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Determinants of Technical Efficiency of Maize/Cowpea Intercropping Among Women Farmers in Gombe State, Nigeria

A. Mustapha[1] and A. Salihu[2]

[1]Department of Agricultural Economics and Extension, Faculty of Agriculture, Bayero University, Kano, Nigeria

[2]Department of Agricultural Economics and Extension services, School of Agriculture and Agricultural Technology, Modibbo Adama University of Technology, Yola, Nigeria

Corresponding Author: A. Mustapha, Department of Agricultural Economics and Extension, Faculty of Agriculture, Bayero University, Kano, Nigeria

Abstract. The study was conducted to examine the determinants of technical efficiency of maize/cowpea intercropping among women farmers in Gombe State, Nigeria. A multistage sampling technique was adopted in selecting 104 respondents. Data were collected using a well-structured questionnaire supplemented with focus group discussion over a period of four months. Data collected were analyzed using descriptive statistics and stochastic frontier production function model. Results from socio-economic variables revealed that majority (61%) of the respondents were between 40-59 years with an average farm size of 1.88 hectares. The result of stochastic frontier production function analysis showed that all the estimated coefficients (farm size, fertilizer, family labour, quantity of agrochemicals, hired labour and quantity of seed used) of the independent variables in the model were positive and significant at either 1% or 5% level with the exception of quantity of agrochemicals used. The results further revealed that household size, educational level, farming experience, access to extensions services and off farm income generation were the major determinants of technical efficiency in the study area. Findings from this research work also revealed that the mean technical efficiency of the farmers was 0.84 indicating that the women farmers are relatively efficient in maize/cowpea intercropping. The study therefore suggests intensive efforts at expanding the present scope of maize/cowpea intercropping, given the estimated technical efficiency for the production system.

Keywords: Women, intercropping, maize, cowpea, technical efficiency.

Introduction

Women constitute more or less than half of many country's population. In most countries however, women contribute much less than men towards the value of recorded production both quantitatively in labour force participation and qualitatively in educational achievement and skilled manpower (Lawanson, 2008). The under-utilization of female in agriculture has obvious implications for economic welfare and growth. Several factors, both economic and non-economic are responsible for this. Traditionally, women are regarded as homemakers, who oversee and coordinate the affairs and activities at home.

Intercropping system is a type of mixed cropping and defined as the agricultural practice of cultivating two or more crops in the same space at the same time (Andrews and Kassam, 1976). Joint cultivation of two or more crops at the same time on the same piece of land within the same year to promote their interaction and also maximizing chances of productivity by avoiding dependence on only one crop is referred to as intercropping (Sullivan, 2003). This is a common practice in Africa, and it is mostly practiced by smallholder famers. The common crop combinations in intercropping systems of this region are cereal-legume, particularly maize-cowpea, maize-soybean, maize-pigeon pea, maize-groundnuts, maize-beans, sorghum-cowpea, millet-groundnuts, and rice-pulses (Ofori and Stern, 1987). In this region, one of the most important reasons for smallholder farmers to intercrop is to minimize measures against total crop failures and to get different produces to take for the family's food and income (Steiner, 1982; Ofori and Stern, 1987; Sullivan, 2003).

In Nigeria, intercropping maize with legumes, particularly cowpea, has gone a long way to improve the already limited fertility profile of many farming plots (Falusi, 1997). The importance of maize and cowpea in bridging the food gap in Nigeria cannot be overemphasized. Every Nigerian consumes cowpea or its related products and the per capita consumption is about 25 kg to 30 kg per annum (Falusi 1997). Cowpea grain is a

good source of protein for human nutrition, while the haulms are valuable source of livestock feed. Additionally, cowpea is regarded as the cheapest source of protein to the poverty ridden populace of Nigeria. Recently, following the interest of international bodies in reducing hunger, poverty and malnutrition, in developing countries, including Nigeria, the prospects for reducing hunger, malnutrition and food insecurity through increase in maize and cowpea productivity is significant (Coulibaly and Lowenberg-Debber 2000). To realize this goal of reducing hunger and malnutrition, the total output of both maize and cowpea must be increased. This can be achieved mainly in two ways. The first being expansion of the area under cultivation. Secondly, the extent to which the farmers are technically efficient, will determine how much of the maize/cowpea produced will be left for general consumption and other uses.

