The Impact of the introduction of Cash Crops on the Production of Food Crops
The Case of Groundnut and Millet Produced in Eastern Darfur Province


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المستخلص:
تحصى هذه الدراسة الأثر المترتبة على إدخال المحاصيل النقدية على المحاصيل الغذائية في الريف. لهذا الغرض تم أخذ محصولي الفول السوداني والدخن بمحافظة شرق دارفور بغرب السودان كدراسة حالة و ذلك بهدف قياس مدى استجابة العرض لكل منهما للأسعار النسبية. في هذا الصدد، فإن الاعتقاد السائد هو أن إدخال المحاصيل النقدية في المناطق الريفية قد يؤثر سلبا على إنتاج المحاصيل الغذائية عن طريق إعادة تخصيص الموارد لصالح المحاصيل النقدية.

Abstract

This study examines the effects of introduction of cash crops on the production of food crops in a rural area. For this purpose, groundnuts and millet grown in Eastern Darfur Province are taken as a case study to measure the supply response to relative prices of each crop. The contention in this respect is that such a policy will negatively affect the production of food crops through resources reallocation in favour of cash crops and hence jeopardizing their food security.

The data used in the analysis are obtained from the Agricultural Planning Unit (APU) of the Ministry of Agriculture North Darfur State. Applying (OLS) technique to the data covering the period (1992-2002), we examined whether the two crops compete on the limited resources by estimating the response of each crop to relative prices. The results revealed that farmers in the area in question respond only to real price of the particular crop. Meaning that, competitiveness between the tow crops on available resources are not exist. Therefore, the introduction of cash cropping on this area has no negative effects on food crops and thus, food security in the study area.

1. Introduction:

Meeting the challenge of improving rural incomes will require some form of transformation out of the semi-subsistence, low-input, and low-productivity farming systems that currently characterize many rural areas especially in Africa (Govereh et
Among other policies, cash cropping represents one potential avenue of improving rural farmers’ incomes, which is supported by many development organization as World Bank and IFAD. However, in addition to the direct effect of cash cropping on family incomes, these potential synergies or trade-offs between cash crops and food crops have been less focused on in food crop research and rural development programs, although they may have important implication for programs designed to promote food security policies and rural poverty production. More comprehensive studies on the interactions between food and cash crop production may help in refining agricultural and rural development strategies and in refining our understanding of the broader effects of cash cropping and associated commercialization of agriculture.

This paper is an attempt to examine the effects of cash cropping on food production. The study focuses on the potential trade-off by which cash crop production may affects food crop production, and then empirically measures these effects using the case of groundnuts and millet grown in Eastern Darfur Province in Sudan, a major groundnuts producing area.

Ordinary least squares (OLS) techniques are applied to annual data covering the period 1992 – 2002. The next paragraph gives a brief account on the study area.

Eastern Darfur province is situated in the Far East part of Northern Darfur State in Western Sudan. Rainfall decreases from south to north, and varies between (250-780mm) in the far south to (10-200mm) in the far north (APU reports, various issues). Farming and rearing animals are the main economic activities of the people in the province. The province is endowed with vast arable land, which has decreased in recent years as a result of the frequent droughts, desert creeping and population growth. Rearing camels and goats is a widely spread activity in the northern part, while sheep and cattle are reared basically in the southern part.
In addition to millet cultivation as a staple crop in the province, groundnuts is also produced by peasants especially in the southern part, particularly in El Tawiesha and El laiet Localities. Groundnut was introduced in this area informally by the Oil Seeds Company in the early 1960s. By late 1970s and early 1980s, and as a result of high increases in groundnut’s prices, large areas were put under groundnuts cultivation, a development that oriented the peasants towards the market economy. Peasants began to compare between their gains from millet production and groundnuts. As millet (subsistence) supply response to its price is very low (Kabbalo, 1984), farmers turned most of their efforts towards groundnuts production. Along the same line, Jayne et al. (2005) argued that: small farmers in Kenya have been shifting away from staple food production as farm sizes shrink to produce horticulture, dairy, and tree crops, Jayne et al. (2005). He argued that, this shift is due to the low prices received for staple foods and farmers’ desires to increase their returns.

