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Research paper

Economics of Wheat (*Triticum spp.*) Production in Dongola Area, Northern State, Sudan

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ABSTRACT

The objective of this study was to analyze the economics of wheat production in the Nile and the Underground water schemes in Dongola area, Sudan, through examining the socio-economic characteristics of wheat-producers, investigating wheat costs, returns and profits and derive wheat's production function in the two mentioned schemes. A multi-stage stratified random sampling technique was used to collect data from 240 respondents by means of questionnaire during 2013/14 season. Descriptive statistics, gross margin and regression analysis techniques were used to meet the stated objectives. Results revealed that; wheat producers in the state used their resources inefficiently. Almost all inputs used were significantly differing from the recommended ones; consequently, farmers gained discouraging profits. There is a great potential for improving farmers productivity/profitability if certain measures are carefully adopted. These measures include improving the technical knowhow of the farmers (strengthening of extension services), access to microfinance and reducing farmers' costs through electrification of agricultural schemes, and removing/reducing taxes.

Keywords: *Cobb-Douglass production function, costs of production, socio-economic characteristics, wheat productivity*

اقتصاديات إنتاج محصول القمح في منطقة دنقلا – الولاية الشمالية – السودان

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هدفت هذه الدراسة إلى تحليل اقتصاديات إنتاج محصول القمح في المشاريع التي تروى من النيل ومن الآبار الجوفية في منطقة دنقلا-الولاية الشمالية–السودان وذلك من خلال تحليل الخصائص الاقتصادية والاجتماعية لمزارعي المحصول وإيجاد التكاليف والعوائد والأرباح ومن ثم إيجاد دالة إنتاج المحصول في كل من المشروعين المذكورين. استخدم أسلوب العينة الطبقية العشوائية المتعددة لجمع البيانات من 240 مستهدف بواسطة استبيان من خلال موسم 2013/14. استخدم الاحصاء الوصفي وهامش العائد وتحليل الانحدار لتحقيق الاهداف الموضوعة. أظهرت النتائج أن مزارعي القمح في الولاية يستخدمون موارد الإنتاج بطريقة غير كفئة. في الغالب كل عوامل الإنتاج استخدمت استخداماً مختلفاً بصورة معنوية عن تلك الموصى بها نتيجة لذلك يكسب المزارعون أرباح غير مشجعة. هنالك إمكانية كبيرة لتحسين الإنتاجية والربحية إذا طبقت بعض المعايير بصورة صحيحة. هذه المعايير تشمل تحسين المعرفة التقنية للمزارعين (تقوية خدمات الإرشاد)، وتسهيل الحصول على التمويل الأصغر وتقليل التكلفة من خلال كهربة المشاريع الزراعية وإزالة أو تقليل الضرائب.

Introduction

Wheat is one of the most important food crops, originating from the levant region of the Near East and Ethiopian Highlands, but the crop is now cultivated worldwide. It almost comes the third most-produced cereal after maize and rice, although sometimes come second after maize. It is grown on about 220 million hectares worldwide, covering more land area than any other crop. Major wheat producing countries include China, India, USA, Russia and France (FAO, 2016).

Domestically, the Gezira scheme produces about 50% of the country's wheat production; the rest is produced in the Northern and Nile States in addition to little areas in Rahad and New Halfa schemes. Production of wheat is insufficient to meet growing needs and imports attempt to cover the deficit because Sudan consumed 2.75 million metric tons of wheat in 2016, and only produced 456000 Tones (MASTAT, 2016). Table (1) shows the fluctuated planted areas and yields which vary significantly due to weather conditions and other factors.

Table 1: Production of wheat in Sudan during the period 2009/10 to 2015/16

Year	Cultivated area (1000 ha)	Yield (ton/ha)	Production (1000 ton)
2009/10	237	1.70	403
2010/11	196	1.50	292
2011/12	187	1.73	323
2012/13	185	1.51	279
2013/14	137	1.77	242
2014/15	237	2.00	473
2015/16	224	2.04	456

Source: Agricultural Statistics Department - Ministry of Agriculture and Forests (2016)

The Northern State occupies the distant Northern part of Sudan and lies between latitudes 16-22 Nº and longitudes 20-32 Eº. It is bordered by Khartoum State in the south, the River Nile State in the east, Republic of Egypt to the north and Libya and north Darfur in the west. The state lies in the arid and semi -arid zones, where the annual rainfall is less than 100 mm. The climate is characterized by distinct seasons where summer extends from April to the end of September. The maximum temperature in summer reaches 45˚C. Winter extends from October to the end of March and it is cold season. The maximum winter temperature is about 30˚C, while the minimum temperature is around 5˚C. The State with an area of 35 million ha is administratively divided into seven localities; Halfa, Dongola (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. 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 37% and 25% on the average of the total winter cultivated area in the State, respectively. About 3.83, 4.10 and 2.58% out of the total cultivated area in the State are grown by spices (cumin, garlic and fenugreek), vegetables and fodder crops, respectively. The total perennials crops area in the State is estimated at 20704 ha, 74% of which is occupied by date palm (NSMA, 2016).

