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FABA BEAN (*Vicia faba* L.) PROFITABILITY AND PRODUCTION FUNCTIONS FOR SMALL PRIVATE SCHEMES IN NORTHERN STATE, SUDAN

Abubakr I. S. Elhori*[1], Asma A. A. Mohamed[1], Ala-Aldin S. Mohamed[1] and Awadia A. Hashim.[1]

[1]Department of Agricultural Economics, Faculty of Agricultural Science, University of Dongola, Sudan

*Corresponding author

ABSTRACT

The objective of this study was to analyze the economics of faba bean production in the Nile and the Underground water schemes in the Northern State, Sudan, through examining the socio-economic characteristics of faba bean-producers, investigating faba bean costs, returns and profits and to derive the faba bean's production function in the two mentioned schemes. A multi-stage random sampling technique was used to collect data from 240 respondents by means of questionnaire during the 2013/14 season. Descriptive statistics, gross margin and regression analysis techniques were used to meet the stated objectives. The results revealed that; the majority of faba bean producers in the state were in the active age group, had a big family size and had a low education level. Land rent was the main cost item in the Nile and the Underground schemes contributed substantially to the total costs of 28.74 and 36.78%, respectively. Faba bean farmers used most of their resources inefficiently. Almost all inputs used different significantly from the recommended ones; however they gained profits. The regression analysis exposed that irrigation cost and harvesting cost were the major variables that affecting faba bean production in both of the named schemes. The study suggested strengthening of extension services, increased the access to microfinance to allow farmers use improved seeds and to encourage them to adopt of technical packages.

Keywords: costs of production, productivity, socio-economic characteristics, technical package

1. INTRODUCTION

Faba bean is a significant crop worldwide, ranking fourth important grain pulse after dry beans, dry peas and chick peas. In Sudan faba bean is the most favored legume. It is the main staple

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food and main source of protein for the Sudanese people and plays a significant role in generating income to farmers. The Northern region of Sudan is considered as one of the main supplier of the crop. The production takes place mainly under farming system of small private pump schemes (Abdalla et al, 2015).

The Northern State occupies the distant Northern part of Sudan and lies between latitudes 16-22 Nº and longitudes 20-32 Eº, and lies in the arid and semi -arid zones, where the annual rainfall is less than 100 mm. The total currently cultivated areas in the State is estimated at 199 958 ha, 75% of which is cultivated in winter. Wheat and faba bean cultivated areas are about 43% and 31% on the average of the total winter cultivated area in the State, respectively (NSMA, 2016).

Northern state is characterized by good and suitable weather conditions, vast fertile land, abundant water for irrigation and skilled labor for its production (Elfeil, 1993). The average yield of faba bean in the research station was 4.00 tons/ha (Fagiri, Elrasheed: Director Agricultural Research Corporation Dongola, Norhern Sudan, personal interview (2013)), compared to 2.92 ton/ha and 2.40 ton/ha in the Nile scheme and the Underground scheme respectively. (Abdallah, 2005) and (Elfeil, 1993) attributed the deterioration of crops yields to inefficient allocation of resources. They attributed the farmers' mismanagement of resources to many factors, the most important of them are: high inputs cost especially fuel for irrigation, unavailability of inputs at the right time, and land fragmentation.

The main goal of this study was to evaluate the economics of faba bean production in the Nile irrigated schemes and the Underground irrigated schemes in the Northern State of Sudan. This main goal in the study was fulfilled through the socio-economic characteristics of the farmers; investigating faba bean costs, returns and profits and deriving faba bean's production functions in the two types of schemes.

2. MATERIAL AND METHODS

This study was conducted in the Northern State of Sudan. The State with an area of 35 million ha is administratively divided into seven localities; Halfa, Al-Porgage, East Nile, Dongola, Algolid, Al-Debba and Merawe, each with a number of administrative units. Irrigated agriculture from the River Nile and/or underground water is the main economic activity. There are four types of schemes in the state namely

(a) Private small pump schemes (represented the majority of the State cultivated areas (75%) (NSMAI, 2016)): generally are small in size and used small water pump (3-4 inches diameter) for irrigation, and classified into two types

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1) Nile pump (watering) schemes and

2) Underground pump (watering) schemes

(b) Large pump schemes: groups of people join together to establish big agricultural schemes, to be irrigated by relatively large water pump (>10 inches)

