Multi-Market Analysis of Sudan's Wheat Policies: Implications for Fiscal Deficits, Self-Sufficiency, and the External Balance

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Abstract: Highly subsidized bread prices financed partially through wheat aid and overvalued currency have stimulated rapid growth in wheat consumption in Sudan at the expense of other staple grains such as sorghum and millet. Inefficient production methods and the resultant low wheat yields have caused domestic supply to lag 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 showing high potential gains in wheat yield under improved crop management also contributed to the choice of 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 resources and substitution between wheat and other cereal grains in consumption were analysed. The impact of the various policies on net exports, food security, and the budget is measured and compared. Results of policy analysis 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.

Introduction

A recent history of highly subsidized bread prices, financed partially through wheat aid and an overvalued currency, has trapped Sudan into a situation of rapidly growing demand for wheat at the expense of traditional food staples such as sorghum and millet. Annual consumption of wheat in Sudan has risen from around 20 kg per capita to 40 kg over the last two decades, whereas growth in domestic production has lagged far behind demand. The result has been a steady deterioration in self-sufficiency and increased wheat imports. For instance, in 1988 only 20 percent of the total wheat consumed in Sudan was locally produced compared to a self-sufficiency ratio of about 70 percent in 1971. The gap was filled by imports, of which more than 80 percent was received as food aid[3] in 1988; i.e., food aid accounted for 65 percent 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 wheat consumption and subsidization.

With reduced availability of food aid and mounting internal and external deficits facing the country, the current wheat gap is increasingly unsustainable. Given that demand management options such as lifting consumer subsidies are politically difficult to implement, the government has chosen to rely on a crash programme to promote 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 contribution of alternative wheat production and consumption strategies to macroeconomic improvement in Sudan. The impact of various supply-promoting and demand-reducing wheat policies on net imports, food security, and the budget are analysed 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 multimarket framework of Braverman and Hammer (1986) to incorporate short-run (partial) adjustment dynamics to modelling supply.

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, the private pump schemes of the North and the public irrigation schemes in the clay Central Plains.

Wheat is a traditional crop and the major food staple in the North. Over the last 20 years, an average yield of 2.3 t/ha has been realized in the Northern Region compared to 1.3 t/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 North.

About 75 percent 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 through the schemes. Cotton is the only winter crop 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 percent 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; and Global 2000, 1990).

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

Consumption. Sorghum, wheat, and millet are the main source of cereal calories. In spite 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 percent of the population reside (Sudan Ministry of Finance and Economic Planning, 1988). The preference for wheat bread by urban consumers is largely due to the high bread subsidy. Wheat bread is also a convenience food that is easy to prepare and uses less time and baking energy than 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 labour force have been identified as important forces behind rising wheat consumption in Sudan (Damous, 1986; and Salih, 1985). The country is currently experimenting with the alternative of using composite flours that mix wheat with other grains for bread flour.

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 on the basis of the parallel exchange rate of S£ 12.5 per US$,[4] whereas the effective exchange rate applied to cotton exports was S£ 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 on the free market (Salih, 1989; Damous, 1986; and Hassan *et al.*, 1991). Consumers, on the other hand, enjoyed a high price subsidy on wheat as they paid less than 25 percent 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.

A Multi-Market Model for Sudan's Wheat Economy

A proper evaluation of Sudan's wheat policy options requires a comprehensive representation of the structure of wheat production, consumption, and marketing. The multi-market approach to modelling supply-demand interactions and their macro implications is adopted in this study. This framework has been used by the World Bank to analyse the impacts of agricultural pricing and marketing policies on the level and composition of agricultural output, farmer income, government budget, and foreign trade (Braverman *et al.*, 1986 and 1987). Supply and demand decisions are modelled on the basis of the neoclassical theory of the firm and consumer behaviour. Possibilities of substitution 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.[5]

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 of Deaton and Muellbauer (1980):

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

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 a 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.

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

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 North and with cotton in public schemes. Sorghum is produced on the irrigated Central Plains and in the traditional and mechanized dryland farming systems of Sudan. Groundnuts under irrigation and sesame and millet in the rainfed sectors compete with sorghum for land.

