

# ADOPTION OF FARM MANAGEMENT PRACTICES IN LOWLAND RICE PRODUCTION IN NORTHERN GHANA

S. A. DONKOH<sup>1\*</sup> and J. A. AWUNI<sup>1</sup>

Department of Agricultural & Resource Economics, Faculty of Agriculture, University for Development Studies, Tamale, Ghana.

\* Corresponding Author's E-mail: [sammidonkoh@yahoo.com](mailto:sammidonkoh@yahoo.com) , Cell phone: (+233) (0)245728465

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The strategy of the Savannah Accelerated Development Authority (SADA) is 'based on the concept of a "Forested North" where agricultural production is modernized and oriented towards a larger market embracing the Sahelian countries, including northern Cote d'Ivoire and Togo. The modernization of agricultural production hinges on the adoption of efficient and sustainable farm management practices. The main objectives of the study were to find out: (1) farmers' perceptions on the most important farm management practices that are relevant in increasing their output or income; and (2) the determinants of the adoption of four soil fertility management practices (improved seed varieties, inorganic fertilizers, dibbling and sowing in rows). The methods of analysis involved a Kendall's Coefficient of Concordance and the estimation of an Ordered Probit Model for the two objectives respectively. The survey covered seven districts in the Upper East and Northern Regions involving a total of 300 lowland rice farmers. In order of importance, the farmers ranked the following as relevant in increasing their output and income : Timely land preparation; Good seed variety; Soil fertility; Water availability/irrigation; Planting time; Weed control; Harvesting time; Commodity price; and others (such as pests infestation). A Kendall's coefficient of 51% was recorded, which means that 51% of the respondents agreed on the ranking. The maximum likelihood estimation results of the probit model showed that extension visits, inputs, experience, training, group membership and household size had a positive influence on the adoption of farm practices while farm size and land ownership had negative influence on adoption. The farmers' field school and the extension delivery systems must be improved. More input shops must also be set up close to farmers for easy access to inputs. Also, in as much as large scale farming must be encouraged, this must not be done at the detriment of small-scale farming and the landless. Above all, it is important that whatever support that is given to the farmers must be timely so as to yield the full impact.

**Key words:** Adoption, Farm Management Practices, Kendall's Coefficient of Concordance, Northern Ghana, Ordered Probit.

## List of Abbreviations

AFD	Agence Française de Développement
CAADP	Comprehensive Africa Agriculture Development Programme
CARD	Coalition for African Rice Development
FAO	Food and Agriculture Organisation
FASDEP	Food and Agriculture Sector Development Policy
GPRS	Growth and Poverty Reduction Strategy
JIRCA	Japan International Research Centre for Agric science
LRDP	Lowland Rice Development Project
MAFF	Ministry of Agriculture, Forestry and Fisheries
MoFA	Ministry of Food and Agriculture
NDPC	National Development Planning Commission
NEPAD	New Partnership for Africa's Development
PSI	Poverty and Social Impact Analysis
SADA	Savannah Accelerated Development Authority
SSA	Sub-Saharan Africa
TICAD	Tokyo International Conference for African Development

## INTRODUCTION

In 2005, the Government of Ghana formulated the Growth and Poverty Reduction Strategy (GPRS II), aimed at achieving accelerated and sustainable shared growth and poverty reduction, among others. In this document, agriculture is expected to lead economic growth in much of the country, especially in the North of Ghana (NDPC, 2005). The agricultural Sector is targeted to grow at an annual rate of about 6% in order to ensure food security and adequate nutrition for all Ghanaians. This implies a doubling of the country's local output of rice. Agricultural policy therefore includes measures such as rice area expansion and intensification through irrigation and dissemination of improved on-farm technologies.

Northern Ghana comprises three regions: the Upper East Region, the Upper West Region and the Northern Region. These regions cover an area extending approximately between lat. 8°N and lat. 11°N. They comprise over 40% of the entire land area of Ghana, but contain about 20% of the national population estimated at about 24 million people. The total land area of Northern Ghana is about 98,000 km<sup>2</sup>, of which 16,000 km<sup>2</sup> are intensely farmed and about 8,000 km<sup>2</sup> are less intensely farmed. The major soils of the area are Alfisols and Plinthic Luvisols with their integrates. About 47% of the soils is considered not suitable for agricultural production, 25% are marginal, and about 28% are suitable for agriculture.

The fact that rice has become an important staple food globally is an understatement. According to the FAO (2006) rice supplies consumers with more calories (e.g. 27 and 20 percent respectively of dietary energy and protein) than other staple crops, particularly in the diets of very poor people whose food purchases account for more than half of all expenditures. The organization stresses that in SSA, rice is even more important considering the fact that many people, especially women and children are susceptible to deficiencies in micronutrients, particularly vitamin A, iron and Zinc. Unfortunately, even though global paddy production has been increasing (in 2005 it reached a record high of 629 million tonnes), it is only enough to cover consumption. In the case of SSA production continues to be outpaced by consumption. For this reason, the continent spends about 1 billion US Dollars annually on rice imports. In Ghana rice output is low compared with China, Vietnam and Thailand. For instance, in 2005 whereas rice output in Vietnam was 32 million tonnes, it was only 142, 000 tonnes in Ghana (FAO, 2006). The FAO (2006) laments that even though the world's population continues to increase, land and water resources for rice production are diminishing because of competition from other sectors of the economy and the increased population. Environmental degradation and climate change are also having large negative impacts on rice productivity.