According to the World Bank (1981), and IFAD, (2001), expansion in cash crops should lead to expansion in food crops expansion. There would not be food shortage in the area (Province). As a result of the introduction of cash crops, however, since 1973 up to 2001, the area witnessed more than ten cases of shortage of food (MOANR workshop, 1999). This argument gives rise to a number of important questions among which are: what is the relationship between the quantity supplied of millet and groundnuts and their own prices?; does groundnuts compete with millet in the available resources?; to what extent are peasants market minded or oriented? and if they are market oriented, to what extent this orientation affects their production choice?. These are some of the questions which will be examined in the following sections. With reference to the experience of Eastern Darfur farmers.

The rest of the paper is organized as follows. Section two gives a review of the literature and developing the theoretical
framework. The methodology and data used to analyze the supply response is outlined in section four, while section five discusses the empirical results. Finally, we give a brief conclusion in section six.

2. Literature Review and Theoretical Framework:

2.1. Literature Review:

Crop diversification, and in particular the introduction of cash crops, is seen to be one of the most important rural development policies in that it protects farmers against failure in food crops. Moreover, introduction of cash crops into areas characterized by low farm household income will increase rural incomes and therefore improve the general welfare of rural communities. The World Bank (1981), for example, argues that “cash crops are the only way to get money into the subsistence economy and improve yield of food crops and the countries which have been doing well in cash crop production have also been most successful in expanding food production”.

The classic case is that of the colonial authorities who encouraged the cultivation of cash crops by traditional subsistence farmers; the usual justification being that once the traditional sector is integrated into the wider (or so-called modern sector) economy the prospects of development for the rural population will improve (Abdul-jalil, M. et al., 1986).

However, the literature on Africa and other less developed countries suggests that such a process may prove the opposite. In this regard, (Abdul-jalil, M. et al., 1986) argue that: “The celebrated integration with world markets induces farmers to consume more goods manufactured in capitalist centers. More efforts therefore has to be put into cultivating cash crops in order to maintain a relatively improved standard of living, which often has a detrimental effect on the production of staple crops”
The result then is that food security of farmers soon becomes endangered and they face two options: either reverting to the production of staple crops; or cultivating more cash crops and importing food. Both options are difficult to pursue at such a stage (Abdul-jalil, M. et al., 1986). Accordingly, some writers blame international capitalism for the famous African Sahel famine of (1968 – 1974). Franke&Chasin (1980) argued that “…the evidence from the Sahel famine shows that ecological deterioration and food shortages are not only linked each other but also are structurally related to a specific form of production-international capitalism- and the many secondary effects it produces in even the most marginal and far away environment”.

This approach definitely rejects the argument that explains famine in terms of the so-called ‘tragedy of the commons’ which apart from the misutilization of the environment emphasizes the imbalance between population density and the amount of food production in a given area.

Arguing along the same lines, Van Apeldoorn (1981) explains how the integration of Northern Nigeria into the capitalist economy was responsible for the severity of famine in Hausa land. Purchase of cash crops, imported goods that displaced local crafts, tax collection and monetization of social obligations, all created a good climate for rapid monetization of the traditional economy. As a result, the pressures of the money economy, together with the changes in rights to land and the growing hectares under cash crops lowered the food reserves and threatened to upset the technical balance in the exploitation of the natural environment.

With regard to the Sudan experience, irrespective of the wide difference between regions, the process of commercialization of Sudanese agriculture in the view of most writers has more or less produced the same results on the traditional subsistence economy. Ahmed (1984) argued that:
The progressive commercialization of agriculture in Dar Hamar (Western Kordofan) has provided an engine for capital accumulation and socio-economic differentiation by fostering a social division of labour as well as exposing the majority of small commodity producers to uncertainties of the market. In Dar Hamer this is evident not only from the survival and reproduction of impoverished household commodity producers, but equally from the emergence of a class of affluent peasants and merchant capitalists. By organizing the transports and sale of produce to distant markets, the supply of consumer goods, the provision of credit to enable small commodity producers to overcome the problems associated with fluctuation in income and more significantly, by their willingness to invest in agricultural production, these latter groups are determined to control the conditions of production and exchange with inevitable creation of new types of rural inhabitants based on the increasing immiseration of household producers.

