Challenges of Agricultural Adaptation to Climate Change: Empirical Evidence from Southeast Nigeria

A.A. Enete* & A.N. Onyekuru

Keywords: Climate Change- Agricultural Adaptation- Challenges- Nigeria

Summary

Climate change has direct impact on agricultural production, because of the climate-dependent nature of agricultural systems. This impact is particularly significant in developing countries where agriculture constitutes employment and income sources for the majority of the population. This paper, based on primary data collected within the auspices of the African Technology Policy Studies Network (ATPS) examines the challenges faced by farmers (Southeast Nigeria), in applying indigenous climate change adaptation practices in their farms. The study was conducted in two randomly selected states of the region namely Imo and Enugu, and in four randomly selected agricultural zones, two from each state. The data was analyzed using descriptive and inferential statistics. The result of the analysis shows that in the face of extreme weather events occasioned by climate change, and apparently because of its tolerance to these conditions, cassava has become the dominant food crop in the area. Virtually all the respondents were reportedly aware of the effect of climate change on agriculture, but were not aware that some of their agricultural practices could exacerbate climate change. The most often practiced farm activities that could contribute to climate change were, in order of importance, burning of wood fuel, the use of fertilizers and bush burning. The major household level socioeconomic factors identified to be driving farmers' investment in climate change adaptation practices were age, level of formal education and level of awareness of climate change issues. At the societal level, the major factors constraining them from adapting to climate change were poverty, farmland scarcity and inadequate access to more efficient inputs, lack of information and poor skills, land tenure and labour constraints. The findings underscore the need for farmers' education, awareness creation, poverty alleviation and increased access to more efficient inputs as potent tools for climate change adaptation in the area.

Résumé

Les défis de l'adaptation agricole au changement climatique: données empiriques provenant du Sud-Est du Nigeria

Le changement climatique a un impact direct sur la production agricole, car de la nature du climat dépendent des systèmes agricoles. Cet impact est particulièrement important dans les pays en développement où l'agriculture constitue la source d'emploi et de revenus pour la majorité de la population. Cet article, basé sur des données primaires collectées dans le cadre des études de l'African Technology Policy Network (ATPS) examine les défis auxquels sont confrontés les agriculteurs (Sud-Est du Nigeria), en appliquant les pratiques autochtones d'adaptation au changement climatique dans leurs exploitations. L'étude a été menée dans deux états choisis au hasard de la région, à savoir Imo et Enugu, et dans quatre zones agricoles choisies au hasard, deux de chaque Etat. Les données ont été analysées en utilisant des statistiques descriptives et inférentielles. Le résultat de l'analyse montre que, face à des phénomènes météorologiques extrêmes causés par les changements climatiques, et apparemment en raison de sa tolérance à ces conditions, le manioc est devenu la principale culture vivrière dominante dans la région. Pratiquement tous les répondants auraient été conscients de l'effet du changement climatique sur l'agriculture, mais ne savaient pas que certaines de leurs pratiques agricoles pourraient aggraver le changement climatique. Les activités agricoles les plus souvent pratiquées qui pourraient contribuer aux changements climatiques ont été, par ordre d'importance, la combustion de combustibles ligneux, l'utilisation des engrais et les feux de brousse. Des principaux facteurs socio-économiques identifiés au niveau des ménages dans les pratiques d'adaptation aux changements climatiques sont l'âge, le niveau de scolarité et le niveau de sensibilisation aux questions de changement climatique. Au niveau sociétal, les principaux facteurs les contraignant à l'adaptation aux changements climatiques sont la pauvreté, la rareté des terres agricoles et l'accès inadéquat à des facteurs plus efficaces, le manque de d'information et de faibles capacités, le régime foncier et les contraintes du travail. Les résultats soulignent la nécessité pour l'éducation des agriculteurs, la sensibilisation, la lutte contre la pauvreté et un accès accru à des outils plus puissants pour l'adaptation au changement climatique dans la région.

