Socioeconomic Factors Affecting Sorghum Productivity in the Rain-fed Sector of Gadarif State, Sudan

Nuha Saeed Elameen Ahmed[1] and Mutasim M. M. Elrasheed[1,2*]

[1]Department of Agricultural Economics, College of Agricultural Studies, Sudan University of Science and Technology, P.O.Box 71, Shambat, Sudan.
[2]Department of Agribusiness and Consumer Science, Faculty of Agriculture and Food Science, King Faisal University, P.O.Box 400, Al-Ahsa, KSA.

Authors' contributions

This work was carried out in collaboration between both authors. Authors NSEA and MMME designed the study and wrote the protocol. Author NSEA wrote the first draft of the manuscript and managed the literature searches. Author MMME supervised the data collection, supervised the work and edited the manuscript. Authors NSEA and MMME manage the statistical analysis. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

The aim of the study was to determine, analyze and compare the socioeconomic factors affecting sorghum productivity of small-scale farmers (male and female) in the rain-fed sector of Gadarif state, Sudan. Multistage random sampling technique was used to collect data from 175 farmers from three villages, by means of questionnaire, in February 2013. Descriptive statistics, F-statistics and robust regression analysis techniques were used to achieve the stated objectives. Results revealed the existence of substantial differences between male and female socioeconomic characteristics affecting rain-fed sorghum productivity in Gadarif State, with various degrees. Unlike

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Corresponding author: E-mail: mutasimmekki@gmail.com, mutasimmekki@yahoo.com;

male-farmers whom they respond significantly to only three independent factors (age (.015; P=.04), education (.29, P=.002) and marital status (.49, P=0001)); sorghum productivity of female farmers was substantially responded to changes of all studied independent variables: age (-0.03; $P<.01$), education level (-0.05; $p<.001$), marital status (0.36; $P<.001$), family members (0.06; $P<.01$), experience (-0.05; $P<.006$), and off-farm income (0.0001; P,.04). Accordingly, it is very important to take gender difference in consideration in setting any improvement plans for sorghum productivity in the study area.

1. INTRODUCTION

Sorghum is the main staple food crop in Sudan, as the majority of the population (90%) depends exclusively on it as the main source of food [1]. It is also very popular in grazing and building particularly in the rural areas of the country. The crop covered the largest cultivated area and produced under three farming systems of the country; mechanized, traditional rain-fed and irrigated systems, although, the bulk is produced under the rain-fed sub-sector [2]. The contribution of rain-fed subsector to the GDP from sorghum accounts for about 18 percent [2]. Gadarif state, the granary of Sudan, is the main producer of sorghum [2]. More than 75% of the total cultivated area of the state, which estimated at 2.92 – 3.36 million ha, is allotted for sorghum production. Despite the largest area occupied by sorghum in both Sudan and Gadarif State and the economic importance of the crop, the general trends of its productivity per unit land reflects a diminishing pattern, unlike other subsectors (irrigated) which showed a continuous increase. It is yield declined from 700 kg/ha in 1970 - 1980 to 531 Kg/Ha in 1991 - 2000 to 319 Kg/Ha in 2001 - 2010 (2). The sorghum highest ever yields obtained from rain-fed sector of Gadarif state was 1.0 thousand Kg/ha and the corresponding yields from local research stations was 3.1 - 4.1 thousand Kg/ha (Babiker, A.G. June 2013, Agriculture Research Corporation, Sudan, Personal Communication). Accordingly, any constraints affecting sorghum-productivity should be considered as a major problem.

Many researchers attribute the poor productivity of the rain-fed agriculture to the climate variability (frequency and the length of dry spells) [3] and cultural practices [4] which highly related to socioeconomics characteristics of small-scale farmers. The risky situation of rainfall variability forced almost all small-scale farmers, who are poor; to avoid jeopardizing their meager resources [5], thus used the least amount of inputs. To solve this problem, many water harvesting techniques and integrated technical packages has been identified for rain-fed sorghum productivity improvement [4,5], coupled with extensive extension programs. Unfortunately, small-scale farmers, both sex, continue using their semi-mechanized methods (conventional farming) [6], which comprise the use of Wide Level Disk in harrowing (seedbed preparation) and broadcasting (sorghum seeds) coupled with the use of the least possible amount of inputs [5,6]. On the other hand, some organization has changed their extension strategy for improving sorghum productivity in the rain-fed sector of Gadarif State by concerning on the female farmers to play a great role in accepting and transferring knowledge to their families. They change their strategy because female-framers encountered less risk compared with men (cultivate small area) and gained high trust from the financial institutions. Accordingly, it is very important to study socioeconomics characteristics that affects sorghum productivity in the rain-fed area of the country to help decision makers setting specific plans for improvement. This study aimed to determine, analyze and compare the socioeconomic factors of small-scale farmers, both male and female, in the rain-fed sector of Gadarif state, that affect their sorghum-crops productivity.