Naïve price expectations are used, where the previous year's 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.

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

Prices of all tradeables are determined in the world market:

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

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's 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 labour, 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 labour by region. There is only one type of labour in the model, namely unskilled labour. 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 generate parameter values econometrically. Supply and demand parameters are estimated separately using seemingly unrelated regressions. The Jacobian algorithm GAMS/MINOS is used to solve the model. Clearing of the product market is employed as the solution strategy for model validation and policy simulations.

Policy Analysis and Simulation Results

Various policy scenarios are designed and evaluated as alternative avenues for improving the performance of Sudan's cereal economy. Scenario A is the present strategy, which represents the current government strategy of expanding wheat area at the expense of cotton, while maintaining a quota on imports, subsidized consumer prices for wheat, and the use of multiple exchange rates.

Improved government régimes are an advance on the present plan to attain self-sufficiency, where four scenarios are assumed. In Scenario B, present policy is adjusted for a 50-percent reduction in current consumer subsidy and 50 percent adoption of a new wheat production technology. In Scenario C, the effective exchange rate on all imports and exports is unified at the parallel rate of S£ 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; hence all wheat is traded at its import parity cost. In Scenario D, 50 percent of wheat farmers adopt the improved technology. The wheat market is partially liberalized by lifting the quota on imports as well as by removing 50 percent of the consumer subsidy. All tradeables are paid the parallel exchange rate. Finally, in Scenario E, the free market exchange rate of S£ 22 per US$ is applied to all tradeables 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.

Col. A of Table 1 shows that this policy could generate domestically only 41 percent of total wheat consumed. The more ambitious government policy (col. B) raised self-sufficiency in wheat to 85 percent. This is due to two forces. While wheat consumption fell by 33 percent as a result of partial lifting of the consumer subsidy, adoption of the new wheat technology increased production by 40 percent. Wheat imports consequently declined by 85 percent,

whereas 36 percent more inputs were imported under the new technology. This policy also saved 83 percent of the budgetary costs of the bread subsidy, or S£ 862 million under régime A. The trade balance also improved by about 8 percent under B.

Table 1—Results of Policy Simulations (1989)

Variable	A	B	C	D	E
	Present Strategy (values)	Improved Strategy (percent change)*	Liberalization and Unified Exchange (percent change)*	Partial Liberalization and Adoption (percent change)*	Complete Liberalization and Adoption (percent change)*
Consumption demand (1,000 t)					
Wheat	864	-33	-52.8	-34.6	-57.4
Sorghum	1,655	8.5	-18.6	-10.8	-22.4
Millet	140	77	67.2	82.9	60.7
Domestic supply (1,000 t)					
Wheat	354	40	-13.6	50.0	76.8
Sorghum	3,461	1.4	-1.4	0.5	1.9
Millet	285	-4.6	0.01	-25	-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 (1,000 t)	510	-83	-80	-93.3	-100.0
Exports					
Value ($ million)	606	-4.3	24.4	22.5	38.1
Sorghum (1,000 t)	1,806	-5.1	14.4	11.0	24.3
Millet (1,000 t)	145	-83.5	-65.5	-84.8	69.0
Cotton (1,000 t)	87	-6.9	47.2	49.4	44.8
Trade balance ($ million)**	496	7.7	43.4	41.6	59.9
Consumer wheat subsidy (S£ million)	862	-83.2	-100.0	-78.6	-100.0
Self-sufficiency ratio	0.41	0.85	0.75	0.94	1.7

*Refers to percentage change relative to present government régime (col. A), except for self-sufficiency (last row), which is given as actual ratios.

**Trade balance defined as net value of exports; e.g., exports minus imports.

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 percent of its budgetary burden. Wheat consumption and imports consequently dropped by 53 percent and 80 percent, respectively. Domestic supply of wheat, however, fell by 14 percent, whereas cotton production rose by 47 percent. This is because exchange rate unification removed the foreign exchange tax on cotton and revealed

the comparative advantage of irrigated cotton compared to traditional wheat production practices. The trade balance then improved by 43 percent, and self-sufficiency reached 75 percent.