*Department of Agricultural Economics, University of Nigeria, Nsukka, Nigeria.
Received on 31.05.11 and accepted for publication on 14.10.11

Introduction

Climatic change, which is attributable to natural climate cycle and human activities, has adversely affected agricultural productivity in Africa (25). As the planet warms, rainfall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent (26), which results in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa (23). Farmers (who constitute the bulk of the poor in Africa), face prospects of tragic crop failures, reduced agricultural productivity, increased hunger, malnutrition and diseases (26). It is projected that crop yields in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change (14), particularly because African agriculture is predominantly rain-fed and hence fundamentally dependent on the vagaries of weather. As the people of Africa strive to overcome poverty and advance economic growth, this phenomenon threatens to deepen vulnerabilities, erode hard-won gains and seriously undermine prospects for development (11, 26). There is therefore the need for concerted efforts toward tackling this menace.

Much of climatic change agricultural research has tended to concentrate on assessing the sensitivity of various attributes of crop systems (e.g. crop/ livestock yields, pest, diseases, weeds etc) - the bio-physical aspects of food production, with little or no regard to the socioeconomic aspects. These partial assessments most often consider climatic change effects in isolation, providing little insight into the level of awareness of the farmers on the issue, what and how they are doing to cope with climate change, etc. To better address the food security concerns that are central to economic and sustainable development agenda, it is desirable to also address these aspects of climate change and agriculture. Wisner *et al.* (24) report that the vulnerability of agriculture is not determined by the nature and magnitude of environmental stress like climate change per se, but by the combination of the societal capacity to cope with and/or recover from environmental change. While the coping capacity and degree of exposure is related to environmental changes, they are both also related to changes in societal aspects such as land use and cultural practices. This could be at the root of the much talked about poverty alleviation and food security for the vulnerable groups in Africa, who are most at risk when agriculture is stressed.

This paper, based on primary data collected within the auspices of the African Technology Policy Studies Network (ATPS) examines the challenges faced by farmers of Southeast Nigeria in applying indigenous climate change adaptation practices. Ozor *et al.* (21) studied barriers to climate change adaptation among farm households of southern Nigeria, dwelling mostly on societal constraints thereby ignoring farmers' level of awareness, household level factors and farm practices, all of which could pose challenges to agricultural adaptation to climate change. In addition, Enete and Amusa (7) presented a literature survey of challenges of agricultural adaptation to climate change with no empirical information. The present study attempts to fill these gaps.

Method of the study

The study area

Southeast Nigeria is located within longitudes 5° 30' & 9° 30' E and latitudes 4° 30' & 7° 00' N. It occupies a land area of 75,488 km^2 and comprises nine states namely Abia, Akwa Ibom, Anambra, Bayelsa, Cross River, Ebonyi, Enugu, Imo, and Rivers. These states fall into two geopolitical zones in Nigeria namely the south-south and southeast. While Akwa Ibom, Bayelsa, Rivers and Cross River are in the south-south, Abia, Anambra, Ebonyi, Enugu and Imo are in the southeast.

The region has a total population of 31,371,941 and an average population density of 416 persons per square kilometer. This average however conceals the true picture of population pressure in the region as Madu (17) has shown that population pressure is the most important problem of rural development in the region. The effects of population pressure in the area have been recognized in a broad spectrum of livelihood activities such as intensive agriculture, engagement in non-farm activities, migration and ecological problems.

Sampling procedure and the data

For logistical reasons, the study was restricted to southeast geo-political zone, comprising Abia, Anambra, Ebonyi, Enugu and Imo. Two states were randomly selected from these for the study. These were Enugu and Imo states. In each selected state, two agricultural zones were then randomly selected. These were Owerri and Okigwe in Imo state and Enugu and Nsukka in Enugu state. In each agricultural zone and with the assistance of the extension services Department, farming communities were compiled, from which two communities were randomly selected making a total of eight communities for the study. These were Ugwuene in Agwu and Amaechi in Nkanu, all in Enugu agricultural zone; Umualumo in Okigwe and Okwe in Onuimo, all in Okigwe agricultural zone; Ovoko and Akpa-Edem in Nsukka agricultural zone; Amaigbo and Okpuala in Owerri agricultural zone. In each selected community, a list of farm households was compiled, also with the assistance of extension agents, from which fifty farmers were randomly selected, bringing the total sampled respondents to four hundred for the study.

