Journal of Sustainable Development; Vol. 7, No. 1; 2014
ISSN 1913-9063 E-ISSN 1913-9071
Published by Canadian Center of Science and Education

Impact of NERICA Adoption on Incomes of Rice-Producing Households in Northern Ghana

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Received: October 1, 2013 Accepted: December 3, 2013 Online Published: January 27, 2014

doi:10.5539/jsd.v7n1p167 URL: http://dx.doi.org/10.5539/jsd.v7n1p167

Abstract

The Multinational NERICA Rice Dissemination Project in Ghana promoted the adoption of NERICA varieties and complementary technologies. NERICA adoption was expected to increase rice production and the incomes of beneficiary households. This study assessed the impact of NERICA adoption on the incomes of rice-producing households in northern Ghana. With data from a cross-section of 150 systematically selected rice-producing households, the study revealed 36.7% adoption rate. Agriculture and rice production were the most important livelihood activities as they contributed 80% and 55.09% of total household income respectively. To control for endogeneity, the study used the local average treatment effect (LATE) estimation methodology and showed that NERICA adoption significantly increased rice income, agricultural income, per-capita income and total annual income by $196.52, $446.37, $0.44 and $498.44, respectively. The major recommendation from this study is the need to continue the promotion of the NERICA varieties by creating access to seeds of the varieties together with other productivity enhancing technologies. Efforts should be focused on the provision of marketing and roads infrastructure to induce access to input and product markets.

Keywords: NERICA, adoption, LATE, impact, income, Ghana

1. Introduction

The Multi-national NERICA Rice Dissemination Project (MNRDP) is a continental initiative that promotes the New Rice for Africa (NERICA) varieties and other complementary technologies throughout Africa. In addition to their high yielding, disease resistance, and early maturity traits, the NERICA varieties also provide new opportunity for upland rice cultivation with the intention to increase (WARDA, 2003). The project was therefore intended to contribute to the expansion of the area under rice cultivation, rice yields, farm and then household incomes, and the overall wellbeing of rice-producers and their households in Africa.

In Ghana, the MNRDP was implemented between 2005 and 2010 with the aim of contributing to poverty reduction and food security. The project included 3 key components, namely, capacity building, technology transfer, and production support. In the third component, seed growers were supported to produce adequate quantities of seeds of the NERICA varieties. In addition community-based seed multiplication systems were established to facilitate access to the seeds of the NERICA varieties (MoFA, Undated).

Considering the elaborate approach of the MNRDP, the impact can be captured across the various stakeholders who were also beneficiaries of the activities of the project. That notwithstanding, rice producers constituted an important and the largest proportion of the targeted beneficiaries. Particularly for rice producers in northern Ghana, which was one of the intervention zones, the MNRDP was expected to have the highest impact. This was because the zone which accounts for nearly 30% of national rice production (MoFA, 2012), also records the highest incidence of poverty (IFAD, 2012) and food insecurity (WFP, 2012).

An earlier study by Asuming-Brempong et al. (2011) during the implementation of the project observed a 6% adoption incidence rate and estimated 90% potential adoption rate. The low level of adoption was attributable to incomplete exposure. The end of the project report outlined remarkable achievement in terms of the number of beneficiaries that were covered, land area under NERICA, improvement in livelihood and wellbeing (MoFA, Undated). It however did not provide indications of the causal effect of the project on these measures. The present study was therefore necessary as it identifies the part of these outcomes that are associated to the project.

Development interventions have been shown to cause significant changes in food security (Amaza et al., 2009), and poverty (Awan et al., 2011). Available evidence from neighboring West African countries suggests that the MNRDP has yielded significant impacts. A study by Ojehomon et al. (2012) revealed that participatory varietal selection (PVS) significantly influenced adoption of the NERICA varieties among rice-producing households in Nigeria. Adoption of NERICA varieties have been shown to stimulate high yields (Dontsop et al., 2012), household expenditure (Adekambi et al., 2009), and income (Dibba et al., 2012).

