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Cost of Climate Change Adaptation Measures among Women Arable Crop Farmers in Ughelli-North and Sapele Local Government Areas of Delta State, Nigeria

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A R T I C L E I NFO

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ABSTRACT

This study examined cost of climate change adaptation measures among women arable crop farmers in Ughelli-North and Sapele Local Government Areas of Delta State, Nigeria. It specifically ascertained the various climate change adaptation measures practiced against climate change, determined the cost of climate change adaptation measures by women arable crop farmers and estimated the effect of socioeconomic characteristics on cost of adaptation to climate change. Six communities were sampled from each of the two LGAs to give 12 communities. 15 women arable crop farmers were sampled from each of the community to give a total of 180 small scale women arable crop farmers that were utilized for the study. Result indicated that to combat effect of climate change, 77.2% used drought resistant varieties, 97%, early planting 80.6%, minimum tillage and 96.% crop rotation. Flooding caused the highest climate-related loss of ₦926,000.00 annually while gully erosion caused damage of estimated value of ₦842,000.00 and damage by wind storm was estimated at ₦832,433.00. Age, marital status, level of education, farming experience, access to credit and number of contact with extension agents were statistically significant in determining women arable crop farmers' expenditure on measures adapted against climate related challenges on their farms. The null hypothesis which stated that socioeconomic characteristics of women arable crop farmers do not affect their expenditure on adaptation measures to climate change was rejected. It is recommended that for consistent growth in agricultural production, it is important to equip rural women farmers with relevant and timely information and technology to improve their production techniques and increase their income and standard of living.

1.0 Introduction

Decreasing rainfall, increases in temperature as well as increasing incidence of late onset of rains in the northern part of Nigeria are all signs of climate change. In the southern part, the main challenge remains mostly flooding of high intensity. As agricultural production in Nigeria is mostly dependent on rainfall, any erratic changes in rainfall and temperature will always exert adverse effect on her agricultural production as the country has only one rainy season which the agricultural production depends on (Assan *et al*, 2018). Ike and Ezeafulukwe (2015) explained that among the consequences of climate change on agriculture are the reduction in yield, losses in farm income, and a reduction in the well-being of farm households. These adverse impacts of climate change could also stifle efforts toward poverty reduction among rural dwellers that depend on agriculture and other climate-sensitive activities for their livelihoods and well-being. Some other studies in Nigeria have shown that losses due to the climate change annually is on the average of 5.5% of total output of some major staple crops such as maize, rice, cassava, yams, millet, sorghum, groundnuts, and plantain (Emaziye, Okoh and Ike, 2012). The study also concluded that revenues generated from crop production by farmers was impeded by increases in temperature occasioned by climate change. Thus, it is crucial for farmers to undertake adaptation strategies to help cushion them against the adverse impacts of climate change. Again, there is the need for agents of the State and other agricultural stakeholders to undertake appropriate adaptation measures as well as implement policies that will focus on transforming the agricultural sector which will ultimately enhance resilience of farm households.

Smallholder farmers in Nigeria have been adapting to variability in precipitation and average temperature over several decades. They engaged in livestock and crop diversification and also diversification into non-farm income-generating activities to improve their livelihoods. According to Nyong, Adesina and Elasha (2007) Climate change adaptation methods are strategies which enable individuals or communities to cope with or adjust to the impacts of changes in climate. Institutional support for adaptation improves farmers' ability to adapt to projections made on expected trends in rainfall, flood and temperature. Such institutional support must be made in such a way that all gender are accommodated. The impacts of climate change are expected to differ across agro-ecological zones and among households because of differences in resources, which tend to influence adaptive capacity.

Ike and Ezeafulukwe (2015) observed that women small scale farmers are much more affected by the challenges arising from changes in climate due to the inherent inadequacies as well lack of capacities to adapt and diversify into other livelihood options. There is gender bias in the nature of vulnerabilities to climate change. This therefore makes the mainstreaming of gender in interventions in climate change adaptation to be very important. As is the case with males, female farmers also have agency and as well possess important knowledge which is useful in planning interventions in climate change adaptation and also strategy development for tackling climate change impacts that are related to food security and household well-being.