A structured survey instrument was then developed and pre-tested in a pilot survey/focus-group discussion. This was to help validate the questions

and check the information to be supplied later by the individual farmers. A farmer to farmer visit was next undertaken to collect the data, which included farmer's opinion on the trend of change of climate change variables in the last ten years, farming practices, climate change adaptation practices and estimated costs and returns from these strategies, the area of land where the adaptation practices were applied, etc. The data were analyzed using descriptive statistics, Ordinary Least Squares regression and Factor Analysis.

Results and discussion

Crops and Animals grown/reared in the area

The first most important food crop in the area was cassava, as ranked by 64% of the respondents. Cassava is not only a major staple but also a major source of farm income for the Nigerian farmers (20). And compared to other crops, cassava is the most resistant to extreme weather events. It is therefore most often described as a hardy crop and may in this sense be the most adaptable crop to climate variations (8). Benhin (3) reports that one of the strategies which serve as an important form of insurance against rainfall variability is increasing diversification by planting crops that are drought tolerant and/ or resistant to temperature stresses. Cassava was followed by Yam and Cocoyam with about 23% and 4% respectively of the respondents ranking them as the first most important crop. Yam is the second most important root crop after cassava, especially in southeast Nigeria, where there is generally an annual celebration in honour of the crop. This was followed by vegetables as ranked by 3%, maize and rice by 2% and 1% respectively, oil palm by 1% and other unspecified crops ranked by 2% of the respondents as the first most important crop. From the second to the fourth most important crops, the respondents just listed variations of the above crops, hence discussions were limited to the first most important crop.

On the animals reared in the area, 50% of the respondents ranked goat as the first most important animal domesticated. About 38% ranked poultry, 6% ranked sheep, 5% ranked pig, while 1% each ranked cattle and fish as the first most important animal reared in the area. From the second through the fourth most important animals in the area, the respondents also listed various combinations of the above animals.

Awareness of climate change and its link with agriculture

The respondents were asked whether they have heard of climate change before. About 96% of them responded in the affirmative. This suggests a high level of awareness of the subject matter in the area. The awareness of climate problems and the potential benefits of taking action is an important determinant of adoption of agricultural technologies (10). Maddison (16) argued that farmer awareness of change in climate attributes (temperature and precipitation) is important to adaptation decision making. For example, Anim (1) and Araya and Adjaye (2) reported that farmers' awareness and perceptions of soil erosion problem as a result of changes in climate, positively and significantly affect their decisions to adopt soil conservation measures. On the source of such information, majority (36%) of the respondents indicated that they hear from friends, about 26% of them hear from extension workers, 24% from radio/ television, 2% from researchers, 1% from farmers' cooperatives, while 6% hear from other sources not specified in the survey instrument.

Similarly, on the question of whether climate change will affect agriculture, the respondents overwhelmingly (97%) said yes. Most governments in Nigeria already have agencies charged with environmental issues including climate change and they most often sensitize the people through the radio and television. This may explain the high level of awareness of the respondents. However, majority (52%) of the respondents do not agree that farming contributes to climate change. Thus, suggesting that the farmers, though aware of climate change and its effect on agriculture, were

Table 1
Mean responses of farmers on extent of practice of activities that could cause climate change

	N	Minimum	Maximum	Mean	Std. Deviation
Bush burning	381	1.00	3.00	2.0682	.70380
Continuous cropping	348	1.00	3.00	1.7126	.69012
Over grazing	323	1.00	3.00	1.1393	.40467
Extent to which swamprice is produced	286	1.00	3.00	1.3986	.73642
Extent to which crop wastes are burnt	357	1.00	3.00	1.8235	.70289
Burning of woodfuel	389	1.00	3.00	2.6967	.54727
Use of fertilizers	389	1.00	3.00	2.1568	.76562
Use of insecticids/ pesticides	317	1.00	3.00	1.5710	.74131
Use of herbicides	316	1.00	3.00	1.5222	.74075
Deforestation	312	1.00	3.00	1.5705	.55689

Cut off mark= 2.0

unaware that some of their agricultural practices could exacerbate climate change. This underscores the need for educating the farmers on the consequences of some of their actions. However, FAO (12) reports that although climate change affects agriculture and vice versa, a lot of uncertainties pervade each step of the logic from economic activity to climate change.