Since Ghana's independence in 1957, the development of the rice industry has always been a priority in the country. In the 1960s, the Government of Ghana placed great emphasis on rice production in the North. It established large-scale rice farming by introducing subsidized tractors and scores of combine harvesters. Around the 1970s civil servants and local rich farmers embarked upon commercial rice farming. However, since the stoppage of government subsidies as part of the Economic Recovery Programmes in the 1980s, large-scale commercial rice farming declined considerably.

In the early 1990s, the Low Risk Rice Programme, funded by the World Bank and piloted by the Agriculture Engineering Department of the Ministry of Food and Agriculture (MoFA), introduced field bunding (the use of stones and grass bunds to trap water) to improve water harvesting to reduce hydrological risks. Most of the beneficiary farmers, however, were absentee commercial farmers. Though in the beginning they obtained good yields (about 3 tonne/ha), they failed to reimburse the credit provided by MoFA and the programme was abandoned. Some of the problems the farmers faced were bushfires at the start of the dry season, and combine harvesters that regularly broke down. In 1999, the Lowland Rice Development Project (LRDP) started. It was based in Tamale, with the objective of improving the production, processing and marketing of rice, originating from small-scale farmers. The project was funded by the Agence Française de Développement (AFD). By 2003, about 1,120 hectares of rice fields had been contour-bunded in both midlands and lowlands. During its five years' operation, average yields were about 3 tonne/hectare. The LRDP proved that intensive rice farming by small-scale farmers was feasible and economic. However, one of their main constraints was timely planting and harvesting as small holders generally gave priority to their upland crops. At the end of the project, farmers also demonstrated laxity in reimbursing credit.

Though the potential exists for rice production, yields obtained from the lowlands by small-scale farmers on the whole are very low. The low yields are mostly due to: lack of water control measures to make maximum use of the uneven rainfall distribution, inadequate input use (e.g. fertilisers and pesticides) either due to high cost or non availability and inadequate tractor and bullock services for proper land preparation. In normal years, farmers' average yield ranges between 1.5 to 2 tonnes per hectare, although 3 tonnes per hectare have been reported in some peak seasons (Feasibility Study Report LRDP, 1997). Farmers are also not well organised, with little information made available to them by extension services. They also have difficulty accessing short and long term credit facilities. However, despite the constraints, Northern Ghana has a high potential for rice

cultivation. At the moment paddy produced in Northern Ghana accounts for a large part of national production. The Northern Region in particular possesses a great potential for rice cultivation, and lowlands represent the largest area but are mostly unused. Official sources put the area of lowlands liable to flooding in the region at 400,000 hectares.

At the Fourth Tokyo International Conference for African Development (TICAD IV) in 2008, Japan made a plan to double African rice production during the coming decade to help African countries to resolve food crisis, so-called CARD (Coalition for African Rice Development). As a contribution to the goal of CARD, JIRCAS has started and commissioned research from Ministry of Agriculture, Forestry and Fisheries (MAFF) entitled "Improvement of soil fertility with use of indigenous resources in rice systems of Sub-Saharan Africa (SSA). This study is part of a broader research project aimed at understanding the present situation of local practices by rice farmers for soil fertility management, among others.

The specific objectives of this study, however, are as follows: (1) to find out farmers' perceptions about what farming practices are important in increasing farm output and revenue; and (2) to determine the factors that influence the adoption of such farm management practices. The farming practices considered in objective one are timely land preparation, adoption of good seed variety, soil fertility management, rainfall/water availability, weed control, right planting time, good harvesting time, and good market prices. It should be mentioned that price is not a farm management practice, but is equally important that we find out farmers' perceptions about its importance in influencing their output levels. For objective two the specific soil fertility management considered are the adoption of chemical fertilizers, improved varieties of rice seeds, dibbling as well as sowing in rows. Note that adoption of improved varieties of rice seeds appears in both objectives. There is however, a difference, in the sense that whereas in objective one we want respondents to rank its importance to increased yield, in objective two, the essence is to find out the impact of the explanatory variables on its (improved seed varieties) adoption.

The importance of good farm management practices cannot be over-emphasized. For instance, when seeds are sowed in rows, not only is there free movement of air for the plants' uptake, but the plants have enough sunlight to carry out photosynthesis. Similarly, dibbling prevents over-crowding of plants as well as making it difficult for birds and rodents to pick the seeds, thereby resulting in a high probability of germination. However, these practices may be quite laborious and expensive compared to not sowing in rows or broadcasting the seeds. Thus, as to whether or not a farmer would adopt these practices is dependent on that farmer's socio-economic backgrounds as well as some institutional and

farm-specific factors such as farm size, extension contacts, training and experience.

## MATERIALS AND METHODS

Considering the objectives of the study, two main analytical tools may be distinguished, namely, the Kendall's coefficient of concordance and the ordered probit model. These are discussed below.

### Kendall's Coefficient of Concordance

The Kendall's Coefficient of Concordance ( $W$ ) analysis is a statistical procedure used to rank (in this context) a given set of farming practices from the most important to the least important, and then measures the degree of agreement/concordance between the respondents (Edwards, 1964).

