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Economic Analysis of Factors Affecting Crop Production in North Darfur State A Study of Umkdada District

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Abstract: This study shed light on the main constraints of crop production in the traditional rainfed sector in Umkdada district, North Darfur State. The study used descriptive statistics and regression for data analysis. The results of regression analysis revealed that the crops produced in season 2006 were significantly affected by some factors. Millet production was affected by labour, period of cropping and amount of rainfall. The significant factors affecting groundnuts production were the total cultivated area of groundnuts, crop rotation and period of cropping. In order to improve the agricultural production in the study area, the study recommended the supply of the farmers with agricultural inputs especially seeds through repayment in kind after harvesting and support agricultural extension to be more efficient and effective in transferring the recommended improved technologies. Resolution of Darfur security problems in addition to solution of other problems facing agricultural production such as pests, marketing, desertification, drinking water, grazing …etc are also essential.

Key words: Regression, crop production, rain-fed agriculture.

INTRODUCTION

Umkdada district, approximately lies between longitudes 25˚ 45´ and 27˚ 30´ east and latitudes approximately11˚ 45´ and 14˚ north[1]. The area of the district is a bout 23 thousand squire kilometers divided into three localities, Umkdada, in the northern part of the district, Ellait, in the southern part and Twisha between Umkdada, and Ellait, localities.

The study area is one of the important agricultural regions in North Darfur State. It contributes in food production beside cash crops. The agricultural production in Umkdada district suffers from many problems (economical, technological, environmental and social) that hinder its development and success resulting in low yield and low income. These problems are (a) shortage of agricultural credit, agricultural inputs, low farm-income and limited chances of off-farm income [2], (b) limited use of technology as a result of lack of technology and absence of know-how[2], (c) variability of rainfall in amount and distribution within the same year and from year to year (the coefficient of variation (C.V) of rainfall for the years 1977-2006 in Alfashir recorded 34.12[3] and (d) Darfur conflict and its consequences of armed robbery and tribal conflicts that negatively affected agricultural production[2].

The objective of the paper was to specify the main factors affecting crop production in Umkdada district.

Background:

1. Rainfall: The prevailing climate in Umkdada, in the northern part is a desert climate while in the southern part is semi poor savanna climate. Elmangouri[1] stated that Umkdada district, is an arid region whose rainfall is hardly reliable in mount and timing, the onset of wet seasons is a highly variable event as is the duration of wet season, an important agro-climatology parameter. In length, it varies appreciably from year to year. Table (2.2) shows rainfall in some years in the district.

2. Land: The average of holding of sandy soils in Umkdada was about 57.37 feddan per farmer. In the district there are small pockets of the clay soils in wadi runs not of significant importance and the farmers fundamentally depend on the sandy soils.

The average cultivated area in Umkdada, was about 37.8 5feddan per farmer and the farmer on average possessed 2 parcels.

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3. Crops Grown and Productivity: The main crops grown in the area in the agricultural season 2006/07 were millet, groundnuts and watermelon. The cropping pattern of the above mentioned season was different from that in the previous seasons (Table 2), this difference was due to insecurity conditions in the district and decrease in family labour participation (pupils) in the season 2006/07 due to the change in the calendar of basic schools by the State Ministry of Education to start in Autumn (14 June) instead of Summer.

Millet was grown as a food crop occupying most of the area (50%) and the remained area was allocated to groundnuts and water melon as cash crops, Table (2).

The productivity of these crops for the same agricultural season 2006/07 was 0.87(sacks/feddan), 4.14 (sacks/feddan), and zero for millet, groundnuts and melon seeds, respectively. The zero productivity of melon seed was due to pests and diseases in the early stages of plant growth. The average cultivated area of water melon in winter season 2006/07 in Umkdada, was 38.44 feddan per farmer. On other hand, the farmer on the average possessed 7.59 feddan of gum Arabic.

On the other hand, the variations of cultivated area during the agricultural seasons 2000/01-2004/05 were due to late rainfall, variability of crop prices and security problems. While the variability of the crops productivity during the above seasons returned to the pests attack and plants diseases, shortage and variability of rainfall from year to year and within the same year plus security problems.