(c) Cooperative schemes: Cooperative farmers societies aim to unite small farms together to benefit from economies of scale

(d) Expansion schemes: These are under direct supervision of Northern State Ministry of Agriculture, Animal resources and Irrigation to produce wheat in upper terrace lands. This study depended mainly on primary data through direct personal interview by a structured questionnaire. The survey was carried out during June and July of the year 2014 using a multi-stage random sampling technique. About 240 farmers were selected representing about 15% of the total farmers of Al-Porgage, East Nile, Dongola and Algolid localities (share the bulk of faba bean cultivated area (70%) of the state (NSMAI, 2016)). The respondents sampled were distributed equally between the two types of private small pump schemes (Nile and Underground). Within each locality numbers of villages were selected randomly and from each village numbers of farmers were randomly selected. Data on farmer's age, educational level, family size, yields, cost of production etc. were collected. In addition, secondary data pertinent to the problem investigated were obtained from relevant sources.

Descriptive statistics, gross margin analysis and Cobb-Douglass production functions were used to meet the objectives of the study. The form of the Cobb-Douglass production function (Heady and Dilon, 1961) is as follows:

$Y=aX1^{b1}X2^{b}\ldots Xn^{bn}e$

Where:

Y=dependent variable, a=intercept, b1-bn= regression coefficients to be estimated, X1-Xn= explanatory variables, e=random disturbance term.

Then the function transformed into linear form (natural logarithm) and variables specified as follows:

$LogY=a+b1logX1+b2logX2+...+bnlogXn+e$

Where:

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a) Nile scheme: Y= revenue (SDG/ha), a=intercept, b1-b3= regression coefficients to be estimated, X1= irrigation cost (SDG/ha), X2=Seed cost (SDG/ha), X3=harvesting cost (SDG/ha), and e=random disturbance term.

b) Underground scheme: Y= revenue (SDG/ha), a=intercept, b1-b3= regression coefficients to be estimated, X1= irrigation cost (SDG/ha), X2=labor cost (SDG/ha), X3=harvesting cost (SDG/ha), and e=random disturbance term.

3. RESULTS AND DISCUSSION

Many aspects pertaining to the production of faba bean in the study area were discussed. These include: socio-economic characteristic of farmers, costs and net returns, and production functions.

3.1. Socio-economic characteristics of faba bean producers in the Northern State

The results revealed that, the majority of producers were in the active age group, highly specialized, and experienced in agricultural activities (more than 10 years), owned their land (67.00%), and had a large family size which helps in farms activities (Table 1). The majorities (85.50%) of the producers had low education level or were illiterate, as presented by the percentage of illiterate (2.50%), informal Islamic schools (1.50%) and basic + secondary formal educational level (81.60%). Low education level of farmers and inaccessibility to the extension services, lead to the adoption of traditional methods of productions these result as confirmed by (Ahmed, 2008) and (Mohamed, 2000). Moreover, 70% of the farmers had no second job this is important in ensure that farmers focus on farm activities; however, a second job helps in facing unexpected farm conditions. The size of agricultural holdings was small, and that may be due to the fact that the available cultivable lands are limited to the narrow area along the river bank limiting the use of machinery in farm cultivation, which may affect crops productivity (Tawfeeq, 1999).

3.2. Costs, revenues and profits of faba bean production

In calculating production costs, the following items were considered: land preparation, agricultural practices, agricultural inputs and land rent and zakat (Table 2). It is clear from Table (2) that the total costs of faba bean production in the Nile and the underground water schemes were relatively high, 9049.98 and 10480.16 SDG/ha, respectively with land rent representing the main cost items in both schemes contributing substantially to the total costs of 28.74 and 36.78%, respectively. The harvesting costs were the second big cost item in the Nile watering scheme contributing significantly to the total cost of 21.85%, while seeds in the Underground

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watering scheme came second with 20.79% out of the total cost. In the third cost item, seeds came third in the Nile watering scheme (20.40%), and harvesting came third in the Underground watering scheme (18.16%).

