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Research Article

Determinants of Off-Farm Income among Smallholder Rice Farmers in Northern Ghana: Application of a Double-Hurdle Model

Benjamin Tetteh Anang[1] **and Richard W. N. Yeboah**[2]

[1]*Department of Agricultural Economics and Extension, Faculty of Agriculture, University for Development Studies, Tamale, Ghana*
[2]*Department of Agribusiness Management and Finance, Faculty of Agribusiness and Communication Sciences, University for Development Studies, Tamale, Ghana*

Correspondence should be addressed to Benjamin Tetteh Anang; benjamin.anang@uds.edu.gh

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Income diversification by farm households has gained the attention of researchers and policy makers due to its commonness especially in developing countries. This study sought to empirically investigate the determinants of off-farm income among smallholder farmers in northern Ghana using a sample of 300 rice farmers. A double-hurdle model was used to determine the factors influencing participation in off-farm work as well as the predictors of actual amounts earned from working outside the farm. The results revealed that gender, farming experience, years of education, and access to credit are the factors determining participation in off-farm work while farming experience, years of education, and geographical location are the determinants of income from off-farm work. The paper concludes that measures to enhance rural income diversification will spur the rural economy and these measures should seek to address the problem of low level of formal education in rural areas.

1. Introduction

Majority of the world's poor live in rural areas in developing countries and depend on agriculture and its related activities as a source of livelihood. Despite the dependence on agriculture in these countries, including Ghana, the agricultural sector continues to grapple with challenges that impede its growth and contribution to socioeconomic development. These challenges include dwindling budgetary allocation to the agricultural sector, farmers' inability to acquire and replace farm equipment, inadequate credit sources, among others.

In the wake of the dwindling fortunes and challenges facing agriculture in most developing countries, the rural off-farm sector has emerged as an important source of livelihood [1–4]. Income diversification by farm households has gained the attention of governments, policy makers, and researchers because of its commonness and contribution to socioeconomic development especially in developing countries.

The role of the off-farm sector in employment creation, income generation, farm expansion, and poverty reduction especially in developing countries is well documented (see, for example, [3, 5–7]. According to [2], farm households diversify their income sources by allocating productive resources among diverse income generating activities including farm and off-farm work. Diversification may be a deliberate household strategy or a spontaneous response to crisis as noted by [8]. It may serve as a safety net for the poor whereas for the rich it may be a means of accumulation. Income diversification by farm households may also be attributed to dwindling and uncertain farm incomes, rising poverty, and emerging opportunities for off-farm work.

Off-farm activities involve participation in remunerative work outside the participant's own farm and have been recognised to play an increasingly essential role in sustainable development and poverty reduction particularly in rural areas [9]. Income from off-farm work supplements on-farm income and helps to expand economic activity and

employment opportunities in rural areas. For the agricultural sector, income from off-farm activities is an alternative source of income which may be used to finance agricultural production. Income diversification therefore has the potential to increase farm investment leading to higher productivity.

Off-farm activities also reduce income uncertainty. As noted by [10], employment diversification helps households to smooth income through the spread of risks across different activities. The reduction in income uncertainty opens up opportunities to invest in improved production technologies to enhance agricultural production.

Income diversification as a livelihood strategy is considered a global phenomenon. According to [11], income from nonfarm work contributes 40% to total income in Latin America while, in sub-Saharan Africa, nonfarm income constitutes between 30% and 42% of total household income. According to [12] the estimated share of nonfarm income in total household income for Asian countries ranges between 29% and 32%.

Agriculture's contribution to the provision of livelihood opportunities in most rural areas cannot be overemphasized. However, recent structural transformation in the economies of most countries has seen faster growth in other sectors of the economy like manufacturing, industry, and the service sector, leading to a decline in the contribution of agriculture to rural livelihoods and gross domestic product (GDP). Agriculture therefore cannot be the only source of livelihood for many rural farm households, hence the significance of off-farm enterprises to rural incomes and employment creation. For example, [13] highlighted the need for the integration of activities such as nutrition gardening, livestock rearing, product diversification, and related income generation activities as a means of improving household food and nutritional and income security among farmers in India.