These studies on NERICA applied the treatment effect estimation methods which have the ability to address the problem of sample selection and unobserved biases (Imbens & Wooldridge, 2009). Even though randomized evaluation is highly recommended (Duflo et al., 2006), quasi-experimental methods such as propensity score matching (PSM), difference-in-differences (DiD), and instrumental variable (IV) regression methods have been useful in evaluating the impact of development interventions (Khandker et al., 2010).

Using the PSM method Liebenehm et al. (2011) showed that international agricultural research resulted in improvement in farmer knowledge and emphasized the importance of different matching methods in the analysis. However the PSM assumption of selection on observable characters of project beneficiaries breaks down when there is the potential of unobserved selection bias (Khandker et al., 2010). To account for this bias Kumar and Quisumbing (2011) assumed that the existing unobserved factors were time invariant and used difference-in-differences (DiD) method to evaluate the long-term impact of improved agricultural technologies on individual and household wellbeing in Bangladesh. The DiD method is however subject to the availability of a panel database.

With data from a cross section of households, Kilic et al. (2009) also employed the IV regression method to analyze the overall impact of nonfarm income generating activities on agricultural expenditure, and technical efficiency of rural farm households in Albania. The method allows for endogeneity in treatment status and involves the identification of a variable (an instrument) that is highly correlated to the treatment status but not correlated with the outcome of interest (Khandker et al., 2010).

The selection of a good instrument can be challenging since a weak instrument can worsen the bias situation. To address this problem the local average treatment effect (LATE) has been use (Khandker et al., 2010). Here the selected instrument, a dummy variable, is related to the nature of the program. The LATE method was use by Dontsop et al. (2012) and Dibba et al. (2012) in the estimation of the impact of NERICA adoption. In these exposure was used as an instrument and the impact was estimated on the subpopulation of farmers who were exposed to the NERICA varieties and went ahead to adopt the varieties.

In this study, it is argued that exposure is a necessary but not a sufficient condition for adoption. The possible reason is that farmers can be exposed to the NERICA varieties through other sources other than the project. For this reason exposure cannot be a unique treatment tool by the project. A more appropriate treatment tool is via the distribution of the NERICA seeds. Farmers who have access to the NERICA seeds are in a better position to adopt than those who are exposed. Indeed a study by Buah et al. (2011) has shown that access to seeds of improved rice varieties, stimulate adoption. The production and distribution of seeds of the NERICA varieties under the MNRDP was therefore considered by this study as an important impact channel. For this reason, this study used access to the NERICA varieties as an instrument in the estimation of the LATE impact of NERICA adoption on incomes of rice producing households in northern Ghana.

2. Method

2.1 Determination of NERICA Access and Adoption Status

Given the nature of the Multinational NERICA Rice Dissemination Project (MNRDP) in Ghana, access to the seeds of the NERICA varieties is assured through different channels. In addition to the seed growers, seed dealers, community seed producers, and PVS plots, some farmers received seeds of the NERICA varieties directly from the project (MoFA, Undated). Apart from these, farmer-to-farmer transfer of seeds was also a likely mode of seed distribution. By this description, farmers could obtain seeds directly or indirectly from the project. For the purpose of this study, any farmer who obtained seeds (directly or indirectly) of the NERICA

varieties had access to seeds of NERICA, denoted as P_i. Farmers who had access to seeds of NERICA varieties were assigned the value 1, and the value 0 was assigned to those without access to the seeds of the NERICA varieties. The proportion of farmers who had access to the seeds of NERICA was then computed.

Beyond access, the study identified the farmers who planted the seeds or in other words adopted, (T), the NERICA varieties. Any farmer who adopted the NERICA varieties was thus assigned the value 1 and the value 0 was assigned to the non-adopters. This was also use to compute the proportion of adoption of the NERICA varieties.

2.2 Computing Household Income

As mentioned in the introduction, this study measured the income gains of the project beneficiaries as an indication of the achievement. Some studies have pointed out that direct measurement of income can be laborious (Benin & Randriamamonjy, 2008). Instead expenditure has been used as a proxy for household income. An earlier study by Morris et al. (1999) also tested the validity of household wealth and monetary measures of income and found that in some cases wealth was highly correlated to complex monetary value of income.

