THE CHOICE OF CLIMATE CHANGE ADAPTATION STRATEGIES AMONG FOOD CROP FARMERS IN SOUTHWEST NIGERIA

A. A. Enete[1], M. A. Otitoju[1,2] and E.J. Ihemezie[1]
[1]Department of Agricultural Economics, University of Nigeria, Nsukka Enugu State, [2]Agricultural Biotechnology and Bioresources Development Department, National Biotechnology Development Agency, Abuja.

Abstract

The performance of food crop production is currently, greatly threatened by climate change. However, the extent to which these impacts are felt depends principally on the adaptation measures used by farmers to cushion the effects of climate change. This study centered on the factors that drive the choice of major adaptation measures by farmers in Southwestern Nigeria. The study used multistage sampling procedure to select 360 food crop farmers in the area. Primary data were collected through surveys to achieve this. Data analysis was done using descriptive statistics and multinomial logit model. The results indicated that the main climate change adaptation strategies were multiple crop varieties, land fragmentation, multiple planting dates, crop diversification, off-farm employment and cover cropping. Factors influencing the choice of these adaptation strategies were household size, age, education, gender, average farm distance, access to credit, tenure security, and agro-ecology. A summary of their influence on the farmers' choice of adaptation strategies suggests a relatively growing popularity for the use of cover cropping as an adaptation strategy among them. Increased use of cover cropping as climate change adaptation strategy should therefore be encouraged among farmers. In addition, land tenure security encouraged the choice of crop diversification among the respondents. This is also considered a very important strategy, given that different crops have varying degrees of resilience to climate change. A kind of land reform strategy that could make the farmers more land secured is therefore recommended.

Keywords: Climate Change, adaptation strategies, food crop framers, Nigeria.

Introduction

The performance of food crop production is currently, greatly threatened by climate change. However, the extent to which these impacts are felt depends principally on the adaptation measures used by farmers to cushion the effects of climate change. Nigerian agriculture is already under significant pressure to meet the demand of rising population, using finite, often degraded soil and water resources, which are now further stressed by the impact of climate change (Awotoye and Mathew, 2010). There are two central ideas for dealing with climate change, namely, mitigation and adaptation. Adaptation to climate change is an adjustment made to human, ecological or physical system in response to vulnerability (Adger*et al*., 2007). Adaptation helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socioeconomic conditions, including volatile short-term changes in local and large-scale markets (Kandlinkar and Risbey, 2000). Adaptation reduces the negative impact of climate change (Adger*et al*., 2003; Kurukulasuriya and Mendelson, 2006a). The modification of agricultural practices and production in order to cope with climate change will be imperative in order to meet and continue meeting the growing food demands of Nigerians. Evidence shows that farming systems and farming technologies in Nigeria have been changing in response to the effects of climate change (Adebayo *et al.,* 2011a). Farmers, especially food crop farmers, can reduce the potential damage by making tactical responses to these changes. Jagtap (1995) identified crop diversification, mixed cropping, using different crop varieties, changing planting and harvesting dates and drought resistant varieties. Enete *et al*. (2011) also identified multiple/intercropping, agro-forestry/afforestation, mulching, purchase/harvest of water for irrigation, among others as some of the climate change adaptation strategies in Southeastern Nigeria. Adebayo *et al.,* (2011a, 2011b) reported tree planting, timely planting of crops, avoidance of bush burning, small-scale irrigation, mulching, avoidance of felling trees and studying weather condition before planting crops as climate change adaptation strategies promoted by extension officers to assist farmers cope with climate change in Southwest Nigeria.

None of these studies dwelt on the factors that drive the choice of climate change adaptation strategies by farmers. Although, Ajao and Ogunniyi (2011) attempted to deal with this, their study had some methodological shortcomings. This study therefore, centred on the factors that drive the choice of major adaptation measures by farmers in Southwestern Nigeria.

Methodology

Method of data collection

The study area is Southwest Nigeria. Multistage Sampling Procedure was used to select 360 food crop farmers in the area. The Southwestern states were first classified into the two dominant agro-ecological zones in the region where food crop production predominates namely; savannah and rainforest. One state was then randomly selected from each agro-ecological zone, making two states for the study. The selected states are Ekiti and Ondo states from the savannah and the rainforest agro-ecological zones respectively. In addition, 3 extension blocks were randomly selected from each of the 4 agricultural zones (2 zones of each state), making 12 extension blocks in all. Two (2) farming villages/communities were then randomly selected from each extension block, making a total of 24 villages/communities. In each community/village, with the assistance of the local extension personnel, a list of food crop farm households was compiled and then 15 farmers were randomly selected, making a sample size of 360 farmers for the study.

