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Profitability analysis of foodgrain in the Sudan's irrigated agricultural sector

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Abstract

This paper discusses the situation of irrigated sorghum and wheat with respect to their financial and economic profitability and international competitiveness in use of domestic resources, in light of declared government policy which emphasizes shifting from traditional rainfed sector to irrigated sector for production of staple foodgrain. Domestic resource cost analysis has been employed using official and shadow exchange rates. Measures of domestic resource cost ratio, international value added, international competitiveness, nominal and effective protection coefficients were also estimated. Results indicate that the economic profitability has been significantly higher than the financial one due mainly to variability in international prices, yields and overvalued exchange rates; but devaluation of the currency is not a sufficient condition for paying higher prices to farmers.

The Sudan agricultural sector is composed of two distinct subsectors: irrigated and rainfed. The irrigated subsector is mostly concentrated in partially sponsored governmental schemes along the banks of the Nile River and its tributaries. It occupies 4.5 million feddans (one feddan = 0.42 ha) dominated by gravity irrigation schemes. The major schemes of this subsector include, the Gezira (2.12 million feddans), New Halfa (330 000 feddans), Rahad (300 000 feddans) and pump schemes. The main crops grown include cotton, wheat, sorghum, groundnut and vegetables.

The rainfed subsector, largely encompasses private mechanized farming schemes of growing importance. The dominant crops grown in the rainfed areas are sorghum and millet, however, returns from crops in this subsector are highly fluctuating and increasingly unstable relative to international standards, with a coefficient of production variation of 28% (Maxwell, 1988). This level of variability is attributed to the horizontal expansion of the mechanized rainfed areas and unpredictable annual rainfall levels. The irrigated subsector produces all of the country local supplies of wheat while it contributes about 15–36% of sorghum during seasons of high and low rainfall respectively with provision of a more stable

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production (Hamid et al., 1992). In general, the country is in surplus in most years for sorghum, exporting more than 500 000 t annually, and nearly in balance for millet. However, it is in great deficit for wheat due to declining production output which coincides with rising consumption. While consumption is increasing at a rate of 3% per annum, production is growing at 2% only (World Bank, 1990a). This discrepancy is mitigated by a continuous carry-over of sorghum stocks under the buffer-stock programme and balanced by imports. During the 1980's Sudan typically imported 75% of its total wheat supplies due mainly to faster consumption growth rate, particularly among urban consumers.

Since 1989, a planned shift of emphasis to the irrigated subsector, with regard to foodgrain (wheat and sorghum) has been adopted. This shift was undertaken to provide broadly-based and reasonably steady production growth rate for the future (Government of Sudan, 1990). Expansion of cultivable area and liberalisation of the domestic marketing, particularly devaluation of the currency are the two main options which are sought to provide incentives for foodgrain producers. Consequently, wheat cultivated area in the irrigated schemes increased by 182% between 1989 and 1992 and that of sorghum increased by 77% during the same period.

The main objective of this study was to investigate the following: (1) the competition provided by the market structure of goodgrain in the Sudan; (2) the extent of effectiveness of devaluation with regard to competitiveness of the two crops; (3) the full benefit of devaluation (in terms of comparative advantage); and (4) the likely impact of alternative policies.

The approach followed here consisted essentially in deriving the cost structure to reveal the competitiveness and comparative advantage of the two crops. The results can be used to identify what kind of farmers (categorized by schemes under consideration) and the technology they use, are competitive under current policies affecting input-output prices and how profit changes as policies change. Although the context is foodgrain in the Sudan, the lessons are applicable to many other countries.

1. Methodology and theoretical basis

The theory behind production profitability for international competitiveness lies in the opportunity to exploit the net economic profitability of a productive activity. The starting point of such an evaluation was to derive actual costs of production by adjusting domestic costs and tradable products for taxes, subsidies and other price distortions. Once the real costs of production are estimated, competitiveness will be evaluated along the lines initially developed by Bruno (1967) in his measurement of domestic resource costs and the various refinements that subsequently have been introduced (Corden, 1974; Ingram and Pearson, 1981; Pearson et al., 1987; Monke and Pearson, 1989).