Notable problems of maize/cowpea intercropping includes inappropriate decision on how best to allocate resources, inadequate use of corresponding production inputs and inadequate adoption of improved technologies by farmers. Also farmers might use resources rationally but not at the economic optimal level. In order to realize increased production and efficiency, small-scale farmers in developing countries need to efficiently utilize the limited resources accessed for improved food security and farm income generation. The specific objectives of the study were to:

i. describe the socioeconomic characteristics of the women farmers,
ii. determine the technical efficiency of the respondents; and,
iii. Identify the factors affecting technical efficiency of the respondents.

Methodology

The study was conducted in Gombe State. Gombe State is one of the 36 States of Federal Republic of Nigeria. It is geographically located between latitude 9°30'N and 12°30'N and longitudes 8°45'E and 11°45'E of the Greenwich Meridian. The State is situated in the Sudan Savannah zone with a land area of 20,265sqkm and a population of 2,982,599

people as of 2013 out of which 1,383,925 are females (NPC, 2006) projected using an annual growth rate of 3.2%.

Data collection and sampling technique

Primary data was collected with the aid of a well- structured questionnaire administered by the researcher and well trained enumerators which was supplemented with focus group discussion. A multistage sampling technique was used for the study. In the first stage, three Local Government Areas were purposively selected based on abundance of female maize/cowpea producers. In the second stage, three wards each were purposively chosen based on high concentration of female maize/cowpea farmers from each of the three LGAs selected making a total of nine wards.. The third stage involved the random selection of two villages from each of the selected wards making a total of eighteen villages. In the last stage, a total of 104 respondents (30% of the sampling frame) out of 255 female maize/cowpea producers were randomly selected for the study, however only 97 questionnaires were retrieved and used for the analysis.

Method of data analysis

Data for the study was analyzed using both descriptive and inferential statistics. Frequencies and percentages were used to achieve objective I while stochastic frontier production model was used to achieve objective ii and iii. The model is specified as follows;

$$\text{Ln } y_i = \beta_0 + B_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + V_i - U_i$$

Where,

Y_i=Output of maize/cowpea in kilogramme (kg)

X_1= Farm size devoted to maize/cowpea intercrop production (ha)

X_2= Amount of fertilizer used in maize/cowpea intercrop production (kg)

X_3= Family labour used in maize/cowpea intercrop production (mandays)

X_4= Quantity of Agrochemical used in maize/cowpea intercrop production (litres)

X_5= Hired labour used in maize/cowpea intercrop production (mandays)

X_6= Quantity of Seed used for maize/cowpea intercrop production (kg)

V_i= Random noise

U_i= Technical inefficiency effect which is assumed to be independent of V_i

Where u_i is a function of socioeconomic variables which is specified as follows;

$$U_i = \sigma_1 Z_1 + \sigma_2 Z_2 + \sigma_3 Z_3 + \sigma_4 Z_4 + \sigma_5 Z_5 + \sigma_6 Z_6 + \sigma_7 Z_7 + \sigma_8 Z_8$$

Where,

U_i= Technical inefficiency effects

Z_1= Age (years)

Z_2= Household size (numbers)

Z_3= level of education in years

Z_4= years of farming experience

Z_5= Status of respondents in the household (House head=1, 0 otherwise)

Z_6= Access to extension services (yes=1, 0 otherwise)

Z_7= off farm income (off farm income=1, 0 otherwise)

Z_8= Access to credit (yes=1, 0 otherwise)

σ_1 to σ_8= Unknown scalar parameters to be estimated

Result and discussions

Socio economic characteristics of women farmers

The result of the study as shown in Table 1 indicated that majority (61%) of the women farmers were between the ages of 40-59 years. The result also shows that mean age was 42years. This implies that the production of food and other farming activities were in the hands of the ageing population. Previous studies have indicated similar trend in the age of practicing farmers in Nigeria (Gbadegsin et al 2002, Abdulfatah, 2012). This can limit uptake of improved technologies (Conroy 2003) and militate against the national objective of attaining self-sufficiency in food production.

