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## Government Policies and Food Security in Sudan (1970-2007): Incentives, Efficiencies and Comparative Advantage for Sorghum Producing in Mechanised Rain-fed Subsector

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**Abstract:** This study aimed to analysis the impacts of government policies on food security in Sudan (1970-2007). The incentives, efficiencies and comparative advantage for sorghum producing in mechanized rain-fed subsector were analyzed using the Policy Analysis Matrix. The calculations of private and social profitability provided information to identify the impacts of policies on sorghum production. The period of the analysis divided into five sub-periods to represent the different economic situations in the Sudan. The results were summarized within a sub-period by using moving average of intervals. The results found that the government intervention policies were incentive producers in the sub-periods within the range of 1985-2007. Therefore, the country was economically had a competitiveness in producing sorghum (DRC was positive and less than one and range from 0.4464 to 0.6570. The exception made for sub-period of 1992/94-2000/02 where the DRC was more than one. Moreover, the policies distortions taxed producers by 31.6% and 29.1% in sub-periods within the range of 1970-1985 and subsidized them by 335%, 95% and 74% in sub-periods within the range of 1985-2007.

**Keywords:** Self-sufficiency; Policy matrix analysis; Intervention.

### 1. Introduction

In Sudan, different policies were considered and focussing on self-sufficiency and trade policy and their impact assessed on the comparative advantage and trade flows of the agricultural markets [1-4]. During 1970s, agricultural policy was geared towards one major objective: the realization of food self-sufficiency. The economic programs during the 1980s included the economic recovery program ECRP (1978-1983) and the four-year economic salvation program (1986-1989). Both programs conceived an outward-oriented development strategy, especially export expansion, in addition to self-sufficiency. The major targets of the programs were to adopt an economically more realistic exchange rate, reduce quantitative restrictions, and remove export taxes. Having realized the problematic economic performance during the 1980s, Sudan embarked in the early 1990s on a wide range of economic reforms to overcome the severe macroeconomic crisis. Those reforms were embodied in the so-called National Economic Salvation Program (NESP), which was adopted in 1990-1993. The Sudan's economic reform policies in 1990s through National Comprehensive Strategy (1993-2002) aimed at improving the balance between aggregate demand and supply, attenuating inflationary pressures, strengthening the balance of payments position and achieving higher economic growth [5].

It is realistic that domestic production - such as sorghum- has a vital role in food security, mainly for regions like sub-Saharan Africa – such as Sudan- where it represents the main source of food consumption [6-8].

Sorghum in mechanized rain-fed sub-sector (MRS) in Sudan is produced for commercial purpose. It contributed in total production of sorghum in Sudan by more than 40%. Thus, the question that rises is: to what extent has the commercial production in mechanized rain-fed sub-sector contribute to food security in Sudan? Food security has interrelated components, i.e. availabilities of food through production, storage and imports, and ability of all people in a nation to acquire the adequate food. But it is still, there are many factors hampered this subsector to response to policies and incentives programs, such as drought, increasing of production cost caused by devaluation and inflation. Moreover, increasing of area under cultivation led to ecological disastrous and decreasing yield. The behaviour of

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sorghum price showed instability through different sub-periods. Sorghum market prices had fallen below production costs in the main farming areas and the marketing and distribution systems are poorly developed.

The objective of this study was to estimate producers' incentives under the government intervention policies to achieve food security in sorghum production in MRS for the period 1970-2007.

## 2. Method of Analysis

Policy Analysis Matrix (PAM) have been used widely in estimating the incentives, efficiencies and comparative advantage of agriculture sector under government interventions in a numerous studies such as [Mulk and Khan \[9\]](#); [Elbadawi, et al. \[10\]](#); [Quddus and Mustafa \[11\]](#) and [Dahmardeh and Faghihzadeh \[12\]](#). The detailed PAM procedures in this study follow those formulated by [Monke and Pearson \[13\]](#) as shown in [Table 1](#).