Estimation procedure:

Data were analysed using the multinomial logit (MNL) model. MNL was employed because it is widely used in adoption decision studies involving unordered multiple choices and is easier to compute than its alternative, the multinomial probit (MNP) model.

The Multinomial logit (MNL) model for climate change adaptation choice specifies the following relationship between the probability of choosing option A_i and the set of explanatory variables X as (Greene, 2003):

$$\Pr(Y_i = j) = \frac{e\beta_j{}' x_{ij}}{1 + \sum_{m=0}^{6} e^{\beta_m x_{ij}}}, j = 0,1,2,3,\ldots,6$$

Where β_j is a vector of parameters that relates the socio-economic, farm and institutional characteristics x_i to the probability that $Y_i = j$. Because the probabilities of the six (6) main climate change adaptation strategies must sum to one, a convenient normalization rule is to set one of the parameter vectors, say β_0, equal to zero ($\beta_0=0$). The probabilities for the six (6) alternatives then become (Greene, 2000):

$$P_j = \Pr(Y_i = j) = \frac{e^{\beta_j{}' x_{ij}}}{1 + \sum_{m=0}^{6} e^{\beta_m x_{ij}}}, j = 1,2,3,\ldots,6$$

The estimated parameters of a multinomial logit system are more difficult to interpret than those of a bivariate (or binomial) choice model. Insight into the effect that the explanatory variables have on the climate change adaptation strategies choice can be captured by examining the derivative of the probabilities with respect to the kth element of the vector of explanatory variables. These derivatives are defined as (Greene, 2000):

$$\frac{\partial \Pr(Y_i = j)}{\partial x_{ik}} = P_j \left[\beta_{jk} - \sum_{m=0}^{6} \Pr\left(Y_i = m\right)\beta_{jk}\right] j = 0,1,\ldots,6;\ k = 1,\ldots,k$$

Clearly, neither the sign nor the magnitude of the marginal effects need bear any relationship to the sign of coefficients. The Y_i is the probability of choosing a climate change adaptation strategy. The main climate change adaptation strategies used here were coded as follows: 1. for multiple crop types/varieties, 2. for change in location of food crop farmlands/plots (i.e. land fragmentation/ land use planning), 3. for change in timing of operations/ change in planting dates (i.e. multiple planting dates), 4. for crop diversification (i.e. changes in crop mix), 5. For diversification of source of household income to unrelated off-farm employment (off-farm employment opportunities) and 6 for planting of cover crops (cover cropping).

Results and Discussion

Socio-economic characteristics of the respondents:

Majority (70%) of the farmers fell within 20-60 years age bracket. Their average age was 53 years (Table 1). This result suggests that food crop production is tending towards the declining productivity class of greater than 50 years. These findings agree with the study of Chavanapoonphol *et al.* (2005) that Thailand rice farmers were quite old, averaging 51 years, and also agrees with the study of Nwaru and Onuoha (2010) that the respondents (credit-using farmers) were a bit old with average age of about 52 in Imo State, Nigeria. Majority (about 86%) of the respondents were male. About 17%

of the farmers never attended school, that is, they had no formal education while about 83% of them had formal education. Out of the 83% that had formal education, about 32% of them only attended primary school, 30% attended secondary school while about 20% attended higher institution at various levels (Table 1). The average year of schooling of the respondents was 8.38 years. This is equivalent to secondary school attempted. Nwaru and Onuoha (2010) made similar observations in Imo state, Nigeria, and also agrees with the findings of Ogundari (2008) that rain-fed rice farmers in Nigeria had the average age of schooling of 10 years. Majority of the respondents (47.8%) fell within the household size of 6 to 10, followed by 33% of them which fell within the range of 1 to 5 persons per household size (Table 1). The average household size was 7.40 persons per household. Otitoju and Arene (2010) reported an average family size of 7 persons for medium-scale soybean farmers in Benue State Nigeria. Abdulai and Huffman (2000) had similar findings.

