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## Factors Affecting the Adoption and use of NERICA Varieties among Rice Producing Households in Ghana

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### Abstract

This paper uses cross sectional data which were collected from 200 smallholder rice producers in Ghana, to examine the factors influencing the adoption and extent of use of NERICA rice varieties in Ghana. About 57.93 per cent of the sampled rice producers allocated 35.77 per cent of their land to NERICA accounting for about 33.13 per cent of seeds planted. The Tobit regression model suggests fertilizer use, existence of other complementary projects in the area, proportion of active persons in household, access to alternative income sources, distance to seed source and education as key factors influencing the quantity of seeds planted as well as the proportion of land allocated to the NERICA varieties. With the exception of distance to seed source, all the other factors positively influenced the extents of adoption. The findings suggest the need to ensure availability of NERICA seeds within acceptable distances to farming communities. This could be achieved through identification of certified rice seed growers in strategic locations throughout the country and supported with necessary logistics to produce NERICA seeds at reasonable proximities to rice producing communities. This could also be enhanced through establishment of linkages with existing institutions and projects to compliment promotional efforts.

**Keywords:** Intensity of adoption, NERICA varieties, rice, Tobit model

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## Introduction

Rice is important to Ghana's economy and agriculture, accounting for nearly 15% of the agricultural Gross Domestic Product (GDP) (ISSER, 2010). The rice sector is an important provider of rural employment. Undoubtedly, rice is an important Ghanaian staple; its availability throughout the year is of greater importance.

Besides being an important food staple for both rural and urban communities across Ghana, it is the most important cash crop in the communities in which it is produced (Asumming –Brempong and Osei-Asare, 2007).

Despite the importance of rice in the Ghanaian economy, it has been very difficult for the country to achieve self-sufficiency in rice production over the years. As at 2009, rice was the only domestic food that had deficit in supply. Between 2010 and 2015 for instance, rice demand was projected to grow at an annual rate of 11.8 percent (ISSER, 2010).

Self-sufficiency could be achieved through area expansion or increased output per unit area. However, issues including, lack of improved seeds, land tenure, water control systems and poor soil fertility, which consequently, lead to low yields and profitability have been the major constraints in the Ghanaian rice industry (Kranjac-berisavljevic, 2000).

In response to the increasing importance of rice in Ghana in terms of food security and incomes of farmers, governments have in the past years increased attention and support to the rice industry.

These include the implementation of a number of rice development projects such as the Lowland Rice Development project, the Gatsby Rice Project, the Inland Valley Rice Development Project, the Fertilizer Subsidy Program, the Block Farm Project and the Multi-national NERICA Rice Dissemination Project (MNRDP) (METASIP, 2010). Implemented since 2005, the MNRDP involved a number of

rice development and improvement activities including, the distribution of improved seeds of NERICA rice varieties among selected small scale rice producing households in Ghana.

Although many varieties of rice have been developed, adoption rates have generally been low (Efisue *et al.*, 2008). Consequently, most of these farmers continue to use low-yielding rice varieties in addition to poor agronomic practices (Agyei-Holmes *et al.*, 2011).

Adoption of improved rice varieties may differ depending upon the concerns of the farmers, which are defined by the attributes of the variety. Farmers assess a new technology such as crop variety, in terms of a range of attributes, such as grain quality, early maturity, input requirements in addition to grain yield (Joshi and Bauer, 2006).

Existing literature on Ghana have revealed that adoption decisions in the country are largely influenced by socioeconomic, institutional and technical factors. Specific conditions such as poor access to credit, high cost of inputs and the existing land tenure arrangements serve as constraints to effective adoption of agricultural technologies.

In these studies adoption was computed as a binary variable where a person is assigned a value of 1 for adoption and 0 for non-adoption.

These studies have mostly applied Probit regression models to estimate the determinants of adoption (Akudugu *et al.*, 2012; Aneani *et al.*, 2012; Asuming-Brempong *et al.*, 2011; Donkoh *et al.*, 2011; Wiredu *et al.*, 2011 and Adeoti, 2009). The literature on intensity of adoption of these interventions in Ghana is however limited.

