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Farmers' Adaptation to Climate Change Using Agroforestry Practices: Case Study of Kaduna Metropolis

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Abstract
The study was carried out in Kaduna Metropolis, with primary and secondary data used for this study. The primary data were generated through the use of structured questionnaires which were distributed among farming communities in the study area. Secondary data was gotten from (rainfall distribution data) Nigeria Metrological Agency, to justify the evidence of climate change and its effects on crop yields in the study area. A total of one-hundred questionnaires (100) were administered, out of which eighty-six (86) was retrieved for analysis. Results revealed that majority of the respondents (80%) were between the ages of 45-50, 77.90% were married, and male (69.8%). Results revealed that many of the farmers (45.30%) had primary education and they preferred information from Radio and Television (26.7%), and 25.7% from friends and family. Majority of the farmers (55.8%) strongly agree that the effect of climate change is highly deleterious in livestock production, 33.7% strongly agree that the climate change effects can easily be handled in livestock farming, while, 27.9% agree that climate only affect crop production. The agro-forestry adaptation strategies usually practiced include; alley farming (47.7%) and taugya system (46.5%), while 46.5% and 44.2% strongly agree with the adoption of improved fallow and shifting cultivation respectively, and 27.9% agreed that the use of Tropical Shelter Wood System (TSS) and crop production as a viable means for coping with the effects of climate change. About 23.9% of the farmers were constrained with inadequate knowledge of predicting possibility of climate change, 22.3% indicated inadequate knowledge of the choice of tree species that can be used in mitigating the problems of climate change in agricultural environment. Results therefore concludes that farmers' are faced with menace of climate change induced hazards on activities which in reality affect their productivity, and they do not have adequate knowledge and fund towards coping or mitigating the effects of climate change. Hence, it is recommended that farmers should equipped with knowledge of the principle that guide the use of agroforestry practice because it is considered as the best way to sustainable, cost-effective and eco-friendly approach to enhancing food security.

Keywords: Farmers, Adaptation, Climate Change, Agroforestry, Practices

Introduction

The cultivation of trees in combination with agricultural crops was a common practice dating back to the beginning of plant and animal domestication. Agroforestry is defined as the deliberate integration of woody species with agricultural crops and/or pastures on the same land-unit resulting in the integration of economical and ecological interactions between components (Young, 2002). The International Development Research Centre (IDRC) in Canada established that priority in research should be given to combined agroforestry production systems in tropical regions in order to optimize land-use, establish food security, and address the increasing problem of environmental degradation (King, 1987). Since then, agroforestry practices were promoted as a sustainable land-use management system in developed and developing countries. For example, agroforestry practices range from low-input systems such as alley cropping and short-term improved fallow with leguminous shrubs to nitrifying the soil.

Modern agro-forestry practices minimize the need for external nutrient inputs from fertilizers or manure, which are difficult or not economically feasible for small producers. The potential of agroforestry systems

and their role in providing ecosystem services has become the forefront of research as a result of global climate change (Pagiola *et al*., 2008). Agroforestry systems are unique because they are a land management practice that simultaneously addresses biophysical, economical, and socio-ecological components and ecosystem services. Ecosystem services not only provide an economic incentive but are also of value to society by maintaining environmental sustainability (FAO, 2012). Climate Change Adaptation using Agroforestry Practices suggested that apart from providing ecosystem services, agroforestry practices, are a means of diversifying agricultural production and increase food security for smallholder agriculture producers, especially under current climate change scenarios (Verchot *et al*., 2007).

Although maintaining agricultural productivity under changing climatic conditions is challenging due to the lower capacity to adapt in developing nations compared to developed nations (IPPC, 2007). The inherent environmental degradation associated with conventional agriculture especially in developing countries such as: deforestation, erosion, desertification, shortages of water and food which produces greater risks to health and life as a result of climate change. The changes in the climatic variable especially rainfall and temperature pattern have greatly affected vegetation and agriculture negatively (Barrett, 2009). To cope with the afore-mentioned challenges, the rural poor drew from indigenous knowledge and innovation through local experimentation and adaptation. Hence, more prudent action regarding available, sustainable and affordable climate change adaptation strategies is therefore becoming increasingly important in order to mitigate these farmers' induced climatic and environment menace. Therefore, this research seeks to evaluate the application of agro-forestry practices as a strategy to climate change adaptation in the study Kaduna Metropolis.