An important factor determining employment of rural people in nonagricultural enterprises is level of education. The level of education in most rural areas of developing countries is lower than what prevails in urban areas, which makes rural people less likely to be employed in high-paying jobs in nonagricultural enterprises. Education is also an important factor in the decision to participate in off-farm work. Education improves the human capital and the likelihood to engage in high-paying nonagricultural jobs. Less educated individuals without the requisite skills and technical knowhow may find it difficult to participate in many nonagricultural jobs that require specific skills and expertise. This may impede participation of less educated rural folks in the nonfarm labour market. As indicated by [1], better education is one of the most important factors affecting off-farm earnings. Similarly, [14] reported that less educated households in rural Nigeria were limited in their ability to engage in more lucrative off-farm labour activities. As noted by [15], the nonagricultural sector is vital to employment and income generation in rural areas through the provision of various economic activities such as petty trading, businesses, craft, and services.

The marginal productivity of labour in the agricultural sector is generally low as a result of disguised employment, resulting in low level of income. The low income of agricultural labour as a result of low productivity is a major cause of rural poverty in many developing countries. A key strategy to enhance agricultural productivity and farm incomes is to improve human capital, which is embodied in education and farming experience. Education does not only improve agricultural productivity and farm incomes, but also promotes off-farm activity participation and the returns from off-farm work. Education also facilitates diversification of the rural economy away from agriculture. In either way, education is expected to play a positive role in the rural economy. As indicated by [3], developing the human capital through training and skill building is important to promote both agricultural development and rural off-farm employment.

Previous studies on off-farm/nonfarm employment in Ghana include [16–21]. Authors such as [17, 19] focused on the determinants of participation in rural nonfarm employment while [18] assessed the relationship between gender, poverty, and nonfarm employment in Ghana and Uganda. Other authors such as [20] explored household-level farm-nonfarm linkages and household welfare implications in Ghana while [21] examined nonfarm work and food security among farm households in northern Ghana. From these studies, it can be observed that little has been done on the determinants of total earnings from off-farm income in Ghana.

Due to the foregoing, this study was carried out to investigate the factors influencing participation in off-farm work as well as the predictors of total amount of off-farm income among small-scale farmers in northern Ghana. The findings of the study are expected to guide policy makers on measures to improve rural incomes and livelihood security.

2. Materials and Methods

2.1. Study Area, Sampling, and Data. The study was carried out in the Northern and Upper East Regions of Ghana. These regions and the Upper West Region make up northern Ghana where agriculture is the mainstay of the population. Northern Ghana is characterized by savannah vegetation and a unimodal rainfall regime which makes irrigation an important requirement for crop production during the dry season.

Respondents were selected using multistage stratified random sampling. The Northern and Upper East Regions were selected followed by the selection of three major irrigation projects for rice production in these areas. These included the Botanga Irrigation Scheme in the Northern Region, and the Vea and Tono Irrigation Schemes in the Upper East Region. One hundred (100) rice producers per irrigation scheme were sampled to give a total of 300 respondents. The total sample was made up of equal number of irrigators and nonirrigators.

The data collected included individual/household, farm, and institutional factors. Information on income from both farm and off-farm activities was collected. Individual/household data included gender, age, and educational attainment of the respondent, household size, among others.

Table 1: Data description and summary statistics of the respondents.

Variable	Definition	Mean	Std. Dev.	Min.	Max.
Z	Participation in off-farm work (1 = yes)	0.427	0.495	0	1
Y	Off-farm income (GH¢) per year	1111	1398	0	6300
SEX	Sex of respondent (1 = male)	0.78	0.41	0	1
EXP	Years of farming experience	20.6	12.2	2	60
EDU	Education of respondent (years)	3.85	5.34	0	20
HSZ	Household size (number)	9.68	7.20	2	71
DIST	Market distance (kilometres)	7.99	4.30	2	18
REG	Regional dummy (1 = Northern)	0.33	0.48	0	1
CRED	Access to credit (1 = access)	0.40	0.49	0	1
DSPEC	Degree of specialization (%)	45.4	25.1	3.6	100

Farm data included farm size, output level, and input and output prices. Information on access to irrigation and extension services was also collected.