Information on these factors will also be useful in promoting improved agricultural interventions. In addition, to address the instantaneous decision to adopt an improved agricultural technology and the extent of adoption, some studies have applied Tobit regression models (Wiredu *et al.*, 2012; Katungi

and Akankwasa, 2010; Kavia *et al.*, 2007; Acheampong, 2002; Adejobi and Kormawa, 2002; Mussei *et al.*, 2001; and Degu *et al.*, 2000).

This study applied the Tobit regression model to estimate the determinants of intensity of adoption of the NERICA rice seeds by the households. Factors hypothesized to be influenced by policy and development partners to improve adoption and use of improved agricultural technologies were identified.

Likewise, these factors will guide rice scientists, agricultural extension agents and other stakeholders in refining their research and development procedures.

The remaining portions of the paper are presented as follows. First, a description of the methodology for the study is presented. This includes a description of the study area, sampling and data collection methods as well as the analytical framework for the study.

The next two sections present the results of analysis of the empirical findings and the implications of the result. The final section presents conclusions and policy recommendations.

## Methodology

### The study area

The study was conducted in 3 major rice producing districts in Ghana, namely, Ejura-Sekyedumase District and Hohoe District in southern Ghana, and Tolon-Kumbungu in northern Ghana.

The Ejura-Sekyedumase district is geographically located within longitudes 1°5' W and 1°39' W and latitudes 7°9' N and 7°36'N. It consists of a relatively large land size of about 1,782.2 square km with Ejura as its capital (Figure1).

It is the fifth largest district in Ashanti Region accounting for about 7.3% of the region's total land area. The district is located in the Northern part of the region and is bounded in the north by

Atebubu/Amantin and Nkoranza districts, both in the Brong-Ahafo region, on the west by Offinso District, on the East by Sekyere East District and the south by Sekyere West and Afigya-Sekyere districts. The current population is estimated at about 81,119 (Ghana statistical service, 2010).

Ejura-Sekyedumase lies within the transition zone of the semi-deciduous forest and Guinea Savannah agro-ecological zones (Figure 1). Thus, it experiences both the forest and savannah climatic conditions. The district is marked by two rainfall patterns; the bi-modal pattern in the south and the uni-modal in the north.

The annual rainfall ranges between 1500mm and 1600mm with an average of about 1300mm per annum. Temperatures are generally low throughout most part of the year with the highest of 28°C in March and April. Lower temperatures are experienced during the major season in June and July.

Relative humidity is high especially during the rainy season recording the highest of about 90% (in June) and 55% (in February). Rice, roots and tuber crops such as cassava, yam, cocoyam and sweet potatoes as well as plantain are the major food crops cultivated in the zone. Rice cultivation is basically in valleys. Cocoa (*Theobroma cacao*) and oil palm (*Elaeis guineensis*) are the common tree crops that form an integral part of the people's livelihood.

The Hohoe District is located in the centre of the Volta Region, with Hohoe as its capital. The district is geologically located between latitudes 07° 08' 56.54'' N and longitude 00° 28' 28.56'' E, and shares boundaries with the Kpando District to the west, the Jasikan District to the north-west and the Ho Municipal to the south, all three districts in the Volta region (Figure 1). To the east, it is bounded by the Republic of Togo.

The current population is estimated at about 152,627 (Ghana statistical service, 2010), and covers an area of about 1,172 square kilometers.

Available land suitable for agricultural purposes is 65,000 hectares consisting of about, 55,085 hectares for crop and 9,962 hectares for livestock production representing about 47% and 8.5% for crops and livestock respectively (Ghana districts, 2012).

Hohoe district is in the coastal savannah agro ecological zone. The zone is characterized by a bi modal rainfall pattern. The first begins in May and ends in mid-July and the second season begins in mid-August and ends in October with an annual rainfall ranging between 750mm and 950mm.

The mean monthly temperature ranges from 24.7°C in August (the coolest) to 28°C in March (the hottest) with an annual average of 26.8°C. Relative humidity is generally high varying from 65% in the mid-afternoon to 95% at night.

The Tolon-Kumbungu is one of the oldest districts in the Northern Region with Tolon as its capital. The district is located closer to the center of the region and is bordered in the north by the West Mamprusi district, and in the west by the West Gonja district.

In the south, it is bordered by the Savelugu-Nanton district and in the east by the Tamale Municipal Assembly. Geographically, the district is located between latitude 10°N and 20°N and between 10°W and 50°W longitude (Figure 1).

