DOI: 10.17707/AgricultForest.62.1.37

Solomon Adedapo ADESOJI [1]

EATING TODAY AND TOMORROW: EXPLORING INDIGENOUS FARMING SYSTEMS OF SMALLHOLDER ARABLE CROP FARMERS IN THE AGE OF CLIMATE CHANGE IN NIGERIA

SUMMARY

Indigenous farming systems have been able to sustain agriculture in Nigeria before the introduction of Western systems of farming which have brought changes to the farming systems and rural economy. This study assesses the use of indigenous farming systems by smallholder arable crop farmers with a view to providing sustainable rural economy. Quantitative data were collected with the aid of structured interview schedule from the farmers in derived savannah of Osun State, Nigeria. Descriptive statistics were used to summarise the data while multinomial logit, and farming system index were used to determine the sustainable indigenous farming systems that thrives during change in climate and their extent of use. Results showed that the mean age of farmers was 48±5 years. The mean farming experience was 22±3 years with more male farmers and extension contacts. Farming system index revealed that indigenous farming systems used by arable crop farmers include; different planting dates, planting of different varieties, multiple cropping, shifting cultivation, cereal and legume intercrop and mulching among others. Irrigation and zero tillage were the least practices among the farmers. Multinomial logit analysis showed that; Different planting dates, multiple cropping, mulching and shifting cultivation were positively significant with age of the farmers at $P < .05$. Also planting different varieties, multiple cropping and crop rotation were positively significant with their income at $P < .05$. The study concluded that farmers used different sustainable farming system that improves their rural economy to the advantage of their production.

Keywords: Smallholders, Farmers, Arable and Indigenous systems

INTRODUCTION

Agriculture is the main source of livelihood for about 60 to 70 per cent of population of the region and also contributes substantially to the Gross Domestic Product (GDP) of the regions. Agriculture is the economic mainstay accounting for about 20-30 per cent of GDP in sub-Saharan Africa and representing up to 55 per cent of the total value of African export (Sokona and Denton, 2001). In fact,

[1]Solomon Adedapo ADESOJI, (corresponding author: dapadesoji@yahoo.co.uk), Department of Agricultural Extension and Rural Development, Obafemi Awolowo University, Ile – Ife, NIGERIA.
Paper presented at the 6th International Scientific Agricultural Symposium "AGROSYM 2015".
Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.

70 per cent of all Africans and nearly 90 per cent of their poor, work primarily in agriculture (World Bank, 2000). Agriculture in the region is still rain fed and anchored on smallholders; as a result it has been very difficult to cope with ever increasing population of the region.

Climate change is a challenge facing all countries across the globe. The Intergovernmental Panel on Climate Change IPPC (2007) defines the climate change as statistically significant variations in climate that persist for an extended period typically decades or longer. It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. The panel went further that climate change is known to be caused directly or indirectly by human. Zoellick (2009) stated that as the planet warms, rainfall patterns shift, and extreme events such as droughts, floods and forest fires become more frequent. UNFCCC (2007) reported that results in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa. However, sub-Sahara African countries are particularly disadvantaged because the region tops others among the poorest countries of the world.

Besides, Africa has recently experienced growing environmental degradation such as deforestation, desertification, declining soil productivity, loss of biodiversity and depletion of freshwater. Rosenzweig (2001) had predicted that "in a most fundamental way, climate change will bring change to agriculture wherever it is practiced." Given Africa's high dependence on agriculture as highest provider of labour, the effect of climate change could put millions of people at risk of poverty and hunger. Butt et al. (2005) also predicted future economic losses and increased risk of hunger due to climate change. The United Nations Intergovernmental Panel on Climate Change (IPCC) (2007) predicted that climate change could cause crop yields in some African countries to fall by 50 per cent between 2000 and 2020, seriously threatening the continent's food security. Nigeria like other countries of sub-Saharan Africa is highly vulnerable to the effects and impacts of climate change (NEST, 2004; IPCC, 2007; Apata et al., 2009). The threats of climate change can be observed in both agriculture and non-agricultural socio-economic and infrastructural developments, agricultural production activities are generally more vulnerable to climate change than other sectors, (Kurukulasuriya et al., 2006). If the threats of climate change continue unchecked in Nigeria and Africa, the aim of poverty eradication or drastic reduction by the year 2020 will be a mirage. This is because food security is an important factor in poverty control.