Despite these arguments, this study employed three monetary measures of household income, total income, agricultural income, and per capita income. To do this, the sampled households were made to state their annual monetary income by sources, $y_{i,k}$. This was a means of improving the data on income. The total cash, Y_i, and the contribution of each income source, $y^*_{i,k}$, were then computed respectively as:

$$Y_i = \sum y_{i,k} \quad (1)$$

$$y^*_{i,k} = \frac{y_{i,k}}{Y_i} \quad (2)$$

Household daily per capita income, $DPCI_i$, was also computed in very simple steps. First the household total income was divided by the number of days in the year (365) to give the household daily income, DY_i. The household daily income was then divided by household size, Hs, to give the household daily per capita income. The derivation is summarized below.

$$DPCI_i = \left(\frac{Y_i \div 365}{Hs_i}\right) \quad (3)$$

The household daily per capita income provided a means for comparing the incomes across the sampled rice producing households. It also served as an indication of the poverty status of the households.

2.3 Estimating the Treatment Effect Impact Outcome

2.3.1 The Basic Concept

In this study the treatment effect estimation approach was used to determine the impact of NERICA adoption on household income. The choice of this approach, which is also based on the counterfactual (Note 1), was informed by the ability of the methods to produce consistent estimates of impacted outcomes (Imbens & Wooldridge, 2009).

Following the general notation in the sections above, Y represented the outcome of interest, T, the adoption status of farmers. By the counterfactual outcome framework a randomly selected rice producing household had two potential outcomes of adopting NERICA varieties (i.e. $Y = Y_1$ if $T = 1$ and $Y = Y_0$ if $T = 0$) (Caliendo & Hujer, 2005). For the sample of randomly selected rice producing households the average effect of adoption, which is also known as average treatment effect, ATE, is generally given by;

$$ATE = E(Y_1 - Y_0) \quad (4)$$

Differences in knowledge and access to information, physical accessibility as well as socioeconomic condition were expected to present unequal opportunities for adoption (Tambo & Abdoulaye, 2011). The impact parameter given adoption status, also known as the average treatment effect on the treated, ATT, is also given by;

$$ATT = E\big((Y_1 - Y_0)|T = 1\big) \quad (5)$$

In this study access to the NERICA varieties was considered the most satisfactory condition for adoption. However, it was possible that some farmers had access to the seeds but did not plant the seeds. This implies that some farmers may have complied while others did not comply. In this case the impact on the farmers who received the seeds and subsequently planted, which is the local average treatment effect (LATE), is a more useful estimate of impact. The LATE parameter was expressed as;

$$LATE = E\big((Y_1 - Y_0)|P = 1, T = 1\big) \quad (6)$$

2.3.2 The Econometric Procedures

In addition to NERICA adoption, the incomes of the rice producers were assumed to be also affected by some exogenous factors, X, such that the potential outcomes of adoption in terms of X and the unaccounted factor, μ, was given by; $Y = Y_1 = X\beta_1 + \mu_1$ if $T = 1$ and $Y = Y_0 = X\beta_0 + \mu_0$ if $T = 0$. With these, the LATE was re-expressed as;

$$LATE = X\beta_1 - X\beta_0 + E(\mu_1 - \mu_0|X, T = 1, P = 1) \quad (7)$$

Subsequently, the observed income, $Y = Y_1 + Y_0$, was expressed in terms of the LATE as;

$$Y = X\beta_0 + T * LATE + \varepsilon_{LATE} \quad (8)$$

The estimation of the LATE parameter in equation 8 followed a two stage instrumental variable regression procedure. In the first stage a model of adoption was estimated with access to seeds of NERICA, P, as an instrument, W, as additional explanatory variables, and γ, as coefficient estimates. The model for adoption was specified as;

$$Prob(T = 1) = \Phi(PW\gamma) \quad (9)$$

The second stage involved the estimation of the LATE model with the predicted probability of adoption. The model was also specified as;

$$Y = X\beta_0 + \widehat{T} * LATE(X) + \varepsilon_{LATE} \quad (10)$$

2.3.3 Sampling Technique and Data

2.3.3.1 Sampling Procedure

The study was based on data from a cross-section of 150 rice-producing households in Northern Ghana. Sampling was done in 2 stages. The first stage involved random selection of 15 rice-producing communities from a list of NERICA communities. In the second stage, 10 households were randomly selected from a list of rice-producing households in each community.