2.2. Double-Hurdle Model of Off-Farm Income Determination. The first step in the implementation of the double-hurdle model relates to the decision or willingness to participate in off-farm work. This binary decision can be modelled as an index function using a probit model as follows:

$$Z_i^* = w_i{}'\alpha + \varepsilon_i$$
$$where\ Z_i = \begin{cases} 1, & if\ Z^* > 0 \\ 0, & if\ Z^* \leq 0 \end{cases} \quad (1)$$

Z_i is a dichotomous variable which takes the value of 1 if the respondent is a participant in off-farm work and 0 otherwise, w is a vector of explanatory variables, α denotes a vector of parameters, and ε is the error term.

The empirical model for rice farmers' decision to participate in off-farm work is specified for this study as follows:

$$\begin{aligned} Z_i = {} & \alpha_0 + \alpha_1 sex_i + \alpha_2 edu_i + \alpha_3 exp_i + \alpha_4 expsqd_i \\ & + \alpha_5 hsz_i + \alpha_6 reg_i + \alpha_7 cred + \alpha_8 dspec + \alpha_9 dist \\ & + \varepsilon_i \end{aligned} \quad (2)$$

where Z_i measures the choice of the ith rice farmer to participate in off-farm work, α is the coefficients of the independent (explanatory) variables, and ε is the error term.

The second equation in the double-hurdle relates to the amounts of off-farm income earned by the respondents. The second hurdle equation can be estimated using a regression truncated at zero (similar to a Tobit model) with the following formulation:

$$Y_i^* = x_i{}'\beta + u_i$$
$$where\ Y_i = \begin{cases} Y_i^*, & if\ Y^* > 0 \\ 0, & if\ Y^* \leq 0 \end{cases} \quad (3)$$

where Y_i represents the observed income from off-farm work which depends on the latent variable Y^* being greater than zero, x_i denotes a vector of explanatory variables, β represents a vector of parameters to be estimated, and u_i is a random error term.

Empirically, the truncated regression model is specified for this study as follows:

$$\begin{aligned} Y_i = {} & \beta_0 + \beta_1 sex_i + \beta_2 edu_i + \beta_3 exp_i + \beta_4 expsqd_i \\ & + \beta_5 reg_i + \beta_6 dist_i + u_i \end{aligned} \quad (4)$$

where Y_i is the amount of off-farm income of the ith rice farmer, β_i are coefficients of the explanatory variables, and ε_i is the random error term.

3. Results

3.1. Summary Statistics of the Respondents. The summary statistics of the respondents are presented in Table 1.

Most of the respondents in the study were male (78%). The average age of the respondents was 41.2 years while household size averaged 10 members. The respondents had 4 years of formal education and travelled an average of 8 km to the nearest market. Forty-three percent (43%) participated in off-farm work. Total income from off-farm work averaged 1,111 Ghana Cedis (GH¢) (approximately $232) per annum. On average, respondents had 21 years of farming experience and allocated 45% of total land to rice cultivation (a measure of the degree of specialization in rice production). In addition, 33% of the respondents were located in the Northern Region while 40% used credit in farming.

3.2. Amount of Income Earned from Off-Farm Work. Table 2 presents the amount of income earned from off-farm work by respondents in the study area. Close to 43% of the respondents took part in off-farm work to supplement income from on-farm work. Twenty-eight percent of the respondents earned up to GH¢1,000 which translates into $208. Ten percent of the respondents earned between GH¢1,000 and GH¢2,000 from off-farm work. Only 4.3% of the respondents earned between GH¢2,001 and GH¢6,000 from off-farm work.

3.3. Double-Hurdle Regression Estimates of the Determinants of Off-Farm Income. The double-hurdle regression estimates

Table 2: Distribution of amount of income earned from off-farm work by respondents.

Off-farm income (GH¢)	Number of farmers	Percentage
0 (Nonparticipants)	172	57.3
1 – 1,000	83	27.7
1,001 – 2,000	31	10.3
2,001 – 3,000	4	1.3
3,001 – 4,000	1	0.3
4,001 – 5,000	3	1.0
5,001 – 6,000	5	1.7
More than 6,000	1	0.3
Total	300	100

1 US dollar equals 4.8 Ghana Cedis.

of the determinants of off-farm income are presented in Table 3. The first hurdle related to assessment of the factors influencing the decision to participate in off-farm work using a probit model (columns 2 and 3).

