Efficiency Analysis of Rice Farmers in the Upper East Region of Ghana

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Abstract
This paper examines the efficiency of two rice producer groups in Kassena–Nankana Municipality, the upper east region of Ghana. The first farmer group practices irrigation, and the second one engages in rain fed agriculture. Normally, Ghanaian farmers do not irrigate crops. The group received NGO support to build water reservoirs for irrigating community's farms. This research applied the Total Factor Productivity methodology to examine the level of efficiency between these two groups in the 2015-2016 cropping season. Regression analysis was used to establish the relationship between farmers' production and their inputs. Other social variables such as age, education, access to extension officers and years of farming experience were also compared with farmers' production to know their level of significance. The multi-stage sampling procedure was used to obtain 150 small-holder farmers. The mean efficiency estimate for farms under irrigation was 63% while that of rain fed was 36%. The results give evidence of inefficiency in rice production among rain fed farms. This implies that on average, irrigation farmers could reduce their farm inputs by 37% and still produce the current level of output. The factors that influenced farmers' efficiency were land size, labor, age, education and years of farming experience. Rice production could improve if younger farmers learn from the knowledge of experienced farmers.

Keywords: Total Factor Productivity, Efficiency, Rice Production, Kassena–Nankana Municipality, Ghana

1. Introduction

Rice is one of the main staple foods in the upper east region of Ghana. This region is among the major producers of rice in the country, but has experienced a decline in the production of rice from 2008 to 2013 (Ministry of Food and Agriculture, 2014). This declining trend poses a threat to food security in the country. As one of major causes, local farmers in this region emphasized more frequent flooding incidences because of the upper river spillage from Bagre Dam in neighboring Burkina Faso. Although this spillage occurs annually, these farmers appeared to be convinced about this reason.

As an agricultural extension officer, Kofi Kyei investigated this area, but all flooded areas did not appear to be negatively affected. In fact, rice production in the northern and the upper west regions have increased. We then considered the scenario in which the Bagre Dam spillage might not be the major cause of the rice production decline. This paper, therefore, examines the causes of rice production decline in the upper east region.

2. Study Area

According to the 2010 Ghana population and housing census, Kassena-Nankana Municipality had the total population of 109,944, representing 10.5 percent of the upper east region. Males constitute about 49 percent. About 73 percent of them live in rural areas (Ghana Statistical Service, 2014). The municipality had about 19,790 households. The average household size in the municipality was 5.4 persons per household. Children constituted about 45 percent.

This study area is predominantly agricultural region. In 2010, about 83 percent was engaged in agriculture. In rural areas, 93.1 percent of households practiced agriculture whereas in urban areas, about 57 percent engaged in agriculture. More than 96 percent of these households were crop farmers who typically combined it with poultry (chicken) farming (Ghana Statistical Service, 2014). According to the 2017 Ghana agricultural productivity survey report, the upper east region had 109,905 rice farmers, of which more than 9,000 were in Kassena-Nankana Municipality (Ministry of Food and Agriculture, 2017).

3. Methodology

3.1. Samples

In order to better understand various conditions rice farmers faced in the upper east region, we collected the data through interviews and questionnaire surveys from practicing smallholder rice farmers in five communities of Kassena–Nankana Municipality. The multi-stage sampling procedure was used in selecting these five communities. In May and June 2016, we interviewed 75 smallholder rice farmers who had practiced irrigation agriculture to obtain input and output data for the 2015-2016 cropping season. In order to compare the efficiency and productivity of these farmers, we collected another group of 75 smallholder rice farmers who had engaged in rain fed rice farming at five communities. These five communities are Yogbania, Korania, Biu, Gaani and Bonia.

3.2. Total Factor Productivity

To determine the efficiencies of the two farmer groups, this study used the Total Factor Productivity (TFP) model. The Total Factor Productivity measures the extent to which farm inputs of production is efficiently used. Efficiency is determined by the ratio of useful aggregate output to aggregate inputs of production. The Total Factor Productivity model is given as $A = Y/X$. A is the total factor productivity or efficiency of the individual farmer. Y is aggregate output and X is the aggregate input of production. The aggregate output means the cost of a bag of rice by the total number of rice bags produced after harvest. Aggregate input means the total cost of seeds multiplied by the total cost of fertilizer and the total cost of labor.