2.3.3.2 Data, Variables and a Priori Expectations

The data was collected through informal interviews of the sampled rice producers with semi-structured questionnaires. The questionnaires were designed to generate information that describes the characteristics of the sampled rice-producing communities and households, their rice production characteristics and welfare indicators. The information also described access and adoption of the NERICA varieties.

Access to NERICA seeds and adoption of NERICA were dummy variables and were assigned the values 1 for access or adoption and 0 for no access or non-adoption. The main welfare indicator, incomes, was measured in US Dollars. In addition, the various components were also presented in terms of their percentage shares.

The rest were explanatory variables in the estimation of the determinants of the impacted outcomes. Land area was measured in hectares and was also expected to positively influence income. All things being equal, a large land area is expected to lead to high production volume which will in turn translate to higher incomes (Safa, 2005). This argument can also apply to the volume of paddy rice produced which was measured in kilograms. Also in the model were quantity of fertilizer used, measured in kilograms, and man-days of labor. Both were also expected to increase incomes through increases in production.

Availability of markets facility within the community of a farm or nearby community was a dummy variable that represented access to market. It was expected to have positive effect on income because markets provide opportunity for commercial activities which potentially provide both farm and off-farm incomes to households. Availability of access roads was also a dummy variable and was expected to have positive effect on incomes. The reason was that the roads could facilitate economic activities which contribute to income. Distance to input shop, measured in kilometers was however expected to negatively affect income. The farther the distance to input source the more difficult it is to access input in the right quantity and time. This was therefore expected to reduce productivity and therefore farm incomes (Agbola et al., 2010).

Participation in activities of government agricultural extension, projects, and farmers based organization was considered a useful source of information on agriculture and other livelihood activities. These could also provide information for marketing of agricultural produce by the rice producers. For these reasons, these variables were expected to impact positively on the incomes the sampled farmers (Sharma et al., 2007).

Among the characteristics of the households, sex of the rice producer was assigned the value 1 for male and 0 for female. Males were expected to have more income than female in that they had better access to production

resources than females. The resources could easily be converted into financial resources through agricultural production or other off-farm generating activities. A similar explanation holds for age. Elderly person have relatively better access to productive resource and thus incomes. However younger persons are more dynamic and risk loving relative to older household heads. They are able to adopt technology quickly relative to the elderly which will translate to higher income. Age was therefore expected to significantly affect income but without expectation on the direction of the effect. Educated rice producers with the value of 1 were expected to have higher incomes than non-educated rice producers with the value of 0. In addition to their ability to convert productive assets to income, educated farmers were expected to identify and explore different sources of incomes (Ghafoor et al., 2010). Even though large household sizes have negative effect on incomes in this study, number of economically active individual in a household was expected to have positive effect on income. The economically active persons may be involved in activities that potentially contribute to household incomes.

3. Results

3.1 Household Income Profile

Table 1 presents the profile of the rice-producing households which include about 37% adopters of the NERICA varieties. On the whole there is very minimal variation in the characteristics of the adopters and non-adopters.