Climate change adaptation strategies used by the respondents:

Climate change adaptation strategies are changes in agricultural management practices in response to changes in climatic conditions (Nhemachena and Hassan, 2007). Majority (43.33%) of the respondents chose or were using multiple crop varieties as the main climate change adaptation strategy, 27.78% of them chose land fragmentation (different farm plots/parcels of land) as the main climate change adaptation strategy and 12.22% of them used multiple planting dates as the main climate change adaptation strategy. About 9% of the respondents used crop diversification while 3.61% and 3.89% chose and used off-farm employment and cover cropping respectively as the main climate change adaptation strategies (Table 2).

Factors influencing the farmers' choice of climate change adaptation strategies

Using cover cropping as the base category, the result of the multinomial logit (MNL) model indicate that different household characteristics (household size, age of the household head, years of education of household head, gender of the household head, and years of climate change awareness), farm-specific variables (farm size and average farm distance) and institutional variables (extension contact, tenure security, social capital and access to credit) affected the farmers' choice of farm-level climate change adaptation strategies. The estimated coefficients along with robust standard errors from the multinomial logit (MNL) model are presented in Table 3. The likelihood ratio statistics (as indicated by χ^2 statistic) is highly significant ($P < 0.0000$), suggesting the model had a good fit. The parameter estimates provide only the direction of the effect of the independent variables on the dependent variable in comparison with the base category; estimates do not represent actual magnitude of change or probabilities. Thus, the marginal effects, which measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable, were reported and discussed. Marginal effects of the explanatory variables are presented in table 4.

Household size:

The result shows that there was a negative relationship between household size and the probability of choosing multiple crop types/varieties, land fragmentation, multiple planting dates and crop diversification as adaptation strategies as opposed to cover cropping among the respondents. This implies that smaller households chose these adaptation strategies while larger ones preferred cover cropping as a climate change adaptation strategy.

Age of the household head:

Age of the household head was significantly and negatively correlated to the probability of choosing multiple crop varieties, land fragmentation, multiple planting dates and off-farm employment, in comparison with cover cropping (Table 3). This shows that older farmers generally preferred cover cropping to these strategies perhaps because of its benefits i.e. protection of the soil from physical impact of rain and wind, improvement of soil moisture retaining ability and stability of soil temperature at the surface layers. Alexander and Mellor (2005) reported that GM corn adoption increased with age for younger farmers as they gain experience and increase their stock of human capital but declines with age for those farmers closer to retirement. A unit increase in the age of food crop farmers would decrease adaptation of multiple crop varieties, land fragmentation, multiple planting dates, and off-farm employment by 0.012 (1.2%), 0.0044 (0.44%), 0.0147 (1.47%), 0.00977 (0.98%) and 0.00401 (0.401%), respectively but would increase adaptation of cover cropping (Table 4).

Education of the household head:

Education of the household head had an inverse relationship with the probability of a farm household choosing multiple crop varieties, land fragmentation and multiple planting dates as climate change adaptation strategies compared to cover cropping (Table 3). This means that the more educated farmers chose cover cropping probably because of the benefits that can be derived from it. A one-unit increase in education would lead to 0.0051 (0.51%), 0.000435 (0.044%) and 0.000058 (0.0058%) decrease in the probability of choosing and using multiple crop varieties and multiple planting dates respectively (Table 4). Bayard et al. (2006) also found that education was inversely related to adoption of rock walls as soil conservation practice in Forte- Jacques.

Gender of the household head (1 if male, 0 if female):
Male household heads had a higher probability of choosing multiple crop varieties, multiple planting dates and off-farm employment than their female counterparts (Table 3). An additional unit of a male-headed household would lead to 0.00333 (0.33%), 0.1067 (10.67%) and 0.0393 (3.93%) increase in the probability of choosing and using multiple crop varieties, multiple planting dates and off-farm employment respectively (Table 4). Correspondingly, the following previous studies found that male household heads had a positive relationship with adoption of manure and fertilizer as farm technology in Kenya (Ogada*et al.*, 2010). Hassan and Nhemachena (2008) reported that gender had a positive relationship with multiple crops under irrigation and multiple crop-livestock under irrigation as African farmers' strategies for adapting to climate change. Deressa*et al.* (2010) reported similar findings in the Nile Basin of Ethiopia.