Methodology: Cross sectional data on socioeconomic characteristics of farmers and inputs and outputs of crops grown in the study area in the agricultural season 2006/07 were collected through personal interview survey of a random sample of 59 farmers.

The specified form of production function to study the behavior and effects of independent variables on the dependent variable in the study area in season2006/07 was a Cobb-Douglas (CD) production function. All the continuous variables in log form (linear logarithmic form) while the dummy variables in the linear form. Most economists are satisfied that CD production function is a suitable function[5]. Shepard *et al*[6] stated that the CD production function is the most common form used in applied studies because it is simple to estimate and is consistent with economic theory of production in agriculture. The general form of CD production function is given as:

$$Yi = \alpha X_{1i}\beta_1 X_{2i}\beta_2 \ldots\ldots X_{ki}\beta_k \exp(Ui) \ldots\ldots\ldots\ldots (1)$$

The major advantage of the power function is the fact that it can be transformed in log-linear function[8] {Http://www.tuta.hut.}. The linear logarithmic form of the model appears as below:

$$\text{Log } Yi = \text{Log } \alpha + \beta_1 \text{ Log } X_{1i} + \beta_2 \text{ Log } X_{2i} + \ldots + \beta_k \text{ Log } X_{ki} + U_i \ldots (2)$$

Yi: is dependent variable (output).

α : is intercept .

$X_1 \ldots\ldots X_k$: are independent variables

$\beta_1,\ldots,\beta_k$: are elasticities to be estimated.

U_i : is random error.

The study depended on ordinary least squares (OLS) method in estimating the model parameters. The OLS estimators possess characteristics of good estimators which are (a) linear, (b) unbiased and (c) best estimator's property. Koutsoyiannis[1] mentioned the importance of OLS methods from them (a) the parameters obtained by OLS have some optimal properties, (b) the computational procedure of OLS is fairly simple as compared with other econometric techniques, and the data requirements are not excessive, and (c) the mechanics of least squares are simple to understand.

Empirical Specification of the Regression Model:

1. The Dependent Variable in the Model: The dependent variable for each model is output in kilogram per feddan of millet and groundnuts.
2. The independent variables in the models (Tables 3 and 4 show the independent variables for millet and groundnut, respectively}.

2.1 The Continuous Variables in the Model:

2.1.1. Rainfall Quantity: Rainfall in the regions of Northern Darfur State varies from year to year and within the same year in the amount and distribution. Rainfall in North Darfur State is frequently low[9].

Rainfall quantity independent variable (mm) is assumed to affect the output of the different crops.

2.1.2. Land Variable: The area under the crop in feddan was chosen as one of regression independent variables that assumed to affect the output of different crops in Umkdada region. According to Elfiel[5], the importance of land comes into two ways, first is that the land differs in fertility and there is a lot of variation in the size of holding between the farmers. Second, the land variable carries the effect of other variables added to the land such as labor and fertilizer …etc.

Table 1: Rainfall (mm) in the years 2000 - 2006: Umkdada district

Station / Year	2000	2001	2002	2003	2004	2005	2006
Allait	547.5	621.5	530	712	368	622	652.5
Tiwisha	196.7	269.2	371.8	568.4	198.4	457.2	476.1
Umkdada	210	102	161.7	308.2	-	155.4	233.7

Source : State Ministry of Agriculture, Animal Wealth and Irrigation, North Darfur State {2000/01-2005/06}[4].

Table 2: Cultivated area (feddan/ household) and crops productivity (sacks/feddan) in the agricultural seasons 2000/01- 2004/05.