The average elevation of the district is 163.43 metres above sea level and it covers an area of about 2741 km<sup>2</sup>. The current population is estimated at about 145,876 (Ghana statistical service, 2010).

Tolon-Kumbungu is located in the Guinea savannah agro ecological zone. The zone experiences a unimodal rainfall pattern, beginning in May and ending in October, with

annual rainfall ranging between 900 and 1000 mm.

Temperatures are high throughout most of the year with the highest of 36°C in March and April.

Lower temperatures are experienced between November and February, the *harmattan* period. The major arable crops cultivated in the zone include maize, rice, millet, sorghum, cassava, yam, groundnut, cowpea, and soybean.

Generally, Agriculture is the main occupation of the inhabitants of these districts with almost about 65 percent of them engaged in agriculture employing mainly traditional technologies. Rice cultivation is common among selected communities in the districts be it inland or upland.

### Data and sampling

Data for the analyses was basically primary data, collected through informal interviews by the use of structured questionnaires. Data collected included information on household characteristics, farm level characteristics, access to institutions, extension and information.

Multi-stage systematic random sampling technique was employed for the selection of respondent. The first stage involved a purposive sampling of the three districts involved in the study.

This was followed by a random selection of a minimum of 20 communities from a list of rice producing communities in the project districts. The next stage involved the selection of farm households from a list of rice producing households in the selected communities representing at least 60 households from each agro-ecological zone. Overall, 200 rice producers, 10 per community were involved in the study.