Studies have been conducted in Nigeria to explore how agriculture have been impacted by climate change. Others studies have been on vulnerability to climate change and adaptation strategies by farm households in countering the negative challenges of climate change, and also the importance of adaptation strategies among others. None of these studies have focused solely on cost of climate change adaptation measures among women arable crop farmers in Delta State, Nigeria. Hence, this study which sought to analyse the Cost of Climate Change Adaptation Measures among Women Arable Crop Farmers in Ughelli North and Sapele Local Government Areas of Delta State, Nigeria. The study objectives were to: (i) ascertain the various climate change adaptation measures practiced against climate change, (ii) determine the cost of climate change adaptation measures by women arable crop farmers and (iii) estimate the effect of socioeconomic characteristics on cost of adaptation to climate change.

2.0 Review of Literature

According to Farauta, Egbule, Idrisa and Agu, (2011), natural changes in climate result from interactions such as those between the atmosphere and ocean and are referred to as internal factors, and from external causes, such as variations in the sun's energy output which would externally change the amount of solar radiation that reaches the earth's surface and in the amount of material injected into the upper atmosphere by explosive volcanic eruptions. A conceptual model was developed (Figure 1) that facilitates the understanding of farmer adaptive decision making. The framework is a combination of that adaptive decision making as developed by Smit and Skinner (2002) and the Theory of Planned Behavior (TPB) as put forward by Ajzen (1991) as well as the Reasoned Action Approach (RAA) by Fishbein and Ajzen (2010).

The linking of these two conceptual frameworks together brings about a better understanding of the intention of the farmer to adapt to climate change in the agricultural context. The various factors that help to explain decisions taken by farmers to manage the various risks associated with weather were explained by Smit *et al*. (2000). Among these factors are climate related stimuli, the scale and responsibility of farmer, the various forms of adaptation and other non-climatic factors/conditions, as well as the evaluation of the effects of adaptation. Climate-related stimuli according to Smit *et al*. (2000) is the form, timing, and severity of a given climate signal while scale and responsibility refers to whom or what entity is involved in adapting and at what scale.

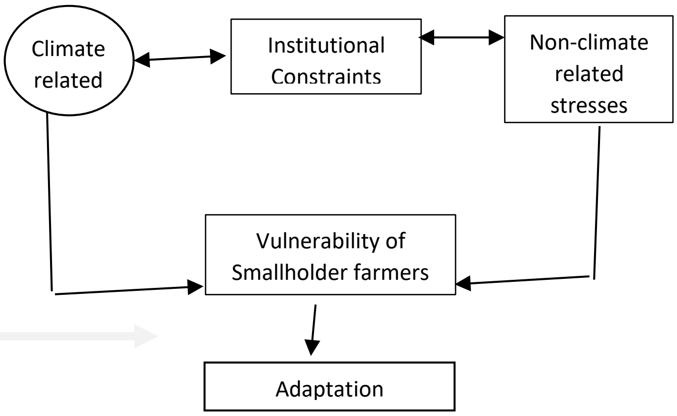

***Figure 1**: Conceptual Framework on Climate Change Impact on Arable Crop Farmers*

This research focused on how women small scale arable crop farmers would change or maintain their current farm management practices as a response if there is a signal of changes in climate and the form of adaptive actions. Smit and Skinner (2002) identified four different types of adaptation in the agricultural sector. These forms are technical development and government/insurance while others are farm production practices, and farm financial management.

The second conceptual framework developed on cost of climate change adaptation and presented in Figure 2 shows the linkage between climatic variables with agricultural production, hence food security. Climate change influence the various policies that governments make and the adaptation strategies adopted by victims of climate change. Policies and various Institutions existing also have influence on households' susceptibility to climate change. Crop yield and the livelihood patterns of different households are affected by changes in climate depending on adaptation strategies put in place.

Smit and Pilifosova (2001) observed that the adaptation strategies of households generally determine to a great extent the productivity of ecosystems as well as their food security status. Households' livelihoods and food security is negatively impacted by low agricultural production and productivity due to climate change. It is well known that as defined by FAO (1996) that food security exist when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and health life. Food availability is a function of domestic production, distribution, storage, imports and exports. In most cases food availability is used as a measure of food security.

The conceptual framework was developed on the bases that climate change has an impact on agriculture. To improve on this situation, households adapt to the changed climate with the aim of reducing the effects. However, to achieve maximum yields, the adaptation strategies must be assessed to identify the most economic and effective adaptation strategies. Cost benefit analysis is used to evaluate the strategies such that improved yields can be realized even if there are negative impacts of climate change. This also allows farmers to choose the most efficient strategy.