In addition to correcting the internal structure of incentives to producers, 50 percent of the farmers adopted the new wheat technology in Scenario D. In spite of the partial elimination of the wheat subsidy, a higher self-sufficiency ratio (94 percent) and larger decline in wheat imports were realized with this policy compared to Scenario C, in which 100 percent lifting of the consumer subsidy was adopted without improved production efficiency. This indicates the relative importance of supply-shifting policies and the contribution of the technology factor to bridging the wheat deficit in Sudan. Both scenarios produced substantial gains in net foreign exchange.

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 Sudan's agriculture.

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, has 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 the high bread price subsidy and dependence on external sources 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 for agricultural resources with alternative crops such as cotton and faba beans as well as substitution between wheat and other cereals in consumption were analysed. Policy analysis showed that the current strategy of expanding the 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]Centro Internacional de Mejoramiento de Maiz y Trigo.

[2]US Department of Agriculture.

[3]Food aid here includes both donations and concessional imports.

[4]The official exchange rate in 1990 was S£ 4.5 and the free market rate S£ 22 per US$. S£ refers to Sudanese pounds.

[5]Detailed discussions of the multi-market approach are found in Singh *et al.* (1985) and Braverman and Hammer (1986). Sudan's wheat model is developed on this basis.

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Discussion Opening—*Mesfin Bezuneh* (Clark Atlanta University)

The issue addressed in the paper is relevant and timely. It uses a straightforward household-firm model, recognizing the linkages of production to consumption in a multi-market environment. This is a highly relevant analytical approach, which captures the essential tradeoffs between competing government strategies. However, the paper did not take advantage of the model to explore explicitly the impact of food aid.

The driving force of their paper is the increasing gap between food supply (wheat in particular) from domestic production and demand for wheat due to highly subsidized bread prices. Food aid (or wheat aid) is the major source of government revenue for subsidizing bread prices. As a result, the authors assert that "annual consumption of wheat in Sudan has risen from around 20 kg per capita to 40 kg over the last two decades, whereas growth in domestic production has lagged far behind demand," and that 80 percent of the supply-demand gap was fulfilled by food aid.

The paper could have focused first on analysing the effects of food aid on production and consumption in Sudan and then evaluating the government's alternative production and policy

strategies. Clearly two types of food aid linkages need to be incorporated into analysis of this type: the production linkage, which is felt through the domestic prices of wheat and other grains, such as millet and sorghum; and the consumption/demand linkage, which is felt through its income effect. Relevant questions in this regard include whether food aid results in production disincentives and whether it generates additional net income that could partially or fully offset the disincentive effects and/or exacerbate the production consumption balance by increasing demand.

It is possible to hypothesize that food aid might have disincentive effects on the production not only of wheat but also sorghum and millet, since their prices are determined in the free market. Thus, food aid not only increased demand for wheat but might also have caused a reduction in domestic cereal production, thereby exacerbating the gap.

Given the frequency of drought and the existence of other disincentive production factors in Sudan, food aid will remain an important means of filling the gap. Reliance on food aid will continue to be an increasing risk in the 1990s and beyond as the food aid donors move closer to reducing their own farm subsidies (under a GATT agreement) and the number of countries seeking food aid increases (e.g., Eastern Europe).

What is needed is thus a clear understanding of the total effects of food aid so that decision makers in the recipient countries can make the necessary policy changes in developing both food aid alternatives and efficient food aid management strategies. Kenya, for example, is formulating a desirable national food strategy by determining the appropriate levels of food aid in order to meet local, regional, and national nutritional and development needs.

Sudan has been consistently receiving over 300,000 t of grain food aid (mostly wheat) annually for the last 20 years and over 671,000 t (ranging from 330,000 t to 890,000 t) annually for the last six years (as well as about 10,000 t non-cereal food aid), making it one of the highest food aid recipient countries in Africa. The impact of such a massive infusion of food aid needs to be understood.

[Other discussion of this paper and the authors' reply appear on page 236.]