To calculate the net economic profitability all inputs and outputs must be valued at their respective shadow prices. The net economic profitability (NEP) of the xth production activity may be written as the difference between the economic value of outputs and the economic value of inputs used, plus externalities:

$$\text{NEP}_x = \sum_s q_{sx} p_s - \sum_i a_{ix} v_i + E_x \qquad (1)$$

where q_{sx} is the quantity of the sth output from the xth activity, and P_s is its shadow price; a_{ix} is the amount of the ith input to xth activity, and V_i is its shadow price; E_x is a general term covering external costs and benefits.

When traded outputs are produced and some traded inputs are used in the process, Eq. (1), can be written as follows:

$$\text{NEP}_x = \left(\sum_s q_{sx}\ p_s^{\text{t}} - \sum_x a_{ix}^{\text{t}}\ v_i^{\text{t}} \right) v^{\text{e}} - \sum_i a_{ix}^{\text{d}}\ v_i^{\text{d}} + E_x \qquad (2)$$

where 't' and 'd' represent traded and non-traded products, respectively. The corresponding shadow prices are v_i^{t} and v_i^{d} and since the activity in question produces a traded product, we designate its price as p_s^{t} in foreign exchange and V^{e} is the shadow price of foreign exchange (in terms of domestic currency).

Based on Eq. (2), the international value added

(IVA) by the x^{th} activity in foreign exchange may be written as follows:

$$\text{IVA}_x = \sum_s q_{sx} p_s^t - \sum_i a_{ix}^t v_i^t \quad (3)$$

when Eq. (3) is multiplied by the shadow exchange rate (V^e) it is the international value added in domestic currency terms. Having the domestic resource cost (DRC)

$$\text{DRC}_x = \sum_i a_{ix}^d v_i^d - E_x \quad (4)$$

Eq. (2) may be written as follows:

$$\text{NEP}_x = \text{IVA}_x^d - \text{DRC}_x \quad (5)$$

If NEP_x is positive, the productive activity enjoys a comparative advantage in world trade.

By using V^e to value traded inputs and products, it is possible to ask whether or not a given activity earns sufficient (IVA) to bid effectively for the domestic resources. Consequently, positive (NEP) is an indication of efficient competition in the world market.

For empirical approximation of policy impact, the framework utilizing Eqs. (1) through (5) can perhaps be explained most clearly by the use of Policy Analysis Matrix (PAM) developed by Monke and Pearson (1989). PAM approach is shown in Table 1.

2. Financial analysis

The concept of (NEP) rests on the utilization of economic prices rather than financial ones. However, the economic benefits in an activity that enjoys a comparative advantage requires that production operates in an environment of financial (market) prices. In the Sudan, till recently, there were substantial tax and subsidy distortions which derive a wedge between financial and economic prices (Nashashibi, 1980; Osterdiekhoft and Wohlmuth, 1983; Hussain and Thirlwall, 1984; D'Silva, 1985, 1986; D'Silva and El Badawi, 1988).

In order to analyze financial profitability, it is necessary to construct budgets for individual productive activities and to link these budgets where farming system considerations arise. Referring to Table 1, financial calculations show the competitiveness of the agricultural system, given current technologies, output values, input costs and policy transfers.

Table 1
Policy analysis matrix

	Revenue	*Cost*		Profits
		Tradable inputs (Foreign exchange)	Domestic factors (Local)	
Financial prices	A	B	C	D
Economic prices	E	F	G	H
Effects of efficiency policy and market imperfections	I	J	K	L

where D = (A − B − C): financial profitability H = (E − F − G): economic profitability I = (A − E): output transfers J = (F − B): input transfers K = (G − C): factor transfers L = (D − H = I − J − K): net transfers.