2. METHODOLOGY

Gadarif State occupied a total area of 75,000 km2, together with Kassala and Red Sea States, comprises the region of East Sudan. The state is located between longitudes 33°30' and 36°30' East, and latitudes 12°40' and 15°46' North. The state, the largest cultivated rain-fed area of the Sudan (2.92-3.36 million ha), is endowed with vast fertile arable agricultural land (6.72 million ha), representing more than 20% of the total cultivated area of the country. The annual sorghum cultivated area in the state is estimated at 50% of the total cultivated rain-fed area of the country. This state was chosen because of it is

strategic location, and the fundamental role it plays in the country food security situation.

Multistage random sampling technique was used to collect data from small-scale farmers located in three villages (Kajara, Janan and Kassab) of the moderate rainfall zone (rainfall 500 – 600 mm/annum) of Gadarif State by means of questionnaire. A relatively large sample size of 175 respondents was collect from the homogenous population of the three villages, in February 2013. Data analysis involved the use of both descriptive and inferential statistic. Robust regression was used to analyze the effect of the socioeconomic factors affecting sorghum productivity in the study area. This method is widely used to remove the effect of outliers [7], [8,9] and reach to reliable results. STATA 10.1 program was used for the analysis. The robust equation can be written as:

$$Y = \propto + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 \qquad (1)$$

Where:

α= intercept

β1 - β7= coefficients to be estimated.

Y=Sorghum yield (Sack/Feddan), 1 sack=90 Kg.

X1=Gender (Male= 1, female=0).

X2=Age (years)

X3=Education (illiterate=1, Islamic education =2, former education=3, university=4)

X4=Marital status (married=1, single=2, divorced=3, widowed=4)

X5=Family member (number of family feeding from the same pot)

X6=Experience (years)

X7=Off-farm income (SDG)

3. RESULTS AND DISCUSSION

Results of the socioeconomics characteristics of the small-scale farmers in the study area revealed that, male farmers supersede female farmers in all studied phenomenon (Table 1). F-test revealed high significant differences between female and male socioeconomic studied characteristics: yield, age, marital status, sorghum area, finance and experience. Results

also revealed substantial difference in sorghum productivity/unit area between the two sex, even though, it is very poor for both of them (female= 288 kg/ha and male= 324 kg/ha; P<0.002). Surely, the farmers returns, even though is relatively high for both types of farmers (females= 5424.37 and male= 7818.61; P<0.81), is considered to be very poor compared with the farmers used the recommended technical packages. The average yield and net returns of adopting the improved packages is more than four times the conventional one [5]. Accordingly, to improve the productivity in the rain-fed sector of Gadarif state strong extension plans must be set, taking gender differences in consideration.

Results of the descriptive statistics also revealed the presence of a significant difference (P<0.05) between the average age of farmers (male= 52.6 and female= 41.5 years); although, the two groups fall within the productive age, thus more willing to adopt innovation [10]. But this facts might not come true as the majority of farmers in study area had low education level [average former education: Male= 8 years and female= 6] or illiterate (Table 2). Age and education level are used as indicators of farmers' level of awareness and their abilities of increasing their income [10] and taking decisions on crop cultivation, marketing, finance, resources allocation, and new agricultural technologies adoption [11]. On the other hand, the average years of farmers experience is very high (female = 11.4 and male = 32.3; P<0.001). High experience in agricultural practices assumed to has significant effects on the output of the agricultural crops. In fact, there is positive relationship between the probability of adoption of new technology such as crop varieties and farmer expertise [12]. In the same vein, [13] argued that the more experience the farmer have with the pesticide the faster will be their adjustment to the price change.

On the other hands, the cost of inputs used in sorghum production is somehow low for both types of farmers (male= 348 and female= 323 SDG/feddan, P<0.64), indicating that farmers do not use the recommended packages of inputs.

However, it is worth mentioning here that, the coefficient of variations for all studied variables are very small indicating consistency for each of female and male group's socio-economic characteristics around their means.

On the other hand, results of the robust regression analysis for both female and male are

presented in Table 3. It is very clear that, while female productivity is substantially and significantly affected by all studied independent factors by various degrees, male productivity is affected only by three independent factors (age, education and marital status).