Table 1: Socio-economic characteristics of the farmers in the Northern State

Items	%	Items	%
Age		Land type	
Less than 20	1.30	Owned	67.00
20-40	39.90	Rented	15.80
40-60	53.80	Governed	17.20
More than 60	5.00	Total	100.00
Total	100.0		
Education level		Family members	
Illiterate	2.50	1-4	20.50
Khalwa	1.50	4-7	42.10
Basics (primary)	46.20	7-9	27. 90
Secondary	35.40	10 and above	9.50
High secondary	14.40	Total	100.00
Total	100.00		
Marital status		Farmers' occupation	
Married	84.20	Farmer only	70.10
Not married	15.80	Merchant	7.90
Total	100.00	Governmental employee	15.80
Size of holding (ha)		Other occupations	6.20
Less than 2	44.20	Total	100.00
2-4	41.30		
4-6	7.00		
6 and above	7.50		

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Total	100.00

Other main cost items in the Nile scheme in descending orders were zakat (8.90%), land preparation (8.89%) and irrigation (6.62%). In the Underground watering scheme, zakat followed by irrigation and land preparation represented 7.73, 6.88 and 6.82% of the total cost respectively. The study shows that, the variation of the total costs and cost items between the Nile and the Underground water schemes can be explained by differences in soil fertility, farm distance from the river bank, availability and cost of inputs in the specific time and place and, of course, the cost of lifting the water irrigation either from Nile or wells. This is true because land rent near river bank is greater than land rent in upper terraces; although the land rent cost in the Underground watering scheme was greater than that of the Nile scheme, this is not surprising because there were considerable areas in lower terrace land watering from wells. Irrigation cost in the Underground scheme was greater than that in the Nile one because lifting water from wells is more expensive than lifting from the river. This result is confirmed by Abdalla (2005) and Elhori and Babiker (2009) in their studies of Agricultural production and the optimum cropping pattern in the Northern State. They mentioned that irrigation is one of the important production factors in the Northern State. On the other hand, almost all farmers in both studied schemes used the resources inefficiently these can be attributed to many reasons, some of them being financial and credit constraints, the unavailability of resources in the appropriate time and also lack of knowledge, and this comfirmed by Elhori et al (2017). The study shows some of these deviations as follows: only 13% of the farmers sowing their crop at recommended date which is from mid October to mid November and that was due to a shortage of credit and labor and the expensive rent of tractor. These results come in line with (Elhori et al, 2013) and (Iqbal et al, 2015) in their study of potato production in the Northern State of Sudan and potato production in Okara district- Pakistan; they mentioned that farmers in the State usually trim down their seed rate and delay their sowing date in order to decrease their costs. Hago (2005) stated that late sowing markedly reduces the faba bean yield potential because flowers and pods abort if flowering is during a period of high temperature, while on the other hand, sowing too early promote disease development.

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Table 2: Percentage distribution of costs, revenues and profits of faba bean production in the Northern state

Cost item	Nile watering scheme		Underground watering scheme	
	Cost (SDG/ha)	%	Cost (SDG/ha)	%
Land preparation:				
Ploughing	409.05	4.50	336.84	3.21
Leveling	374.61	4.13	303.14	2.89
Tagnets and canals	24.04	0.26	75.28	0.72
Agricultural practices:				
Sowing	81.44	0.90	49.28	0.47
Irrigation	600.00	6.62	720.59	6.88
Weeding	206.38	2.27	161.79	1.54
Harvesting	1978.40	21.85	1903.43	18.16
Agricultural inputs:				
Seeds	1846.33	20.40	2178.49	20.79
Fertilizers	0.00	0.00	0.00	0.00
Pesticides	130.17	1.43	86.63	0.83
Land rent and Zakat:				
Land rent	2601.74	28.74	3854.34	36.78
Zakat	806.82	8.90	810.39	7.73
Total production cost (SDG/ha)	9049.98	100.00	10480.16	100.00
Average yield (ton/ha)	2.92		2.40	
Average price (SDG/ton)	6610.21		7828.53	
Average revenue (SDG/ha)	19301.81		18788.47	
Average profit (SDG/ha)	9516.76		8308.31	

One US$ =20 SDG

Regarding seed cultivars, almost all farmers used traditional seed varieties from the previous season(s) rather than using improved seeds. In the Nile scheme the actual seed rate applied was over the recommended dose (0.23 ton/ha) by 10%, whereas, in the Underground scheme seed