Most of the empirical studies concentrated on the analysis of the supply response of underdeveloped agriculture which focus on the short and long-run response of individual crops to the relative price changes (Binswanger, 1989). Reviews of this literature can be found in Askari and Cummings (1976) Bond (1983) and Binswanger, (1989).

Binswanger (1989) for example found that individual crops respond strongly to price factor – a response that is well known. Reviews by Askari and Cummings (1976) show that, short-run elasticities for individual crops can be high and that they vary depending on the characteristics of the crops or reigns.

Most studies that have examined the price responsiveness of agriculture in different countries have lent support to Manghas (1966) argument that “although the price mechanism played a reasonably efficient role in the resource allocation, its positive role in raising agricultural output has not been confirmed due to
weak response of yield and output growth to a positive price change”. It must be born in mind that farmers react differently to different types of crops, and high supply elasticity for one crop does not necessarily mean that peasants will also react in the same way for all agricultural crops.

For sub-Saharan Africa, the results of the available studies by Bond (1983), Tolley et al (1982) and World Bank (1986) were unsurprising in that the supply elasticities for individual crops are positive and significant.

With regard to the Sudan, a number of studies have been conducted on different cash and food crops, including sorghum, groundnuts, cotton, sesame and millet. Examples of those include the work by Medani (1975), Kaballo (1984), El moula, (1994). Applying the Nerlovian model on data covering the period (1951 – 1965), Medani (1975) found that unlike traditional farmers, the farmers in modern sectors of Sudan are commercially minded and respond strongly to price change. He also found that the short-run elasticity of groundnuts was 0.72 while the long-run elasticity was 1.62.

Using the Nerlovian model, Kaballo (1984) applied regression methods to annual data for the period (1942 – 1977) to estimate supply functions for Sesame and Groundnuts grown in Kordofan region. He found that traditional cultivators of groundnuts responded positively to changes in money prices with a short-run elasticity estimated at 2.8. The short run elasticity of sesame was 2.1. He argued that sesame producers have no money illusion (i.e. they respond to real rather than to nominal price).

Using the Nerlovian model, El moula (1994) applied regression methods to annual data for sorghum, sesame and millet crops covering the period 1970 – 1990, to estimate short and long-run elasticity for each crop. The study reveals that some of individual crops, usually export crops, respond strongly to the price change, while subsistence crops have weak response. The exception here is sesame: although it is considered as a cash
crop, its price elasticity appears to be very low both in the short and the long–run.

This result goes along the same lines of the results reported by Medani, (1975) and Kabbalo, (1984) for different periods.

2.2: Theoretical Framework:

In this section we outline the theoretical framework of the analysis of the supply response of millet and Groundnuts. It is well known that one of the most important problems that face any society is the scarcity of economic resources. Coupled with the problem of scarcity is the problem that the available productive resources are insufficient to produce all the goods and services that satisfy the individual’s ends. Because resources are scarce and have alternative uses, any decision to use them in producing one good or services means that they can not be available for the production of something else. So scarcity and limitation of the total resources capable of producing different commodities necessitates a choice between relatively scarce commodities, Gravelle et al, (1990). The economic cost of choosing one alternative over another is measured by the opportunity cost Gravelle et al, (1990). Specifically, the opportunity cost is the value of the best alternative foregone.