Table 1. Socioeconomic characters of male and female sorghum farmers in the rain-fed sector of Gadarif State

	Male	C.V.	Female	C.V.	F-value	Sig.
Yield (Kg/feddan)	324	0.52	288	0.34	10.69	0.002
Age (years)	52.61	0.29	41.5	0.27	4.96	0.03
Education	2.74	0.28	2.6	0.30	0.23	0.64
Marital status	1.08	0.25	1.3	0.64	15.76	0.00
Family member	5.26	0.41	4.4	0.47	2.04	0.15
Sorghum area (Feddan)*	11.01	0.73	4.93	0.76	20.41	0.00
Cost of inputs (SDG/Feddan)	348.13	0.29	323.13	0.14	0.22	0.64
Finance	870.26	1.88	129.80	0.88	14.49	0.00
Experience (Years)	32.34	0.50	11.36	0.80	15.23	0.00
Off farm income (SDG)**	2846.72	2.19	1589.55	1.49	1.70	0.29
On-Farm income (SDG/Feddan)	710.12	0.91	5424.37	1.01	0.058	0.8 1

*Source: Field survey 2013; *1 feddan= 0.42 hectare; **1 US$ = 6.1 SDG*

Table 2. Distribution of small-scale farmers (male and female) in the rain-fed sector of Gadarif state according to their marital status and education level

Variable	Male	Female	Total
	%	%	%
Marital status:			
Single	7.9	7.1	7.5
Married	92.1	82.1	87.1
Divorce	0.0	3.6	1.8
Widow	0.0	7.1	3.6
Total	100.0	100.0	100.0
Education level:			
Illiterate	10.5	17.9	14.2
Quranic	13.2	3.6	8.4
Former	68.4	78.6	73.5
University	7.9	0.0	4.0
Total	100.0	100.0	100.0

Table 3. Regression results of the socioeconomic factors of male and female farmers that affect their sorghum productivity in the rain-fed sector of Gadarif State, Sudan

Independent variable	Coefficient	T-value	Coefficient	T-value
	Female		Male	
Intercept	3.33314	7.18***	-7.0E-03	-0.0138
Gender	1.26555	10.19***	1.4E-01	0.8795
Age	-0.0316015	-4.54***	1.5E-02	2.1188**
Education	-0.5461647	-6.15***	2.9E-01	2.9451***
Marital status	0.35554	4.42***	4.5E-01	3.7624***
Family member	-0.0562859	-2.26***	3.9E-02	1.1764
Experience	0.03348	6.63***	5.6E-03	0.9053
Off-farm income	0.00001	2.10**	6.3E-06	0.592
	R^{-2}=0.8694		R^{-2}=0.5374	
	F=10.5***		F=6.3***	

*** $P=<.05$, *** $P<.01$*

The adjusted coefficient of determination (R^{-2}) for female (0.86) revealed the presence of a high degree of association between the female productivity (dependent variable) and all independent variables. This implies that 86.94% of the variation in the female productivity is explained by the variations in the independent variables. The F-statistics of the female farmers (F-test= 10.5., P<0.001) was found to be highly significant, implying that the independent variables were collectively important in explaining the variation in the dependent one.

The coefficients on marital status, farmers experience and off-farm incomes were found to be positive and highly significant (P<0.001) in explaining the variation in the female productivity, indicating that a unit increases of each of these factors increases sorghum productivity by 0.36, 0.03 and 0.00001 units, respectively. Accordingly, provision of well-equipped extension services is essential in the improvement of sorghum productivity. Likewise, it is very important to finance (microfinance) and train farmers on non-farm activities like fabrics for female to improve their income and saving. On the other hand, the coefficient on age, education and family members were found to be highly significant (P<0.001), indicating that a unit increase of each of the independent variables decreases sorghum productivity by 0.03, 0.54 and 0.06 unit, respectively. These results indicate that, high unemployment rate exists in the area as most of the family members works as family-labor in their small farms area. It also indicate that, the more educated the females are the less they dedicated to their agricultural activities, this is also true for the elderly women.

On the other hand results of the robust regression revealed the presence of a reasonable degree of association between male sorghum productivity and three independent variables (R^{-2}=0.54). This implies that 53.74% of the variation in the dependent variable was explained by the variation in the independent ones. The F-statistics (6.3) was found to be highly significant (P<0.001), indicating that the independent variables were collectively important in explaining the variation in the dependent one. Age, education and family members are highly significant (P=0.05) in explaining variation in the dependent variable, indicating that a unit increases of each of the independent variables (age= 0.015, education=0.29 and marital status=0.45) increase sorghum productivity by corresponding amount of elasticity. This result

coincide with the finding of [14,15]. Those authors [14,15] found a positive results between age and rain-fed crops production in western Sudan.

4. CONCLUSION

Results revealed a significant socioeconomic characteristics variation between male and female that affect their sorghum productivity in the rain-fed sector of Gadarif State, Sudan. It also showed, a substantial differences between their respond of sorghum-productivity to these changes. Female farmers significantly respond to changes in all studied factors with varies degrees, but male farmers respond only to three factors: age, education and marital status. In fact, their reactions to changes in age and education level varies: Female-farmers got negative sign but male-farmers got a positive one. Accordingly, to improve the productivity in the rain-fed sector of Gadarif state strong extension plans must be set, taking gender differences in consideration. Likewise, it is very important to finance (microfinance) and train farmers on non-farm activities like fabrics for female to improve their income and saving.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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