Table 1. Characteristics of farm households

Description	Non-adopters (N=95)	Adopters (N=55)	Total (N=150)
Knowledge of NERICA	26.32	100.00	53.33
Access to NERICA	14.74	100.00	46.00
Age of household head	51.37	50.02	50.87
Male (%)	76.84	80.00	78.00
Female (%)	23.16	20.00	22.00
Educated heads (%)	51.59	47.28	49.99
Household size (N)	10.19	10.49	10.30
Percent of active persons	48.54	49.27	48.81
Percent of educated persons	47.94	48.85	48.27
Secondary activities (%)	44.21	54.55	48.00
Land area (ha)	0.77	0.91	0.82
Quantity of seeds (kg/ha)	195.25	150.02	178.66
Total labor (man-days/ha)	209.43	191.72	202.94
Yield (kg/ha)	4559.38	3943.18	4333.44
Fertilizer use (%)	64.21	81.82	70.67
Fertilizer use (kg/ha	546.00	342.40	471.35
Relationship with government institutions (%)	60.00	65.45	62.00
Relationship with development projects (%)	4.21	16.36	8.67
Relationship with FBOs	7.37	9.09	8.00
Access road	26.32	25.45	26.00
Market in the village (%)	31.58	18.18	26.67
Distance to big market (km)	2.02	1.91	1.98

The results show 53% of the farmers knew the NERICA varieties. Farmers who had access to the seeds of NERICA were 7% less than those who had knowledge of the varieties. The case of non-compliance was shown by the 14.74% of the non-adopters who had access to the seeds of NERICA.

The majority of the sampled households were male-headed and the household heads were above 50 years old. Almost 50% of the heads of the sampled households had formal education. The percentage of educated heads of the non-adopting households was relatively higher than the adopting households. Sex, age and education may therefore have little effect on adoption of NERICA. The sampled households had an average of 10 members. Within the households about 49% were economically active and a similar proportion of the members of the households were educated.

The sampled households cultivated rice on an average area of 0.82 ha of land and employed about 203 man-days of labour. They planted about 178.66 kg of seeds per hectare and applied an average of 471.348 kg per hectare of fertilizer. On the whole, about 71% of the households apply fertilizer and harvested 4333.44 kg of paddy rice per hectare. With the exception of land area under cultivation and the percentage of farmers who used fertilizers, the adopters fell slightly behind the non-adopters in their farm level characteristics.

The majority of the households had relationships with government institutions. Less than 10% of the farmers had relationships with development projects. The same percentage also had relationship with farmer based organisations. About 26% of the households lived in communities with access to roads. Similarly nearly 26% lived in communities with markets. In the absence of markets, the farmers travelled almost 2km to participate in markets in other communities.

3.2 Household Income Profile

In Table 2 is the income profile of the sampled rice-producing households differentiated by adoption status. On the whole, the daily per capita income of the sampled rice producers was less than USD 1 for both adopters and non-adopters. Rice contributed nearly 55% of the total household income. This was followed by incomes from production of other crops, livestock rearing, trading activities, craftsmanship and remittances in that order. With the exception of income from remittances, all income sources of the NERICA adopters were generally higher than those of non-adopters. There were variations in the contribution of the various sources to the total income. For instance, income from crop production constituted about 77% of the total income for the adopters and about 80% for the non-adopters. On the other hand, livestock income constituted nearly 16% of the total income for the adopters and 12% for the non-adopters.

Table 2. Incomes of sampled rice producer in USD

Activities	Non-adopters (N=95)	Adopters (N=55)	Total (N=150)
Daily per capita income	0.33	0.73	0.48
Total income	879.47	1138.83	974.57
Distribution of income by sources			
Total agricultural	810.79	1056.14	900.75
Livestock	104.86	181.97	133.13
Crop	705.93	874.17	767.62
Rice	492.41	613.73	536.89
Other crops	213.52	260.44	230.72
Non-agricultural	68.68	82.69	73.82
Trading activities	60.25	73.19	64.99
Craftsmanship	5.43	7.19	6.07
Remittance in	3.00	2.31	2.75

Values in parenthesis are in percentage.

3.3 Estimated Impact of NERICA Adoption on Household Incomes

The impact of NERICA adoption was assessed on four main income categories namely, rice income, agricultural income, household daily per capita income and total household income (Table 3). The results of the study

showed insignificant difference in the incomes of the sampled rice producing households across all the income categories.