Agricultural Season	Millet		Groundnuts		Sorghum		Melon seed		Sesame		Karkdai	
	CA	CP	CA	CP	CA	CP	CA	CP	CA	CP	CA	CP
2000/01	12.00	0.87	3.24	5.81	0.70	1.22	12.44	1.65	0.19	0.50	0.27	2.33
2001/02	12.48	0.23	3.56	7.90	0.33	0.71	0.07	0	0.13	0.22	0.05	0.67
2002/03	12.61	0.68	1.75	4.62	1.22	1.41	7.41	1.33	0.19	0.47	0.57	2.10
2003/04	13.25	0.63	2.99	5.62	0.06	0	0.24	0	0.06	0.49	0.35	1.64
2004/05	5.90	1.11	1.6	4.47	-	-	1.16	1.18	-	-	-	-
Average	8.85	0.70	2.54	5.68	0.46	0.84	4.26	0.83	0.14	0.42	0.31	1.69

Source: State Ministry of Agriculture, Animal Wealth and Irrigation, North Darfur State{2000/01-2004/05}[4]
CA: Cultivated area. CP:Crop productivity
One sack of millet =106 kg One sack of sorghum =100 kg One sack of groundnuts = 47 kg
One sack of melon seed =76 kg One sack of sesame =80 kg One sack of karkdai =27 kg

Table 3: Millet regression equation

Variables	Coefficient	St. error	t. value	Level of sig.
Constant	2.91	1.011	2.880	***
Labour (mandays/feddan)	0.41	0.181	3.333	***
Capital expenses(SDG)	0.21	0.217	1.641	
Rain quantity(mm/year)	-0.27	0.341	-2.252	*
Period of cropping (months)	0.26	0.128	2.148	*
Off-farm income(SDG)	0.13	0.178	1.099	
Security situation	0.15	0.209	1.122	

* Significant at 0.05 level of significance. *** Highly significant.

R squ.	Adj. R squ.	F-sta.	Pro.	Whi. F-sta.	Pro.
0.44	0.37	5.18	0.00	0.72	0.48

Table 4: Groundnuts regression equation.

Variables	Coefficient	St. error	t. value	Level of sig.
Land(feddan)	0.471	0.175	2.377	*
Capital expenses (SDG/feddan)	0.204-	0.375	1.08-	
Labour (mandays/feddan)	0.470	0.159	2.25	*
Rain quantity.(mm/year)	0.111	0.335	0.595	
Period of cropping.(months)	-0.381	0.107	1.963-	*
Agricultural extension	0.243	0.177	1.279	
Dry-spell	0.038	0.109	0.204	
Crop rotation	0.438	0.101	2.39	*

* Significant at 0.05 level of significance.

R squ.	Adj. R squ.	F-sta.	Pro.	Whi.F-sta.	Pro.
0.51	0.30	2.44	0.044	0.96	0.52

2.1.3. Labour Variable The amount of labor input employed (mandays / feddan) is assumed to influence the agricultural production in the area especially at the critical periods (weeding and harvesting).

2.1.4. Capital Expenses: Capital expenses represent the total cash expended in purchase of agricultural inputs such as seeds, fertilizers, tools…etc. Capital is assumed to have an effect on the output.

2.1.5. Period of Cropping: The period of cropping (time between sowing date and harvesting date) in months is expected to influence the crops output since the period of cropping reflects the time of agricultural operations between sowing and harvesting, also, period of cropping reflects the length of rainfall period since some times rainfall starts late and stops early.

2.1.6. Agricultural Credit: Credit facilities (in SDG) help in obtaining the agricultural inputs and labor at the right time[10]. In spite of the importance of credit to the agricultural development there was no formal credit recorded by the farmers in the study area.

2.2. Dummy Variable in the Model:

2.2.1. Off-farm Income: The off-farm income (working in the farm of others, received money from relatives ...etc) is assumed to be an important factor affecting the output of different crops by its investment in agricultural production. Many studies demonstrated the significance of off-farm income on farm product in the developing counties[11]. Also, off-farm income used in the model as a dummy variable since some farmers in the study area did not have off-farm income.

2.2.2. Dry Spell: The irregular distribution of rainfall during the agricultural season is assumed to affect the agricultural production.

2.2.3. Agricultural Extension: Agricultural extension is important to agricultural development, to transfer the information, knowledge, ideas, direction, attitudes and skills[10]. This factor was used as a dummy variable as, farmers received agricultural extension against farmers not receive.

2.2.4. Crop Rotation: Following proper crop rotation returns fertility to the soils. This factor is assumed to affect the agricultural production.

2.2.5. Security: Northern Darfur State suffers from war and conflicts and their secretion i.e. armed robbery. The case of insecurity is assumed to affect negatively crops production. Thus this factor is used as a dummy variable good security situation versus bad security situation.