3.3. Regression Analysis

The study then carried out a regression analysis to establish the relationship between farmers' production and their inputs. This helps determine how significant the inputs of production were on farmers production. Other social characteristics such as age, education, years of farming experience were also compared with the production to determine the level of significance.

4. Results and Discussion

4.1. Farmers Social Characteristics

Table 1 shows farmers' social characteristics in the study area. The average mean ages for both rain fed, and irrigation farmers were forty-seven and forty-eight years old. The average household size in the study area was ten persons, of which four were children. Most farmers were educated up to the junior high school level. Both farmer groups had limited access to extension service officers for the 2015-2016 cropping season. On average, farms in the study area received extension services for only twice in the year. Both farmer groups used three to four acres of land for rice cultivation. This means that most farmers engaged in rice farming for subsistence rather than business.

Farmers	Irrigation		Rain fed	
	Mean	S. D[1].	Mean	S. D.
Age	48	10.96	47	11.05
Land Size (acre)	4	2.08	3	2.23
Years of Land use	15	8.13	13	7.77
Household Size	10	5.56	10	6.22
Number of Children in Household	4	2.71	4	2.47
Household members engaged in farming	5	2.34	6	2.83
Number of hired labor engaged in farming	9	4.83	7	3.52
Years of Schooling	7	4.82	7	4.7
Extension service contact (number of times a year)	2	1.08	2	1.01

Table 1: Descriptive Statistics of Farmers Social Characteristics

Table 2 shows the quantity of rice produced by gender for the 2015-2016 cropping season. Male irrigation farmers produced 3,320 bags or 332,000 kg of rice whereas their female counterparts produced 658 bags or 65,800 kg of rice. At rain fed farms, males produced 2,458 bags or 245,800 kg of rice and females produced 897 bags or 89,700 kg of rice.

Female farmers in the study area could not increase their production due to insufficient labor force and lack of land access. Farm sizes were greatly influenced by the traditional land tenure system. Most of these lands were owned by men. Those women who owned the land had either inherited or received it as a gift from their husbands. Most land owners preferred to sell their lands to men. Customarily men can pay laborers, but woman cannot. Women also had limited time to spend in the farms due to their household chores and childcare responsibilities.

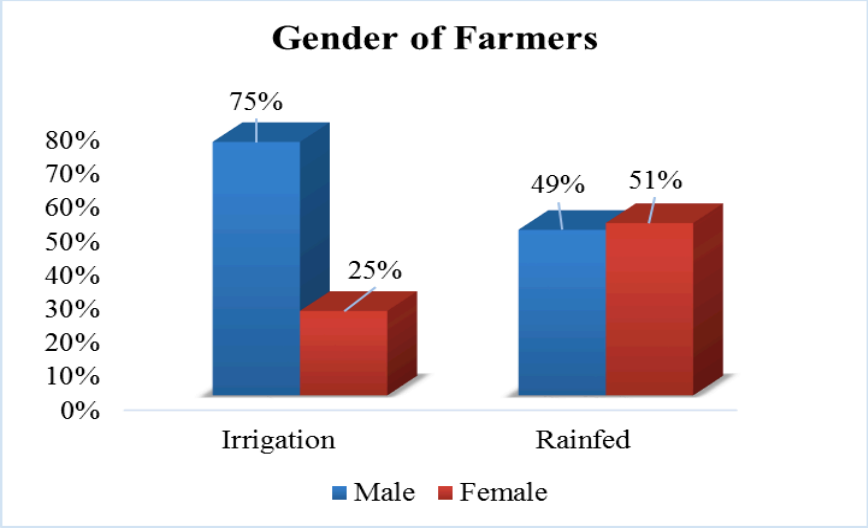

Figure 1: Gender of Farmers

[1] S.D. means Standard Deviation

Farmer	Male	Female	Total
Irrigation	332,000 kg	65,800 kg	397,800 kg
Rain fed	245,800 kg	89,700 kg	335,500 kg

Table 2: Quantity (Kg) of Rice Produced by Gender

4.2 Efficiency of Farmers

Table 3 shows that the mean efficiency estimate for the irrigation farms was 63% whereas that of rain fed ones was 37%. Irrigation farmers had higher efficiency because they received support from a non–governmental organization. Otherwise, irrigation in Ghana is very challenging largely because of inhibiting costs to establish and maintain the irrigation system.