**Table-1.** Schematic policy analysis matrix

	Revenue	Tradable Input	Domestic Resources	Profit
Private prices	A	B	C	D
Social prices	E	F	G	H
Transfers (policy effects)	I	J	K	L

Table note;

1. Private profits  $D = A - B - C$
2. Social profits  $H = E - F - G$
3. Output transfers  $I = A - E$
4. Tradable input transfers  $J = B - F$
5. Domestic factor transfers  $K = C - G$
6. Net transfers  $L = D - H = I - (J + K)$
7. Nominal Protection rate:  
Output NPRO =  $A/E$   
Input NPRO =  $B/F$
8. Effective Protection Rate  $EPR = (A - B) / (E - F)$
9. Profitability Coefficient  $PC = D/H$
10. Effective Subsidy Coefficient  $ESC = L/E$
11. Domestic Resource Cost  $DRC = G / (E - F)$

The nominal protection coefficient NPC is an indicator of the incentives or disincentives in place, defined as the ratio of domestic price to a comparable world (social) price. NPC could be calculated for both output (NPCO) and input (NPCI). NPCO is the ratio between private and social revenue of the output [14]. If the NPC is equal to one, then the domestic market price will be equals to world price and therefore there is no protection and the price is efficient. If the NPC is greater than one, then there will be a positive protection on output. If the NPC is less than one, then there will be a negative protection on output. This could be occurring if an imported commodity was subsidized in domestic market. For the purposes of this study, the NPC only considered sorghum (output) price. The domestic price was calculated as the producer or retail price of sorghum. The border price was estimated as the product of the export price for sorghum. The nominal exchange rate at Port Sudan (the port of export) adjusted for internal costs to markets in mechanized rain-fed subsector.

The Domestic Resource Cost (DRC) measures competitiveness in domestic production of a commodity. It is a measure of the relative efficiency of domestic production by comparing the opportunity cost of domestic production to the value generated by the product[15]. The measure is calculated as the ratio of the costs of domestic resources and non-traded inputs (valued at their shadow prices) of producing the commodity to the net foreign exchange earned or saved by producing the good domestically. The using of domestic factor i.e. the production is socially profitable if  $(DRC < 1)$  or otherwise  $(DRC > 1)$

Calculations of private and social profitability provided information to identify the impacts of present policies on production. Social profits measure efficiency or comparative advantage of production for the whole economy. Different indicators were calculated such as Output transfer; Tradable input transfer; Domestic factor transfers; Net transfers; profitability coefficient (PC) and subsidy ratio to producers (SRP) (for more detailed see [Mahmoud \[16\]](#)).

In order to make use of the PAM methodology, detailed budgets were required for the activity under consideration. Private values were measured using market prices and quantities of all inputs and outputs. Social prices were determined differently for primary factors and tradable. The inputs classified into tradable, primary factors and non-tradable production inputs that have the characteristic of containing both the tradable and the domestic factor components.

*Accounting of shadow exchange rate*

$$SER = OER (X) + MER (1 - X)$$

Where SER is shadow exchange rate; OER is official exchange rate; MER is market exchange rate (black market rate); X is value of exports/ value of import \* 100%; 1-X is trade balance%

*Accounting of social price of inputs*

$$1. E_{Pi} = F_{Pi} + (SERP * FX * F_{Pi})$$

Where  $E_{Pi}$  is economic price of input;  $F_{Pi}$  is financial price of input; SERP is shadow exchange rate premium which equal to  $((SER - OER) / OER)$  and FX is foreign component

$$2. E_{Pi} = F_{Pi} * CF \quad \text{where CF is conversion factor [16].}$$

## 2.1. Source of Data

The data for the study collected from various secondary sources for the period from 1970 to 2007. The period divided into five sub-periods to represent the different economic situations in Sudan:

- Period of the fiscal and monetary imbalances from (1970-1972) to (1976-1978).
- Period of the Economic Recovery Programmes from (1978-1980) to (1983-1985).
- Period of the economic and political instability from (1985-1987) to (1990-1992).
- Period of the liberalization policies from (1992-1994) to (2000-2002).
- Period of the continuing in liberalization policies from (2002-2004) to (2005-2007).