The formula for the coefficient of concordance ( $W$ ) is given as:

$$W = \frac{n[\sum T^2 - (\sum T)^2/n]}{nm^2(n^2 - 1)} \text{ or } nT/nm^2(n^2 - 1) \text{-----(1)}$$

Where:

$T$  = sum of ranks for the factors being ranked;

$m$  = number of respondents; and

$n$  = number of factors being ranked

Note that  $W$  is an index that measures the ratio of the observed variance of the sum of ranks and the maximum possible variance of the sum of ranks.

The maximum variance ( $T$ ) is given by:

$$T = m^2(n^2 - 1)/12 \text{-----(2)}$$

$$\text{Var}T = [\sum T^2 - (\sum T)^2/n] \text{-----(3)}$$

Where the variables are as defined.

The idea behind this index is to find the sum of ranks given to each item (in this case farming practice) being ranked by respondents and then examine the variability of this sum. If the rankings are in perfect agreement, the variability among these sums will be a maximum. The farming practices are ranked according to the most important to the least important using numerals 1, 2, 3, 4, .....  $n$ , in that order. The least score rank is the most important while the one with the highest score is ranked as the least important. The total rank score computed is then used to calculate for the Coefficient of Concordance ( $W$ ) to measure the degree of agreement in the rankings. The limits for  $W$  cannot exceed 1.00 and cannot be negative. That is, it can only be positive in sign and ranges from 0 to 1. It will be 1.00 when the ranks assigned by each respondent are the same as those assigned by other respondents and it will be 0.00 when

there is a maximum disagreement among the respondents.

The Coefficient of Concordance ( $W$ ) may then be tested for significance in terms of the  $F$  distribution as follows:

$$F\text{-ratio } (F_c) = (m - 1) \times W / 1 - W \text{ -----(4)}$$

$$\text{Degree of freedom for numerator } (df) = (n - 1) - (2 / m) \text{ ----}$$

$$\text{-----(5)}$$

$$\text{Degrees of freedom for the denominator } (df) = (m - 1) \{ (n - 1) - (2 / m) \} \text{ -----(6)}$$

In this study, farmers were asked to rank in order of importance, some farming practices by assigning 1 to the most important and 9 to the least important. The farming practices are as follows: timely land preparation; adoption of good seed variety, soil fertility management; rainfall/water availability; weed control; right planting time; good harvesting time; and good market prices among others. The Kendall's Coefficient of concordance has been applied to consumer preference for rice by Al-hassan et al., (2008).

**The Ordered Probit Model**

The ordered probit model is built around a latent regression in the same manner as the binomial probit model (Greene, 2003; Maddala, 1983) as follows:

$$y^* = x' \beta + \varepsilon \text{ (7)}$$

$y^*$  is not observable, instead we observe

$$y = 0 \text{ if } y^* \leq \mu_1$$

$$y = 1 \text{ if } 0 < y^* \leq \mu_1$$

$$y = 2 \text{ if } \mu_1 < y^* \leq \mu_2$$

$$\vdots$$

$$y = J \text{ if } \mu_{j-1} \leq y^*$$

Where  $x$  is a vector of independent variables. The  $\mu$ s are unknown parameters to be estimated with  $\beta$ , and  $\varepsilon$  is the two sided error term with mean zero and constant variance.

The probabilities are given as follows:

$$Prob(y = 0|x) = \Phi(-x' \beta)$$

$$Prob(y = 1|x) = \Phi(\mu_1 - x' \beta) - \Phi(-x' \beta)$$

$$Prob(y = 2|x) = \Phi(\mu_2 - x' \beta) - \Phi(\mu_1 - x' \beta)$$

$$\vdots$$

$$Prob(y = J|x) = 1 - \Phi(\mu_{j-1} - x' \beta) \dots (8)$$

For all the probabilities to be positive, we must have

$$0 < \mu_1 < \mu_2 \dots < \mu_{j-1} \dots (9)$$

The log-likelihood function and its derivatives are obtained by Maddala (1983).

The marginal effects of changes in the regressors for the first three probabilities in equation 8 are given as

$$\frac{\partial Prob(y = 0|x)}{\partial x} = -\phi(x' \beta) \beta$$

$$\frac{\partial Prob(y = 0|x)}{\partial x} = -\phi(x' \beta) - \phi(\mu - x' \beta) \beta$$

$$\frac{\partial Prob(y = 0|x)}{\partial x} = -\phi(\mu - x' \beta) \beta$$

(10)

The ordered probit model has been applied to women's role in farm management making process in Kaduna State, Nigeria by Damisa and Yohanna (2007).

**Empirical Model**

The dependent variable is adoption, ranging from non-adoption to full adoption. Four main soil fertility management practices were identified as: adoption of any chemical fertilizer; adoption of improved varieties of rice seeds; dibbling; and sowing in rows. If a farmer did not do any of these during the farming season under review he scores zero. Thus, he is a non-adopter. If he adopted one, two or three of them he is a partial adopter, but of course the one who adopted three is better than the one who adopted two. In the same vein, the one who adopted two is better than the one who adopted one. If a farmer adopted all the four he is a full adopter and scores four. Note that apart from the ordered probit model we could also have used a count data model such as the Poisson distribution.