The ordinary least square (OLS) estimate of the impact parameters yielded insignificant outcomes and showed positive selection bias. There were improvement when the other treatment effect estimators were used. The problem of selection bias was resolved when the OLS model was estimated with an interaction between the adoption status and the other covariates in the OLS model. With the exception of rice income where a positive significant impact of adoption was reported for the adopters, there was no significance in the impacted outcomes for all the other income categories. The PSM method also eliminated the selection bias in the adoption status with positive impacted outcomes. However, all the estimated impact outcomes were not significant.

Using the access to NERICA as an instrument to correct for endogeneity in adoption, the estimated LATE parameters were significant for all the income categories. The results show that rice income of farmers who had access to the seeds of NERICA and subsequently planted increased by about USD 92.32. For those farmers their total agricultural income increased by about USD 342.93, per capita income by USD 0.30 and total income by USD 410.74 (Table 3).

3.4 Factors Affecting Household Incomes

After controlling for the endogeneity in adoption decision an OLS regression model of income was estimated with a set of covariates (Table 4). The results show that the incomes of the farm households were affected differently by different factors. In addition to NERICA adoption, volume of rice production had positive effect all the examined income categories.

Engagement in government projects positively affected rice income alone. Engagement in non-government development projects, and proportion of economically active persons positively affected household per capita income. Access to roads positively affected rice income, agricultural income and total household income, while access to market affected only agricultural and household per capita income.

Table 3. Impact of NERICA Adoption on Income

	Selected income categories											
	Rice Income			Agricultural Income			Per capita Income			Total income		
Impact parameters	Parameter	Std. Err.	P>|z|	Parameter	Std. Err.	P>|z|	Parameter	Std. Err.	P>|z|	Parameter	Std. Err.	P>|z|
Observed sampled mean outcomes	121.3245	142.9163	0.396	245.3504	190.9989	0.199	0.4027	0.2835	0.156	259.3621	208.5396	0.214
OLS estimation of population parameters												
ATE	77.28	132.58	0.56	155.45	180.06	0.39	0.187	0.20	0.34	171.97	193.06	0.37
ATT	77.28	132.58	0.56	155.45	180.06	0.39	0.187	0.20	0.34	171.97	193.06	0.37
ATU	77.28	132.58	0.56	155.45	180.06	0.39	0.187	0.20	0.34	171.97	193.06	0.37
Selection bias	-2.15e-06	6.55e-10	0.00	-1.32e-06	6.44e-10	0.00	-5.23e-10	7.33e-13	0.00	-2.63e-06	3.57e-10	0.00
OLS estimation of population parameters with interactions												
ATE	2936.17	2820.01	0.30	97.85	185.03	0.60	0.15	0.20	0.44	92.36	200.08	0.64
ATT	-333.09	570.13	0.56	143.06	178.79	0.42	0.18	0.19	0.33	167.67	193.33	0.39
ATU	4828.90	4470.76	0.28	71.68	200.31	0.72	0.13	0.21	0.53	48.76	216.60	0.82
Selection bias	-3269.26	2887.07	0.26	45.21	70.75	0.52	0.03	0.07	0.66	75.31	76.50	0.33
Inverse propensity score weighting estimates												
ATE	27.89	120.13	0.82	161.37	222.86	0.47	0.18	0.21	0.38	158.88	230.76	0.49
ATT	67.50	159.87	0.67	176.09	245.77	0.47	0.38	0.45	0.40	209.22	272.45	0.44
ATU	4.96	134.38	0.97	152.85	292.00	0.60	0.07	0.12	0.58	129.74	302.92	0.67
Selection bias	39.61	104.94	0.71	14.72	213.88	0.95	0.20	0.26	0.45	50.34	235.41	0.83
LATE parametric (OLS) estimation of population parameter												
LATE	196.52	2.84e-07	0.00	446.37	3.09e-07	0.00	0.44	3.46e-10	0.00	498.44	5.19e-07	0.00