Average farm distance:
Average distance of the farms to the residents of the farmers was positively related to the probability of choosing multiple planting dates as against cover cropping (Table 3). In addition, a one-unit increase in average distance would lead to 1.2% increase in the probability of choosing multiple planting dates as an adaptation strategy (Table 4). This suggests that long distance (i.e. remoteness of the food crop farmers' residents to their farms) permits the use of land fragmentation as an adaptation strategy, which in itself would encourage multiple planting dates as strategy.

Access to credit:
Access to credit had negative effect on the probability of choosing multiple crop varieties, multiple planting dates, crop diversification and off-farm employment as against cover cropping (Table 3). An additional unit of credit access would decrease the probability of choosing and using multiple crop varieties, multiple planting dates and crop diversification by 0.0605 (6.05%), 0.105 (10.5%), 0.0699 (6.99%) and 0.00838 (0.838%) respectively among the respondents (Table 4).

Tenure security:
Tenure security had positive relationship with the probability of choosing crop diversification as opposed to cover cropping (table 3). This means that food crop households that own their plots or lands have higher probability of choosing crop diversification as adaptation strategy than their counterparts that are land tenants. Tenants can be assumed less likely than landowners to use new or emerging climate change adaptation strategies, as the benefits may not necessarily flow to them, while land ownership reverts back to the owners. An additional unit of land secured farm household would increase the probability of choosing crop diversification by 0.0602 (6.02%) as seen in Table 3. Ogada*et al*. (2010) found that secure land tenure had a positive influence on the probability of adopting terrace as a farm technology in the rain-fed semi-arid lands of Kenya.

Agro-ecology (1 if savannah, 0 if rainforest):
Savannah agro-ecology had an inverse relationship with multiple planting dates and crop diversification as compared to cover cropping. This implies that farmers in the savannah agro-ecological zone of the region preferred using cover cropping to multiple planting dates and crop diversification. Savannah is a relative drier ecology than the rainforest. Farmers in the savannah could therefore derive immense benefit from the use of cover cropping because of its soil conservation properties. The above enumerated benefits of cover cropping refer. FAO (2010) noted that farmers and extension workers should adapt the conservation agriculture practices to suit their particular farming systems, socio-economic situations and agro-ecological zones.

Conclusion and Recommendations
The foregoing results suggest a relatively growing popularity for the use of cover cropping as an adaptation strategy among the farmers. This may not be unconnected with the proven excellent soil conservative properties of cover cropping which may have proved helpful especially against such climatic factors as excessive heat/dry spell, heavy and erratic rainfall and erosion. Cover cropping should therefore be encouraged among farmers as an adaptation strategy. In addition, crop diversification is also very important strategy, given that different crops have varying degrees of resilience to climate change. Land tenure security encouraged the choice of crop diversification among the respondents. A kind of land reform strategy that could make the farmers more land secured is therefore recommended.

References

Abdulai, A. and Huffman, W. (2000). Structural adjustment and economic efficiency of rice farmers in Northern Ghana. *Economic Development and Cultural Change*, 48(3), 503-520.

Adebayo, K., Dauda, T.O., Rikko, L.S., George, F.O.A., Fashola, O.S., Atungwu, J.J., Iposu, S.O., Shobowale, A.O. and Osuntade, O.B. (2011a). *Emerging and indigenous technology for climate change adaptation in southwest Nigeria* (ATPS Research Paper No. 10). Nairobi, Kenya: African Technology Policy Studies Network.

Adebayo, K., Dauda, T.O., Rikko, L.S., George, F.O.A., Fashola, O.S., Atungwu, J.J., Iposu, S.O., Shobowale, A.O. and Osuntade, O.B. (2011b). *Emerging and indigenous technology for climate change adaptation in the farming systems of southwest Nigeria: Issues for policy action* (ATPS Technobrief No. 27). Nairobi, Kenya: African Technology Policy Studies Network.

Adger, W.N., Agrawala, S., Mirza, M.M.Q., Conde, C., O'Brien,K., Pulhin, J., *et al.* (2007). "Assessment of adaptation practices, options, constraints and capacity. Climate change 2007: Impacts, Adaptation and Vulnerability". Contribution of the working group II to the Fourth Assessment Report of the IPCC; In M. L. Parry, O.F. Canziaw, J.P. Palutikof, P.J. Vander Linden and C. E. Hanson (Eds.). Cambridge UK: Cambridge University Press. pp.717- 743.