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rate was applied less than the recommended by 20%. In fact the contribution of seeds in the total cost might increase substantially if the farmers used certified improved seeds instead of the traditional or mixed varieties, but its negative effect on total yield would be substantial. Dealing with the crop fertilization of the faba bean it fixed nitrogen to the soil because it is a leguminous crop and phosphorous fertilizers were applied as super phosphate with recommendation of 50 kg/ha, and micro nutrients were applied in form of chicken manure or in any other form (Hago, 2005). Actually farmers in both schemes applied zero rate of fertilizers accordingly that would affect negatively the crop yield. This confirms the findings of Elfiel et al. (2001) in their study of wheat, faba bean and sorghum production in the Northern State of Sudan. They found that farmers in the Northern state usually reduced their agricultural inputs to cope with the increasing input prices. And also the findings of Ali et al, (2012) say the same. In their study in Dongola and Al-Debba localities they concluded that, one of the farmers' strategies to avoid risk is by decreasing the amount of fertilizer or perhaps not to use it at all when growing faba bean instead of wheat. Regarding the irrigation numbers, farmers in the study area applied number of irrigations almost equal to the recommended ones (8 watering). The average yields in the Nile scheme and the Underground one were 2.92 ton/ha and 2.40 ton/ha respectively compared to 4.00 ton/ha achieved in Dongola research station. The revenues per hectare of the Nile and the Underground watering schemes were found to be 19301.81 and 18788.47 SDG, respectively. Gross margins analysis revealed that farmers gain good net return (9516.76 and 8308.31 SDG/ha for the Nile and the Underground scheme respectively) and that might push them to continue in the business in the future. The returns per SDG invested which equivalent to SDG/TVC were found to be 2.13 and 1.80 for respective schemes. Indicating the profitability of this business, as each one SDG invested gained a net return of 2.13 and 1.80 SDG.

3.3. Faba bean production functions in the Northern State

Table (3) shows the regression equations for faba bean production in the Nile and the Underground water schemes, the adjusted R^2 of the Cobb-Douglass production function for the Nile scheme and the underground water schemes were 0.63 and 0.72 implying that 63% and 72% of the total variation in faba bean revenues (SDG/ha) are explained by the explanatory variables in the models. The F-statistics which was highly significant (0.000) implying that, the explanatory variables were collectively important in explaining the variation in the dependent variable (faba bean revenue). The results revealed that, the effect of each of the explanatory variables in the Nile scheme (seed costs, irrigation costs, and harvesting costs) were positive and highly significant (0.05, 0.1 and 0.01%). For the Underground scheme; irrigation cost, weeding cost and harvesting cost were positive and highly significant (0.05, 0.01 and 0.01%). This means that a one percent increase of each of the explanatory variables increases faba bean revenues by their corresponding elasticity. This result indicates that farmers in the study area used their inputs

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in inefficient ways. According to the authors' field survey (2014), faba bean production was limited by the shortage and expensiveness of labor especially during sowing, weeding and harvesting practices. Almost all agricultural operations were done manually. Mohamed et al (2013) mentioned that weeds among faba bean is the main problem facing production of the crop in the Northern State because of the low competitive ability of the faba bean during the early stage of its growth and shortage of labor to resist weeds.

4. CONCLUSION

Based on the result obtained the low education level of farmers, inefficient use of resources especially the sowing date, sowing rate and fertilizer; and traditional seeds used were all major direct contributors to the lessening of faba bean yield. Also the cost of seeds, irrigation, weeding and harvesting were the main factors limiting the faba bean revenues. These results suggest strengthening the extension services to improve farmers' technical knowhow, the provisioning of microfinance to use improved seeds, to adopt the technical packages and to enhance the usage of the reasonable technology especially in the operations of sowing, weeding and harvesting.

Table 3: Faba bean production functions in the Northern State

Cost item SDG/ha	Nile schemes				Underground schemes			
	Coe.	T-Value	St. error	Sig.	Coe.	T-Value	St. error	Sig.
Constant	0.92	1.71	0.54	*	0.84	2.20	0.38	*
Seeds	0.36	2.83	0.14	**				
Irrigation	0.24	1.80	0.09	*	0.44	4.18	0.07	**
Weeding					0.36	3.38	0.04	**
Harvesting	0.65	5.11	0.11	***	0.63	5.97	0.11	***
R-square	0.63				0.72			
F-ratio	14.23			***	22.03			***

***=Significant at 0.01 level of significance
**=Significant at 0.05 level of significance
*=Significant at 0.1 level of significance

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