The result of the study further revealed that majority (77.3%) of the respondents were married, 21.6% widowed while only about 1% were divorced. Marriage may suggest a

great influence on the production performance of these farmers because majority of them are responsible for their family's upkeep which includes the provision of adequate quality and quantity of food. This result is in conformity with the findings of Segun and Bamire (2010), who reported that majority of female maize/cowpea intercrop producers in Oyo state were married.

The result of the study also showed that 35.1% of the respondents have household size between 3-6, 44.3% had between 7-10 people, 10.3% had between 11-14 people and 8.2% had between 15-18 people while only 2.1%% have household between 19-22 people. The average household size is 8 persons which is in line with African tradition of large family size and the average family size in Nigeria is 5 persons. The major reason why farmers keep large family members is for the provision of farm labour during peak production periods (Tijjani 2006). Thus, the larger the family size, the more labour is available for farming operations.

Majority (62.8%) of the respondents devoted between 1.5-2.4 hectares of their total farm holdings to maize/cowpea intercrop production while 4.1% devoted 2.5-2.9 hectares. This implies that most of them cultivated maize/cowpea on a small scale basis. This may be explained as a result of the vicious cycle of poverty in the rural areas of Nigeria. A situation where farmers are poor and can only afford to operate on small portion and obtain small output that could neither satisfy consumption nor surplus for sale and expansion of his farm (Ogundari and Ojo, 2007). This result is in conformity with the work of Ajibefun and Abdulkadir, (1999) who reported that majority of farmers in Ondo state cultivate less than 2.5 hectares of land.

Status of a respondent in the household is important in determining the types of crops to be grown and who does what in the farm (Lawanson 2008). The result in Table 1 showed that majority (77.3%) of the women farmers in the study area were non-household heads while only 22.7% were household heads. Status of respondents in the household has a great influence on decision making because only household heads

make key decisions regarding family matters and production operations in the farm (Damisa, et al 2007). Since majority of the women farmers are non-household heads, this implies they do not have the ability to take major decisions regarding production activities and types of crops to be grown on their farmlands which might affect their productivity.

Technical efficiency estimates of the women farmers

The frequency distribution of efficiency estimates obtained from the stochastic frontier production model as shown in Table 2 revealed that 76.4% of the farmers operated above a technical efficiency level of 0.8. The mean technical efficiency of the farmers is 0.84. This signifies that the respondents are highly technically efficient although their observed output is 16% less than the maximum output. This implies that farmers output can be increased by 16% through improved resource allocation with no additional cost. This agrees with the findings of Taru *et al* (2011) who reported a mean technical efficiency of 0.89 among sole cowpea producers in Adamawa State, Nigeria.

Factors affecting technical efficiency of the women farmers

Result in Table 3 revealed that all the coefficients of the physical variables in the model have expected prior signs. The model reveals that all the estimated coefficients of the variables of the stochastic frontier production function were positive, this implies that as each of these variables are increased, maize/cowpea output will also increase. Family labour was found to be significant at 1% level of probability, while farm size, fertilizer, hired labour and quantity of seed used were statistically significant at 5% level of probability. However, quantity of agrochemical used though positively related to output was not significant. Farm size has the highest coefficient with a value of 0.3552 and by implication the farm size used existed as the most important input that impact on maize/cowpea intercrop output of the women farmers. This agrees with the findings of Abdulfatah (2012) and Ogundari and Ojo (2007) who reported a similar result. The result of the inefficiency model also shows that the coefficients for age, status of

respondents in the household and access to credit were not statistically significant. This implies that these characteristics do not contribute to technical inefficiency. The coefficient for education, household size, access to extension services and off farm income were negative and statistically significant at 5%. This implies that these variables increase technical efficiencies of the respondents. Also the coefficient for farming experience is negative and statistically significant at 1% meaning that farmers tend to decrease their technical inefficiencies as they become more experienced. This may be due to good managerial skills that they have learnt over time. Hence level of education, household size, access to extension services, off-farm income and farming experience were the major determinants of technical efficiency among the women farmers. This is consistent with the findings of Khairo and Battese (2005).