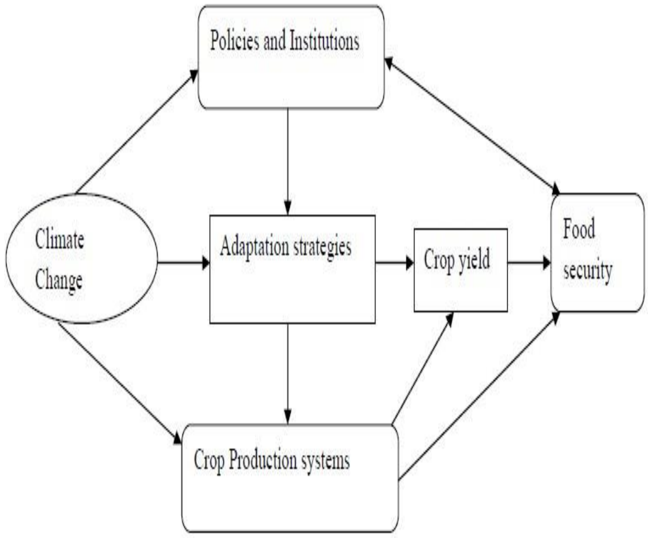

Figure 2.2 *Conceptual framework on Cost of Climate Change Adaptation Measures*

3.0 Methodology

The study was carried out in Ughelli North and Sapele Local Government Areas (LGAs) of Delta State, Nigeria. The two LGAs are among the twenty-five (25) LGAs that make up Delta State. They are both in the Central Agricultural zone of Delta State. The two LGAs were selected for the study because they are the areas where farming is mostly carried out in the zone. **Ughelli North** LGA has the headquarters located in Ughelli town and it has a land area of about 818 Km^2 with a population of 321,028 in 2006 while **Sapele** LGA on the other hand has its capital/administrative headquarters in the Sapele town. Sapele is part of Okpe kingdom which is under the Urhobo ethnic group with a population of 242,652 as of 2005/06 (NPC, 2006).

3.1 Sampling Procedure/ Data Collection

A two-stage sampling procedure was used for the study. Stage one involved the random selection of six communities from each of the two LGAs. This gave a total of twelve (12) communities. The second stage involved selecting randomly fifteen women arable crop farmers from each of the sampled community. This gave a total of 180 small scale women arable crop farmers that were utilized for the study.

Data for this study were collected from primary sources through the use of a structured questionnaire. Data were generated on women small scale arable crop farmers' socioeconomic characteristics, various adaptation measures against climate change, cost of climate change adaptation measures and constraints of small scale farmers to adaptation to climate change.

3.2 Methods of Data Analysis

Data for this study were analysed through the use of descriptive and inferential statistics. Descriptive statistical tools such as mean, percentages and frequency tables were used to summarize the data in ascertaining the various climate change adaptation measures practiced against climate change. The cost of climate change adaptation measures was realized by the use of cost and return analysis while the effect of socioeconomic characteristics on cost of adaptation was achieved through the use of Ordinary Least Square (OLS) Regression analysis.

The stated Hypotheses was tested through the use of Multiple Regression analysis.The multiple regression was adopted to examine the effect of socioeconomic factors of smallholder farmers on cost of adaptation measures to climate change. The model is implicitly expressed as:

COA =f (AGE, MTS, HHS, EDU, FMA, EXP, ACC, EXTC; e_i

Where:

COA = Cost of Climate change adaptation in Naira

AGE = Age of smallholder farmer (years)

MTS = Marital status (dummy: married 1; otherwise 0)

HHS = Household size (number of persons in a household)

EDU = Educational level (years of formal education)

FMZ = Farm size in hectares

EXP = Years of experience in the farming enterprise (years)

ACC = Access to credit (dummy: If credit was accessed 1; otherwise 0)

EXTC = Extension contact (Number of visits of Extension officers)

$\beta_0 - \beta_8$ = Parameters to be estimated

e_i = Error term

The equation is explicitly specified and tried in four functional forms of the regression model (linear, exponential, semi-log and double-log) and output of the form with best result according to econometric *apriori* criteria was adopted as the lead equation.

The ordinary and transformed values of the dependent and independent variables were fitted into the respective models and analyzed using appropriate statistical package. The regression output that produced the best result in terms of number of significant parameters, values of F- statistic and coefficient of multiple determination (R^2) was chosen as the lead equation.