Ajao, A. O. &Ogunniyi, L .T. (2011). Farmers' strategies for adapting to climate change in Ogobomoso agricultural zone of Oyo state. agris on-line papers in Economics and Informatics, III (3), 3-13.

Alexander, C. & Mellor, T. V. (2005). Determinants of corn rootworm resistant corn adoption in Indiana. *AgBioForum*, 8(4), 197-204.

Awotoye, O. O. and Mathew, O.J. (2010).Effects of temporal changes in climate variables on crop production in tropical sub-humid South-western, Nigeria. *African Journal of Environmental Science and Technology,* 4(8), 500-505. Retrieved August 12, 2011 from http://www.academicjournals.org/AJEST

Bayard, B., Jolly, C. M. and Shannon, D. A. (2006). The adoption and management of soil conservation practices in Haiti: the case of rock walls. *Agricultural Economics Review*, 7(2), 28- 39.

Chavanapoonphol, Y., Battese, G.E. and Chang, H.C. (2005, February 9 – 11). *The impact of rural financial services on the technical efficiency of rice farmers in the Upper North of Thailand.* Paper presented at the Annual Conference of the Australian Agricultural and Resource Economics Society at Coffs Harbour.

Enete, A. A. and Achike, A. I. (2008). Cash income diversification in rural smallholder cassava producing households of Nigeria, *Tropicultura,* 28 (3), 159- 163.

Enete, A. A. and Onyekuru, A. N. (2011). Challenges of agricultural adaptation to climate change: empirical evidence from southeast Nigeria. *Tropicultura,* 29(4), 243-249

Enete, A.A, Madu, I.I, Mojekwu, J.C, Onyekuru, A.N, Onwubuya, E.A. and Eze, F. (2011). *Indigenous agricultural adaptation to climate change: study of southeast Nigeria*. (ATPS Research Paper No. 6). Nairobi, Kenya, African Technology Policy Network.

Fasola, T.R. (2007). "Controlling the advancement of savannah into south western Nigeria", *ZonasAridas* 11(1), 251-259.

FAO](2010). "Cultivating sustainable livelihoods: Socioeconomic impacts of conservation agriculture in Southern Africa". *REOSA Technical brief* 02, Food and Agricultural Organization of the United Nations (FAO), Regional Emergency office for Southern Africa (REOSA), Johannesburg, South Africa.

Foltz, J. and Chang, H. (2001). *The adoption and profitability of rbST on Connecticut Dairy farms* (Research Report No. 55). Connecticut: University of Connecticut, Food Marketing Policy Center, Department of Agricultural and Resource Economics.

Greene, W.H. (2000). *Econometric analysis (*4th ed). Prentice Hall, New Jersey.

Greene, W.H. (2003). *Econometric analysis*. (5th ed). Prentice Hall, New Jersey.

Hassan, R. and Nhemachena, C. (2008). “Determinants of African farmers’ strategies for adapting to climate change: Multinomial choice analysis”. *African Journal of Agricultural and Resource Economics,* 2(1), 83-104.

Jagtap, S.S. (1995). “Discovery and innovation changes in annual, seasonal and monthly rainfall in Nigeria and consequences to agriculture”. *Journal of African Academic science,* 7(4), 311-426.

Kandlinkar, M and Risbey, J. (2000). “Agricultural impacts of climate change: If adaptation is the answer, what is the question?” *Climatic change*, 45, 529-539.

Kurukulasuriya, P. and Mendelsohn, R. (2006a). “A Ricardian analysis of the impact of climate change on African cropland”. *CEEPA Discussion paper* No. 8: Pretoria, South Africa: Centre for Environmental Economics and Policy in Africa.

Nhemachena, C. and Hassan, R. (2007). “Micro-level analysis of farmers’ adaptation to climate change in Southern Africa *IFPRI Discussion paper* No. 00714. Washington DC, USA: International Food Policy Research Institute (IFPRI), Environmental and Production Technology Division

Nigerian Environmental Study/Action Team (NEST) (2003). *Climate change in Nigeria.A communication guide for reporters and educators.* Ibadan: NEST pp. 5-16.

Nwaru, J.C. and Onuoha, R.E. (2010). Credit use and technical change in smallholder food crop production in Imo State, Nigeria. *New York Science Journal*, 3(11), 144-151.

