarios are designed and evaluated as alternative avenues for improving performance of the cereals economy of Sudan:

a) **Present strategy**: This represents the current government strategy of expanding wheat area at the expense of cotton while maintaining a quota on imports, subsidized consumer prices of wheat and the use of multiple exchange rates.

Improved government regimes: These provide a step foreward in the present plan to attain self-sufficiency where the following scenarios are assumed:

b) Present policy is adjusted for 50% reduction in current consumer subsidy and 50% adoption of a new wheat production technology.

c) The effective exchange rate on all imports and exports is unified at the parallel rate of Ls 12.5 to eliminate internal distortions in relative prices. The wheat market is also liberalized so that the consumer subsidy and quotas on wheat are lifted and hence all wheat is traded at its import parity cost.

d) 50% of wheat farmers adopt the improved technology. The wheat market is partially liberalized by lifting guota on imports as well as by removing 50% of the consumer subsidy. All tradables are paid the parallel exchange rate.

e) The free market exchange rate of Ls. 22 per 1 US$ is applied to all tradables in this experiment. The wheat sector is completely liberalized (zero subsidies and no quota) and all farmers adopt the new wheat technology.

The model is solved for two consecutive years 1988 and 1989.

While demand adjusts instantaneously in this model, the full effects of policy changes are realized a year later due to partial adjustment in supply. Table (1) therefore reports results obtained for the second year only (1989) when full

adjustment is completed. Solution values for the current government strategy were used as the basis for comparison.

Column A of Table (1) shows that this policy could generate domestically only 41% of total wheat consumed. The more ambitious government policy (column B) raised self-sufficiency in wheat to 85%. This is due to two forces: wheat consumption on the one hand fell by 33% as a result of partial lifting of the consumer subsidy while adoption of the new wheat technology on the other hand, increased production by 40%. Wheat imports consequently declined by 85%, whereas more inputs (36% higher) were imported under the new technology. This policy also saved 83% of the budgetary costs of the bread subsidy that amounted to Ls. 862 million under regime A. The trade balance has also improved by about 8% under policy B.

Relative price distortions were eliminated in experiment C as a result of the exchange rate unification thus producing important supply and demand effects. Unification removed the wheat subsidy entirely, saving 100% of its budgetary burden. Wheat consumption and imports consequently dropped by 53% and 80% respectively. Domestic supply of wheat, however fell by 14% whereas cotton production rose by 47%. This is because exchange rate unification removed the foreign exchange tax on cotton and revealed the comparative advantage of irrigated cotton compared to the traditional wheat production practices. The trade balance then improved by 43% and self-sufficiency reached 75%.

In addition to correcting the internal structure of incentives to producers, 50% of the farmers adopted the new wheat technology in scenario D. Inspite of the partial elimination of the wheat subsidy higher self sufficiency ratio (94%) and larger decline in wheat imports were realized with this policy compared to scenario C, where 100% lifting of the consumer subsidy was adopted without improved production efficiency. This indicates the relative importance of supply shifting policies and contribution of the

technology factor to bridging the wheat deficit n Sudan. Both scenarios produced substantial gains in net foreign exchange (Trade balance).

The best results however, were obtained under complete liberalization and full adoption of improved wheat production methods (Policy E). This policy could generate undesirable distributive effects that are not explored by this model. It also represents a politically sensitive option and requires considerable foreign exchange resources and critical institutional changes in the factor and product markets for Sudanese agriculture.

4. SUMMARY AND CONCLUSIONS:

A high subsidy on the consumer price of wheat and food aid have stimulated increased wheat consumption in Sudan. Domestic supply on the other hand, lagged far behind due to inefficient production practices and hence lower wheat yields. Faced with serious shortages in foreign exchange, severe external and internal imbalances and reduced availability of food aid Sudan could not sustain th e high bread price subsidy and dependance on external source to bridge the growing wheat gap. Given the political difficulties associated with demand management options, the government has chosen to promote domestic supply for higher self-sufficiency in wheat. This choice was also encouraged by research results indicating high potential gains in wheat yield under improved production methods.

A dynamic multi-market model was developed, estimated and used to evaluate and compare alternative supply promoting strategies and demand control options. Competition with alternative crops such as cotton and beans, for the country's agricultural resources as well as substitution between wheat and other cereals in consumption were analyzed. Policy analysis showed that the current strategy of expanding wheat area at the expense of cotton while maintaining existing distortions in relative prices, consumer subsidies and low input levels in wheat production was out-performed by all alternative options. Much higher gains in wheat self-sufficiency, net foreign exchange and reduced budgetary costs were realized with various combinations

of lower consumer subsidies, unified exchange rates, and adoption of more efficient wheat production technologies.