Researchers have shown that Nigeria is already being plagued with diverse ecological problems, which have been directly linked to the on-going climate change (Odjugo, 2001). The increasing temperature and decreasing rainfall have led to frequent drought and desert encroachment. The effects of climate change is noticed everywhere, how to mitigate this effect should be the concern of everyone. Dabi et al. (2007) reported that many rural households in Nigeria typically have low capacity to adapt to climate variability because of very limited financial, natural, physical, human, and social capital. Fluctuations in crop outputs over the years have been due mainly to fluctuations in weather and climate (Sekumade and Adesoji, 2009). However, smallholder arable crop farmers in Nigeria have employed different farming systems as strategies to mitigate climate change, which have enabled them to remain in production. These strategies are not known by many farmers in developing countries who are leaving farming for other enterprises. This study aims at filling this information gap by investigating into sustainable farming systems which serves as mitigation strategies of smallholder arable crop farmers in Nigeria. This will afford policy makers the advantage of providing friendly, affordable, and sustainable policy for the farmers, these are policies that are expected to assure food security for now and the future. With sustainable indigenous mitigation methods in practice, smallholder arable crop farmers would not suffer much from climate change. Therefore this study described the socio-economic characteristics of smallholder arable crop farmers in the study area, identified adaptation strategies employed by these farmers to mitigate climate change; and determined the extent of use of the strategies.

MATERIAL AND METHODS

Multistage and proportionate random sampling techniques were employed. Purposive selection of 50% of the total Local Government Areas (LGAs) where arable crop farming was prominent was the second stage. The prominence was based on the records from the Ministry of Agriculture in each of the State. Incidentally, the LGAs were found in the derived Savannah zone of the States. This resulted to 24 LGAs (15 from Osun and nine from Ekiti) out of the 48 in the two States. The third stage involved random selection and interview of at least ten smallholder farmers who cultivates only arable crops. Structured interview schedule was used to collect information on socio-economic characteristics of respondents, adaptation strategies used to mitigate change in climate and the extent of utilization of the adaptation strategies. In all, total of 240 smallholder arable crop farmers were interviewed, 150 in Osun and 90 in Ekiti States.

Measurement of variables and Analytical Methods

The dependent variable was adaptation strategies used to mitigate change in climate. This was measured by counting the number of adaptation strategies claimed to be used from the list of strategies among smallholder arable crop farmers. The list of adaptation strategies were standardised by asking sampled arable crop farmers in Southwestern Nigeria the adaptation strategies they employed to mitigate climate change. All the different strategies employed were included in the list. The list include different planting dates, planting different varieties, multiple cropping, crop rotation, shifting cultivation, mulching, irrigation and cultivation of cover crops.

Each adaptation strategy was scored one. If none of the strategies was adopted respondent was scored zero.

Analytical Techniques

The dependent variable was adaptation strategies used by arable crop farmers. Multinomial Logit (MNL) regression model was used to determine the probability of usage of the adaptation strategies. In MNL model, if y denote a random variable taking on the values of {1,2…J} J denotes a positive integer, and if x denote a set of conditioning variables. In this case, y denotes adaptation options and x contains respondents attributes like age, education etc.

Let χ be a l x k vector with first element unity. The MNL model has response probabilities:

$$P(y = j|x) = \exp(x\beta j) / [1 + \sum_{h=1}^{j} \exp(x\beta h), J = 1\ldots$$

Where β; is k x1, j =1….j

Kurukulasuriya and Mendelsohn (2006); Adesoji and Farinde (2010) used MNL model to analyse crops, livestock and fisheries, respectively on choice of respondent's adaptation to mitigate change in climate. MNL was used because it permits analysis of decisions across more than two categories, allowing the determination of choice probabilities for different strategies.

Parameter estimate of MNL model require that the probability of using a certain adaptation option (that is Pj |Pk is independent of the remaining probabilities).

$$Uj = \beta j\ Xj + \sum j \text{ and } Uk = \beta\ k\ Xj + \sum k..$$

Uj and Uk are perceived utilities of adaptation options j and k, respectively, Xj is the vector of explanatory variables that influence the perceived desirability of the method, Bj and Bk are parameters to be estimated, and ϵj and ϵk are error term (Green, 2000). The parameter estimates of the MNL model provide the direction of the effect of the independent variables on the dependent (response) variables. Parameter estimate coefficient provides the actual magnitude of change or probabilities in SPSS. The marginal effects measures the expected change in probability of a particular choice being made with respect to a unit change in an independent variable from the mean (Koch,2007).