Activities of farmers that contribute to climate change

The respondents were asked to indicate the extent to which they practice some suggested farm related activities that could contribute to climate change on a 3-point LSR. The information collected (Table 1) shows that the most often practiced activities by the respondents were burning of wood fuel (mean= 2.70), the use of fertilizers (mean= 2.16), and bush burning (mean= 2.07). With the widely reported rising poverty in Nigeria, especially among farming households, and the also rising prices of cooking gas and kerosene, burning of wood fuel as cooking energy has become the predominant practice, not only in rural farming communities but also among the urban poor (7).

Moreover, decreasing soil fertility is one of the extreme weather events that nearly all the farmers (84%) said has been on the increase in the past ten years. The natural tendency would therefore be to increase the application of fertilizer in order to maintain soil fertility, which contributes to greenhouse gases. In addition, bush burning is generally the preferred traditional means of clearing farmland for seedbed preparation, which increases the concentration of greenhouse gases and particulate matter in the atmosphere. The International Federation of Organic Agriculture Movement (IFOAM) (13) reports that conventional agricultural activities of farmers contribute to climate change because they apply excessive amounts of nitrogen fertilizer that is released as nitrous oxide and mines the earth of the nutrients needed to sustain production through rainforest clearing. Slash and burn techniques reduce carbon storage and release huge amounts of carbon dioxide from burning vegetation.

Household level factors affecting investment in adaptation practices

In assessing the factors that influence the level of investment in climate change adaptation practices, we assume the utility maximization theory, where the household maximizes utility in farm income, which is assumed dependent on the household's level of adaptation to climate change, *ceteris paribus*. This in turn is a purely farm management decision that is related to the household's socioeconomic characteristics (9) such as age, level of education, awareness of climate change related issues. The household's level of adaptation to climate change was indexed by the amount of money (Nigerian Naira) spent on adaptation practices per hectare of farmland.

In doing this, the ordinary least squares regression analysis was used. The result of the analysis (Table 2) show that the explanatory powers of the specified variables seem low (24%), but this is not uncommon in cross sectional analysis. Other works with similar coefficient of determination include Nweke (20) and Enete (8). The overall goodness of fit as reflected by the F-value of (2.93) was however highly significant at ($p< 0.01$).

Four of the nine explanatory variables were significant. Age of the farmer was positively and highly significantly related with the level of investment in climate change adaptation practices by the farmers. This is surprising because older farmers are more likely to be risk averse, especially regarding climate change matters, than younger ones. However, age may likely endow the farmers with the requisite experience that will enable them make better assessment of the risks involved (22) in climate change adaptation investment decisions. Enete *et al.* (9) noted that older farmers have more experience and are able to take healthier production decisions than younger ones.

The farmer's number of years of formal education was also positive and highly significantly related with the level of investment in indigenous climate change adaptation practices. This is to be expected as educated farmers may better understand and process information provided by different sources regarding new farm technologies, thereby increasing their allocative and technical efficiency (22).

The two variables on level of awareness of climate change effects were all positive and significantly related with the level of investment in adaptation practices. These were "*whether the farmer knows that climate change will affect agriculture*" and "*whether the farmer knows that agriculture contributes to climate change*" This underscores the importance of awareness in adaptation measures. The awareness of climate problems and the potential benefits of taking action is an important determinant of adoption of agricultural technologies (12). Maddison (16) argued

Table 2
OLS Regression result on factors affecting the farmers level of investment in adaptation practices

s/n	Variables	Coefficients	t
i.	Age (years)	2716.444	2.55***
ii.	Gender of household head (male=1, female= 0)	-5998.05	-0.26
iii.	Level of education (years)	6453.965	2.68***
iv.	Profit from adaptation practices	25760.96	0.93
v.	Av. Annual income from farming	0.0418673	0.66
vi.	Farm size (ha)	3145.585	0.38
vii.	Household size	1482.901	0.27
viii.	Climate change affect agriculture (yes=1, No= 0)	49687.81	2.01**
ix.	Farming contributes to climate change (yes= 1, No= 0)	91423.52	1.72**

No of observations= 94; R^2= 0.2391; F= 2.93; Prob> F= 0.0045, *** = significant at p≤ 0.01, ** = significant at 0.01≤ p≤ 0.05.

that farmer awareness of change in climate attributes (temperature and precipitation) is important to adaptation decision making. For example, Anim (1) and Araya and Adjaye (2) reported that farmers awareness and perceptions of soil erosion problem as a result of changes in climate, positively and significantly affect their decisions to adopt soil conservation measures.