The problem of what to produce and how much to produce is approached in a number of ways, including the formal solution of the problems of profit maximization or revenue maximization. In this respect, the importance of the market signals, represented by the commodity prices cannot be more emphasized. Thus, for two products \(y_1\) and \(y_2\), the problem of revenue maximization may be written more formally as Grew, (1975):

Maximize \( TR = P_1 y_1 + P_2 y_2 \) \hspace{1cm} (1)

\( y_1, y_2 \)

Subject to the resource constraint given by:

\[ R = R(y_1, y_2) \]
Which may be written in the implicit form:

$$G(y_1, y_2, R) = 0$$

(2)

Where :

- $TR$ = total revenue.
- $y_1$ = quantity supplied of product (1)
- $y_2$ = quantity supplied of product (2)
- $R$ = The total available resources
- $P_1$ = The price of product (1)
- $P_2$ = The price of product (2)

Proceeding with the optimization problem involve writing up the Lagrangian:

$$L = P_1 y_1 + P_2 y_2 - \lambda G(y_1, y_2, R)$$

The first order condition is given by :

$$\frac{dL}{dy_1} = P_1 - G_1 (y_1, y_2, R) = 0$$

(3)

$$\frac{dL}{dy_2} = P_2 - \lambda G_2 (y_1, y_2, R) = 0$$

(4)

$$\frac{dL}{d\lambda} = -G(y_1, y_2, R) = 0$$

(5)

from (3) and (4) we have :

$$P_1 = G_1$$

$$P_2 = G_2$$

(6)

which is the optimality condition.

let $P = P_1/P_2$ , and $P_2 = 1$ then equations (3), (4) and (5) can be written as follows:

$$P - \lambda G_1 (y_1, y_2, R) = 0$$

(7)
\[
1 - \lambda G_2 (y_1, y_2, R) = 0 \quad (8)
\]
\[-G(y_1, y_2, R) = 0 \quad (9)
\]

Given \((R)\), totally differentiating \((7); \ (8); \ (9)\) and rearranging yields:

\[\lambda G_{11} dy_1 + \lambda G_{12} dy_2 + G_1 d\lambda = 1\]
\[dP \quad dP \quad dP\]

\[\lambda G_{21} dy_1 + \lambda G_{22} dy_2 + G_2 d\lambda = 0\]
\[dP dP dp\]

\[G_1 dy_1 + G_2 dy_2 = 0\]
\[dP dP\]

which may be written in the following matrix notation:

\[
\begin{pmatrix}
\lambda G_{11} & \lambda G_{12} & G_1 \\
\lambda G_{21} & \lambda G_{22} & G_2 \\
G_1 & G_2 & 0
\end{pmatrix}
\begin{pmatrix}
dy_1/dP \\
dy_2/dP \\
d\lambda/P
\end{pmatrix} =
\begin{pmatrix}
1 \\
0 \\
0
\end{pmatrix}
\]

Using Cramer’s Rule (Mahran H., 1999) we obtain:

\[dy_1 = -G_2 > 0\] \quad (10)

\[dP \Delta\]

\[dy_2 = G_1 G_2 < 0\] \quad (11)

\[dP \Delta\]

where, \(\Delta\) is the determinant of the bordered Hessian matrix given by:
suggesting that:

\[ 0 < \Delta = - \lambda (G_{11}G_{2} - 2G_{1}G_{2} + G_{22}G_{1}) \]

Which is the sufficient condition for maximum revenue and for the concavity of the transformation curve (increasing marginal rate of transformation).

Equations (10) and (11) provide one of the standard predictions of producer theory (Mahran H., 1999). They suggest that as the relative price of one commodity increases, resources will be diverted to the production of that commodity (so that its output is increased) at the expense of the other commodity, the output of which will decrease. Graphically, this is illustrated by a movement along the production possibilities curve given in the diagram below.

Point (D) is the point where the production possibility frontier is tangential to the revenue curve and represents the optimal point of production, where maximum revenue is obtained and resources are fully and efficiently employed (Mahran H., 1999).
The main concern of this paper is to test these predictions of producer theory in the context of farmers producing millet and groundnuts in Eastern Darfur province. For this purpose, the next section outlines the methodology and data used in the analysis.