Ogada, M.J., Nyangena, W. and Yesuf, M. (2010). Production risk and farm technology adoption in the rain-fed semi-arid lands of Kenya. *African Journal of Agricultural and Resource Economics*, 4(2), 159-174.

Ogundari, K. (2008).” Resource productivity, allocative efficiency and determinants of technical efficiency of rain fed rice farmers: A guide for food security in Nigeria.” *Journal of Sustainable Development in Agriculture & Environment,* 3(2), 20-33.

Otitoju, M. A. and Arene, C. J. (2010). “Constraints and determinants of technical efficiency in medium-scale soybean production in Benue State, Nigeria”. *African Journal of Agricultural Research*, 5(17), 2276-2280. Available online at http://www.academicjournals.org/AJAR

Rogers, E. (1995). *Diffusion of innovations* (4th ed.). New York: The Free Press

Rosegrant, M.W., Ewing, M, , Yohe, G., Burton, I., Huq, S. and Valmonte-Santos, R. (2008). “Climate change and agriculture: threats and opportunities”. *Deutsche Gesellschaft fur TechnischeZusammenarbeit* (GTZ). Climate protection programme for developing countries. Federal Ministry for Economic Cooperation and Development, Germany.

Table 1: Frequency distribution of the respondents by their demographic profile

Age (years) Mean = 52.98	**Frequency**	**Percentage**
20 – 40	70	20.0
41 – 60	180	50.0
61 – 80	104	28.9
> 80	4	1.1
Total	**360**	**100**
Sex		
Male	311	86.4
Female	49	13.6
Total	**360**	**100**
Level of Education	**Mean = 8.38**	
No Formal Education	61	17.0
Primary	116	32.2
Secondary	108	30.0
Tertiary	75	20.8
Total	**360**	**100**
Household size	**Mean =7.41**	
1 – 5	119	33.0
6 – 10	172	47.8
11 – 15	59	16.4
> 15	10	2.8

Source: Computed from field survey, 2011.

Table 2: Frequency Distribution of Main Farm-level Climate Change Adaptation Strategies Used by the Farmers

Adaptation strategies	**Frequency**	**Percentage**
Multiple crop types/varieties	156	43.33
Land fragmentation	100	27.78
Multiple planting dates	44	12.22
Crop diversification	33	9.17
Off-farm employment	13	3.61
Cover cropping	14	3.89
Total	**360**	**100**

Source: Computed from field survey, 2011.

Table 3: Parameter Estimates of the Multinomial Logit (MNL) Analysis of Factors that Influence the farmers' Choice of Climate Change Adaptation Strategies

Explanatory Variables	Coefficients				
	MLTCRPV	LANGFRAG	MLTPLNTDT	CRPDVER	OFFFMEMP
Household Size (number)	-0.170 (0.070)**	-0.181 (0.073)***	-0.340 (0.094)***	-0.342 (0.099)***	-0.419 (0.127)
Age of Household Head (years)	-0.064 (0.037)*	-0.0856 (0.0379)**	-0.061 (0.040)	-0.037 (0.041)	-0.082 (0.045)*
Years of Education	-0.121 (0.057)**	-0.112 (0.059)*	-0.109 (0.064)*	-0.068 (0.063)	-0.095 (0.089)
Gender (1 if male, else 0)	1.184 (0.751)	0.906 (0.776)	3.106 (1.267)***	1.123 (0.921)	2.213 (1.209)*
Average Distance (km)	0.110 (0.112)	0.1602 (0.1021)	0.208 (0.119)*	0.093 (0.151)	-0.274 (0.288)
Farm Size (ha)	-0.915 (0.153)	0.0953 (0.1464)	0.0073 (0.169)	0.211 (0.147)	-0.047 (0.204)
Extension Contact (number)	0.036 0.058	0.0559 (0.0580)	-0.132 (0.062)	0.047 (0.067)	0.0799 (0.0691)
Access to Credit (1/0)	-1.660 (0.781)**	-1.224 (0.792)	-1.427 (0.845)*	-2.617 (0.970)*	-1.860 (0.948)**
Tenure Security (1/0)	0.518 (0.607)	0.541 (0.618)	0.747 (0.690)	1.599 (0.824)**	0.686 (0.809)
Social Capital (number)	-0.0156 (0.031)	0.019 (0.0311)	0.0038 (0.036)	-0.060 (0.036)	-0.0433 (0.0461)
Savanna agro-ecology (1/0)	-1.195 (0.659)*	-1.066 (0.676)	-0.594 (0.735)	-1.305 (0.756)*	-0.620 (0.885)
Constant	8.644 (2.561)***	8.019 (2.599)***	5.541 (2.977)**	5.695 (2.825)**	5.368 (3.317)
Number of Observations			**360**		