Cost of production and marketing margins data were taken from the Economic Survey Reports of the Ministry of Finance and National Economy; Department of Economic Planning and Development. Numerous estimates were made to fill data gaps. The major gaps were in a domestic marketing margin data, especially in the period 1970-1978 and fixed percent was used to fill these gaps. Records of the Annual Reports of the Bank of Sudan formed a major source for quantities and values of foreign trade and GDP. The Bank of Sudan with US agriculture Department were also the supplier of some figures on sorghum production, consumption, imports, and exports, but most of the domestic production data were taken from the records of the Ministry of Agriculture and Forests and the Ministry of Animal Resources, which were additionally used to obtain wholesale prices of sorghum. The Central Statistical Bureau was important in providing early statistics on domestic quantities and sales of sorghum and prices in different markets.

## 3. Results and Discussion

**Table 2** represented the complete PAM table for sorghum production activities in mechanized rain-fed subsector (MRS). The private profitability was positive and increasing during different sub-periods. The negative one appeared in sub-period of (1992/94-2000/2002). Increasing in private profitability through different sub-periods might be due to inflation rate and policies of devaluation through entire period. At the same time, the social profitability for sorghum production activities was positive for two sub-periods within the range of (1970-1985) and negative for other sub-periods in the range of (1985-2006). As it was, social profitability measures efficient of production for the whole economy, then the production system worse the whole economy in three later sub-periods, which were represented from economic view periods of political instability and liberalization policies. The important characters of these sub-periods were highly increasing in inflation rate and devaluation policies. Moreover, the production of sorghum in mechanized system continuing under ecological disasters and low yield.

The output transfers were negative in sub-periods within the range of (1970-1985). A negative sign mean the providing a negative transfer because it caused production system to decrease private profit than it could without the intervention of policy. In this case, there was a transfer of income from sorghum producers to whole economy. The divergence might be due to government pricing policies which result from government offering to achieve food security for consumer by establishing prices in constant levels. For the periods from 1985 to 2006, the output transfers were positive which mean that policy of food in Sudan caused the production system to realize higher profit than it could be without it. This positive divergence between private and social prices of the sorghum output might be due to willingness of governments to continuing increasing sorghum production as a main food crop in Sudan.

Traded inputs transfers shown in **Table 2** were negative for sub-periods within the range of (1970-1992) these mean producers paid lower market prices than the world market prices for inputs. The divergence in tradable inputs prices were caused by distorting policies. For sorghum in MRS most of tradable inputs were imported from others countries and distributed to producers with subsidies rate which lead to policy distortion. Never the less, the sub-periods within (1992-2007) distinguished by positive tradable inputs transfers which lead to conclude that producers paid higher input market prices than world market prices i.e. producers suffering from implicit and/or direct taxes. Moreover, these sub-periods distinguished by liberalization policies implied, removed of subsidies and price control and applied of floated exchange rate policies.

Domestic inputs transfers in **Table 2** were positive for all sub-periods i.e. Producers were facing implicit and/or direct taxes when using domestic resources. Net transfer is output transfer less than traded input transfer and less domestic transfer. Also, it is sum of the divergence that caused the private profits to differ from social profits. According to **Table 2**, the values of net transfer showed an inefficiency of sorghum production in MRS for the sub-periods in the range from 1970 to 1985, because of negative signs of its values. For sub-periods within the range of 1985-2006 net transfers had positive signs, so total effects of government policies went toward generating more benefits for producers of sorghum according to implicit and/or direct subsidies that incentive sorghum industry. The disincentive policies for sorghum in sub-periods within the range of (1970-1985) could be explained on the ground of overvaluation of exchange rate and taxes on sorghum output. The overvaluation led to depressed prices and lowering sorghum producers' profit, causing an undervaluation of farm resources and oversupply of output [17]. Incentive policies for producing sorghum in MRS in sub-periods within the range of (1985-2007) were results of successive devaluation of Sudanese pound during these sub-periods that could be emphasized through arguments given by Alawad [18] and Kidane [19], which explained the role of devaluation of exchange rate in enhancing the production.