3. Economic analysis

Economic calculations depend on the process of disaggregation to separate intermediate costs into four categories: tradable inputs, domestic factors, transfers (taxes and subsidies) and non-tradable inputs (which themselves have to be further disaggregated). Ultimately, all components are classified into tradable inputs and domestic factors (Table 1) and as such economic revenues and costs permit computation of (NEP), H, net transfers from all policies, L, and output, input and factor transfer (I, J, and K, respectively). The analysis, thus permits comparison of the effects of market failures and distorting policies on commodity systems.

4. International competitiveness analysis

Using the described framework, measures of comparative advantages could be estimated with reference to Table 1. The most important ratios are the following:

(1) International value added (IVA): gross revenue less foreign exchange component of all

cost (A – B) in financial analysis (in foreign exchange) or (E – F) in economic analysis (in local currency).

(2) Domestic resource cost ratio (DRC = [G/(E – F)]): cost of domestic resources divided by the (IVA) in local currency.

(3) Nominal protection coefficient (NPC = (A/E)): revenue at market prices divided by the revenue at world price equivalent.

(4) Effective rate of protection (ERP = (A – B)/(E – F)): ratio of value added at market prices to value added at world prices.

Table 2.1
International comparative advantage indicators for sorghum production in some irrigated schemes

A) *Gezira*

	NEP	FP	DRC	IVA	CIC	NPC	ERP
1986/87							
O (2.5)	−7.51	−18.46	1.15	26.65	5.19	0.77	1.10
S (8.2)			0.70	24.25	5.71	0.45	0.61
1987/88							
O (4.5)	426.32	−49.03	1.72	34.56	5.92	2.15	3.81
S (10.86)			0.70	26.96	7.59	1.01	2.02
1988/89							
O (4.5)	261.79	183.54	0.70	50.57	8.57	0.78	1.00
S (11.52)			3.65	10.31	42.04	0.83	5.21
1989/90							
O (4.5)	676.42	−127.42	1.27	38.86	15.48	1.60	2.64
S (20.1)			−1.20	−24.93	−24.14	1.06	−2.50
1990/91							
O (12.2)	4283.19	−773.86	3.13	29.72	38.24	5.62	15.32
S (29.1)			−1.01	−38.51	−29.51	2.82	−4.96
1991/92:							
O (15.0)	2653.90	1714.89	0.53	66.17	29.08	0.95	1.12
S (66.75)			−0.74	−38.89	−49.49	0.79	−1.57

B) *New Halfa*

	NEP	FP	DRC	IVA	CIC	NPC	ERC
1986/87							
O (2.5)	3.96	−17.12	0.86	44.11	3.87	0.88	0.99
S (8.2)			0.50	41.71	4.09	0.46	0.57
1987/88:							
O (4.5)	165.36	−32.78	1.21	34.87	5.44	1.46	2.21
S (10.86)			0.97	24.81	9.72	0.74	1.38
1988/89							
O (4.5)	−5.45	252.63	0.59	50.97	7.24	0.53	0.59
S (11.52)			1.33	24.17	15.27	0.56	1.31
1989/90							
O (4.5)	290.34	−71.38	1.14	40.91	13.94	1.16	1.75
S (20.10)			−1.64	−17.26	−33.06	0.77	−2.52
1990/91							
O (12.2)	6611.64	−104.80	1.16	55.56	14.18	6.19	10.87
S (29.10)			−1.15	−30.40	−33.42	2.92	−6.35

Table 2.1 (continued)

C) *Rahad*

	NEP	FP	DRC	IVA	CIC	NPC	ERP
1986/87							
O (2.5)	3.96	−17.12	1.09	43.36	4.89	0.81	1.09
S (8.20)			0.63	40.96	5.18	0.46	0.61
1987/88							
O (4.5)	85.63	−97.27	1.68	31.95	7.54	1.46	2.38
S (10.86)			0.91	24.34	9.90	0.69	1.30
1988/89							
O (4.5)	188.12	52.94	0.89	37.89	10.80	0.52	0.58
S (11.52)			3.09	11.53	35.49	0.54	2.03
1989/90							
O (4.5)	33.79	106.81	1.44	35.09	17.52	1.10	1.54
S (20.10)			−2.55	−11.99	−51.29	0.74	−2.73
1990/91							
O (12.2)	4416.40	−558.36	2.22	37.51	27.08	5.79	12.27
S (29.10)			−1.15	−30.40	−33.42	2.92	−6.35