4.0 Results and Discussion

(i). Adaptation Strategies Employed by Women Arable Crop Farmers against Climate Change

According to Sofoluwe, Tijani and Baruwa (2011) as reported by Shongwe, Masuku & Manyatsi (2014), agriculture is negatively affected by climate change, while adaptation reduces the impact and increase resilience to climate change such that those farmers who adapt are less vulnerable to these negative impacts of climate change. Adaptation strategies employed by the respondents are indicated on Table 1.

The results indicate that the majority (77.2%), of the women arable crop farmers in the area were adapting by using drought resistant varieties. Early planting as a strategy for averting the consequences of climate change on their farming activities was employed by over 97% of the respondents. This goes to show the importance of this strategy in checkmating the consequences of climate change in the area. The use of early planting as an adaptation strategy against climate change by large number of farming household has also been reported by Shongwe *et al* (2014) in their study on Cost Benefit Analysis of Climate Change Adaptation Strategies on Crop Production Systems in Mpolonjeni Area Development Programme (ADP) in Swaziland.

The respondents indicated that they took advantage of early rains as compared to late planting. Two other strategies, minimum tillage (80.6%) and crop rotation (96.7%) were alluded to as among the most effective measure of combating the negative effects of climate change in arable crop production by the respondents. The use of crop rotation as an important method of averting the consequences of climate change has been reported by many researchers including those of Sofoluwe *et al,* (2011) and Shongwe *et al* (2014).

Adaptation strategies that received the least responses were mulching (11.1%) and irrigation (19.4%). This is in support of the work of Abiodun *et al,* (2011) that irrigation involves high capital investment, which can be a challenge to most rural households because of poor financial background. The strategy also needs a good, reliable water source, which is not the case at in most communities under study in both Ughelli North and Sapele LGAs.

(ii). Cost/Expenditure on Climate Change Adaptation Measures by Women Arable Crop Farmers

The various damages to the farms/products of women arable crop farmers in the study area which are climate-related were identified and the financial cost for their remediation as well as losses were presented in Table 2.

The result in the table shows nine climate-related damages/losses/mitigations and annual remediation values. Most of the respondent women small scale arable crop farmers (91.7%) suffered flooding following heavy rainfall and overflow of river banks after such heavy rains. The swampy nature of some farm land according to the respondents also contributed highly to the flooded situations in the farms. Damage to crops was perceived as the highest climate-related expenditure (₦926, 000.00 annual losses) by the women arable crop farmers in the study area and was ranked first.

These heavy rains occasioned by changes in climatic condition most times created erosion, especially gully erosion causing damage to an estimated value of ₦842,000.00 to over 68% small scale women arable crop farms in the area and was ranked second. In the same vein, Wind storm was equally devastating creating annual damages of an estimated value of ₦832,433.00 to over 81% of the women arable crop farms. This was ranked third. Most of the crops affected in this category were plantain and maize farms. Reports showed that at times, farmers wake up to see all the growing plantain farms with promising bunches all broken and some fallen flats due to the activities of violent wind storm which is one of the consequences of climate change.

Damages to crops by thunder and lightning, rot arising from high temperature (heat), control of excessive weeds and insect pests due to high rainfall, damages to harvests due to absence of sun rays for drying/preservation, control of excessive heat and drought by tree planting and cultural control of erosion and flood were climate related effects as perceived by the women small scale arable crop farmers and were ranked fourth, fifth, sixth, seventh, eighth and ninth respectively.

(iii). Effect of Socioeconomic Characteristics of Women Arable Crop Farmers on Expenditure of Adaptation Measures to Climate Change

The various socioeconomic variables of women arable crop farmers in the study area which could impact on their expenditure on different forms of adaptation measures to climate change were examined. The analysis revealed the effects of the socioeconomic characteristics of women arable crop farmers on the amount of money spent on various adaptation measures against the effect of climate change variables in the area (Table 3).

Four (4) different functional forms were fitted to the data and the lead equation was chosen based on the normal econometric and statistical criteria. The coefficient of multiple determination (R^2) for the double log function was the highest (0.7784). Hence the double log model was chosen as the lead equation and used for further analysis of the data. The result revealed that the R^2 was 0.7784 and showed that the extent to which the socioeconomic characteristics of the women arable crop farmers predicts the amount that can be spent on adaptation measures against climate change effects was 77.8%. The adjusted R^2 was 0.6607 and this indicates that 66% of the variance in the amount spent on adaptation measures was accounted for by the socioeconomic characteristics of the respondents in the study area.