The results indicated that gender of the farmer had a significant influence on participation in off-farm work at 1% significance level. From the results, female respondents had higher participation in off-farm work relative to their male counterparts. Participation in off-farm work was also related to years of formal education. Education had a positive and significant association with off-far work at 1% level. In addition, farming experience had a positive and significant relationship with off-farm work at 10% level. Finally, access to credit was negatively related to off-farm work and significant at 5% level.

The second hurdle related to the determinants of off-farm income (columns 4 and 5). Number of years of farming experience of the respondents had a positive and significant effect on income from off-farm work and was statistically significant at 5% level. The quadratic term of the farming experience variable was however positive and significant at 10% level. In addition, the number of years of formal education of the farmer had a positive and statistically significant relationship with off-farm income at 10% level. In other words, income from off-farm work increased with years of formal education of the respondent. Furthermore, the coefficient of the regional dummy variable was statistically significant at 10% level and indicated that farmers in the Upper East Region earned higher income from off-farm work compared to those in the Northern Region. The type of off-farm activities included fishing, petty trading, arts and craft, businesses, and services.

4. Discussion

4.1. Amount of Income from Off-Farm Work. The result highlights high participation in off-farm work by farmers in northern Ghana. The result is consistent with [11] who reported that 30% to 42% of total household income in sub-Saharan Africa comes from nonfarm work. The study is also consistent with [12] who estimated the share of nonfarm income in total household income for Asia to be 29% to 42%. The amount of income from off-farm work is however very small which may be inadequate to support the household and its agricultural production. The "one district, one factory" policy of the government of Ghana which is aimed at creating jobs at the district level is a flagship government policy that could go a long way to enhance rural employment and income from off-farm work.

4.2. Factors Influencing Participation in Off-Farm Work. In most Ghanaian societies, women play several economic roles and are noted for their entrepreneurial abilities. Women in many rural communities engage in petty trading and other income earning activities to supplement household income. Thus, women tend to be engaged in multiple off-farm activities to supplement household income compared to men and play multiple roles in the household. The result of this study is consistent with [22] who reported higher participation of women in off-farm work in Malaysia. Other previous studies on participation in off-farm work in Ghana support the findings of this study [17–19].

The results of the study highlight the important role of education in off-farm work. As noted by [1], education affects participation of rural people in off-farm work as well as the amount of income from off-farm work. The result of this study is in consonance with [14] who found that less educated households in rural Nigeria were limited in their ability to engage in more lucrative off-farm labour activities.

In addition, the result of the study suggests that experienced farmers are more likely to participate in off-farm work compared to less experienced farmers. The result does not lend itself to easy interpretation but may be indicative of the general lack of job opportunities outside the farm in rural areas. The result agrees with [23] who observed that older farmers in Cambodia were more likely to participate in off-farm work which is related to their experience.

Finally, farmers who had access to credit had a lower propensity to engage in off-farm work, which is consistent with *a priori* expectation. This is because credit tends to ease the financial constraints of farm households and could increase on-farm income. Credit-constrained farmers are therefore more likely to seek employment from off-farm sources. The result of this study is contrary to [20], who found that access to credit enhanced female participation in off-farm employment in Ghana. Owusu et al. [21] also found a positive effect of credit access on participation in nonfarm employment in Ghana.

4.3. Determinants of Off-Farm Income. Education is one of the key variables in the economic literature influencing participation in off-farm work and total earnings from off-farm work. The result of this study is in consonance with *a priori* expectation: education improves the human capital and hence the likelihood to engage in high-paying nonagricultural jobs. Educated farmers have higher opportunity cost of labour and therefore are more likely to trade their labour in the nonfarm labour market. Education is also expected to enhance entrepreneurial abilities and self-employment, which may enhance the level of income from off-farm

Table 3: Maximum likelihood estimates of double-hurdle model for participation in off-farm work and amount of off-farm income.