Figures in parenthesis are exchange rates. O, with official exchange rate; S, with shadow exchange rate

(5) Coefficient of international competitiveness (CIC = (C/IVA)): ratio of domestic resource cost to IVA in foreign exchange.

5. Data sources and estimation procedure

Approximate economic prices of wheat and sorghum were considered as c.i.f. import prices and the f.o.b. export prices respectively. Given world prices, border-equivalent farmgate prices were calculated (by adjusting for transport costs to or from producer and consumer locations, storage costs and other elements of marketing margins). These were then compared with average producer prices. The cost of non-tradable inputs were disaggregated into their underlying tradable inputs and domestic factor costs. The former changed as a function of the change in the exchange rate used.

After netting out all direct policy effects on prices (excise, taxes and custom duties (subtracted), subsidies (added), the ratio of total economic cost to total financial cost was referred to as 'conversion factor' and used to convert financial values to economic values.

Weighted average exchange rates (official, regulated parallel, sanctioned free market and unsanctioned free market rates) were computed and used together with the official exchange rates for comparison of policies' impact. This was necessary due to the presence of multi-exchange rates operating at any point in time since 1978 (Nashashibi, 1980; World Bank, 1990b) with no agreed-upon way of defining the correct exchange rate (Harvey, 1988; Krueger et al., 1988).

Data was collected from the schemes annual economic reports supplemented with farm surveys and single interviews with key resource personnel. International prices were collected from available FAO records and other international publications. Foreign components for specific items are based on the calculations of imports and exports parity prices to farm-gates of the respective schemes. Machinery and transport foreign component costs are based on estimates provided by the officials in the schemes.

Using Quatro Pro spreadsheet software package, worksheets were prepared to allow sensitivity analysis and updating.

'Files' were created for each crop for each year at each scheme.

6. Results and discussion

Results of comparative advantage indicators are presented in Table 2.1 for sorghum in Gezira, New Halfa and Rahad and in Table 2.2 for wheat in all irrigated schemes.

Generally, the net economic profitability (NEP) and financial profitability (FP) of the two crops in the different schemes and through time were unstable. They fluctuated between negative profitabilities and fairly positive ones, and this was attributed to changes in exchange rates, international prices, cost of production and seasonal variability of yield. Moreover, economic prof-

Table 2.2
International comparative advantage indicators for wheat production in irrigation schemes
A) *Gezira*

	NEP	FP	DRC	IVA	CIC	NPC	ERC
1986 / 87							
O (2.5)	25.00	125.00	0.40	57.33	1.81	0.99	1.16
S (8.2)			0.23	55.52	1.07	0.55	0.66
1987 / 88							
O (4.5)	61.00	166.00	0.43	64.80	1.95	1.14	1.31
S (10.86)			0.19	68.06	2.10	2.10	0.49
1988 / 89							
O (4.5)	554.00	197.00	0.53	93.82	2.40	1.82	2.64
S (11.52)			0.23	84.96	2.63	0.75	1.14
1989 / 90							
O (4.5)	−747.00	26.00	0.95	85.02	4.19	0.69	0.56
S (20.10)			0.27	66.81	5.34	0.17	0.16
1990 / 91							
O (12.2)	−618.00	−628.00	4.43	14.99	54.06	2.20	7.47
S (29.2)			−0.76	−38.11	−22.23	0.79	−1.78
1991 / 92							
O (15.00)	1966.00	−385.00	1.30	84.76	19.54	2.09	5.41
S (66.75)			−1.22	−90.82	−18.24	0.50	−5.05