Age of women arable crop farmers, marital status, level of educational attainment, farming experience, access to credit and number of contact with extension agents were all statistically significant in determining women arable crop farmers' expenditure on measures adapted against climate related challenges on their farms. While age of the farmers and contact with extension agents were significant at the 5% level, level of educational attainment, farming experience and access to credit were significant at the 1% level. Marital status of the farmers however was significant at the 10% level.

Age of women arable crop farmers: The Beta coefficient had a positive value ($\beta=0.9072$; $P<0.05$) implies that an increase in age of the women arable crop farmers lead to an increase in the amount of money spent on fighting against the challenges of climate change. This result suggested that a 1% increase in age increased the probability of the respondent to make more expenditure by 0.9072%.

Marital Status: This was found to negatively determine women arable crop farmers' expenditure on measures adapted against climate related challenges at 10% significance level ($\beta=-2.0181$; $P= <0.10$). This result implied that married respondents has the probability of reducing their expenditure on adaptation measures to climate change related problems.

Education: This was found to be a positive predictor ($\beta=0.5157$; $P<0.01$) of amount of women arable crop farmers' expenditure on measures adapted against climate related challenges in the study area. This result implied that a 1% increase in level of educational attainment by the respondents had the probability of increasing expenditure on adaptation measures by 0.52%, *ceteris paribus*.

Farming Experience: The number of years of farming experience by the women arable crop is positive and statistically significant on its effect on the level of expenditure on climate adaptation measures. The parameter estimate (β= 0.6254) with a t-value of 4.2256 is statistically significant at the 1% level. This result implies that a 1% increase in farming experience of respondents increases the probability of spending more on adaptation measures by 0.63%.

Access to Credit: Access to agricultural credit by women arable crop farmers had a positive statistically significant effect on the amount of money that can be expended on climate change adaptation measure. With a coefficient value of 4.6472 and a t-value of 3.6557, it is significant at the 1% level. The implication of this is that an increase in financial credit given to the women arable crop farmers will propel them to spend more in combating the challenges posed by climate related damages in their farms.

Extension Contact: The number of contact with extension farmers affected the level at which women arable crop farmers spend to combat the incidences of climate change in the study area. The coefficient (β= 0.6625) with a t-value of 2.5346 is positive and statistically significant at the 5% level. This implies that a 1% increase in the frequency of contact with extension officers will improve the women arable crop farmers by about 0.66%.
The F-statistic value of 15.0693 indicated that collectively all the socio-economic characteristics of the women arable crop farmers significantly influenced expenditure on checkmating damages of climatic variables, and that the regression model was a good fit for the data. Therefore, the null hypothesis which stated that socioeconomic characteristics of women arable crop farmers do not affect their expenditure on adaptation measures to climate change is hereby rejected.

5.0 Summary and Conclusion

The different strategies employed by women small scale arable crop farmers to combat the challenges of climate change indicated that majority (77.2%) were adopting by using drought resistant varieties, early planting was employed by over 97% of the respondents while minimum tillage (80.6%) and crop rotation (96.7%) were alluded to as among the most effective measure of combating the negative effects of climate change in arable crop production by the respondents. Others were mulching (11.1%) and irrigation (35%).

Most of the respondent women small scale arable crop farmers (91.7%) suffered flooding following heavy rainfall and overflow of river banks after such heavy rains and damage to crops was perceived as the highest climate-related loss of ₦926, 000.00 annually while gully erosion caused damage to an estimated value of ₦842,000.00. Damage by Wind storm was estimated at value of ₦832,433.00 while damages to crops by thunder and lightning, rot arising from high temperature (heat), control of excessive weeds and insect pests due to high rainfall were minimal.

The various socioeconomic variables of women arable crop farmers which could impact on their expenditure on different forms of adaptation measures to climate change revealed that age, marital status, level of educational attainment, farming experience, access to credit and number of contact with extension agents were statistically significant in determining women arable crop farmers' expenditure on measures adapted against climate related challenges on their farms. While age of the farmers and contact with extension agents were significant at the 5% level, level of educational attainment, farming experience and access to credit were significant at the 1% level and marital status was significant at the 10% level. The null hypothesis which stated that socioeconomic characteristics of women arable crop farmers do not affect their expenditure on adaptation measures to climate change was rejected.
Apart from labour issues more than half of the respondents rated every other constraint as being an impediment to adaptation measures against climate change in the area. Among these are farm land related constraints which includes limited availability of land for farming, high cost and system of land ownership (tenure system). Other major constraints were rain fed/ unreliable water source, high cost of farm inputs (i.e. fertilizer, pesticides, seeds etc.), inadequacy of information on climate change and poor agricultural extension service delivery system.