Societal constraints to climate change adaptations

In this context, we define societal constraints as those that result from the shortcomings of the society at large. In economic terms they are factor constraints resulting from market failure *ceteris paribus*. In this sense therefore they are not within the control of the farm households. The applicable economic theory here is that of externalities and public goods (15). Our focus in this section therefore is to sieve out, from among these constraints, those that are hindering the farm households from adapting to climate change. This was done using factor analysis.

Table 3 presents the result of the factor analysis. It shows the varimax-rotated factors constraining farmers in the area from climate change adaptations. From data in the table, five factors were extracted based on the responses of the respondents. Only variables with factor loadings of 0.40 and above at 10% overlapping variance were used in naming the factors. Variables that have factor loading of less than 0.40 and those that loaded in more than one factor were not used (18). The next step was to give each factor a denomination according to the set of variables or characteristics it was composed of. In this regards, the variables were grouped into five major factors as: factor 1 (poverty constraints), factor 2 (land and more efficient input constraints) and factor 3 (information and training factor), factor 4 (land tenure constraint), and factor 5 (labour constraints).

Under factor 1 (poverty constraints), the specific constraining variables against climate change adaptation include high cost of farmland (0.580), high cost of irrigation facilities (0.483), non-availability of storage facilities (0.648), limited income (0.782), non-availability of processing facilities (0.668), high cost of processing facilities (0.808), and lack of access to weather forecast technologies (0.751). With limited income (poverty), the acquisition of necessary facilities will be difficult. They may not only be costly, but may also appear scarce for poor farmers. In addition, the farmers may not also have the necessary facilities for current information like radio and television to obtain weather forecasts. This underscores the problems of under capitalization of farmers (6) and suggests the need to improve the availability of credit to them. Benhin (3) reports that lack of access to credit or saving and adequate information about climate change are some of the major problems encountered by farmers in adapting to climate change in Africa. Deressa (4) reported that most of the problems or constraints encountered by farmers in adaptation to climate change are associated with poverty.

Under factor 2 (Land and more efficient input problem), the constraining variables against climate change adaptation were: limited availability of land for farming (0.558), non-availability of improved seeds (0.598), high cost of fertilizer (0.761), and high cost of improved varieties (0.725). Benhin (3) noted that farm size is a major determinant of speed of adoption of adaptation measures to climate change. Moreover, Downing *et al.* (5) reported that high yielding and fast growing crops can easily escape the vagaries of climate change by completing their growth cycle before storm and drought sets-in, thereby checking the impact of climate change. The use of heat tolerant and drought resistance crops is also effective adaptation practices.

The factors that loaded under factor 3 (information and training constraints) include poor access to information sources (0.588) and inadequate knowledge of how to cope (0.771). In the present information age, information problems could pose serious challenges to the farmers' coping strategies as they may not be aware of recent developments regarding climate change adaptations and the necessary readjustments needed. Mark *et al.* (19) argued that a lack of adaptive capacity due to constraints on resources like information may result in further food insecurity. In addition, Benhin (3) noted further that farmers' level of education and access to extension service are major determinants of speed of adoption of adaptation measures to climate change.

Under factor 4 (land tenure constraints), the constraining variables were inherited system of land ownership (0.786) and communal system of land ownership (0.775). In traditional societies, individual farmers do not usually have title to farmland but enjoy user rights, which could be withdrawn at any time by the custodian of the communal land. One of the factors identified by Benhin (3) as determining the speed of adoption of climate change adaptation measures is land tenure status.

Under factor 5 (labour constraints), only one variable loaded – high cost of farm labour (0.743). Previous analyses of barriers to climate change adaptation show that shortage of farm labour is one of the major constraints to adaptation by farmers (4).