Methodology

Study Area

Kaduna State is located between longitude 7^0 $25^{'}$ $46.2144^{"}$E and latitude10^0N $36^{'}$ $33.5484^{''}$N of the Greewich Meridian (Yusuf, 2015). Kaduna State has a population of 6,066,512 people according to 2006 population census and it is the largest in the Federation after Lagos and Kano (NPC and ICF, 2014). Kaduna shares boundary with the Federal Capital Territory to the South West, Niger to the West, and Zamfara to the North West, Kano and Katsina to the North and Bauchi and Plateau to the East. The state is located within the savannah ecological zone. The climate is characterized by alternating wet and dry season; enjoys an average of 5 month of raining season, with a mean annual rainfall of between 1007mm- 1286mm, while relative humidity ranges between 60-80 percent in July. The cultivable land measures of 3.44 million ha. Commonly grown crops in the State include among others maize, millet, groundnut, soya beans, cotton, tomatoes and pepper.

Methods of Data Collection

Primary data used for the study were generated through the use well-structured questionnaires and oral interview. The questionnaires were distributed among crop producing farmers, aquaculturists, livestock producing farmers and the related ministries (Forestry and Natural Resources and Agriculture). Secondary data were generated on climatic variable (i.e rainfall and crop yield data for selected crops) for Kaduna State from Nigeria Metrological Agency, text books and related publications. During the data collection, the following were put into consideration. Multi-stage sampling techniques was used for this study such that two (Kaduna North and Kaduna South Local Government Area) out of the Four Local Governments within the Metropolis were purposively selected for the study on the basis of diversification of farming activities (crop production, animal husbandry and aquaculture). From the two selected Local Governments, five villages each were selected based on agricultural activities commonly practiced. Hence, Ten (10) questionnaires each were randomly distributed in each of the five (5) villages within the two (2) selected Local Governments. Information were retrieved on farmers' experience of climate change, crop yield, farming system and practices as well as farmers' adaptation mechanism towards coping with climate change. This was achieved through randomly distributed structured questionnaires. Information on climate records and yield of some selected crops for the period of fourteen (14) years was also obtained from the related ministries and agencies such as (Nigeria Metrological Agency and Kaduna State Ministry of Agriculture). Data collected from the field were analyzed using descriptive statistics

Results and Discussion

Socio-economic characteristics

Table 1 describes the social-economic characteristics of the respondents. The table shows the age distribution of Agro-forestry farmers in the study area and reveals that 7% of the respondents are within the ages 15-25, 22.10% 26-35, 37.20% 36-45, 27.90% 46-55 while 5.80% are within ages 56-65yrs. From this result, it could be seen that many of the respondents (37.20%) are between the ages of 36-45 which is the normal active working age in every society. The concentration of this age categories in the farming community could be premised to many factors such as; problem of unemployment, availability of arable land, low cost production, level of education and the quest for source of livelihood for themselves and their families. Moreover, it is believed in Africa setting that the individual in this age group must be responsible for some other people in the society if at all they are not married. Therefore, to meet up with these numerous responsibilities, there is the need for them to seek for a legitimate means of livelihood through farming (agriculture). They also need efficient use of their available scarce resources (land, finance and labour) to yield multiple outputs that will serve as an alternative source of food during periods of deficit and security in case of uncertainty e.g crop failure and alternative

sources of income for owners. This result is in consonance with Nguyen *et al*. (2013) who reported that use of multipurpose trees and integrated approaches can enhance the profitability of farmer. For example, trees can be sources of fodder, which in turn can be converted into valuable plant nutrients (Neupane and Thapa 2001). Trees on farms can also provide wild edible fruits and non-timber products that serve as alternative food during periods of deficit and primary sources of income for many rural communities (Neufeldt *et al*., 2012). Molua (2005) documented that Agroforestry in general may increase farm profitability through improvement and diversification of output per unit area of tree/crop/livestock and protection against damaging effects of wind or water flow, and through new products added to the financial diversity of the farming enterprise. From the table, it was discovered that the majority of the respondents (77.90%) are married while 22.10% are single. The reason behind the higher population of married respondents in the study area may be due to fact that the respondents are seeking for the means to satisfying their family responsibilities and livelihood amongst other factors. The gender distribution of the farmers depicts that majority of the farmers are male (69.8%) while female farmers represent 22.10% of the study population. This result conforms to the cultural setting in the study area where male have more access to land for agricultural activities. Also, because of the arduous nature of farming activities, farm work becomes a predominant job for male farmers than their female counterparts. This agrees with the *apriori* believe that females are weaker vessel. The table also shows that the sampled farmers have varying degree of educational background ranging from primary education to others. This result reveals that 45.30% of the farmers have primary education, 25.60% secondary education, 19.80% tertiary education, 7.00% non-formal education, while 2.30% have other forms of education. We can deduce from this results that majority of the farmers have primary education, while few have tertiary level of education. This implies that the level of education of the farmers in the study area is low and this may have a direct effect on their understanding and adoption of agro-forestry as a means towards enhancing crop yields and mitigating climate change effect on their farming activities in the study area.