Thus following from the theoretical model in equation 7, the empirical model is defined as:

$$y_i = \beta_0 + \beta_1 \text{ Extension} + \beta_2 \text{ Farmsize} + \beta_3 \text{ Land Ownership}$$

$$+ \beta_4 \text{ InputDist} + \beta_5 \text{ Experience} + \beta_6 \text{ Training} + \mu_1 \text{ (11)}$$

Where;

- $y = 0$  if a farmer failed to adopt any of the four categories of the farming practices during the farming season under review;
- $y = 1$  if a farmer adopted any one of the four categories of the farming practices;
- $y = 2$  if a farmer adopted any two of the four categories of the farming practices;
- $y = 3$  if a farmer adopted any three of the four categories of the farming practices; and
- $y = 4$  if a farmer adopted all the four categories of the farming practices.

**RESULTS**

Table 1 below shows the sum of ranks of the farming practices. The information is used to construct Figure 1 below and to compute the Kendall's Coefficient of Concordance ( $W$ ) in the Appendix.

Tables 2 and 3 give the results of the maximum likelihood estimation of the ordered probit Model (equations 11). While Table 2 shows the coefficients, Table 3 shows the marginal effects for all levels of the dependent variable

(adoption). What makes the the ordered probit (or ordered logit) different from the basic binary models is that it gives effects of changes in the explanatory variables on all the observed levels of the dependent

variable. It should be noted that being a limited dependent variable model, we are more interested in the marginal effects than the coefficient (Greene, 2003). In Table 2 the threshold parameters ( $\mu_1, \mu_2$  and  $\mu_3$ ) are reported. These thresholds provide help in calibrating differential individual adoption behaviour.

Table 1: Sum of ranks of farming practices

	T	T sqd	1	2	3	4	5	6	7	8	9	
Timely land prep	1	587	344569	186	116	39	60	20	42	84	40	0
Good variety	2	924	853776	18	268	177	92	170	162	21	16	0
Soil fertility	3	1107	1225449	28	60	276	252	270	102	63	56	0
Rainfall/Water Availability	4	1168	1364224	47	36	114	384	135	414	14	24	0
Weed Control	6	1446	2090916	5	26	111	204	480	462	70	88	0
Planting time	5	1339	1792921	17	74	141	120	345	396	182	64	0
Harvesting time	7	2004	4016016	1	8	15	40	50	144	1561	176	9
Price	8	2224	4946176	2	14	30	24	40	60	77	1896	81
Others	9	2695	7263025	0	0	0	4	0	0	0	0	2691
Total		13494	23897072									

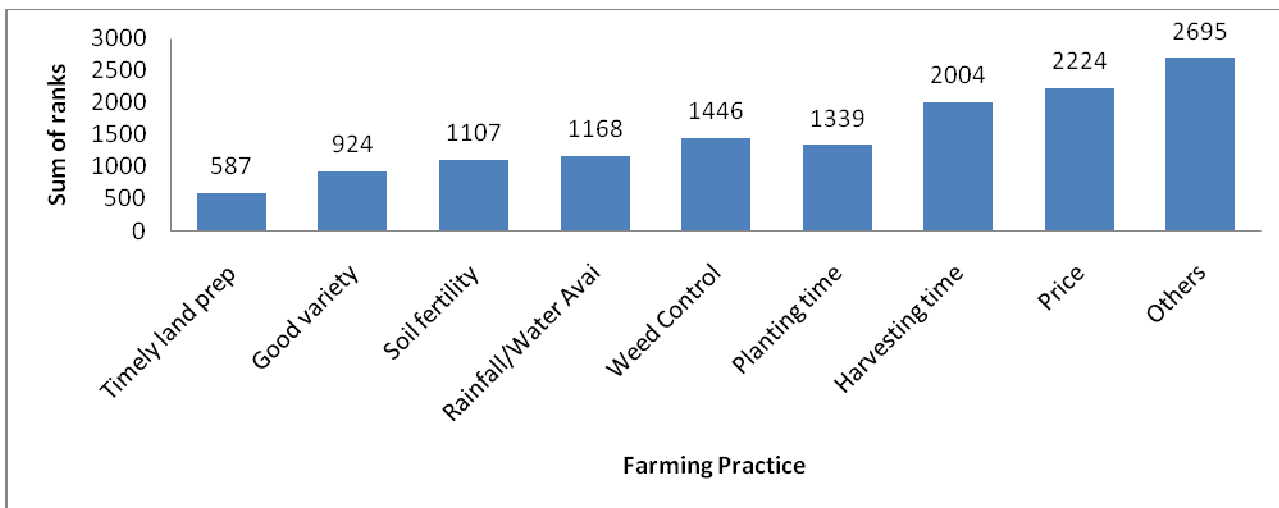


Figure1: Sum of ranks of farming practices

Table 2-Maximum Likelihood estimates of the ordered probit model.

Variable	Parameter	Coefficient	Standard error	t-ratio	Probability
Constant	$\beta_0$	1.67	0.25	6.73***	0.00
Extension	$\beta_1$	0.23	0.09	2.65***	0.00
Farm size	$\beta_2$	-0.19	0.09	-1.98**	0.05
Land ownership	$\beta_3$	-0.73	0.13	-5.54***	0.00
Input distance	$\beta_4$	-0.23	0.07	-3.16***	0.00

Table 2 continues

Experience	$\beta_5$	0.26	0.09	2.76**	0.01
Training	$\beta_6$	0.28	0.15	1.87*	0.06
Mu( 1)	$\mu_1$	1.18	0.12	9.98	0.00
Mu( 2)	$\mu_2$	2.11	0.13	15.79	0.00
Mu( 3)	$\mu_3$	2.71	0.14	18.60	0.00
Chi Square	$\chi^2$	-	-	68.53***	0.00

\*\*\*, significant at 1% \*\* significant at 5% \* significant at 10%

Note: Dependent variable: Farm management practice (improved seeds, inorganic fertilizers, dibbling, sowing in

rows). No. of observation= 301 Degrees of freedom=.6  
Log likelihood function and restricted log likelihood are -419.98 and -454.24 respectively.