B) *New Halfa*

	NEP	FP	DRC	IVA	CIC	NPC	ERC
1986 / 87							
O (2.5)	−37.00	85.00	0.56	42.33	2.50	1.02	1.25
S (8.20			0.31	41.12	2.57	0.57	0.71
1987 / 88							
O (4.5)	−4.00	78.00	0.63	46.26	2.85	1.24	1.52
S (10.86)			0.28	43.36	3.04	0.53	0.67
1988 / 89							
O (4.5)	293.00	26.00	0.90	55.96	4.03	2.03	3.38
S (11.52)			0.78	51.20	4.41	0.83	1.44
1989 / 90							
O (4.5)	700.00	−2.00	1.00	87.94	4.52	2.39	4.17
S (20.10)		0.26	74.99	5.20	0.57	1.10	
1990 / 91							
O (12.2)	−169.00	−591	7.18	7.85	87.58	2.38	17.52
S (29.10)			−0.45	−52.23	13.20	0.93	−1.11

Table 2.2 (continued)

C) *Other Schemes, 1990 / 91*

	NEP	FP	DRC	IVA	CIC	NPC	ERC
Blue Nile							
O (12.2)	− 618.00	− 628.00	4.43	14.99	54.06	2.30	7.47
S (29.10)			− 0.63	− 44.54	− 18.20	0.90	− 1.05
Rahad							
O (12.2)	− 716.00	− 747.00	3.61	21.79	46.48	2.28	5.69
S (29.10)			− 1.66	− 20.93	− 48.39	0.85	− 2.48
White Nile							
O (12.2)	− 770.00	− 816.00	6.14	13.00	74.94	2.17	9.67
S (29.10)			− 0.69	− 51.77	− 18.83	0.78	− 1.08
Northern Region							
O (12.2)	− 3822.00	− 2114.00	4.90	45.99	56.57	2.14	3.25
S (29.10)			− 1.16	− 79.21	− 33.71	0.77	− 0.78

Figures in parenthesis are exchange rates. O, with official exchange rate; S, with shadow exchange rate

itability for both crops at official exchange rate significantly outstripped financial profitability; and this divergence was due mainly to the differences between economic and financial prices as a result of government policies and market imperfections, which in turn was an indication of taxation of the two crops.

The competitiveness of sorghum was moderate in the three seasons prior to 1989/1990. It enjoyed favourable DRC with shadow exchange rates, especially in the earlier two seasons. The international value added was positive under both exchange rates, and the nominal protection coefficients were in most cases less than unity, reflecting low prices received by farmers compared with international prices. The implicit exchange rate (Eq. 2), as indicated by the CIC was generally lower than the shadow exchange rates, reflecting the uncompetitiveness of the crop.

The latter three seasons of the period of evaluation of sorghum witnessed negative signs of DRC, IVA, CIC and ERP confirming Sudan's weak competitive position under attempted policy measures. It is noticeable that while the NPC on outputs was greater than one in the majority of cases, the ERP on inputs showed negative signs at shadow exchange rates. That was due to the fact that disincentives on inputs to production were greater than the incentives or protection on sales. Since in the absence of government policy (and market imperfections) financial prices would be equal to economic prices and both of the above ratios would equal one, results would imply that the attempts to offset part or all of the disincentive effect on sorghum producers by devaluation of the currency alone lead to further waste of resources because of the high import content of irrigated sorghum (57% of inputs are imported as reported by El Hannan (1986) and Hussain and Thirlwall (1984).

High variability in all measures existed in the different schemes during the study period. The IVA ranged between US$10.3 and US$66.2 per feddan, DRC between 0.5 and 3.13 and that was due primarily to annual changes in world prices, yields and the choice of exchange rate used in the analysis. Rahad and New Halfa schemes generally had a better comparative advantage than that of Gezira as depicted by the IVA and the DRC values particularly at the official exchange rates which offered some subsidies on imported inputs.