Access to Climatic Information

Table 2 described the respondents' access to climatic information in the study area. Two (2) indices were being addressed under this table; various sources of climatic information and the prefer source of climate information by the respondents. From the table, it was discovered that many (26.7%) of the respondents source their information from radio and television, followed closely by 25.7% who sourced their information from friends and family, 12.3% from the extension agents, 8.6% from education, 14.9% printed media, 6.4% information from Government agency, while 5.3% get information from all the sources mentioned above. From the result, it was discovered that the many of the respondents source their information from radio and television (26.7%). This is premise to the fact that the respondents have accessibility to source of electricity; therefore, most of these farmers used their leisure period listening to news and agricultural programs. Since most of the program is usually held in their native languages which make it easier for them to comprehend.

Perception of Farmers towards Climate Change

Table 3 described the perception of farmers towards climate change in the study area using the following as measurement indices: Strongly Agreed, Agreed, Undecided, Disagreed and Strongly Disagreed by the respondents. The results show the analysis farmers perception to towards climate change. About 47.7% of the farmers strongly disagreed with no experience of climate change, while 8.1% strongly agreed that they have no experience of climate change in the study area. Many of the farmers (27.9%) agreed that climate only affect crop production in agriculture, while 26.7% disagreed with the effect of climate change on crop production. This implies that climate change affects crop production since the highest population of the survey respondents have attested to this fact. About 55.8% strongly agreed that the effect of climate change is highly deleterious in livestock production and 50.0% disagreed that climate change does not have affect on livestock production in the study area. Since, many of the respondents (27.9%) and 55.8% strongly agreed that climate change is highly deleterious to both crop and livestock productions respectively. Therefore, we deduce that farmers' are being affected by climate change issues in the study area. About 45.3% of the farmers strongly agreed that climate change leads to crop failure, 43.0% that climate change results in low yields/productivity, 39.5% and 38.4% disagreed and strongly disagree respectively, that climate change does not affect production and farming activities. This implies that change affects farmers productivity and yields in either ways (be it positive or negative). About 33.7% of the farmers each strongly agreed to the negatives relationship between livestock production and climate change, and strongly agreed that the climate change induced drought can easily be handled in livestock farming. Almost thirty-three percent (32.6%) of the farmers agreed that there is positive relationship between livestock production and climate change in the study area. Hence, we infer from this study that climate change though have negative effects in both crop and animal production, but if agro-forestry practices are well harnessed may bring about multiple benefits to farmers in terms multiple output and economic return on investment. This corroborates the submission of (FAO, 2009) that through agroforestry, farmers' incomes are augmented, since cash crops are planted simultaneously with forest trees. This, in turn, translates to increased standard of living, economic growth and development. Further, agroforestry improves the quality of water and air, thus promoting water and energy conservation (Onilude *et al.*, 2010).

Adaptation Strategies using Agro-forestry Practices

The result in Table 4 shows the various adaptation

strategies using agro-forestry practices in the study area. Nine (9) agro-forestry practices were observed to justifying agro-forestry adaptation approach to climate change by farmers' in the study area. Result shows that 47.7% and 46.5% of the respondents practice alley farming and taugya system respectively among agro-forestry adaptation strategies in the study area. About 44.2% of the farmers strongly agreed to the adoption of improved fallow and shifting cultivation, 43.0% for the adoption of shelterbelt/wind break as agro-forestry practices to mitigating climate change menace in agriculture, 37.2% strongly agreed that practice of planting trees and grow grasses together on pasture land, while 33.7% strongly agreed with the growing of multipurpose trees and crops. Alley cropping was agreed upon among 32.6% of the farmers in the study area. About 31.4% of the farmers were undecided about the use of trees and crops for reclaiming bared soil. This may be attributed to their level awareness and knowledge of agroforestry. Many of the farmers (26.7%) agreed with the adoption of Aqua-silviculture in coping with menace of climate change, while 27.9% agreed on Tropical Shelter Wood System and crop production as a viable strategy for mitigating the effects of climate change in the study area. We infer from this study that farmers in the study area adopt multi-strategic approach towards coping with effects of climate change. This is supported by Singh *et al*. (2013) who noted that in the present scenario of climate change, agro- forestry practices, emerged as a viable option for combating negative impacts of climate change.