Adaptive Strategies Use Index (ASUI): ASUI was used to access the extent of use of the different climate change adaptive strategies by arable crop farmers. In analyzing the extent of use of any of the options by arable crop farmers, an Adaptive Strategy Index (ASI) was developed by ranking. The extent of use of the ASI was then expressed using a four-point scale with the scoring order 3, 2, 1 and 0 for regularly used, occasionally used, rarely used and not used, respectively. To obtain the ASI score, Islam and Kashem (1999), Adesoji and Farinde (2010) were modified and adopted.

Where:ASUI = Adaptive Strategies Use Index

N1= Number of arable crop farmers using a particular ASI regularly

N2= Number of arable crop farmers using a particular ASI occasionally

N3= Number of arable crop farmers using a particular ASI rarely

N4= Number of arable crop farmers not using any of the adaptive strategies.

The ASUI was used in rank order to reflect the relative position of each of the ASI in terms of their use. The extent of use of the ASI was then obtained for sampled arable crop farmers in the study area. ASUI = $N_1xX_1+N_2xX_2+N_3xX_3+N_4xX_4$.

RESULTS AND DISCUSSION

Results in Table 1 show that the mean age of arable crop farmers was 48±4 years. This indicates that they were still within their active production age. Only 30 per cent fell under 40 years, which could be regarded as youth. About 44 per cent was between the age brackets of 41 and 60 years. Majority (85.8%) of arable crop farmers were male and married. This shows that males were more involved in farming than their female counterparts. Farming could be described as a family enterprise thus members of the family assists on the farm to reduce labour cost. About 48 per cent of arable crop farmers spent between one and six years in school (Primary school level). Also 35.4 per cent had no formal education while only 16.7 per cent spent between 13 and 18 years in formal education institution, which correspond to tertiary education. It could be said that arable crop farmers were not well educated. The mean farming experience of the arable crop farmers was 24±4 years. Information from agricultural extension personnel was generally low for the farmers. This shows that most of the farmers could either acquire information on their farming activities through their neighbours and farmer friends.

Results in Table 2 show the parameter estimate for marginal effect (coefficient) of Multinomial Logit that measures the expected change in probability of adopting a particular strategy of mitigating climate change by arable crop farmers. Age, for example was positively significant to adaptation of planting at different dates, multiple cropping, shifting cultivation, and mulching. This indicates that increase in age of respondents by 1 year would influence the choice of the particular adaptation measures. For example increase in the age of the respondents by 1 year would influence the probability to choose planting at different date by .040 at 5 per cent confidence level. For multiple cropping (.013), Shifting cultivation (.826) However, the probability of chosen irrigation was negatively significant, this shows that as the age of respondents increases, the probability of chosen irrigation to mitigate climate change decreases. This shows that younger farmers would prefer the use of irrigation to mitigate climate change. The coefficient of Multinomial Log of preference was -.062, significant at 1 per cent level of confidence. Years of farming experience of arable crop farmers was found to influence the probability of choice of planting at different date. If year of farming experience increases by 1 year, planting at different dates would increase by .005 units, also planting different varieties would increase by .024 units and probability of chosen shifting cultivation would increase by .167 units. All the adaptation strategies were positively significant at different levels.

Table 1. Distribution of arable crop farmers by Socio–economic characteristics (N = 240)

Variable	Frequency	Percentage	Mean and standard deviation
Age			
< – 20	12	5	
21-40	60	25	48±4
41-60	106	44,7	
61-80	62	25,83	
Gender			
Male	206	85,83	
Female	34	14,17	
Farming experience (years)			
1-10	50	20,83	
11-20	46	19,7	24±4
21-30	60	25	
31-40	28	11,67	
41-50	48	20,00	
> – 50	08	3,33	
Marital status			
Single Married Divorced	36 202 02	15.00 84,17 0,83	
Household size			
1-3	124	51.7	
4-6	90	37,5	3±2
7-9	18	7	
10-12	0,8	3,3	
Farm size (Ha)			
< 3	166	69.17	
3 – 5	64	26,66	
> 5	10	14,17	
***Information sources**			
Extension agents	74	30,83	
Other farmers	144	60	
Other farmers	84	35,0	

*****Multiple responses possible

Household size of arable crop farmers was also found to influence the probability to choose crop rotation and mulching as adaptation strategies for mitigating climate change. The coefficients of Multinomial log are 0.884 and .085 both positively significant at 1 per cent confidence level. This indicate that an increase in the household size by one would course the probability of arable crop farmers to choose crop rotation and mulching to increase by 0.884 and .085, respectively. The parameter estimate for income was positive for all the adaptation strategies. This shows that income is essential in the choice of adaptation strategy to mitigate climate change. Income from arable crops also influenced the probability of choosing planting different varieties of crops, multiple cropping and crop rotation as strategies for mitigating change in climate. Multinomial log increase in income from arable crop of N1 would cause an increase in the probability of chosen planting different varieties of arable crops, multiple cropping and crop rotation by .936,.081 and .083, respectively.