3. Methodology and Data

In this section we outline the methodology used in the estimation of the supply functions for millet and groundnuts. The focus here is on the price response of each crop. Prices represent incentives to affect resource use and thus shape the process of economic development at large. In general, prices are as powerful signals and policy instruments. Based on the theoretical framework in the previous section, the supply functions of millet and groundnuts are specified as follows:

\[ Q_m = \alpha_m + \beta_m P_t + u_t \]  
(12)

\[ Q_g = \alpha_g + \beta_g P_t + v_t \]  
(13)

Where:

- \( Q_m \) = quantity supplied of millet.
- \( Q_g \) = quantity supplied of groundnuts.
- \( P_t \) = The relative Price, defined as \( (P_m/P_g) \).
- \( \alpha_m \) = intercept of millet supply curve.
- \( \alpha_g \) = intercept of groundnuts supply curve.
- \( \beta_m \) = millet price coefficient.
- \( \beta_g \) = groundnuts price coefficient.
As far as the signs of coefficients are concerned, we expect that the sign of the coefficient $\beta_m$ in equation (12) to be positive suggesting that an increase in the the relative price (whether by the increase in millet price, or a decrease in groundnuts price), would lead to a direct increase in millet supply (i.e. a positive relationship between quantity supplied and relative price ($p_m/p_g$). On the other hand, the sign of the coefficient $\beta_g$ in equation(13) is expected to be negative suggesting that an increase in the relative price ($p_m/p_g$) (either by a decrease in groundnut price or an increase in millet price), will lead to a fall in the supply of groundnuts.

Ordinary least squares (OLS) technique is applied to estimate the supply equation using the linear and non-linear forms.

The evidence used in this study is based on annual data covering the period 1992-2002 obtained from annual reports of Agricultural Planning Unit (APU) of the Ministry of Agriculture North Darfur State. The exception here is Groundnuts price which was obtained from Ellaiet Rural market records (various years).

It is obvious that the period under study might be short. This is attributed to a number of problems. First, while data for millet are available since 1986/87, those for groundnuts are available only for 1992 onwards. Even for data on millet,
production level for 1994/95 has been calculated on the basis of yield per feddan and total harvested area.

For groundnuts prices, we used the average of three months namely, November, January and March of the previous year. The reason is that, the majority of rural farmers sell their products during these months. Also the quantities supplied reach their peak during these months, leaving very few quantities in the hands of local traders. Data on quantities and prices of the two crops were available in different units. Data on groundnut output was available in terms of kuntars. For our purposes, we have transformed this data to conform to the data on millet output, which was available in metric tons. Thus, data on groundnuts price have also been transformed in terms of price per metric ton. Furthermore, data on price of millet was also transformed from price per sack to price per metric ton.

Concerning millet prices, we used the average prices of the three localities of the province, namely, Ellaiet, Taweisha and umm keddada, bearing in mind the considerable variations in millet prices between Umm keddada and the other two local councils. Because Umm keddada council did not produce groundnuts at all, we estimated models for both crops at the province level and the council level (Ellaiet&Taweisha). Tables (1) and (2), report the data used in the estimation of the models.

Table (1)
**Output and Prices of Millet and Groundnuts (Umm keddada Province), (1992-2002)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Millet</th>
<th>Groundnut</th>
<th>Millet price</th>
<th>Groundnut</th>
<th>Relative</th>
</tr>
</thead>
</table>

95
### Table (2)

**Output and Prices of Millet and Groundnuts (Ellaiet and El tewiesha Councils)**

*(1992 – 2002)*

<table>
<thead>
<tr>
<th>Year</th>
<th>Output (in tons)</th>
<th>Output (in tons)</th>
<th>Price (Per ton)</th>
<th>Price (Pm/Pg)</th>
</tr>
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</table>

Source: Ministry of Agriculture North Darfur State, Agricultural Planning Unit (APU) El fasher. Groundnut prices are obtained from Ellaiet Rural Market Records. The relative price is own computation.
<table>
<thead>
<tr>
<th>Year</th>
<th>Millet output (in tons)</th>
<th>Groundnut output (in tons)</th>
<th>Millet price (Per ton)</th>
<th>Groundnut price ( per ton)</th>
<th>Relative price (Pm/Pg)</th>
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<tbody>
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<td>12000</td>
<td>16875</td>
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</table>

Source: Ministry of Agriculture North Darfur State, Agricultural Planning Unit (APU) Elfasher. Groundnut prices are obtained from Ellaiet Rural Market Records.