Table 3: Marginal Effects of the explanatory variables on the Dependent Variable

Variable	Adoption=0	Adoption=1	Adoption=2	Adoption=3
Constant	-0.16	-0.42	-0.02	0.2
Extension	-0.02	-0.06	-0.00	0.03
Farm size	0.02	0.05	0.00	-0.02
Land ownership	0.07	0.19	0.01	-0.09
Input supply	0.02	0.06	0.00	-0.03
Experience	-0.02	-0.06	-0.00	0.03
Training	-0.02	-0.07	0.00	0.03

Marginal effects are computed at the means of the independent variables

The Kendall's Coefficient of Concordance ranking is done such that the most important variable has the smallest sum of ranks, while the least important variable has the greatest sum of squares. The degree of agreement among the respondents is measured by the W. The higher it is the better, because it shows that there is degree of agreement among the respondents. From the Appendix, the value of the Kendall's Coefficient of Concordance (W) was 51% and it is significant at 1%. This means that there is agreement among 51% of the respondents over the ranking of the farm management practices. As shown in Table 2, respondents ranked the farm management practices and commodity price in order of importance as follows: Timely land preparation; Good seed variety; Soil fertility; Water availability/irrigation; Planting time; Weed control; Harvesting time; Commodity price; and others, such as pests infestation.

In the case of the maximum likelihood estimation results of the ordered probit model, we found that extension visit, experience and training positively influenced the adoption of farm management practices. This means that the probability of adoption of farm management practices was greater for farmers who received greater number of visits from extension staff, farmers who had been in rice farming for a long time and farmers who had received training in the farming season under review. However, farm size, land ownership and input distance negatively influenced adoption, which also means that the probability of adoption was greater for farmers with smaller farm sizes, farmers who rented their farm plots as well as those whose farms were closer to an input store.

Finally, from Table 2, the P-value of  $\chi^2$  is zero, which implies that all the parameters, except the constant, are equal to zero. What this actually means is that all the variables jointly determine technology adoption

## DISCUSSIONS

### The Ranking of Farm Management Practices

Farmers are most concerned about the timely preparation of their farm plot. The implication is that any support offered them must come before the farming season begins. Over the years it has been observed that when farm inputs come late, they are misapplied and the intended purposes of raising farm outputs and incomes are not realized. Consequently, it becomes difficult for the farmer to pay back any loans he/she might have contracted. Defoer et al., (2009) observe that appropriate land preparation is an important determinant of rice yield in inland-valley lowland rice production systems. They stress that timely land preparation is crucial to avoid delays in crop establishment and to enable decomposition of organic material, such as crop residues and weeds. Furthermore, land-levelling facilitates water management, reduces weed germination and increases the efficiency of mineral fertilizers.

The fact that the adoption of good variety was ranked second by the farmers in the study area also has important implications. First, it underscores their willingness to adopt new varieties of rice seeds if they are perceived to be good. In general, farmers may be interested in high yielding, disease resistant and good-for-consumption varieties. Over the years, there have been instances where improved varieties have gone un-

adopted, apparently, because farmers did not have adequate knowledge about the usefulness of such varieties. In this case, it is important that extension officers make such information available to the farmers and encourage them, through demonstration farms and other useful media to adopt the varieties. The long run solution, however, is for technology developers (scientists and researchers) to collaborate effectively with the end-users of technology (farmers) as well as researchers in the development and dissemination of the innovations. Farmers are also concerned about soil fertility and water availability. It came to light however, that farmers were not applying organic fertilizers to their rice fields for fear that their lowlands would turn upland. Researchers as well as extension officers owe farmers an explanation to this fear that the farmers are having. Water is very essential for growth and other physiological activities of plants to take place, therefore, it is not surprising that farmers have ranked it as their number 4 concern. MoFA (2007) stresses that irrigation is indispensable, if agriculture is to be modernized and the vulnerability of small-scale farmers to rainfall variability is to be reduced, and yet statistics shows that less than 1 percent of arable land is under irrigation in Ghana. It also lamented that "formal irrigation development has been very much supply-driven and over-reliance on the formal system is limiting the area under irrigation (MoFA, 2007). For instance, it is reported that formal public irrigation schemes are operating 30% of their design capacity. Meanwhile, the informal sector is not having sufficient support to play its complementary role. In this study, the fact that farmers have ranked it as the fourth most important need is an indication that irrigation could now be demand-driven. This calls for the provision of an enabling environment and proper price regulation by government for the private sector to go into the production of small affordable irrigation schemes for an all-year round production of rice. North et al. (2002) stress that small scale-farmers need a directly accessible, convenient, low cost, and environment-friendly irrigation technology that enables assured access to water whenever needed. They found availability of funds, literacy status and family size as the main determinants of the adoption of small scale irrigation schemes in India and Nepal.