The result of the study further reveals that the estimate of sigma squared (0.4449) is relatively large and statistically significant at 1% level of probability. This indicates a good fit of the model and the correctness of the specified distributional assumption of the composite error term. This result is consistent with the findings of Xu and Jeffrey (1995) who reported a positive and significant sigma square value among rice producers in Canada. The estimated gamma (γ) parameter is 0.77 which can be interpreted to mean that the differences between actual (observed) and frontier output are dominated by technical efficiency. The result suggests that 77% of the variation in output among the women farmers in the study area is due to differences in their technical efficiencies. The result is consistent with the findings of Ajibefun *et al* (2002) who reported a similar result among small holder food crop farmers in Ondo state, Nigeria.

Conclusion and Recommendations

The study has shown that majority of the women farmers were non-household heads which implies that they do not have the ability to take major decisions regarding production activities and types of crops to be grown on their farmlands which might

affect their productivity. It is evident from the study that maize/cowpea women farmers are highly efficient in their production. Level of education, household size, access to extension services, off farm income and farming experience were the major determinants of technical efficiency in the study area. Given the higher estimates of technical efficiency, the study recommends intensive effort at expanding the present scope of maize/cowpea intercropping. More land should be put into maize/cowpea cultivation to improve the efficiency at which women farmers operate.

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Table 1: Socioeconomic characteristics of women farmers (n=97)

Variables	Frequency	Percentage
Age(yrs)		
20-29	2	2.1
30-39	30	30.9
40-49	44	45.4
50-59	17	17.5
60-69	4	4.1
Mean =	42.40	
Marital status		
Married	75	77.3
Divorced	1	1.0
Widowed	21	21.7
Household Size		
3-6	34	35.1
7-10	43	44.3
11-14	10	10.3
15-18	8	8.2
19-22	2	2.1
Mean =	8	
Farm size(ha)		
1.0-1.4	18	18.6
1.5-1.9	20	20.5
2.0-2.4	41	42.3
2.5-2.9	4	4.1
3.0-3.4	14	14.4
Mean =	1.88	
Status of respondents in the household		
Household head	22	22.7
Non- household head	75	77.3
Total	**97**	**100**

Source: Field survey, 2013.

Table 2: Technical efficiency estimates of the women farmers

Efficiency level	Technical efficiency	
	Frequency	**Percentage**
0.30 – 0.39	-	-
0.40 – 0.49	3	3.1
0.50 – 0.59	4	4.1
0.60 – 0.69	8	8.2
0.70 – 0.79	8	8.2
0.80 – 0.89	35	36.2
0.90 – 0.99	39	40.2
Mean= 0.84		
Total %	**97**	**100**

Source: Field survey, 2013.

Table 3: Maximum likelihood estimates of parameters of the stochastic frontier production function.

Variables	Parameters	Coefficients	t-ratio
Constant	β_0	0.2046***	6.138
Farm size	β_1	0.3552**	2.466
Fertilizer	β_2	0.2620**	2.249
Family labour	β_3	0.1212***	2.859
Agrochemical	β_4	0.1099NS	0.1154
Hired labour	β_5	0.1728**	2.167
Seed	β_6	0.1896**	2.056
Inefficiency model			
Age	δ_1	-0.6804NS	-0.8592
Household size	δ_2	-0.1182**	-2.433
Educational level	δ_3	-0.8653**	-2.063
Farming experience	δ_4	-0.1062**	-3.331
Status of the respondent in the household	δ_5	-0.5486NS	-0.3604
Access to extension services	δ_6	-0.1793**	-2.227
Off-farm income	δ_7	-0.3432**	-2.419
Access to credit	δ_8	-0.5551NS	-0.2882
Sigma squared	δ^2	0.4449***	7.041
Gamma	Γ	0.77***	9.318
Elasticity of production		1.42	

Source: Field survey 2013. ***Significant at 1% ** Significant at 5% NS Not Significant