The relative price is own computation

4. The Empirical Results:
In this section we report the empirical results relating to the supply response of millet and groundnuts to price changes. Applying Ordinary Least Square (OLS) technique to the data covering the period 1992 – 2002, we estimated a linear form of equations (12) and (13) with lagged relative price. These are respectively:

\[ Q_m = 8389.85 + 6282.24 P_{t-1} \]  \hspace{1cm} (14)

\( R^2 = 0.12 \hspace{1cm} F = 1.13 \hspace{1cm} DW = 1.18 \)

\[ Q_g = 32003.73 - 5483.72 P_{t-1} \]  \hspace{1cm} (15)

\( R^2 = 0.06 \hspace{1cm} F = 0.49 \hspace{1cm} DW = 1.24 \)

Where the figures between brackets are the t-rations in absolute values. The F-values indicate the insignificance of the overall models of both crops. Although the coefficients have the right sign, the results are a first indication that the relative price is not important in the allocation of resources between the two crops. The above results revealed that the crops in question responded to their own prices only and not to the relative price. These results stated that the two crops are not competing with each other.

Using the nominal prices of the two crops, the following results are obtained:

\[ Q_m = 2141.94 + 0.03 P_{gt-1} + 0.04 P_{mt-1} \]  \hspace{1cm} (16)

\( R^2 = 0.50 \hspace{1cm} F = 3.46 \hspace{1cm} DW = 2.11 \)
\[ Q_g = 4137.45 + 0.10 P_{gt-1} - 0.01 P_{mt-1} \]  \hspace{1cm} (17)

\[
\begin{array}{ccc}
(0.47) & (2.66) & (-0.41)
\end{array}
\]

\[ R^2 = 0.58 \quad F = 4.81 \quad DW = 2.74 \]

Where the figures between brackets are the t-ratios in absolute values. The model for millet in equation (16) is insignificant and the coefficient of groundnuts price has the wrong sign, while the overall model of groundnuts is significant at 0.05 levels, yet millet price coefficient is insignificant. Unlike for millet model, the expected signs of the price coefficients are obtained for groundnuts model. These results have supported the above results that neither crop responds to the price of the other.

Using the absolute price of each crop, the following results are obtained:

\[ Q_m = 3262.33 + 0.05 P_{mt-1} \]  \hspace{1cm} (18)

\[
\begin{array}{ccc}
(0.49) & (2.75)
\end{array}
\]

\[ R^2 = 0.49 \quad F = 7.53 \quad DW = 2.11 \]

\[ Q_g = 2768.84 + 0.09 P_{gt-1} \]  \hspace{1cm} (19)

\[
\begin{array}{ccc}
(0.36) & (3.25)
\end{array}
\]

\[ R^2 = 0.57 \quad F = 10.54 \quad DW = 2.61 \]

Where the figures between the brackets are the t-ratios in absolute values. The overall model of millet is significant at 0.05 level, with the F-value of (7.53). The value of \( R^2 \) suggests that 49% of the variations in the quantity supplied of millet is explained by the variations in price of millet. It is clear that; millet price is significant as shown by the value of t-ratio (2.75).

With regard to groundnuts, the overall model is also highly significant at 0.01 significance level with the F-value of (10.54). The \( R^2 \) value suggests that 57% of the total variations in groundnuts quantity supplied is explained by the variations in groundnuts price. Moreover, all signs of the coefficients are as
expected for both crops. These results indicate that each crop responds to its own price in the right direction. We may note that other linear and non-linear forms of the supply functions have been estimated at the province and council levels. The results obtained are reported in the appendix.
5. Conclusion:

The present paper examined the response of millet and groundnuts supply grown in Eastern Darfur Province to their relative price. Applying OLS methods to annual data covering the period 1992 – 2002, our results revealed that the relative price is not important in the allocation of resources between the two crops. These results contradict the contention that the two crops compete with each other in the available resources. The results are in line with those reported by Medani (1975), Kaballo (1984) and El-hadi (1995) for different periods. Based on this, it may be argued that the fears that the introduction of cash crops may take place at the expense of food crops in subsistence agriculture has no evidence in the context of Eastern Darfur province.
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