The agronomic practice of planting at the right time was also important since late planting could lead to reduction in crop yields as crops might not have adequate time to grow to maturity. Weeds compete with crops for water, nutrients and light resulting in the reduction of crop yield and farm revenue. Similarly, if post-harvest losses are to be minimized, harvesting must be done at the right time, hence, the farmers ranking harvesting time as the 7<sup>th</sup> most important issue. Price was ranked the last-but-one issue. This is surprising, considering the importance of price in stabilising farmers' revenue. However, probably, the variable was ranked so low because the farmers think that they have little or no control over its determination. Yet, price should be one of the most important factors to

consider if farm output and revenue must be maximized. ISSER (2007) reports that the average national whole sale prices of grain in 2007 were higher than the 2006 levels, with local rice in particular rising by 5%. Perhaps, farmers were satisfied with the price increase of their rice produce, hence, their ranking it as the 8<sup>th</sup> most important factor affecting their returns. The main problems relating to the marketing, and for that matter the prices of farm produce in Ghana are poor nature of roads to production centres, inadequate market information, as well as inadequate storage centres. Sachcharmarga and Williams (2004) also find that price changes are not sensitive to rice output in Thailand. Their argument is that rice cultivation in Thailand is not just food production but a way of life, which implies that rice price changes are not important in influencing the levels of output. The Thai situation may not be different from the Ghanaian situation where, majority of the small-scale farmers are not only producing on a subsistence basis, but also engage in farming as a way of life, rather than as a business.

#### **The Determinants of Adoption of Farm Management Practices**

As observed, the greater the number of visits that a farmer receives from an extension staff the greater the probability of adoption. Doss and Morris (2001), who also find this variable positive and significant, observe that the uptake of a new technology is facilitated by the farmers' contact with extension services, since extension officers provide both inputs and technical advice. Ransom et al., (2003) also find the variable to be significant in influencing the adoption of improved maize varieties in the hills of Nepal. The adoption of new technology is normally influenced by the farmer's contact with extension services, since extension agents provide inputs and technical advice (Doss and Morris, 2001). As strategized in FASDEP II, SADA, in collaboration with MoFA should ensure that a lot more organizations and institutions are brought on board to help in the extension delivery system so that there would be increased access for farmers. It is also hoped that there will be the use of more extension methods such as the farmer-field schools, nucleus-farmer-out growers, extension fields, communication vans as well as dissemination through farmer groups. For instance, Davis et al., (2004) observe that with the focus now on decentralization, democratization, pluralism and privatization, farmer groups are important stakeholders in extension.

The negative sign of farm size did not come as a surprise, considering the fact that most of these soil fertility management practices are laborious, and therefore farmers with small holdings stand a better chance of being able to manage their farm operations. However, in Mugwe et al., (2008), adopters of integrated soil fertility management practices tended to have bigger farm sizes than non-adopters. Also, Baptists et al., (2005) find adoption of improved sorghum varieties to be positively influenced by farm size. As reported by MoFA

(2007) in FASDEP II, the Poverty and Social Impact Analysis (PSI) identified five categories of farmers in Ghana as follows: Large scale commercial; small commercial; semi-commercial; Non-poor complex Diverse Risk Prone; and poor complex Diverse risk Prone farmers. We collaborate with MoFA's (2007) assertion that in formulating policies that would help farmers, such heterogeneity is taken into consideration so that each group would have their needs rightly met. For instance, in FADEP II, it is strategized that while risk-prone, largely subsistence farmers will be targeted with interventions to reduce their vulnerability and help them improve productivity, smallholder commercial and semi-commercial farmers will also be supported to improve productivity and to integrate them into markets competitively. In this case, it would be necessary for the small-scale farmers in the study area to be supported with the needed inputs, to raise productivity and also be well integrated into the marketing chain. Many a time, as a result of poor market access, small-scale farmers are at the mercy of middlemen who buy their produce at very cheap prices.

The fact that farmers who owned their farm plots had smaller probability of adoption, however, was not consistent with our *a priori* expectations, considering the thinking that such farmers would have greater motivation to develop their plots. Damisa and Yohanna (2007) find that women who rent their farm plots in Nigeria do not make significant participation in farm management decision making. Similarly, in Doss and Morris (2001) farmers who own their plot have greater probability of adoption than their counterparts who were tenants. Like Doss and Morris (2001), some analysts have observed that it is normally when the investments (to be made on their plots) are permanent that land owners are prepared to undertake. In this study, the adoption of improved seeds and fertilizers, as well as sowing and dibbling were seen to be short-term, hence, the smaller probability of adoption by land owners. The finding implies that tenants are normally innovative, who have taken farming as their business and therefore would adopt the necessary farming practices to ensure maximum returns. It should be noted that some of these renters do pay rents, most of the time in kind (normally farm produce), which means that they must aim at high yield in order to pay their indebtedness. On the other hand, those who own their plots may not necessarily be interested in farming, but have taken to farming as a way of life, and therefore are not keen in risking to adopt farm practices that may be expensive and laborious. Thus, we have two group of farmers; one group consisting of innovators who are renting their farm plots and another group who own their plot but are not necessarily innovators. The reasonable thing to do, by way of land policy, is for the former group to have the opportunity to buy their plots so that they can be more innovative. It should be borne in mind that the latter group may themselves not necessarily have absolute ownership of their plots, simply because the plot