Agricultural production in the State is believed to be constrained by many factors; mainly high inputs cost especially fuel for irrigation water, unavailability of inputs at the right time, and land fragmentation. These constraints resulted in low yields, inefficient allocation of resources and low farmer's income.

The main objectives of this study were to evaluate the economics of wheat production in the Nile irrigated schemes and the underground-water irrigated schemes in Dongola area, Northern State of Sudan, more specifically were to: study the socio-economic characteristics of the farmers; investigate wheat costs, returns and profits and derive wheat's production function in the two types of schemes.

Methodology

Data collection

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 stratified random sampling technique, which is characterized by its time and cost saving. About 240 farmers were selected which represented about 25% of the total farmers in Dongola area (which consists of four localities Al-Porgage, East Nile, Dongola and Algolid), distributed equally between the two types of schemes. Within each locality number of villages were selected randomly and from each village number 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 and resource persons.

Data analysis

Descriptive statistics, gross margin analysis and Cobb-Douglass production functions were used to meet the objectives of the study (Heady and Dilon, 1961 and John and Arthur, 1991). The form of the Cobb-Douglass production function is as follows:

$$Y=aX_1^{b1}X_2^{b2}\ldots Xn^{bn}e$$

Where:

Y=dependent variable, a=intercept, b_1-b_n= regression coefficients to be estimated, X_1-X_n= independent variables, e=random disturbance term.

Then the function transformed into linear form and variables specified as follows:

$$LogY=a+b_1logX_1+b_2logX_2+...+b_nlogX_n+e$$

Where:

Y= revenue (SDG/ha), a=intercept, b_1-b_n= regression coefficients to be estimated, X_1=land preparation cost (SDG/ha), X_2=Seed cost (SDG/ha), X_3=irrigation cost (SDG/ha), X_4=harvesting cost (SDG/ha), e=random disturbance term.

Results and Discussion

Socio-economic characteristics of wheat producers in Dongola area

Results revealed that, the majority of wheat producers in Dongola area, 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 that helps in farms activities (Table 2). Wheat yield in the area was low (2.19 and 2.00 ton/ha) in the Nile and in the underground water schemes, respectively, compared to the productivity in Dongola research station (5.95 tons/ha). The low productivity might be attributed to the fact that, the majority (85.50%) of the producers had low education level or illiterate, as presented by the percentage of illiterate (2.50%), informal Islamic schools (1.50%) and basic+secondary formal educational level (81.60%), poor extension services leading to practices of traditional methods of productions, these results were confirmed by Mohamed (2000) and Ahmed (2008). Moreover, 70% of the farmers had no second job, this is important in making farmers focusing on farm activities, however, the second job helps in facing unexpected farm risks. The size of agricultural holdings is small, and that is 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 affects wheat productivity (Tawfeeq, 1999).

Costs, returns and profits of wheat production in Dongola area

In calculating production costs, the following items were considered: land preparation, agricultural practices and agricultural inputs (Table 3). It is clear from Table (3) that, the total costs of wheat production in the Nile and the underground water schemes were relatively high, 5856.52 and 5700.07 SDG/ha, respectively with land rent, taxes and Zakat representing the main cost items in both schemes contributing substantially to the total costs of 31.70 and 26.75%, respectively. These results coincide with Elhori *et al.* (2013) in their study of potato production in

Dongola area. They found that harvesting costs were the second cost items in both schemes contributing significantly to the total costs of 22.54 and 22.37%, respectively.

Table 2: Socio-economic characteristics of the farmers in Dongla Area

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	2.790
Secondary	35.40	10 and above	9.50
High secondary	14.40		
Total	**100.00**	**Total**	**100.00**
Marital Status:		Farmer's 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
2 and less	44.20	**Total**	**100.00**
2-4	41.30		
4-6	7.00		
Above 6	7.50		
Total	**100.00**		

Other main cost items in the Nile scheme in descending orders were the land preparation (12.30%), irrigation (11.10%), seeds (11.07%) and fertilizer (8.07%). In the underground water scheme, seeds cost item came third (13.8%), followed by irrigation cost (13.66%), fertilizer cost (10.83%) and land preparation cost (10.52%). 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, 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; moreover, lifting water from wells is more expensive than lifting from the river.