Conclusion

The foregoing shows that cassava has become the dominant crop in the area, essentially because it is a hardy crop and hence relatively tolerant to the harsh conditions occasioned by climate change. Virtually all the respondents were reportedly aware of the effect of climate change on agriculture, but were

Table 3
Constraints to adaptation (Rotated Component Matrix)

Variables	Factors				
	1	2	3	4	5
Limited availability of land for farming	.152	.558	.283	.384	-.010
High cost of farmland	.580	-.002	.388	.287	.105
Inherited system of land ownership	.086	.249	-.113	.786	-.178
Communal system of land ownership	-.110	.310	-.042	.775	-.139
Poor access to information sources	.353	.030	.588	-.045	-.354
Non-availability of credit facilities	.559	.378	.007	.141	-.496
High cost of irrigation facilities	.483	.244	.222	-.109	.357
Non-availability of farm inputs e.g. improved seeds	.255	.598	.329	-.002	.368
High cost of fertilizers and other inputs	.158	.761	.003	.040	.043
Inadequate knowledge of how to cope or build resilience	.050	.267	.771	-.025	.091
high cost of improved varieties	.013	.725	-.076	.203	.021
Non-availability of farm labour	.404	.413	.371	.129	.219
High cost of farm labour	.042	.201	-.150	-.075	.743
Lack of access to weather forecast technologies	.751	.146	-.267	-.200	.086
Government irresponsiveness to climate risk management	.408	-.206	.683	.006	-.131
Non-availability of storage facilities	.648	.017	.348	.311	-.150
Limited income	.782	.146	.145	.139	-.002
Non-availability of processing facilities	.668	.196	.284	-.150	-.089
High cost of processing facilities	.808	.030	.278	.109	.109
Traditional beliefs/ practices e.g. on the commencement of farming season etc	.204	-.154	.179	.663	.408

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

not aware that some of their agricultural practices could contribute to climate change. Some of the farm practices in the area that contribute to climate change were the burning of wood fuel, the use of chemical fertilizers and bush burning, in order of intensity. The major household level factors identified to be driving farmers' investment in climate change adaptation practices were age, level of formal education and level of awareness of climate change issues. At the societal level, the factors constraining them from adapting to climate change were poverty, farmland scarcity and inadequate access to more efficient inputs, lack of information and poor skills, land tenure and labour constraints. These findings underscore the need for farmers' education, awareness creation, poverty alleviation and increased access to more efficient inputs as potent tools for climate change adaptation in the area.

Acknowledgement

This paper was produced as part of the implementation of the African Technology Policy Studies Network (ATPS) Phase VI Strategic Plan, 2008-2012 funded by ATPS Donors including the Ministerie van Buitenlandse Zaken (DGIS), the Netherlands, Rockefeller Foundation, amongst others. The authors hereby thank the ATPS for the financial and technical support during the implementation of the program. The Authors specially thank the ATPS Climate Sense Program Director, Dr. K. Urama (ATPS), and the program coordinators including Prof. F. Mutua (ATPS Kenya), Dr. G.O. Essegbey (Council for Scientific and Industrial Research (CSIR), Ghana, Prof. E. Eboh (ATPS Nigeria), Dr. N. Ozor (ATPS), and Ms Wairimu Mwangi (ATPS) for their technical support during the research process.