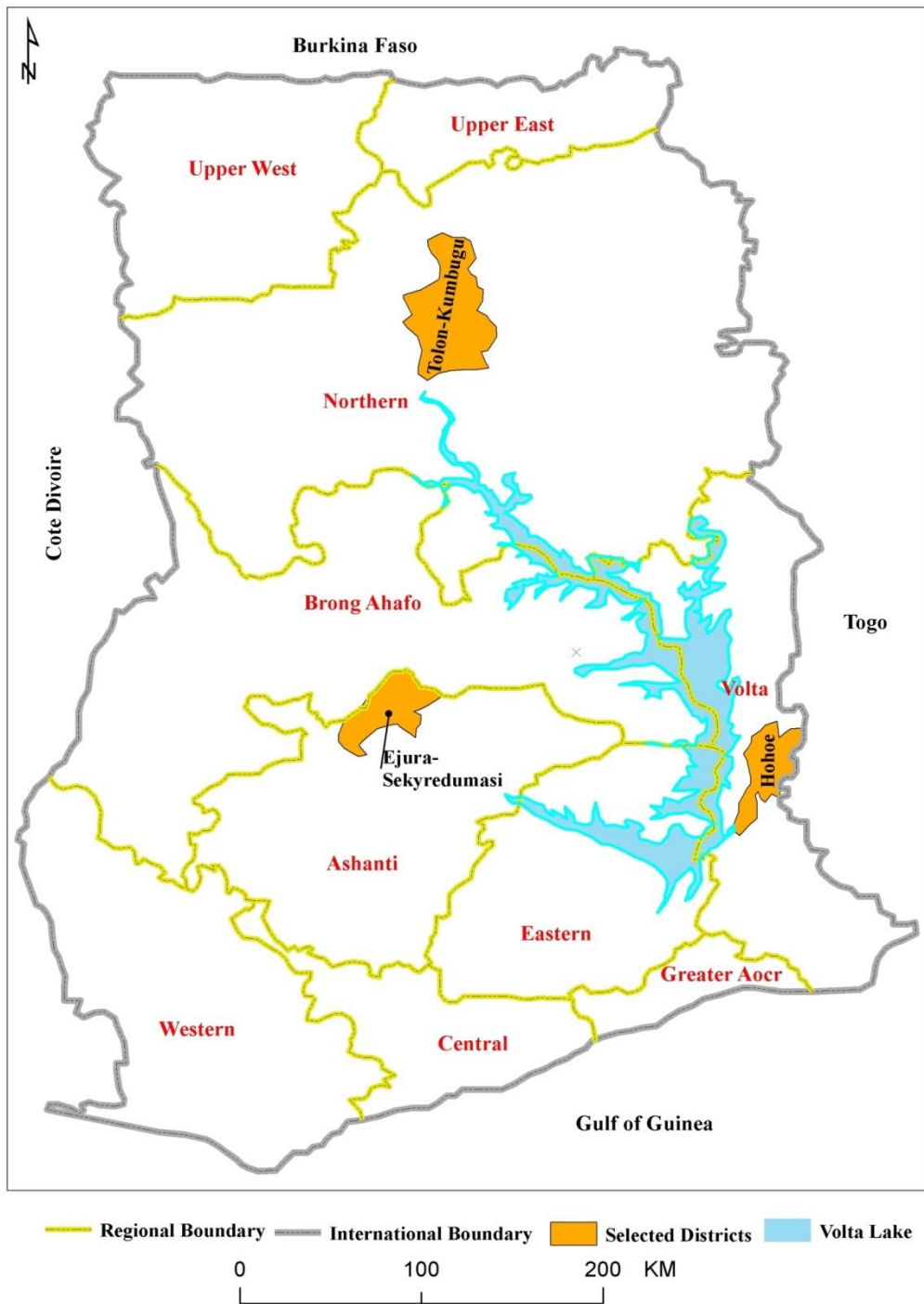


Figure 1: A Map of Ghana showing the study areas.

**Analytical framework**

The instantaneous decision by rice producers to use NERICA seeds (adoption), is not entirely sufficient in the description of the adoption status. In addition, the adopters also make decisions regarding the intensity of adoption; in spite of the fact that the two decisions can be made disjointedly (Wiredu et al, 2012).

In this study however, adoption decision and intensity of adoption in terms of the proportion of land area allocated to the NERICA varieties and quantity of NERICA seeds planted were assumed to be jointly made by farmers.

This is because in contrast with non-agricultural technologies where it is possible to decide to adopt or have a technology without using it, for example a camera, the same cannot be said for rice or other agricultural technologies. A farmer will not adopt it if he does not intend to use it hence cannot decide to adopt without using the technology.

A randomly selected farmer who decided to plant NERICA seeds is expected to allocate a proportion (between 0 and 100 percent) of their farm land to the Variety. A non-adopter did not use or plant NERICA variety and was assigned a value of 0. Thus, the proportion of land allocated to NERICA seeds ( $P$ ) was computed as the ratio of the land area under NERICA ( $L_{Nerica}$ ) and total land area under rice production ( $L_{rice}$ ) as:

$$P_i = \frac{L_{Nerica}}{L_{rice}} \dots\dots\dots (1)$$

Similarly, the proportion of NERICA seeds planted by an adopter ( $Q$ ) was also estimated as the ratio of the quantity of NERICA seeds planted ( $Q_{Nerica}$ ) and the total quantity of rice planted ( $Q_{rice}$ ) as:

$$Q_i = \frac{Q_{Nerica}}{Q_{rice}} \dots\dots\dots (2)$$

Following Greene (2002), the model for the quantity of NERICA seeds planted as well as the proportion of land allocated to it was explicitly expressed by equations 3.0 and 4.0 Respectively as:

$$N_i = a_0 + \sum_{k=1}^k a_{h,k} H_{k,i} + \sum_{k=1}^K a_{s,k} S_{k,i} + \sum_{k=1}^K a_{x,k} X_{k,i} + \sum_{k=1}^K a_{y,k} Y_{k,i} + \gamma_i \dots (3)$$

$$Q_i = \beta_0 + \sum_{k=1}^k \beta_{n,k} H_{k,i} + \sum_{k=1}^k \beta_{s,k} S_{k,i} + \sum_{k=1}^K \beta_{x,k} X_{k,i} + \sum_{k=1}^K \beta_{y,k} Y_{k,i} + v_i \dots (4)$$

$H_{k,i}$  Represents a set of variables that described the characteristics of the sampled rice producers including their respective socioeconomic status.  $S_{k,i}$  Represents the set of variables that described the access to information among the sampled rice producers.  $X_{k,i}$  Represents farm level characteristics and  $Y_{k,i}$  represents the expectation of the rice producers about the returns or challenges of the NERICA varieties.

The computations of the  $N$  and  $Q$  suggests that the proportion of rice land allocated to the NERICA as well as the quantity of seeds planted are truncated for the non-adopters.