Farm size also influenced the probability of chosen different planting dates, multiple cropping and mulching as adaptation strategies to mitigate climate change. An increase in the size of farm by 1 hectare would cause the probability of chosen planting at different dates, multiple cropping, and mulching to increase by .452, .213, and -.526, respectively. Planting crops at different dates and multiple cropping were positively significant while mulching was negatively significant at 1 per cent level. This shows that mulching favours small sized farms while arable crop farmers with large sized farms would prefer planting of crops at different dates and multiple cropping as adaptation strategies to mitigate climate change. Years spent in schools also influenced the probability of chosen different planting date, planting different varieties of crop, multiple cropping, crop rotation, shifting cultivation and cultivation of cover crops as adaptation strategies of mitigating climate change by arable crop farmers. All the strategies were positively significant. This shows that an increase in years of schooling by 1 year would increase the probability of chosen any of the adaptation strategies mentioned.

Results in Table 3 show frequency of usage of the adaptation strategies of arable crop farmers using ASUI method. The table revealed that planting at different dates was the most frequently used adaptation strategy among the arable crop farmers. This was closely followed by planting different varieties of crop. The third mostly used of the strategies was multiple cropping. All the three showed that some of the crops planted either due to wrong timing; non-resistant varieties or even a particular crop that could not withstand the stress of the climate would wither away. The fourth one with ASUI percentage of 13.4 was planting of cover crops. This is an adaptation strategy that would conserve soil moisture. This is also related to mulching which is the fifth frequently used strategy. Shifting cultivation is the sixth and it is followed by another related farming method, crop rotation. The last of the methods that was frequently used is irrigation. Irrigation is expensive might be the reason while it was not frequently used by arable crop farmers who might not be cultivating large hectarage. The mean farm size of the respondents was 2.7 Ha which shows they were small holder farmers.

Table 2. Parameter estimate and marginal effects from multinomial logit on climate change adaptation for arable crop farmers

Explanatory variables	`Difft planting dates		Planting different varieties		Multiple cropping		Crop rotation		Shifting cultivation		Mulching		Irrigation		Cultivation of cover crop	
	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig
Age	.040**	.044	-.013	.508	.013***	.005	.362	.332	.826***	.000	.081**	.024	-.062***	00	-.355	.362
Farming experience (Yrs)	.005*	.101	.024**	.051	.026	.842	-.602***	.013	.167**	.0395	.202	.431	.165	.170	.452**	.044
Household size	-.224	.343	.622	.494	.083*	.082	.884***	.002	.936	.243	.085***	.004	.427	.186	.094	.396
Income from arable farming	.864	.311	.936*	.092	.081***	.003	.083**	.020	.663	.362	.101	.943	.223	.874	.160	.895
Farm size	.452**	.045	.987	.684	.213***	.005	.021	.936	.312	.872	-.526***	.001	.532	.556	-.504	.586
Information source	.000	.633	.010	.969	.000	.999	.000	.966	.000	.999	.000	.887	.002	.966	.004	.899
Extension contact	.299	.300	-0.325	.257	.309	.272	.298*	.091	.409	.338	-0.029	.313	.301	.411	.150	.781
N Years of Schooling	.631*	.081	.399*	.100	.055**	.044	.051***	.008	.801*	.088	.411	.821	-.361	.555	.080***	003

Source: Field survey, 2014 ***1%; **5%; *10%

Table 3. Rank Order of Climate Change Adaptation Strategies of Arable Crop Farmers by Frequency of Usage

Adaptation strategies	Not used 0	Rarely used 1	Occasionally used 2	Regularly used 3	ASUI	Percentage of respondents ASUI/∑ASUIx100	Rank
Different planting dates	3	2	8	93	297	15.5	1
Planting different.							
Varieties	6	6	8	91	295	15.4	2
Multiple cropping	10	12	17	78	280	14.6	3
Crop rotation	47	45	29	29	190	9.9	7
Shifting cultivation	23	18	21	61	243	12.7	6
Mulching	8	14	58	39	247	12.9	5
Irrigation	87	71	9	7	110	5.7	8
Cultivation of cover crop	15	21	31	58	257 Σ =1919	13.4	4

Source: Field survey, 2014 ***1%; **5%; *10%

CONCLUSIONS

Arable crop farmers respond to climate variability and change by employing simple and indigenous methods to mitigate its effects. The methods of the mitigation did not involve any foreign technology thus sustainable. These technologies were common among small holder farmers. The study also revealed that parameters like age of respondents, farming experience which is also a function of age, education measured in years of schooling are very important variables to be considered by policy makers, when planning climate mitigation programmes for arable crop farmers. Farm size and income are also important for arable crop farmers.