**Table-2.** Complete PAM table for sorghum production in MRS

Sub-period	Items	Output	Input		Profit
	Analysis		Traded	Domestic	
1970/72-1976/78	Financial	8.983905	1.85736	5.119305	2.007241
	Social	11.77072	1.923165	3.417628	6.429928
	Transfer	-2.78682	-0.06581	1.701677	-4.42269
1978/80-1983/85	Financial	47.94666	7.022697	21.76944	19.15453
	Social	53,97156	7,56244	13,95073	32,45839
	Transfer	-6.02489	-0.53974	7.818709	-13.3039
1985/87-1990/92	Financial	7306.991	554.3276	2427.368	4325.296
	Social	2100.522	736.5025	1410.417	-46.3981
	Transfer	5206.47	-182.175	1016.951	4371.694
1992/94-2000/02	Financial	55998.08	19312.4	42237.43	-5551.75
	Social	25982.02	19160.4	25481.4	-18659.8
	Transfer	30016.06	152.0071	16756.03	13108.03
2002/04-2005/07	Financial	131615.3	31757.47	63664.64	36193.24
	Social	55048.13	30666.47	31268.26	-6886.59
	Transfer	76567.21	1091.006	32396.38	43079.83

Note: values in ls (1 ls=0.001SDG)

The comparison between domestic output price and international price was measured by the nominal protection coefficient of the sorghum. [Table 3](#) summarizes the NPCo of sorghum in produced in MRS. For all sub-periods, with exception to sub-periods range from (1970/72) to (1983/85), the NPCo is greater than one. The values of NPCo had largest magnitude in period of instability of political situation in Sudan, followed the magnitude in period of comprehensive strategy. The two sub-periods distinguished by high inflation and devaluation of local currency. The liberalization policies applied after (1992) resulted in rapid increase in sorghum prices. Continued in application of liberalization policies and with government efforts to decrease inflation rate in sub-period of (2002/04-2005/07), lead to decrease NPCo when compared with previous sub-periods. Nevertheless, it was still more than one. More than that, it was more than two, which mean more than double subsidies. In sub-periods within the range (1970-1985), the domestic price to what extent was consisting to international market price.

According to NPCo values, one could classify the entire period to three sub-periods in view of liberalization i.e. sub-periods before liberalization (1970/72-1983/85); sub-period of partial liberalization (1985/87-1990/92) and sub-period of liberalization (1992/94-2005/07). The dramatic increase in domestic price of sorghum clearly began in sub-period of partial liberalization and price continued to increase through successive sub-periods.

The effective protection coefficients (EPC) are indication of incentive. The coefficients measure the degree of policy transfers product market and tradable input policies. Like NPC, policy effects that declined producer price were appearing in two sub-periods within the range (1970-1985). So, in other sub-periods, the producers in MRS were incentive by government polices ([Table 3](#)).

**Table-3.** Summary results of nominal protection, effective protection and profitability coefficients for sorghum in

Sub-period	NPCo	EPC	PC
1970/72-1976/78	0.8506	0.8293	0.4596
1978/80-1983/85	0.8489	0.9353	1.0442
1985/87-1990/92	4.8709	5.1992	2.1204
1992/94-2000/02	2.5891	4.0707	-0.5713
2002/04-2005/07	2.3701	3.3654	-5.1286

The profitability coefficients (PC) in [Table 3](#) were extension of EPC. They represented the ratio of private and social profits. The PC was less than one in sub-period of (1970/72-1976/78) and positive which mean the net policy transfers was positive for producers and for society and the society gained, more than producers was. However, in two following sub-periods (1978-1992) producers gained more than the society was and no one worse. Negative signs in later sub-periods resulted from negative effect of policy in social profits. The net effects of policy transfers were incentive producers but whole economy worse. In sub-period (1992/94-2000/02) social loses were greater than private gains, but in sub-period of (2002/04-2005/07) the private gains were more than five times of social loses. This finding showed bias against sorghum production as specific and agriculture as whole in the policy practices in Sudan, which could be emphasized by results found by [Ellis \[20\]](#).