Ordinary least square estimators (OLS) of the determinants of model with  $N$  and  $Q$  as the dependent variables were bound to be characterised by heteroskedasticity (Maddala, 2005).

The application of the Tobit regression procedure produces consistent estimates that eliminate heteroskedasticity associated with the truncated dependent variables. The Tobit model estimated the probability of adoption and extent of use for a randomly selected rice farmer (Asfaw et al., 2010).

**Results**

The results of the study are presented in two parts. The first part presents a comparison of characteristics of the sampled rice producers by agro ecological zones (Table 1).

Thereafter, the results of the Tobit models of factors influencing the intensity of NERICA adoption in terms of proportions of seed planted and land allocated to NERICA are presented in Table 2 and Table 3 respectively.

**Characteristics of the sample rice producers by agro ecological zones**

Table 1 presents descriptive statistics of the sampled households. Overall, 57.93 percent of the farmers have adopted and used the NERICA varieties. However, this adoption rate is relatively higher in the transition zone. The sampled rice producers consisted of about 67 percent male farmers and their average age was about 51 years.

The typical rice producing household includes an average of about 7 persons with almost equal gender distribution. Overall, about half of the sampled rice producers had formal education and this is similar across the three zones.

An average of 6 members of nearly 70 percent of the rice producing households was engaged in off-farm income generating activities. The results further showed that about 19 percent of the rice producers were engaged in off-farm income generating activities.

This proportion is however relatively lower in among the rice producing households selected from the Guinea savannah zone. About 67 percent of the rice producer had contacts with extension services. This proportion is similar across the agro ecological zones.

Other sources of support included non-governmental organizations (NGOs) and farmer based organizations (FBOs) which overall, accounted for about 16 percent and 6 percent respectively (Table 1).

In all, about 30 percent of the sample households had access to market facilities. However, markets access was relatively high in the transition zone (54%) and least in the guinea savannah (6%).

The average distance travelled by rice producer to participate in markets is about 3.83 km across the ecological zones. Rice producers in the Guinea savannah zone however travelled relatively shorter distances (1.85km) than other zones (Table 1).

**Table 1: Characteristics of rice producing households by Agro-ecological Zones**

Characteristic	Agro-ecological Zone			Overall (N=193)
	Transition (N=69)	Coastal Savannah (N=63)	Guinea savannah (N=61)	
<b>Personal/Household level</b>				
Adoption (N)	60.87	55.56	57.38	57.93
Household size (N)	6.7	6.07	7.35	6.71
Male producers (%)	65.22	66.67	68.85	66.84
Female producers (%)	34.78	33.33	31.14	33.16
Age of producer (years)	49.54	49.96	53.1	50.87
Educated producers (%)	55.07	53.97	40.98	50.53
<b>Off-farm activity</b>				
Producer (%)	23.19	20.63	13.11	18.98
Household (%)	69.62	56.45	89.09	71.7
Members (N)	6.7	6.07	7.35	6.71
<b>Institutional support (%)</b>				



Extension	66.67	68.25	65.57	66.83
NGOs	11.11	11.11	25.49	15.9
FBOs	5.56	7.41	3.92	5.63
<b>Infrastructure</b>				
Existence of market (%)	6	53.97	32.79	30.85
Av. distance to market (km)	4.82	4.81	1.85	3.83
<b>Farm level</b>				
Area (ha)	0.92	0.88	0.85	0.86
Labour (man-days/ha)	280.83	147.23	155.34	194.47
Seed (kg/ha)	191.59	210.52	118.38	173.5
Fertilizer (kg/ha)	392.43	316.01	582.32	430.25
Herbicides (lit/ha)	109.56	5.84	11.86	42.42
Agric income(US\$)	973.38	993.26	491.87	819.5
Yield (kg/ha)	4544.18	3503.2	2073.92	3373.77
Nonfarm income (US\$)	112.39	48.65	160.92	107.32

At the farm level, overall, about 175kg of seeds were planted per hectare across the zones, though the quantities were greater in the transition zone.

Labour use was much greater in the guinea savannah zone (280.83 man-days) with an overall average of about 194.47 man-days.

Fertilizer use was greater in the Guinea savannah zone, 582.32kg/ha, with an overall average of about 430.25kg/ha. The average agricultural income across the zones was US\$ 819.50.