Table 4. Determinants of household income

Variables	Rice income			Agriculture income			Per capita income			Total income		
	Coefficient	Std. Err.	P>t	Coefficient	Std. Err.	P>t	Coefficient	Std. Err.	P>t	Coefficient	Std. Err.	P>t
NERICA adoption	196.52	105.20	0.06	446.37	131.52	0.00	0.44	0.21	0.04	498.44	146.14	0.00
Volume of rice harvested	0.09	0.02	0.00	0.09	0.02	0.00	0.00	0.00	0.05	0.11	0.03	0.00
Engagement in government project activities	286.78	121.78	0.02	205.75	152.24	0.18	0.12	0.25	0.63	153.59	169.16	0.37
Participation in projects	-74.28	190.14	0.70	336.09	237.70	0.16	1.80	0.38	0.00	223.69	264.13	0.40
Member of FBO	-72.30	186.70	0.70	26.27	233.40	0.91	0.09	0.38	0.81	45.94	259.35	0.86
Sex	-125.20	128.67	0.33	53.64	160.85	0.74	0.12	0.26	0.64	58.14	178.73	0.75
Age	-3.12	3.92	0.43	-0.57	4.91	0.91	-0.01	0.01	0.52	-0.76	5.45	0.89
Proportion of economically active persons in households	-4.72	304.48	0.99	561.23	380.65	0.14	2.44	0.61	0.00	649.59	422.96	0.13
Access road in the community	293.36	128.00	0.02	380.21	160.01	0.02	0.39	0.26	0.14	370.60	177.80	0.04
Existence of market	95.00	135.25	0.48	343.43	169.08	0.05	0.46	0.27	0.10	196.73	187.88	0.30
Distance to major markets	5.32	14.18	0.71	3.73	17.73	0.83	-0.01	0.03	0.67	3.53	19.70	0.86
Off farm income activities	29.00	40.32	0.47	-47.50	50.41	0.35	-0.11	0.08	0.19	-15.82	56.01	0.78
Proportion of educated persons	-142.01	263.40	0.59	-140.63	329.29	0.67	0.95	0.53	0.08	-38.86	365.90	0.92
Constant	182.42	293.22	0.54	-160.03	366.56	0.66	-1.84265	0.590221	0.00	-238.20	407.31	0.56
Number of obs			124									
F(16,…107)			2.86			3.20			6.11			3.03
Prob>F			0.00			0.00			0.00			0.00
R-squared			0.25			0.27			0.42			0.26
Adj R-squared			0.67			0.19			0.35			0.18

4. Discussion

This study provided evidence that underscore the importance of agriculture and rice in the income portfolio of the sampled rice producing households. Among the list of income sources agriculture contribution was nearly 80 per of the total household income. Rice alone contributed nearly 55% of the total income. Attempts to increase the incomes of these rice producing households should seek the improvement in the performance of their agricultural based livelihood activities.

4.1 Impact of NERICA Adoption on Household Incomes

The results of the study showed that NERICA adoption significantly increased these household income categories. All things being equal, rice producers who had access to seeds of the NERICA varieties, and subsequently planted the seeds received an additional rice income of USD92.32. For those farmers, their total agricultural income increased by about USD 342.93, per capita income by USD 0.30 and total income by USD 410.74. The results of the study was in agreement with that of Dibba et al. (2012) who also reported significant increase in the income of rice farmers who adopted the NERICA varieties in The Gambia.

In addition to total income, this study has also shown that adoption of the NERICA varieties increased specific income categories. Apart from the estimated increases in absolute income, adoption of the NERICA varieties also increased per capita income which suggests the potential of the variety to improve the poverty status as shown by the estimated impact on per capita income (Table 3).

Another important outcome of the study was the importance of seeds as a means of ensuring the success of the NERICA project. As shown by the study, enhancing access to the seeds of the NERICA varieties was very important in the adoption process which further translated to increases in the incomes of the sampled rice farmers. This confirms the results of Buah et al. (2011) who reported that enhancing access to seeds reduced the operations cost and increased the incomes of rice producing households in Northern Ghana.

Since rice contributes more than 50% of the incomes of rice producing households in the study area, efforts to improve the wellbeing of such farmers should include the provision of seeds of improved rice varieties including the NERICA varieties. This can provide a good opportunity to improve adoption and ultimately their wellbeing.