Table 3: Costs, (%) returns and profits of wheat production in Dongola area (SDG/ha)

Cost item	Nile scheme		Underground water scheme	
	Cost	**%**	**Cost**	**%**
Land preparation:				
Land plough	377.31	5.82	299.60	5.24
Land leveling	346.74	5.35	235.17	4.13
Ridges and canals	73.40	1.13	65.48	1.15
Total	**797.45**	**12.30**	**600.25**	**10.52**
Agricultural practices				
Sowing	53.74	0.82	32.75	0.57
Irrigation	718.33	11.10	778.50	13.66
Harvesting	1459.21	22.54	1274.93	22.37
Total	**2231.28**	**34.46**	**2086.18**	**36.60**
Agricultural inputs				
Seeds	716.83	11.07	786.67	13.80
Fertilizer	523.33	8.07	617.45	10.83
Pesticide	155.31	2.40	85.00	1.50
Total	**1395.47**	**21.54**	**1489.12**	**26.13**
Land rent, taxes and Zakat	1432.31	31.70	1524.52	26.75
Total production costs	5856.52	100	5700.07	100
Average yield (ton/ha)	2.19		2.00	
Average price (SDG/ton)	3703.00		3516.00	
Average revenue (SDG/ha)	8109.57		7032.00	
Average gross margin (SDG/ha)	2253.05		1331.93	

One US$ =18 SDG

Considering soil fertility, the average quantity of fertilizer applied in the underground water schemes is greater than the quantity applied in the Nile; these results 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. On the other hand, all farmers in both studied schemes used the resources inefficiently, i.e. differ significantly from technical packages that recommended by the research stations, these can be attributed to many reasons, some of them are financial and credit constraints, unavailability of resources in the appropriate time and also lack of knowledge. The study showed some of these deviations as follows: 25% of the farmers sowing their crop earlier compared to the recommended date and 23% of them delayed planting of wheat till December (after the recommended date), most farmers used traditional seed varieties from the previous season(s) rather than using improved seeds, the seed rate applied for both schemes were over the recommended dose by 80%. Fertilizer rate was applied less than the recommended level by 55% and 40% in the Nile and the underground schemes, respectively (Dongola Agricultural Research Station, 2009). 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 inputs prices. Farmers in the study area applied number of irrigations over the recommended by 18%.

The returns/hectare of the Nile and the underground watering schemes were found to be 8109.57 and 7032.00 SDG, respectively. Gross margins analysis revealed that, farmers gain low and discouraging net return 2253.05 and 1331.93 SDG/ha in the Nile and the underground watering schemes, respectively. This is not surprising if we know that farmers in Dongola area sow wheat as a staple food crop.

Wheat production function in Dongola area

Table (4) shows the regression equations for wheat production in the Nile and the underground water schemes, the adjusted (R^{-2}) of the Cobb-Douglass production function for the Nile scheme was 0.82 and 0.92, for the underground water schemes, implying that 82% and 92% of the total variation in wheat revenues (SDG/ha) are explained by the explanatory variables in the models. The F-statistics which was highly significant (0.000) implying that, the independent variables were collectively important in explaining the variation in the dependent variable (wheat revenue). The results revealed that, the effect of each of the independent variables; seed costs, irrigation costs, harvesting costs were positive and highly significant (0.01% and 0.05%).

Table 4: Wheat production function in Dongola area

Cost item (SDG/ha)	Nile schemes			Underground water schemes		
	Coefficient	T-Value	Sig.	Coefficient	T-Value	Sig.
Constant		-2.52	0.019		-9.33	0.362
Land preparation	-2.34	-3.89	0.001	-0.31	-3.20	0.005
Seed	0.89	7.24	0.000	0.80	11.42	0.000
Irrigation				0.31	2.37	0.029
Harvesting	2.68	4.50	.000	0.39	2.72	0.014
R^2	82%			92%		
F-Value	20.98	0.000		54.76	0.000	

This means that a one percent increase of each of the independent variables increases wheat revenues by their corresponding elasticity. The coefficients of land preparation in both schemes were found to be highly significant (0.00%) and (0.01%), respectively, but with negative signs. The negative relationship indicates the over usage of the land preparation cost, especially in the Nile scheme and this result coincides with the results of budget analysis in Table (3).

Conclusion and recommendations:

There is a high potential for improving wheat production and farmers income if certain measures are taken. These measures are; strengthening extension services to improve farmers' technical

knowhow, provision of microfinance and subsidized agricultural inputs to use an improved seeds and to encourage farmers' adoption of the technical packages, electrification of agricultural schemes, and removing/reducing taxes. Thus policies aiming at expanding wheat production in the State (National Program to Produce Wheat) need to consider the achievement of high productivity and lowering the production cost.

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