The average non-farm income was about US\$ 107.32; with coastal savannah recording the minimum (US\$ 48.65). Incomes from Agriculture were consistent across all three agro ecological zones.

Overall, the average yield is about 3373.77 kg/ha, with the highest average recorded in the transition zone, and the least in the Guinea savannah zone (Table 1).

**Determinants of proportion of NERICA seeds planted**

The Tobit regression results of the factors influencing the proportion of seeds of NERICA varieties planted by sampled households are

presented in Table 2. The significant likelihood ratio revealed joint significance of the independent variables in explaining the disturbance of the error terms in the model.

In addition, the marginal effects of the explanatory variable expressing the relative change to intensity of adoption resulting from changes in the explanatory variables were also presented.

The results exemplify that the proportion of NERICA seeds planted by the households was influenced by fertilizer use, existence of projects in the area, existence of FBOs, proportion of active persons in household, access to alternative income sources, education, existence of markets, extension and distance to seed sources. All other variables were not significant.

There were positive relationships between the proportion of NERICA seeds planted and fertilizer use, existence of projects in the area, existence of FBOs, access to alternative income sources, education and extension.

Conversely, negative relationships were identified with distance to seed source, proportion of active persons in the household and existence of markets. Interestingly, the results suggest that an increase in the proportion

of active persons in the household decreases the quantity of NERICA seeds planted.

Other factors including quantities of fertilizers and herbicides used, agricultural income, age,

yield, herbicide use and labour did not have any significant effect on the proportion of NERICA seeds planted (Table 2).

**Table 2: Factors influencing quantity of NERICA seeds planted**

Variable	Marginal effects	Std. Error	t-stat	p-value
Age	-0.003425	0.00267	-1.28	0.202
Yield	-0.000014	0.00001	-1.15	0.253
Projects	0.179576	0.0865	2.08	0.040
FBOs	0.158800	0.0742	2.14	0.034
Herbicide use	0.039619	0.0821	0.48	0.630
Fertilizer use	0.208395	0.0801	2.60	0.010
Nonfarm income	0.000093	0.00005	1.76	0.081
Rice income	-0.000003	0.00001	-0.27	0.787
Fertilizer (kg/ha)	0.000021	0.00002	0.84	0.403
Herbicides (l/ha)	-0.000001	0.00005	-0.03	0.978
Labour (man-days)	-0.000110	0.00016	-0.67	0.505
Proportion of active persons	-0.020007	0.00902	-2.22	0.028
Education	0.181067	0.0769	2.35	0.020
Markets	0.145090	0.0762	1.91	0.059
Distance to seed source	-0.024045	0.00812	-2.96	0.004
Extension	0.118137	0.06769	1.75	0.083
Constant	-0.072261	0.1783	-0.41	0.686

N=150; LR chi2 (16) = 144.42; Prob>chi2=0.000; Predicted adoption=0.708177

**Determinants of the proportion of land allocated to NERICA varieties**

Table 3 presents the Tobit regression results of the determinants of proportion of land allocated to NERICA varieties by sampled households.

The result suggests that the proportion of land allocated to NERICA varieties was influenced by herbicide use, existence of projects in the area, proportion of active persons in household, access to alternative income sources, education, existence of markets, labour use, extension, yield and distance to seed sources.

Positive relationships were identified between extent of adoption in terms of proportions of land allocated to NERICA and herbicide use, existence of rice projects in the area, fertilizer

use, and man-days of labour used, extension, access to alternative income sources, existence of markets and education. On the contrary, negative relationships were also identified with distance to seed source and the proportion of active persons in household.

Although not significant, the following identified factors also affected on the proportion of land allocated to NERICA varieties.

This relationship was positive with membership of FBOs, fertilizers used and rice income. However, factors such as age, quantity of herbicides used and fertilizer use were negatively related with proportion of land allocated to NERICA (Table 3).