NOTES

(1) Food aid here includes both donations and concessional imports.

(2) The official exchange rate was Ls. 4.5 and the free market rate Ls. 22 per 1 US$ in 1990. Ls. refers to Sudanese pounds.

BIBLIOGRAPHY

Ageeb, O., H. Faki, I. El Mekki, A. Mussa, and A. ElNour (1989) "Wheat Pilot Production and demonstration Plots in Gezira" Annual National Wheat Coordination Meetings, 4-7 September ARC Wad Medani, Sudan.

Braverman, A. and J. Hammer (1986) "Multi-market analysis of Agricultural pricing policies in Senegal" In "Agric. Household models: Extensions, Applications and Policy, eds. I. Singh, L. Squire and J. Strauss, John Hopkins University Press, Baltimore.

Braverman, A.J. Hammer and A. Young (1987) "Multi-market Analysis of Agricultural pricing policies in Korea" in the theory of Taxation for Developing countries, eds. D. Newberg and N. Stern, Oxford University Press, London.

Damous, H.M. (1986) "Economic Analysis of Government policies with respect to supply and demand for wheat and wheat production in Sudan "Ph.D thesis, Washington State University

Deaton, A. and J. Muellbauer (1980) "An almost Ideal Demand System "American Economic Review 70: 312-326.

Hassan, R.M., H. Faki and H. El Obeid (1991), "Economic Policy and Technology determinants of the comparative advantage of wheat production in Sudan" CIMMYT Economics Paper, Mexico (Forthcoming).

Hassan, R.M. (1990). "Technological Options and Policy Incentives for Higher Self-Sufficiency in wheat in Eastern and Southern Africa" Presented to the 1990 Rockefeller Foundation Social Science Research Fellows Workshop at IITA, Nigeria October 2-5, 1990.

Global 2000 Sudan. Annual Reports (1989&1990).

Ministry of Finance and Economic Planning (1988) - Economic Survey.

Salih, S.A. (1985). "Consumption effects of eliminating Bread subsidies in Sudan" USAID/Khartoum - Sudan.

Salih, S.A. (1989) "A cheating model of wheat production in Gezira" presented to the AAEA meetings, Aug. 3-7, Paton Rogue, Missisipi, USA.

Singh I., L. Squire and J. Krichna (1984) "Agricultural pricing and marketing policies in Malawi "Wash. D.C., World Bank.

TABLE (1) RESULTS OF POLICY SIMULATIONS (1989)

Variables	A Present Govt. (values)	B Improved Govt. (% change)[a]	C Liberal. and unified exchange (% change)[a]	D Partial Liberal & adopt. (% change)[a]	E Complete Lib.& adopt (% change)[a]
Consumption Demand (000 ton)					
Wheat	864	-33	-52.8	-34.6	-57.4
Sorghum	1655	8.5	-18.6	-10.8	-22.4
Millet	140	77	67.2	82.9	60.7
Domestic supply (000 ton)					
Wheat	354	40	-13.6	50.0	76.8
Sorghum	3461	1.4	-1.4	0.5	1.9
Millet	285	-4.6	.01	-2.5	-5.3
Cotton	87	-6.9	47.2	49.4	44.8
Imports					
Total value($ million)	110	-58.2	-60.1	-63.7	-60.0
inputs($ million)	22	36.4	13.7	59.1	100.0
wheat(000 tons)	510	-83	-80	-93.3	-100.0
Exports					
Value ($ million)	606	-4.3	24.4	22.5	38.1
Sorghum(000 ton)	1806	-5.1	14.4	11.0	24.3
Millet (000 ton)	145	-83.5	-65.5	-84.8	-69.0
Cotton (000 ton)	87	-6.9	47.2	49.4	44.8
Trade Balance ($million)[b]	496	7.7	43.4	41.6	59.9
Consumer wheat subsidy (Ls. million)	862	-83.2	-100.0	-78.6	-100.0
Self-sufficiency ratio	.41	.85	.75	.94	1.7

[a]Refer to percentage change relative to present government regime (column A)

- except for self-sufficiency (last row) which is given as actual ratios.

[b]Trade balance defined as net value of exports e.g. Exports-Imports.