Wald chi-square $(\chi^2)(55) = 130.73$
Prob> $\chi^2 = 0.0000$
Pseudo $R^2 = 0.1081$
Log pseudo likelihood = -462.470

Note: MLTCRPV stands for multiple crop types/ varieties; LANDFRAG stands for land fragmentation; MLTPLNTDT stands for multiple planting dates; CRPDVER stands for crop diversification; OFFMEMP stands for off-farm employment; and CVRCRP stands for cover cropping, which is the base category. Figures in parentheses are the robust standard errors, *** denotes P ≤ 0.01, ** denotes 0.01<P≤0.05, while * denotes 0.05<P≤0.10

Source: Computed from field survey, 2011.

Table 4: Marginal Effects from Multinomial Logit (MNL) Analysis of Factors that Influence the Choice of Climate Change Adaptation Strategies Used in Food Crop Production in Southwestern Nigeria

Explanatory Variables	**Marginal Effects**					
	MLTCRPV	**LANGFRAG**	**MLTPLNTDT**	**CRPDVER**	**OFFFMEMP**	**CVRCRP**
Household size (number)	0.012 (1.37)	0.0044 (0.55)	-0.0147 (-2.59)***	-0.00977 (-2.55)***	0.00401 (1.79)**	0.00389 (2.22)**
Age of household head (years)	0.00184 (0.69)	-0.00552 (-2.15)**	0.000676 (0.43)	0.00205 (1.63)*	-0.000385 (-0.56)	0.00134 (2.06)**
Years of Education	-0.0051 (-0.92)	-0.000435 (-0.08)	0.000058 (0.02)	0.00285 (1.35)	-0.000385 (0.21)	0.00220 (1.85)*
Sex[b] (male) (1/0)	0.0131 (0.02)	-0.0898 (-1.07)	0.110 (4.03)***	-0.000353 (-0.09)	0.0192 (1.24)	-0.0375 (-1.05)
Average distance (km)	-0.0055 (-0.37)	0.00116 (0.95)	0.00872 (1.21)	-0.00190 (-0.28)	-0.0105 (-1.24)	-0.00242 (-1.02)
Farm Size (ha)	-0.0433 (-2.07)**	0.0293 (1.93)*	0.00096 (0.10)	0.0142 (3.03)**	-0.00120 (-0.30)	0.000043 (0.02)
Extension contact (number)	-0.0011 (-0.27)	0.00534 (1.54)	-0.00521 (-2.43)**	0.0059 (0.27)	0.00110 (-1.78)*	-0.00758 (-0.66)
Access to credit[b] (1/0)	-0.0605 (-1.04)	0.0925 (1.66)*	0.105 (0.32)	-0.0699 (-2.43)**	-0.00838 (-0.30)	0.0358 (1.63)*
Tenure security[b] (1/0)	-0.044 (-0.73)	-0.0198 (-0.36)	0.0138 (0.44)	0.0602 (2.43)**	0.00204 (0.14)	-0.0131 (-0.94)
Social capital (number)	-0.00489 (-1.58)	0.00753 (2.75)***	0.000941 (0.49)	-0.00269 (-1.85)*	-0.0010 (NE)	0.00011 (0.18)
Savannah agro-ecology[b] (1/0)	-0.0640 (-1.09)	0.00113 (-0.02)	0.0476 (1.49)	-0.0.161 (-0.61)	0.0117 (0.69)	0.022 (1.63)*
Number of Observations			360			

(*b*) dy/dx is for discreet change of dummy variable from 0 to 1

Note: MLTCRPV stands for multiple crop types/ varieties; LANDFRAG stands for land fragmentation; MLTPLNTDT stands for multiple planting dates; CRPDVER stands for crop diversification; OFFMEMP stands for off-farm employment; and CVRCRP stands for cover cropping, which is the basecategory.

Figures in parentheses are z- ratios;*** denotes P ≤ 0.01, ** denotes 0.01<P≤0.05, while * denotes 0.05<P≤0.10