may be a family inheritance, to which he/she may not have proper title. "In Ghana, complex and uncertain land tenurial arrangements have tended to hamper private investment" (Nankani, 2007). Nankani (2007) cites an empirical work in Akwapim by Goldstein and Udry (2008) in which it was found that because farmers did not have adequate legal right of ownership of their plots and were therefore not certain about their property's security during fallow periods, investment, and for that matter productivity was hampered. He estimates that the rate of return to land titles is about 39% and stresses that as much as 80% of the arable land in Ghana is uncultivated, partly because of insecure property rights. He however, admits that the Government has initiated a new Land Policy and Administration Project that seeks to address land issues comprehensively, but his concern is that the plan falls short of an action plan or an implementing strategy. There is the need for Government to speed up the reformation process and ensure that an implementing strategy is designed and followed. According to Nankani (2007) land reforms, and for that matter, markets have played a very important role in the agricultural revolution in many countries, including China and Vietnam.

The closer a farmer's farm is to an input store, the greater the probability of adoption. This meets our *a priori* expectation in the sense that the closer an input store is to the farmer's farm the greater his probability of adopting the inputs sold. In Honduras, Hintze et al., (2003) find that road quality index is significant in determining the adoption of improved maize variety. However, distance to the nearest (product) market is not significant. In Ghana issues concerning input demand include absence/inappropriate policy and regulatory framework or input marketing and low demand for agro-input. In this case, the strategies, as outlined in FASDEP II by MoFA (2007), are to advocate the passage and enforcement of laws and regulations; foster an enabling environment to enhance trade in and use of inputs; and facilitate the creation of the enabling environment for the establishment of input shops in the districts.

Farmers who had been in farming for a longer period had greater probability of adoption. This is arguably plausible, considering the fact that such farmers may have had the opportunity to try the innovation to see that it was good. "Increasing farming experience provides better knowledge about the environment in which decisions are made" (Lapple, 2010). On the other hand, some people may argue that farmers who have been in operation for long periods are conservative and are normally not willing to be innovative. This however, does not apply to the sample farmers in this study. In Ghanaian agriculture, as identified in FASDEP II, there is limited manpower to address current issues, including value addition and production of high value commodities. Also, most of the farmers, though experienced are aged and need to be replaced. Unfortunately, the youth are not attracted to agriculture.

Similarly, trained farmers have greater probability of adoption than their untrained counterparts. It has been argued that training is an added input which embraces good performance and adoption. The benefits of training include new knowledge, skills or attitudes. In Adesina and Baidoo- Forson (1995), a farmer's participation in on-farm tests, as well as the number of times farmers attend workshops influence the adoption of new agricultural technologies in Burkina Faso and Guinea.

**Conclusion**

The vision for the agricultural sector of Ghana as stated in FASDEP II is "a modernised agriculture culminating in a structurally transformed economy and evident in food security, employment opportunities and reduced poverty" (MoFA, 2007). As Nankani,(2007) observes, this vision is in line with the national vision in the GPRS II, CAADP and NEPAD. The intervention areas for the realization of the above vision as stated in the GPRS II include reform of land acquisition and property rights, accelerating provision of irrigation infrastructure, enhancing access to credit and inputs for agriculture, promoting selective crop development; and increasing access to extension service. These proposed interventions, which are also in line with SADA's objectives, have been validated in this study. Farming practices such as timely land preparation, good rice variety, soil fertility, rainfall/ water availability, weed control, planting time, harvesting time are the agronomic practices that lead to increased output of rice. Factors that influence the adoption of farm management practices are extension visits, farm size, land ownership, input distance, experience and training. Variables such as extension visits, inputs, experience, training, group membership and household size have a positive influence on the adoption of farm practices while variables like farm size and land ownership have negative influence on the adoption of farm practices. The following specific recommendations are made to SADA:

- i. Agricultural extension services should be tailored towards addressing the farming challenges of rice farmers through the dissemination of innovations including field schools and demonstration farms;
- ii. Farm inputs such as chemical fertilizer should be made accessible to farmers in order for them to be adopted for increased yield. The fertilizer subsidy instituted by the Government of Ghana is laudable and needs to be sustained;
- iii. Farmers with many years of farming experience should be encouraged to teach the less experienced ones by way of the out grower scheme; and
- iv. Regular training sessions should be organised to upgrade the knowledge and skills of farmers through the establishment of farmer training schools.

**Appendix-Computation of the Coefficient of Concordance and the level of significance.**

From the data  $n=9$  and  $m=301$ . Thus, given

$$VarT = [\sum T^2 - (\sum T)^2 / n] \text{-----}(12)$$

$$VarT = [23,897,072 - (13494)^2 / 9] \text{-----}(13)$$

$$= [23897,072 - 182,088,036 / 9]$$

$$23,897,072 - 20,232,004$$

$$= 3,665,068$$

$$W = nT / nm^2(n^2 - 1) \text{-----}(14)$$

$$W = \frac{9(3,665,068)}{9(300)^2((9^2) - 1)} \text{-----}(15)$$

$$= \frac{32,985,612}{9(90,000)(80)}$$

$$= \frac{32,985,612}{64,800,000}$$

$$= 0.51$$

Since  $W=0.51 > 0$  we can say that there is a degree of agreement among the rice farmers over the soil fertility management practices. However, we can test this to see the extent to which this is significant. This is done using the F-test as follows:

$$F_c = (m - 1) \times W / 1 - W \text{-----}(16)$$

$$= (300 - 1) \times 0.51 / 1 - 0.51$$

$$= 299 \times 0.51 / 0.49$$

$$= 299(1.04)$$

$$= 311.2$$

Degree of freedom ( $df$ ) for numerator

$$(n - 1) - (2 / m) \text{-----}(17)$$

$$(9 - 1) - (2 / 300)$$

$$= 8 - 0.01$$

$$= 7.99$$

Degree of freedom ( $df$ ) for denominator

$$df = (m - 1) \{ (n - 1) - (2 / m) \} \text{-----}(18)$$

$$= (300 - 1) \{ (9 - 1) - (02 / 300) \}$$

$$= 299 * 8 - 0.01$$

$$= 2391.99$$

$$F_{t0.001} = 2.51$$

$$F_c = 311.2$$

Since  $F_C > F_{t0.001}$  the null hypothesis is rejected and the alternative accepted, meaning that there is agreement (uniformity) among the respondents over the soil fertility management practices.

## REFERENCES

- Adesina, A. A. and Baidoo-Forson, J. (1995) *Agricultural Economics*. 13, 1-9
- Al-Hassan, R. M., Agbekporku, H. G., and Sarpong, D. B. (2008). Consumer preferences for rice quality characteristics in Accra and the effects of these preferences on price. *Agricultural and Food Science Journal of Ghana*. 7, .575-591.
- Baptists, J. Jattoe, D., Al-hassan, R.M Abatania, L.N (2005). Factors Affecting the Adoption of Sorghum Improved varieties among farm households in northwest Ghana: A probit Analysis. *Ghana Journal of Development Studies*, 2, 1.
- Damisa, M. A. and Yohanna. M. (2007), Role of rural women in farm management Decision making process: Ordered Probit Analysis. *World Journal of Agricultural Sciences* 3, (4): 543-546.
- Davis, K., Franzel, S., Hildebrand, P., Place, N. (2004), The role of farmer groups in technology dissemination: Ingredients for success. Proceedings of the 20<sup>th</sup> Annual Conference AIAEE, Dublin, Ireland.
- Defoer, T., Wopereis, M.C.S., Idinoba, P., Kadisha, T.K.L.Diack S. and Gaye, M. (2009), Curriculum for Participatory Learning and Action Research (PLAR) for Integrated Rice Management (IRM) in Inland Valleys of Sub-Saharan Africa: Facilitators' Manual, Module1, 1-7. African Rice Centre (WARDA). <http://www.warda.cgiar.org/publications/PLAR/manuel/Module7.pdf> Accessed (14, June, 2011)
- Doss, C.R. and Morris, M.L. (2001). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agricultural Economics*, 25, 27-39.
- Edwards, A. L. (1964). *Statistical Methods for the Behavioural Science.* Holt, Rmehart and Winston, New York, 402-410.
- FAO(2006) Report of the International Rice Commission. Twenty-First Session 1-88. <http://www.fao.org/ag/AGP/AGPC/doc/field/commrice/pages/finalreport.pdf> Accessed, (14,June, 2011)
- Goldstein, Markus, and Udry Christopher (2008). The Profits of Power: Land Rights and Agricultural Investment in Ghana. <http://www.econ.yale.edu/~cru2/pdf/goldsteinudry2008.pdf> Accessed, (14, June, 2011)
- Greene W.H. (2003) *Econometric Analysis*. New Jersey-U.S.A: Prentice Hall Griffin, 736-740.
- Hintze, L.H, M. Renkow, Sain, G. (2003) Variety Characteristics and maize adoption in Honduras. 307-317.
- ISSER (2007). The State of the Ghanaian Economy. Accra-Ghana. 145-146.
- Lapple, D (2010). Adoption and Abandonment of organic farming: An empirical investigation of the Irish Drystock Sector. *Journal of Agricultural Economics*, 61, 3.
- Maddala, G.S (1983). *Limited-Dependent and Qualitative Variables in Econometrics*.Cambridge University, New York, 6-26.
- MOFA (2007). Food and Agriculture Sector Development Policy (FASDEP II).Accra: Ghana.23-43.
- Mugwe, J., Mugendi, D., Mucheru-Muna, M. Mierckx, R., Chianu, J., Vanlauwe, B.(2008) Determinants of the Decision to adopt intergrated soil fertility management practices by smallholder farmers in the Central Highlands of Kenya. *Expl. Agric* 45, 61-75.
- Nankani, G (2007).The Challenge of Agriculture in Ghana. What is to be done. [http://www.gnankani.com/pdf/The\\_Challenge\\_of\\_Agriculture\\_in\\_Ghana.pdf](http://www.gnankani.com/pdf/The_Challenge_of_Agriculture_in_Ghana.pdf) Accessed (12, April, 2011)
- NDPC (2005). Ghana Growth and Poverty Reduction Strategy (2006-2009) (GPRS 11)Accra, Ghana.23-26.
- North, N., Bajrachorya, S., Gupta, S., (2002) Local environmental management in a north-South perspective issues of participation and knowledge management, 213-223.
- Ransom, J.K, Pandyal,K. Adhikari, K. (2003) Adoption of Improved varieties in the hills of Nepal . *Agricultural Economics*, 29,299-305.
- Sachchamarga, K., and Williams, G. W.(2004) Economic Factors affecting rice production in Thailand. TAMRC International Research Report No.IM-03-04