**Table 3: Factors influencing proportion of land allocated to NERICA varieties**

Variable	Marginal effects	Std. Error	t-stat	P-value
Age	0.001033	0.003067	0.34	0.737
Yield	0.000002	0.000011	0.17	0.867
Projects	0.225217	0.090445	2.49	0.014
FBOs	0.129154	0.098956	1.31	0.194
Herbicide use	-0.207920	0.105147	-1.98	0.050
Fertilizer use	0.354864	0.104045	3.41	0.001
Nonfarm income	0.000102	0.000053	1.91	0.059
Rice income	0.000002	0.000013	0.18	0.859
Fertilizer (kg/ha)	0.000010	0.000028	0.35	0.727
Herbicides (l/ha)	-0.000026	0.000054	-0.48	0.634
Labour (man-days)	0.000171	0.000164	1.04	0.299
Proportion of active persons	-0.026313	0.010301	-2.55	0.012
Education	0.312331	0.086063	3.63	0.000
Markets	0.136163	0.072164	1.89	0.061
Distance to seed source	-0.023935	0.010661	-2.25	0.026
Extension	0.173649	0.083835	2.07	0.040
_cons	-0.422541	0.199522	-2.12	0.036

N=150; LR chi2 (16) = 134.38; Prob>chi2=0.000; Predicted adoption=0.708173

## Discussions

The study jointly examined the instantaneous decisions to adopt and use the NERICA varieties among rice producers in Ghana. Subsequent discussions and recommendations about strategies to effectively target and promote the NERICA rice varieties are expected to be influenced by certain factors. These include observations about the rice producer and production characteristics.

### Household characteristics and extent of adoption

The sampled households were male dominated; the observed male dominance in the rice production systems in Ghana is an obvious and unique characteristic of the agricultural based production systems in the country (Wiredu *et al.*, 2011; Asuming-Brempong *et al.*, 2011).

The results of this study highlighted the fact that rice production and Ghanaian agriculture is generally male dominated. The generally high proportion of male headed households in the country may limit access to land resources especially rice valleys among females and could possibly account for this finding.

The high gender imbalance in the rice production system can limit the full potential of the rice sector. In addition, the study also confirmed results from other studies in the country of a generally aging farming population (Asuming-Brempong *et al.*, 2011; Wiredu *et al.*, 2012).

This observation can negatively affect efforts to improve rice production in the country as these farmers who are targeted by interventions are already heading towards retirement.

Their enthusiasm to invest in new technologies as well as productivity levels can be low. It is therefore necessary to design strategies to attract the youth as well as women to invest their time and resources in the rice production systems. Efforts should thus be made at targeting the youth and women especially in the development and dissemination of technologies.

Intervention should ensure equal attention to both gender and age groups during the implementation process. Additionally, it may be very useful to target interventions beyond heads of households and involve specific members of the households. Interestingly, the results illustrate a high rate of education among heads of rice producing households. However this is in contrast with the

general situation across the country. Studies have shown variation in education status in the northern and southern parts of the country.

They report relatively high rate of education amongst most farmers in southern Ghana and the reverse was true for those of northern Ghana (Akudugu et al, 2012; Wiredu et al, 2010). This has the tendency of improving ability to understand and discover new things in their farming operations.

The role of off farm activities as a source of livelihood for most farm households in Ghana in terms of income provision is very vital. Regardless of the fact that majority of the heads of the rice producing household were not into off-farm income activities, most of the households had members who were actively engaged in off-farm activities.

This has been found by Villano and Fleming (2006) to significantly contribute to household income status thereby easing the financial burden on the heads of the rice producing households. It can also provide additional source of funds for adequate investment in rice production including new technologies (Kuwornu and Owusu, 2012; Mendola, 2006).

Besides the role played by the national extension service which is predominant in the country, NGOs and FBOs also provided access to information and development support to rice producers. These institutions serve as a pathway for the dissemination of improved technologies to farmers.

To ensure effective promotion of agricultural technologies aimed at achieving desired impacts, it is important for development interventions to engage these institutions.

### **Factors influencing the extent of NERICA adoption**

Interestingly, the results show that, the quantity of NERICA seeds affected the proportion of land allocated to NERICA varieties were influenced by similar factors. This is because the proportion of land allocated and the quantity of NERICA

seeds planted are related hence likely to be affected by similar factors.

The results revealed the presence of active persons in the household has significant influence on the quantity of seeds as well as the proportion of land allocated to NERICA. This is important because cultivation does not end with planting rather; it requires intensive provision of labour to ensure good harvest in the face of other important factors.