RESULTS AND DISCUSSION

I. Millet Regression Equation: The mathematical form specified for millet was a log-log form which gives the results presented in Table 3.

R squared of 0.44 and adjusted R squared of 0.37. It observed the R squared was not high. The R-squared could be low because of a high variance of the disturbance term[4]. Time series data generally lead to much higher R-squared than do the sectional data sets. The reason is that in the time series data the units of observations are essentially aggregations whereas cross sectional data are typically based on micro-units where such variation has not been averaged out. There is no such things as good, best, optimal or acceptable R-squared[4] El Feil, has stated that in applied research the R-squared is a summary statistics not a score board.

The model was significant because F-statistics was 5.52 which was significant at 0.01 level of significance.

The results showed no hetroscedasticity problem because White hetroscedasticity test gave F-statistics of 0.72 which was significant (probability of 0.48).

Also, the results showed no multicolinearty because R squared was reasonable and there were relatively significant coefficients.

The significant variables in the model were:

1. The Labour Variable: Labour variable (mandays/feddan) has got a coefficient of 0.41. The coefficient was significantly different from zero at 0.01 level of significance.

The significant result is read as at 0.01 level of significance increasing labour input by 1% would increase millet output by 0.41%. This result is reasonable because in the season 200/07, Umkdada district suffered shortage of labour due to non-participation of pupils during weeding and harvesting and shortage hired labour participation during weeding and harvesting operations and (b) Shortage of hired labour.

2. The Rainfall Quantity Variable: Rainfall quantity is the amount of the annual rainfall (mm) that registered by the different stations in the district in season 2006/07. Rainfall quantity got a coefficient of -0.27 in millet equation which was significantly different from zero at 0.05 level of significance.

The result is read as at 0.05 level of significance increasing the amount of rainfall by 1% would decrease millet output by 0.27%. The result reflected the fact that some times the abundance and continuity of rainfall affected negatively the crop.

3. The Period of Cropping Variable: The period of cropping got a coefficient of 0.26 in millet equation. The coefficient was significant different from zero at 0.05 level of significance. The result is read as at 0.05 level of significance, increasing the period of cropping by 1% would increase millet production by 0.26%.

II. Groundnuts Regression Equation: The model form of groundnuts was in the log –log form for all the continuous variables. The groundnuts regression equation results were presented in Table4.

R squared of 0.51 and adjusted R squared of 0.30. The R squared was not high (discussed before}).

F-statistics of 2.44 which showed that the model was significant at 0.01 level of significance. The results showed no heteroscedsticity problem because white heteroscedasticity test gave F-statistics of 0.96 which was significant{probability of 0.52}.

The results showed no multicolinearity problem in the model.

The significant variables in the model were presented in the following:

1. The Land Variable: Land variable (feddan) got a coefficient of 0.471 in groundnuts equation. The coefficient was significantly different from zero at 0.05 level of significance.

The result is read as increasing groundnuts land by1% would increase groundnuts output by 0.47%.

2. The Labour Variable: Labour variable (mandays/feddan) got a coefficient of 0.47. The coefficient was significantly different from zero at 0.05 level of significance.

The significant result is read as at 0.05 level of significance increasing labour input by 1% would increase groundnuts output by 0.47%.

3. The Period of Cropping Variable: Period of cropping got a coefficient of -0.381. The coefficient was significantly different from zero at 0.05 level of significance. The result is read as at 0.05 level of significance increasing period of cropping by 1% would decrease groundnuts production by0.381% due to security problems.

4. The Crop Rotation Variable: The crop rotation dummy variable got a coefficient of 0.438. The coefficient was significantly different from zero at 0.05 level of significance. The significant result is read as at 0.05 level of significance the crop rotation had a positive impact on groundnuts production.

Conclusion: In order to improve the agricultural production in the area, the study recommended the supply of farmers with agricultural inputs especially seeds through repayment in kind after harvesting and support agricultural extension to be more efficient and effective in transferring the recommended improved technologies. Resolution of Darfur security problems in addition to solution of other problems facing agricultural production such as pests, marketing, desertification, drinking water, grazing …etc are essential.

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