It could therefore be recommended that:

•Awareness about climate change should be raised among farmers and empowerment programmes should include sustainable methods of climate change mitigation;

•Adaptable crops that are resistant to harsh climatic conditions should be developed.

•Calendar of work should be developed by extension experts so that farmers could know the appropriate time to plant their crops.

REFERENCES

Adesoji S.A and A.J. Farinde (2010): Assessment of Fish Farmers' Perception of Climate Change and Adaptation Strategies in Nigeria: Osun State Experience. In Biotechnology Development and threat of Climate Change in Africa: The Case of

Nigeria. Odunayo C Adebooye, Kehinde A. Taiwo and Andrew A Fatufe (eds.) Cuvillier Verlag Gottingen. Germany. Pp 1 – 15.

Apata T. G. Samuel, K. D. and Adeola, A. O. (2009). Analysis of Climate change perception and Adaptation among Arable Food Crop Farmers in south Western Nigeria. Paper presented at the conference of International Association of Agricultural Economics pp. 2-9.

Butt, T. A. McCari, B. A. Angerer, J Dyke, P. T. and Stuth, J. W (2005). The economic and food security implications of climate change. Mali Journal Climatic change 6(8) 355-378.Directgov (2010). Causes of climate change. http://www.direct.gov.uk/en/environmentandgreeneerliving/thewiderenvironment.

Dabi, D. D., A. O. Nyong, A. A. Adepetu, V. Ihemegbulem and J. Agaye (2007). ‘Determinants of adaptive strategies and opportunities of rural households in northern Nigeria.’ In N. Leary, J. Adejuwon, V. Barros, I. Burton and R. Lasco (eds), Adaptation to Climate Change. Earthscan, London, U. K.

Green, W. H. (2000) Economic analysis, 4th ed. Prentice Hall, Upper Saddle River, New Jersey: Prentice – Hall.

Intergovernmental Panel on Climate Change (IPCC) (2007). Climate Change: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report, M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson, eds. (Cambridge University Press, 2007).

Islam, M. M. and M.A. Kashem (1999) Farmers use of Ethno-veterinary Medicine (EVM) in the rearing and management of livestock: An Empirical Study in Bangladesh, Journal of Sustainable Agriculture, Vol.13, No.4 pp. 39-56.

Koch, S. (2007) University of Pretoria: Lecture series 14: University of Pretoria.

Kurukulasuriya, P., and R. Mendelsohn (2006) A Ricardian analysis of the impact of climate change on African crop land CEEP. A Discussion Paper No. 8. Centre for Environmental Economics and Policy in Africa. Pretoria, South Africa. University of Pretoria.

Nigerian Environmental Study Team (NEST) (2004). Regional Climate modelling and climate scenarios Development in support of vulnerability and adaptation studies: Outcome of Regional Climate modelling Efforts over Nigeria, NEST, Ibadan Nigeria. Pp12-20

Odjugo, P. A. O. (2001). Global warming and food production: A global and regional analysis. African Journal of Environmental Studies, 2(2), 85-91.

Rosenzweig P. K. (2001): Climate change and agriculture: Effects on developing countries. Journal of Environmental Economy. Vol. 41 pp.239-296.

Sekumade A.B and S.A. Adesoji (2010): Climate Variability for sustainable Food Crop Production: Implications for Agricultural Extension Delivery in Nigeria. In Biotechnology Development and threat of climate change in Africa: The case of Nigeria. Odunayo C Adebooye, Kehinde A.Taiwo and Andrew A Fatufe (eds.) Cuvillier Verlag Gottingen. Germany. Pp 137 – 148.

Sokona, Y. and F. Denton (2001). Climate Change Impacts: can Africa cope with the challenges? Climate Policy, 1: 117– 123.

United Nations Framework Convention on Climate Change (UNFCCC) (2007). Climate Change Impact, Vulnerabilities and Adaptation in Developing Countries. UNFCCC Secretariat, Martin-Luther King-Street 8 53175 Bonn, Germany. www.unfccc.int

World Bank (2000), Can Africa claim the 21 century? Washington, D. C., USA.

Zoellick, R.B. (2009). Climate Smart Future. The Nation Newspapers. Vintage Press Limited, Lagos, Nigeria. P. 18.