Wheat (Table 2.2) was generally more competitive than sorghum under the current technology arrangement. It realized quite favourable DRC ratio and relatively high levels of IVA during the period 1986/87–1989/90. The CIC was, however, low in that period. Lower NPC and ERP were also recorded as compared to sorghum, showing limited protection on output and sizeable taxation in the production process of wheat through ex-

change rate policies. A similar situation to that of sorghum (i.e. negative DRC, IVA, CIC and ERP) prevailed in later seasons under study. It is to be noted that wheat was the only crop which was fully mechanized in the irrigated subsector and understandably with very high import content (estimated by El Hannan, 1986, as 89%). Average annual yields, however, are still quite low compared to either those in the irrigated sector of neighbouring Egypt where yield is approximately 60% higher (Bright, 1990) or those obtained in the Sudan's agricultural research stations (Hamid et al., 1992).

Weak competitiveness position was computed for Blue Nile, White Nile, Rahad and Northern Region schemes in 1990/91 for which data are available. The former three schemes are new areas of wheat production with less favourable conditions for its growth and limited farmers experience. Many problems such as exceptionally high winter temperature and limited input availability during that particular season contributed to the poor performance.

The Northern Region suffered from the above mentioned factors in spite of relatively better crop management (Hamid et al., 1992). Nevertheless, both the IVA and the CIC were high in the North at official exchange rates as compared to other schemes. However, a negative sign appears also with DRC, IVA, CIC and ERP confirming the view that had farmers of wheat received the border-equivalent prices for their output at the shadow exchange rates, under the current marketing structure, they would have had large negative profits.

Both cereal crops were generally uncompetitive under the conditions prevailing in the seasons for which the analysis was made. The overall results were consistent with the view that with high import content, devaluation of the currency alone can cause production cost to rise sharply providing no incentive for producers, because farmers face additional constraints such as physical and administrative barriers to increased supply. Agricultural inputs must be available so that the technical conditions for raising output can be met. Institutional arrangements that ensure that the benefits of higher cost of foreign exchange and therefore higher international prices accruing to the farmers and not to private traders must be in place. The relevant technology must be available so that the incentive of higher prices can significantly speed up the growth of production. Transport bottlenecks must be solved in time to ensure the smooth flow of inputs and outputs.

On the technology side, the average usage of fertilizers per hectare of wheat was 7.5 Kg, compared to 15.5, 46 and 62 for Zambia, Kenya and Zimbabwe, respectively (World Bank, 1990a). Seeds were unsufficiently handled and usually being saved from the previous harvest (Bright, 1990). The lack of spare parts was such that an estimated 70% of Sudan railways wagons were out of commission in 1991 and the shortage of fuel reduced the efficiency of road and the available rail transport (Government of Sudan, 1992). Furthermore, the marketing boards of the irrigated schemes covered by the study were often late in providing price signals (D'Silva and El Badawi, 1988) and the organizational set-up of these marketing agencies lead to a monopolistic market structure for water, aerial spraying, fertilizers and certain mechanical operations. Furthermore, the schemes also act as monopsonists for wheat and sorghum on the output side (Osman, 1989; Maxwell et al., 1990).

7. Summary and conclusions

Using the Policy Analysis Matrix for estimating domestic resource cost and other efficiency measures, the competitiveness situation of two staple foodgrain crops in state-owned schemes was discussed. The underlying assumption to the competitiveness approach is based on constant costs of production which is one of its limitations, particularly when dealing with a highly dynamic situation (Monke and Pearson, 1989). However, like most publicly owned and administered schemes, cropping changes in the Sudan irrigated sector are rather slow and as such the competitiveness approach should fairly approximate the situation. Such implication of allocation, however, must be approached cautiously, as there might be sharp changes in costs from one set of

cost conditions to another. With this in mind, the following conclusions can be drawn.