Although these irrigation farmers produced more than rain fed farmers, this does not always mean that irrigation farmers receive more profits. As part of the agreement to receive irrigation support, these farmers must sell their products to this NGO association after every harvest. The association determines the price of rice by bag. Apart from building water reservoirs for farmers to do irrigation, the association supplies member farmers with seeds and fertilizers at a reduced cost. It also gives loans to their farmers at a lower interest rate with flexible payment plan.

Farmer	Efficiency
Irrigation	63%
Rain fed	37%

Table 3: Farmers Efficiency in Kassena–Nankana Municipality

4.3 Determinants of Rice Output

Table 4 shows the result of the regression analysis of farmers' input variables on production. It indicates that land and labor significantly affected the efficiency of the farmers. In particular, land (R squared = 0.764, Correlation = 0.874 and P value < 0.05) has the highest significance in determining the output of farms, followed by labor (R squared = 0.381, Correlation = 0.617 and P value < 0.05). This implies that relatively larger farms with more hired laborers were more efficient than those with smaller ones with less labor forces. The amount of applied fertilizer (R squared = 0.001, Correlation = 0.0316 and P value > 0.05) does not appear to have a significant impact on farmers' production.

Variable	R Squared	Correlation	P-Value
Land	0.764	0.874	1.13E-36
Labor	0.381	0.617	9.11E-06
Fertilizer	0.001	0.0316	0.915457

Table 4: Farm Input Variables of Farmers on Production

Table 5 shows the result of the regression analysis on farmers' social variables concerning production. It indicates that age, education and years of farming experience had a positive relationship with farmers' output at 5% level of significance. Though these three social variables are not very strong statistically, they did influence the output. The implication is that more experienced farmers tend to be more efficient than those with less experience. This suggests that rice production efficiency in Kassena-Nankana Municipality could increase if younger farmers learn from experienced farmers. On the other hand, the number of times extension officers visit farms did not appear to have any positive effect on the output. Government agents from its agricultural extension service work under the Ministry of Food and Agriculture to provide new knowledge of agricultural practices to farmers. This result is contrary to the recent study published in *Science*, in which researchers found the good co-relation between personal initiative training and increase in profits (Campos et al., 2017).

Variable	R Squared	Correlation	P-Value
Age	0.063	0.2529	0.000724437
Years of Farming Experience	0.009	0.095	0.037858166
Extension Service Contact	0.023	0.152	0.185035421
Education	0.010	0.1	2.55E-20

Table 5: Social Variables of Farmers on Production

Table 6 shows the equations to assess various variables on farmers' rice production to be used for the regression model. It shows that an increase in the size of land, laborers and education raise the productivity of the average farmer, thereby increasing efficiency. Although an increase in the amount of fertilizer applied decreases the productivity of the farmer, older farmers with more years of farming experience tends to maximize their productivity.

Variable (X)	Equation
Land	$Y = 11.36X + 8.621$
Labor	$Y = 4.044X + 16.28$
Fertilizer	$Y = -3.047X + 52.31$
Age	$Y = 0.640X + 18.43$
Farming Experience	$Y= 0.300X + 43.20$
Education	$Y = 0.599X + 44.59$
Extension service contact	$Y = 4.057X + 41.63$

Table 6: Regression Model Equations of Variables on Farmers' Production

5. Conclusion

This paper has analyzed the efficiency of two groups of rice producers in Kassena-Nankana Municipality. The estimated mean efficiency for farms under irrigation was 63% while that of rain fed was 36%. This implies that irrigation farmers could reduce their farm inputs by 37% and still come out with the same level of production. The regression analysis indicates that land size, age, labor, education and years of farming experience significantly influenced the efficiency of rice production.

There is the need for the Ghana government to invest in rural agricultural education. Even though extension service personnel did not appear to be helpful in increasing production so far, extension service has a good potential to help farmers by using its good networks with farmers. For example, the personnel can connect experienced farmers to younger farmers so that more young farmers can succeed and increase their productivity. Also, to increase productivity among women farmers, further policies are needed to strengthen women's land rights, childcare facilities and education opportunities.

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