Literature

1. Anim F.D.K., 1999, A note on the adoption of soil conservation measures in the Northern Province of South Africa. Journal of Agricultural Economics, vol. **50**, 336-345.
2. Araya B. & Adjaye J.A., 2001, Adoption for farm level soil conservation practices in Eritrea. Indian Journal of Agricultural Economics, vol. **56**, 239-252.
3. Benhin J.K.A., 2006, Climate change and South African agriculture: impacts and adaptation options. CEEPA Discussion paper N° 21. CEEPA, University of Pretoria, South Africa.
4. Deressa T., 2008, Analysis of perception and adaptation to climate change in the Nile Basin of Ethiopia. An unpublished Ph.D. thesis, Centre for Environmental Economics and Policy for Africa (CEEPA), University of Pretoria, South Africa.
5. Downing T.E., Ringius L., Hulme M. & Waughray D., 1997, Adapting to climate change in Africa. Mitigation and adaptation strategies for global change Vol. **2**, 19-44.
6. Enete A.A. & Achike I.A., 2008, Urban agriculture and food insecurity/ poverty in Nigeria; the case of Ohafia-Southeast Nigeria. Outlook on agriculture, **37**, 2, 131-134
7. Enete A.A. & Amusa T.A., 2010, Challenges of agricultural adaptation to climate change: a synthesis from the literature. FACTS Reports, vol. **4,** http://factsreports.revues.org/
8. Enete A.A., 2003, "Resource use, marketing and diversification decisions in cassava producing household of Sub-Saharan Africa". A Ph.D dissertation presented to the Department of Agricultural Economics, Catholic University of Louvain, Belgium.
9. Enete A.A., Nweke F.I. & Tollens E., 2002, Determinants of cassava cash income in female headed households of Africa. Quarterly Journal of International Agriculture, **41**, 3, 241-254
10. F.A.O., 2000, Two essays on climate change and agriculture. A developing country perspective. FAO, Rome, Italy.
11. German Advisory Council on Global Change (WBGU), 2004, World in transition fighting poverty through environmental policy. Earthscan, London Gregory, P.J., Ingram, J.S.I and Brklacich M., 2005. Climate change and food security. Philosophical transactions of the Royal Society B. vol. **36**: 2139-2148.
12. Hassan R. & Nhemachena C., 2008, 'Determinants of African farmers' strategies for adapting to climate changes: multinomial choice analysis. AFJARE, **2**, 1, 85-104.
13. IFOAM, 2007, Organic agriculture's role in countering climate change. IFOAM, Germany.
14. Jones P.G. & Thornton P.K., 2002, Croppers to livestock keepers: livelihood transition to 2010 in Africa due to climate change. Global Environmental Change, World Health Organization, Geneva, Switzerland.
15. Kolstad C.D., 2000, Environmental Economics. Oxford University Press, Inc. New York, USA.
16. Maddison D., 2006, The perception of and adaptation to climate change in Africa. CEEPA Discussion paper N° 10, CEEPA, University of Pretoria, South Africa.
17. Madu I.A., 2005, "Population and settlement constraints to sustainable agricultural land use in southeastern Nigeria" *in*: Okoko, E. Adekunle, V.A.J and Adeduntan, S.A. (eds). Environmental sustainability and conservation in Nigeria. Environmental Conservation and Research Team, Federal University of Technology, Akure Nigeria pp. 163-171.
18. Madukwe M.C., 2004, "Multivariate analysis for agricultural extension research". *In*: Terry. A.O. (ed) Research Methods in Agricultural Extension. Pp. 206-236.
19. Mark W.R., Mandy E., Gary Y., Lan B., Saleemul H. & Rowena V.S., 2008, Climate change and agriculture: threats and opportunities. Federal Ministry for Economic Cooperation and Development, Germany.
20. Nweke F.I., 1996, Cassava: a cash crop in Africa. COSCA working paper N° 14, COSCA, IITA, Ibadan, Nigeria.
21. Ozor N.S., Madukwe M.C., Enete A.A., Amaechina E.C., Onokala P., Eboh E.C., Ujah O. & Garforth C.J., Barriers to climate change adaptation among farming households of Southern Nigeria. Journal of Agricultural Extension, 14, 1.
22. Panin A. & Brummer B., 2000, Gender differentials in resources ownership and crop productivity of smallholder farmers in Africa: a case study. Quarterly Journal of International Agriculture, **39**, 1, 93-107.
23. United Nations Framework Convention on Climate Change (UNFCCC), 2007, Climatic change impact, vulnerabilities and adaptation in developing countries UNFCCC Secretariat, Martin-Luther-King-Straat 8 53175 Bonn, Germany. www.unfccc.int
24. Wisner B., Blaikie P., Cannon T. & Davis I., 2004, At risk: natural hazards; people's vulnerability and disasters. 2nd Edition. Routledge, London.
25. Ziervogel G., Nyong A., Osman B., Conde C., Cortes S. & Dowing T., 2006, Climate variability and change: implications for household food security. Assessments of Impacts and Adaptations to Climate Change (AIACC) Working Paper N° 20, January 2006. The AIACC Project Office, International START, Secretariat, Washington DC, USA.
26. Zoellick R.B.A, 1993, Climate smart future. The Nation Newspapers. Vintage Press Limited, Lagos, Nigeria. Page 18

A.A. Enete, Nigerian, Ph**,** Lecturer at the Department of Agricultural Economics, University of Nigeria, Nsukka (UNN), Nigeria.

A.N. Onyekuru, Nigerian, PhD student, Department of Environment, University of York, UK.