The comparative advantage of sorghum was determined through measurements of domestic resource cost (DRC), factor ratio cost (FRC) and policy transfers. Subsidy ratio to producer (SRP) was added to [Table 4](#). The DRC used to indicate whether the used of domestic factor was profitable to society ( $DRC < 1$ ) or not ( $DRC > 1$ ). In the producer level, the DRC values with exception of sub-periods (1992/94-2000/02) were less than one over the four other sub-periods. This implied that government policy on sorghum self-sufficiency lead to significant efficiency when using domestic resource as shown in [Table 4](#). In addition, that mean value of domestic resource used in

production of sorghum was less than value of foreign exchange earned or saved, and then the country was economically competitive in producing sorghum. Table 4 showed that the DRC was positive and less than one and range from 0.4464 to 0.6570.

Factor ratio cost (FRC) estimated to explain if the tradable input was financially profitable ( $FRC < 1$ ) or not ( $FRC > 1$ ). That implied to how much value added by tradable inputs cover the domestic resource cost. From Table 4 the results indicate that the use of tradable inputs in sub-periods range within (1970-1985) was efficient and the value added was cover domestic resource cost financially. For the two sub-periods within range of (1985- 2002) domestic resource cost was more than value added by tradable input. Sub-period of continued liberalization explained efficient use of tradable inputs.

The subsidy ratio to producer (SRP), the ratio of net transfers to the social value of revenue, showed in Table 4, explained that the SRP was negative for two sub-periods within range of (1970-1985) and equals to -0.316 and -0.291. Two findings could be generated from these figures, first in the sorghum production system the producers output was taxed and the second effects of the policy decreased the private revenue of producer by 31.6 and 29.1 percents from social revenue. So, the policy distortion was against the producers and the system of sorghum production had disincentive for them by 31.6% and 29.1%. The positive sign of SRP in the following sub-periods within the range of (1985-2007) explained that the system of sorghum production was distorting by 335%, 95% and 74% successively. Therefore, the entirely distorting policies had increased the gross revenue of the system by these percentages.

**Table-4.** Indicators of comparative advantage and policy incentive for production of sorghum in MRS

Sub-period	DRC	FRC	Policy transfer	SRP
1970/72-1976/78	0.4464	0.7765	-4.422	-0.3161
1978/80-1983/85	0.5593	0.8408	-13.303	-0.2917
1985/87-1990/92	0.5374	1.0994	4371.694	3.3515
1992/94-2000/02	3.9797	1.6159	13108.03	0.9577
2002/04-2005/07	0.6570	0.8052	43079.83	0.7428

## 5. Conclusion

It's economically for Sudan to produce Sorghum to achieve self-sufficiency according to DRC indicators. So, applications of such policies to achieve food security were fruitful with consideration on controlling inflation rate. The government interventions in sorghum production system had distorted price away from efficient situations in term of taxes or subsidies on output and input (tradable input) prices. So, more consideration in policy applications should be taken to remove distortions from prices to make sorghum industry more incentives. Producers in mechanized rain-fed subsector were vulnerable to sorghum price variations because of their limited capacity to response to change in prices and they affected negatively by the most of policies reform. In order to increase producer's responsiveness to price policies and enhance the role of them in formula of equality food security with national security and food security with food self-sufficient, particular attention should be devoted to modelling producers' decisions to alternative government policies through:

- Accounting such changes in producers' behaviour in designing and assessing, the outcome of market reforms i.e. liberalization programmes, implications of taxes, devaluation of Sudanese currency etc...
- Building up a database that allows future studies on impacts of policy changes is important.
- Restructure producers of sorghum in mechanized rain-fed subsector in groups and build their capability to deal with marketing reforms through training and extension.

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