Variable	1st hurdle (Probit model)		2nd hurdle (outcome model)	
	Coefficient	Std. Error	Coefficient	Std. Error
Sex	-0.675∗∗∗	0.203	0.370	0.173
Education	0.066∗∗∗	0.015	0.037∗	0.056
Experience	0.037∗	0.022	-0.058∗∗	0.039
Experience squared	-0.001	0.000	0.001∗	0.092
Household size	-0.016	0.013	-	-
Regional dummy	0.330	0.290	-0.416∗	0.070
Access to credit	-0.549∗∗	0.261	-	-
Specialization	0.003	0.003	-	-
Market distance	-0.011	0.018	-0.019	0.389
Intercept	-0.117	0.367	7.734∗∗∗	0.000
Sigma	1.151	0.170		
Covariance	-0.945∗∗∗	0.289		

∗∗∗ Significant at the 1% level. ∗∗ Significant at the 5% level. ∗Significant at 10% level.

work. On the other hand, less educated farmers may not have the required skills and technical knowhow which may hinder their participation in high-paying nonagricultural wage employment. The finding is consistent with [14] in their study of off-farm labour market participation in rural Nigeria which showed that education enhances employment of rural people in higher-paying nonfarm activities. As indicated by [24, 25], education creates opportunities for farm households to participate in higher-return nonfarm activities. Lack of education creates entry barriers to certain off-farm employment opportunities [16] leading to a situation referred to as labour market dualism [1] where individuals with education get employed in relatively high-paying jobs while the uneducated end up with relatively low-paying jobs. Majority of the participants in off-farm work were self-employed as fishermen, petty traders, craftsmen, and small business owners.

The study also indicated that experienced farmers had lower incomes from off-farm work, which is consistent with *a priori* expectation. Experienced farmers are expected to devote more time to farming and less time to off-farm work, thus earning less income from off-farm activities.

In addition, the study underlined that income from off-farm work differs across regions. Northern Region has greater agricultural potential than the Upper East Region in terms of fertile lands for crop production. Land scarcity also characterizes agricultural production in the Upper East Region, which may encourage the trading of agricultural labour for off-farm income. Households facing the challenge of land scarcity are therefore more likely to trade agricultural labour for nonagricultural wage employment, which may result in higher income from off-farm work.

5. Conclusion and Policy Recommendations

The study assessed the determinants of off-farm income of smallholder rice farmers in northern Ghana using a double-hurdle model. The first hurdle related to the factors influencing participation in off-farm work while the second hurdle related to the estimation of amount of income earned from off-farm employment. The results of the study indicate that small-scale farmers in the study area earn low income from off-farm work. This may suggest unavailability of well-paying jobs outside the farm, the lack of requisite skills by farmers to participate in off-farm labour activities, or inadequate off-farm opportunities.

A major conclusion from the study is that human capital plays an important role in off-farm income determination. Education had a positive influence on both the decision to participate in off-farm work and the amount of income earned from off-farm employment. Thus, educated farmers have higher propensity to participate in off-farm work and tend to earn higher incomes from off-farm activities. On the other hand, farming experience had a negative influence on the amount of off-farm income and a positive influence on off-farm employment. This implies that less experienced farmers are less likely to participate in off-farm work, but if they participate, they will tend to earn higher income than more experienced farmers.

Policy recommendations arising from the study include the following: To enhance rural employment in off-farm activities, there is the need to promote rural industrialization such as the Government of Ghana's "one district, one factory" policy initiative. In addition, since most Ghanaian rural communities are agrarian in nature, the government of Ghana must take steps to make agriculture attractive to keep the youth in particular in farming. Agriculture is the largest employment sector in the Ghanaian economy and the economic potentials of agriculture to socioeconomic development have been recognized. Hence, government's facilitation of measures that promote agriculture such as the provision of credit to farmers will enable producers with large farmlands to increase production. This will boost employment in agriculture and reduce rural-urban migration of the youth. Government must also create the enabling environment for value addition to agricultural products produced in rural areas which will increase opportunities for off-farm income generation.

The promotion of education in rural areas is also important in promoting income diversification because education enhances the human capital by way of skill acquisition and adaptability to different employment opportunities. Income from off-farm work is becoming increasingly important to rural farm households, hence the need for government policy to improve access to education in rural areas. Policies directed at promoting the education of rural people will go a long way to enhance their ability to take advantage of available employment opportunities or venture into self-employment to improve their income levels and living conditions. Furthermore, the provision of skills training to adults without formal education will enable them to take advantage of employment opportunities that do not require formal education and training, thereby enhancing income from off-farm work.

Data Availability

The data supporting the findings of the study is found in the Supplementary files. The data is also available upon request from the corresponding author.

Conflicts of Interest

Authors declare there are no conflicts of interest.

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Supplementary Materials

The data supporting the findings of the study is attached. The data is also available upon request from the corresponding author. *(Supplementary Materials)*

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