5.1 Conclusion

This study concludes that flooding was the major damage to crops incurred the highest climate-related expenditure of ₦926, 000.00 per annum. Age of the women farmers, marital status, level of education, farming experience and access to credit, number as well as contact with extension agents were all statistically significant in determining women arable

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crop farmers' expenditure on measures adapted against climate related challenges on their farms.
Based on the findings of the study, the following recommendations are made:

i. For consistent growth in agricultural production, it is important to equip rural women farmers with relevant and timely information and technology to improve their production techniques and increase their income and standard of living.

ii. There is the need for Government at all levels to make agricultural extension programme more effective through employment of more extension agents so that there will be adequate dissemination of appropriate and timely information to women arable crops farmers so as to enhance production which could in turn improve their household food security, income and standard of living.

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Table 1: Adaptation strategies employed by women arable crop farmers against climate change

Adaptation Strategy Used	Frequency (Did Use)	Percentage (Did Use)	Frequency (Did Not Use)	Percentage (Did Not Use)
Drought resistant varieties	139	77.2	41	22.8
Early planting	176	97.8	4	2.2
Late planting	56	31.1	124	68.9
Minimum tillage	145	80.6	35	19.4
Crop rotation	174	96.7	6	3.3
Mulching	20	11.1	160	88.9
Irrigation	35	19.4	145	80.6
Intercropping	138	76.7	42	23.3

**Note: Multiple responses were recorded*

Table 2: Estimated annual average expenditure/ cost of adaptation on climate related damages in the Farm (180)

Damages/Losses	Frequency	Percentage (%)	Annual Estimate of Cost/Loss (₦)	Rank
Damages to Crops in the Farms by flood	165	91.7	926,000.00	1st
Damage to Crops occasioned by gully erosion in farms	123	68.3	842,000.00	2nd
Damage to crops due to wind storm	147	81.7	832,433.00	3rd
Damage to Crops due to thunder and lightening	132	73.3	723,825.00	4th
Rotting of Crops due to excess heat	117	65.0	642,000.00	5th
Control of excessive weeds and insects pests due to high rainfall	109	60.6	628,120.00	6th
Damages to harvest due to absence of sunlight for drying/preservation i.e. High relative humidity	105	58.3	530,120.20	7th
Control of excessive heat and drought by tree planting	99	55.0	527,060.00	8th
Cultural control of erosion and flood with bonds, cross bars, cover crops and alley cropping	123	68.3	522,300.00	9th

**Note: Multiple responses were recorded*

Table 3: Determinants of expenditure on climate change adaptation measures by women arable crop farmers

Variables	Linear	Semi-log	Double log	Exponential
Constant	2.3624**	0.4572***	0.3658***	0.9907***
	(0.2985)	(4.3651)	(4.9427)	(4.1257)
Age	0.1245	0.8123**	0.9072**	0.6325**
	(0.2743)	(2.4127)	(2.5457)	(2.3254)

Variables	Linear	Semi-log	Double log	Exponential
Marital status	-0.3755	-2.3913**	-2.0181*	-0.5621
	(-0.1246)	(-2.5128)	(-1.8366)	(-0.6248)
Household size	0.9658	1.7505	0.4733	-1.0728***
	(0.9685)	(1.3734)	(0.3561)	(-3.2721)
Educational level	0.2187	0.5138	0.5157***	1.0139**
	(0.3561)	(0.7851)	(3.1569)	(2.5031)
Farming experience	-0.3525***	0.7854	0.6254***	2.8110**
	(3.9657)	(0.4589)	(4.2256)	(2.9659)
Farm size	0.3546	0.7821	0.4325	0.8198
	(0.2487)	(0.6953)	(0.1254)	(1.9832)
Access to Credit	4.9856***	3.6732	4.6472***	2.0984
	(3.91240)	(0.7892)	(3.6557)	(0.5746)
Extension Contact	0.3682	0.3357	0.6625**	0.4362
	(0.3566)	(0.2548)	(2.5346)	(0.5202)
R^2	0.4957	0.4555	0.7784	0.6213
Adjusted R^2	0.4542	0.4254	0.6087	0.5922
F-ratio	9.1254***	6.4653***	15.0693***	12.5476***

Figures in Parenthesis are t-values
Note *** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%;