The economic profitability was significantly higher than the financial one due mainly to variability in international prices over-valued exchange rates and low yields resulting from low levels of production technology and weak institutional arrangement. Moreover, the two crops were uncompetitive at shadow exchange rates, reflecting that nominal devaluation does not necessarily result in a fall in the real exchange rates, nor in improved terms of trade (in terms of comparative advantage) for farmers.

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References

Bright, G., 1990. Production trends and farm policy issues in the Sudan. In S. Maxwell (Editor), Food Security in the Sudan. Intermediate Technology, London.

Bruno, M., 1967. Planning the External Sector: Techniques, problems and policies. United Nations, New York.

Corden, W.M., 1974. Trade Policy and Economic Welfare. Clarendon, Oxford.

D'Silva, B.C., 1985. Sudan: Policy Options and Prospects for Agricultural Recovery After the Drought. USDA Econ. Rep. AGES 86-081.

D'Silva, B.C., 1986. Sudan Irrigated Subsector: Issues for Policy Analysis. USAID/USDA Staff Rep. AGES 86-0811.

D'Silva, B.C. and El Badawi, I., 1988. Indirect and direct taxation of agriculture in the Sudan: the role of the government in agricultural surplus extraction. Am. J. Agric. Econ., 70: 431–437.

El Hannan, M.M., 1986. Comparative advantage of Sudan's major agricultural exports. Working Document, Ministry of Agriculture, Khartoum.

Government of Sudan, 1990. The Three Year Economic Salvation Programme 1990–1993. Economic Committee of the Revolutionary Council, Khartoum.

Government of Sudan, 1992. The General Annual Financial Budget for the fiscal year 1992/93. Ministry of Finance and Economic Planning, Khartoum.

Hamid, H.F., Gumaa, Y.T., Ismail, M., Elobeid, O., Mohamed, A., 1992. The economics of grain production in the Sudan's irrigated sector. Working Document, Ministry of Agriculture, Khartoum, 68 pp.

Harvey, C. (Editor), 1988. Agricultural Pricing Policy in Africa. Macmillan, London/Basingstoke.

Hussain, M.N. and Thirlwall, A.P., 1984. The IMF supply-side approach to devaluation: an assessment with reference to Sudan. Oxford Bull. Econ. Stat., 46: 145–167.

Ingram, W.D. and Pearson, S.R., 1981. The impact of investment concessions on the profitability of selected firms in Ghana. Econ. Dev. Cult. Change, 29: 831–839.

Krueger, A.O., Schift M. and Valdés, A., 1988. Agricultural incentive in developing countries. World Bank Econ. Rev., 2: 255–271.

Maxwell, S., 1988. Food Security Study – phase I. Institute of Development Studies, Sussex, UK.

Maxwell, S. (Editor), 1990. Food Security in the Sudan. Intermediate Technology, London.

Maxwell, S., Swift, J. and Buchanan-Smith, M., 1990. Is food security targeting possible in SSB Africa? Evidence from Sudan. IDS Bull. 21(3), Institute of Development Studies, Sussex, UK, pp. 52–61.

Monke, E.A. and Pearson, S.R., 1989. The policy analysis matrix for agricultural development. Cornell University Press, Ithaca, NY.

Nashashibi, K., 1980. A supply framework for exchange reform in developing countries: the experience of Sudan. IMF Staff Paper, 27(1): 24–80.

Osterdiekhoft, P. and Wohlmuth, K. (Editors), 1983. The Development Perspectives of the Sudan: The Limits of the Breadbasket Strategy. Weltforum, München/Köln.

Osman, B., 1989. Study of the potential for inter-regional trade in cereals in IGADD Region, Sudan. Report.

Pearson, S.R., Monke, E., Avillez, F., Bentley, J.W., Finan, T.J., Fox, R., Josling, T., Langworthy, M., Tangermann, S., 1987. Portuguese Agriculture in Transition. Cornell University Press, Ithaca, NY.

World Bank, 1990a. Sudan: Reversing the economic decline. World Bank Report 8414-SU.

World Bank, 1990b. Sudan: Toward an action plan for food security. World Bank Report 8167-SU.