The presence of active persons will provide support in terms of labour which is an important factor in rice production systems in Ghana. Moreover, given the aging population of the heads of the households, other members of the households can take up supervisory roles especially when it comes to adopting new technologies.

Availability and access to NERICA seeds beyond the dissemination process should be encouraged in order to improve the intensity of adoption of the varieties. Quality seeds are basic to the production of any crop. Far distances to seed sources negatively impact on the intensity of NERICA adoption.

Available options to increase the intensity of adoption should include strategies of make quality seeds available as close as possible to the farmers. This will enhance farmers' access to NERICA seeds and increase the chances of adoption.

This could be implemented by promoting local rice seed producers in the communities or within certain distance from rice producing communities. For instance the dissemination process adopted by the Roots and Tuber Improvement and marketing Programme (RTIMP) could be emulated. Their approach encouraged the establishment of certified seed growers throughout the country to ease availability of planting materials (METASIP, 2010).

The positive relationship between education and extent of NERICA adoption is encouraging. The ability to process information about the variety is

enhanced by the educational status of the rice producers. Moreover, the educated tend to appreciate the need for information and are better motivated to look for innovations. This results supports the evidence of positive relationships between education and technology adoption in the literature (Tambo and Abdoulaye, 2011; He-XueFeng et al, 2007 and Udoh et al, 2008).

The negative effect of distance to seed source and positive effect of market availability implies that farmers who do not have access to markets and therefore have to travel far distances to seed sources reduces the proportion of resources that can be allocated to the technologies.

Consistent with these findings, availability of market been found to positively influence the adoption of modern rice technologies (Mariano *et al.*, 2012) and water saving technology (Zhou *et al.*, 2008), among small holder farmers in the Philippines and China respectively.

Technology development and dissemination should consider options with improved availability and access to the technology by target beneficiaries. Efforts should be made to provide basic relevant infrastructure such as markets to facilitate access to improved seeds. This will minimize the time spent in obtaining the seeds since this has the potential of hampering the extent adoption of such interventions.

Access to information, capacity enhancement and other production support is assured through membership of farmer based organization (Asante et al, 2011).

In addition, institutions such as farmer based organizations, non-governmental rganizations and extension have been identified as essential in adoption decisions among small scale farmers (Kavia *et al.*, 2007; Langyintuo and Mekuria, 2005; Kristjanson *et al.*, 2005) There is the need for agricultural interventions to link activities with existing institutions such as farmer based organizations and other non-governmental organizations to facilitate dissemination efforts.

Most of all, it is impossible to ignore the influence of development partners such as extension agents and other projects in terms of their ability to reach out to large groups of people hence having a positive impact on farm level performance (Mariano *et al.*, 2012).

## Conclusion and recommendations

This study investigated factors that jointly influence the instantaneous decision and extent of adoption of NERICA rice varieties. About 57.93 of the farmers adopted the NERICA varieties. The adoption decision process was influenced by factors such as fertilizer use, nonfarm income, existence of projects, existence of FBOs, education, existence of markets and distances to seed sources and the proportion of active persons in households.

Seed availability plays an important role in NERICA adoption; hence, promotion of technologies should include strategies to bring the seeds close to rice producers.

Subsequently, because, planting periods are time bound, availability and timely supply of the right kind of seeds is very essential to the rice producers. The ability of farmers to obtain the optimal yield from rice cultivation partly hinges on timely availability of seeds and other essential inputs.

Besides the adoption of the NERICAs, to promote the continued use and an improvement in the proportion of seeds planted and area allocated to NERICA, there is the need to encourage women and the youth to be engaged in agriculture. This will require training and capacity building, sensitization on the use of fertilizers and other good agricultural practices.

Additionally, agricultural interventions of this nature should also establish linkages with existing institutions and projects in complementarity. For example seed dissemination promotional activities should emulate approaches employed by existing project like the RTIMP to ensure the availability of seeds

at affordable prices and at reasonable proximities as possible to farmers.

This could be made possible by identifying certified rice seed growers in strategic locations throughout the country and supported with necessary logistics to produce NERICA seeds at reasonable proximities to rice producing communities.

Other development partners like Non-governmental organizations and farmer based organizations could also be partnered to undertake promotional activities to complement effort by the project in ensuring seed dissemination.

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