4.2 Determinants of Household Incomes

Apart from creating access to seeds and promoting adoption of the NERICA varieties, this study has also identified other important factors that can contribute to higher incomes of the rice producing households. As shown by the results of the study, increasing production volumes is very critical for increasing all the evaluated income categories. Certainly for agricultural households, increases in farm production will subsequently translate to higher incomes. The results also agrees with the findings of Njiru et al. (2013) who further suggested that efforts to boost the incomes of rural household should also encourage agricultural production. The implication for this study is that in addition to seeds, there is the need to also promote sound practices that will further increase production. This aspect was also important in the MNRDP in Ghana (MoFA, Undated).

While some studies have identified inverse relationship between household size and income or poverty (Idowu et al., 2011), this study identified positive relationship between household income and the proportion of economically active persons in a household. Unlike the household size which includes different categories of members, economically active persons in this study were used as a measure of the quality of household members. Two main arguments can be made about the economically active persons. First, they are immediate source of labor for farm operations and can contribute significantly to farm productivity and income. On the other hand, the economically active persons can be engaged in other income generating activities which can contribute to the overall income of the households. Agricultural interventions can also be well targeted at specific members of farm households to harness these potentials.

This argument can be extended to educated members of farm households. In particular these categories of members are better placed to secure off-farm employment which also contributes to overall household income. However Joliffe (2004) reported negative effect of education on farm work. In this case there may be the need to encourage educated members in farm households to take up agriculture since they are in the position to understand the implications of good agricultural practices on productivity and income. In deed as shown by this study this category of household members have the potential of improving household per capita income and for that matter poverty.

Participation in development projects and involvement with government institutions, as shown by this study, also have strong influence on household incomes. Most development project facilitates access to knowledge and productive resources which can stimulate farm performance and household income. Awotide et al. (2011) for instance found that farmers who received improved rice seeds had significant improvement in their incomes and further suggested the intensification of such interventions. By implication, there is also the need to encourage rice producing households to take advantage of ongoing development projects in order to benefit from the available facilities which can subsequently enhance their income and wellbeing.

In rural communities, markets places are important source of commercial activities and in some cases recreation. Farm household who live in communities with market facilities are more likely to be engaged in such activities thereby increasing their chances of earning income. The income could be obtained through easy and quicker sales of farm produce or by sales of non-agricultural commodities. This assertion was confirmed by the study as shown by the positive and significant effect of availability of markets on household incomes. Moreover, in the absence to markets, availability of access roads also provides farmers with the opportunity to participate in markets of other communities. Farmers residing in communities with markets and those who have access roads can effectively engage in commercial activities to generate income for their households. Development interventions should also include the provision of such facilities to encourage the proliferation of commercial activities. These also enable farmers to access produce as well as input markets.

Large farm size implies the ability of the farm households to cultivate and harvest large volumes. Sales of these harvest goes to into household income. This is also shown by the study to influence the incomes of farm households.

5. Conclusion and Recommendations

The study showed that adoption NERICA varieties had significant impact on the incomes of rice-producing households in Northern Ghana. Promoting the NERICA varieties together with complementary technologies that has the potential to increase production and then income.

Moreover, interventions should seek to understand the household structure and extend the benefits to include economically active persons as well as educated members of farm households. In deed participation in government and development interventions must be encouraged among farm households. These interventions should also identify synergies among existing projects to minimize duplication and avoid fatigue among beneficiaries.

Finally, there should also be the provision of market and road infrastructure to facilitate access to produce market and participation in commercial activities by farm households.

Acknowledgment

The authors of this paper wish to acknowledge the contribution of Africa Rice Center (AfricaRice) for the financial and technical support for the generation of the data. The contribution of Council for Scientific and Industrial Research (CSIR) in Ghana for the administrative support and for serving as the host for this study is also acknowledged. All technicians who worked on this study are appreciated.

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Note

Note 1. What would have been observed if an alternative or opposite condition existed.