***Constraints militating against Adoption of Agro-forestry Climate Change Adaptation* Strategies**

Table 5 addressed the constraints faced by farmers towards adoption of climate change adaptation approaches identified in Table 4. Five (5) major problems were identified, they include: lack of Technical know-how, inadequate finance, inadequate knowledge of the choice of Tree Sp, inadequate knowledge of predicting the climate change, inadequate knowledge of the principle of Agroforestry. Results indicate that 16.7% of the farmers in the study area indicated lack of technical know-how as one their major problems which might have hindered them from coping with climate change through Agroforestry principles, 19.2% problem of inadequate finance in the study area, 22.3% inadequate knowledge of the choice of tree species that can be used in mitigating the problems of climate change in agricultural environment, 23.9 inadequate knowledge of predicting the climate change which might disallowed them from coping with climate change through agroforestry practices, while inadequate knowledge of the principle of agroforestry with 17.8%.

Conclusion

The climate change is negatively affecting food security and environmental conservation. The study on farmers' adaptation to climate change using agroforestry practices revealed that the majority of the farmers are middle aged, male, married with primary education and mostly preferred information from radio. Majority of the farmers strongly agreed that the climate change is highly deleterious in livestock production. Alley farming top the agroforestry adaptation strategies normally practiced in the study area. Majority of the farmers are constrained with inadequate knowledge of predicting possibility of climate change. Farmers therefore need to understand the principle that guide the use of sustainable agroforestry practices to overcome challenges of climate change. Also, government should make agro-forestry tree seedlings available and accessible at an affordable cost to farmers as this will go a long way to helping farming communities towards mitigating drought and other adverse effects of climate change.

References

Barrett, S. (2009). Rethinking Global Climate change governance. Economics; *Open Assessment E Journal*, 3:1-12. *Available at http/www.economics-ejournal.org/economics/journal articles 59 (accessed 09; 11;10).*

FAO (2009). Food and Agriculture Organization. A Win-Win War on Climate Change; agroforestry and climate change. Available at www.FAO, cited Dec. 2009; (Access date: 20th December, 2009).

FAO (2012). Food and Agriculture Organization. Greening the Economy with Climate-Smart Agriculture. Background Paper for the Second Global Conference on Agriculture, Food Security and Climate Change. FAO Paper Prepared by Alexandre Meybeck and Vincent Gitz. Rome (Italy): Food and Agriculture Organization of the United Nations.

IPCC (2007) Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IntergovernmentalPanel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, Pp. 7-22.

King, K.F.S. (1987). The history of agroforestry. In: *A Decade of Development* Leakey, R.R.B., Simons, A.J. (1996). The domestication and commercialization of indigenous trees in agroforestry for the alleviation of poverty. *Agroforestry Systems,* 38:165-176.

Molua, E.L .(2005). The economics of tropical agroforestry systems: the case of agroforestry farms in Cameroon. *Forest Policy Econ*., 7:199-211.

Nelson, G. C, Rosegrant, M.W., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M Valmonte-Santos, R., Ewing, M. and Lee, D. (2009). Climate Change Impact on Agriculture and Costs of Adaptation." International Food Policy Research Institute. Food Policy Report. Washington, D.C.

Neufeldt, H., Jahn, M., Campbell, B.M., Beddington, J.R., DeClerck, F., Pinto, A.D. and Gulledge, J. I. (2013). Beyond climate-smart agriculture: toward

safe operating spaces for global food systems. *Agric Food Security*, 2(12):6.

Neupane, R.P. and Thapa, G.B. (2001). Impact of agroforestry intervention on soil fertility and farm income under the subsistence farming system of the middle hills, Nepal. *Agric Ecosyst Environ*., 84:157-167.

Nguyen, Q., Hoang, M.H., O¨born, I. and Noordwijk, M.V. (2013). Multipurpose agroforestry as a climate change resiliency option for farmers: an example of local adaptation in Vietnam. *Climatic Change*, 117:241-257.

NPC and ICFn (2014). National Population Commission, Nigeria and ICF International. Nigeria Demographic and Health Survey 2013. Abuja, Nigeria and Rockville, Maryland.

Onilude, Q. A., Awosusi, B. M. and Ige, P.O. (2010). Climate Change and Biodiversity Conservation. Paper presented at the International Seminar of Tropical Biology Association, held at First Bank Auditorium, Faculty of Agriculture and Forestry, University of Ibadan, Nigeria. 26th August, 2010.

Pagiola, S., Rios, A.R. and Arcenas, A. (2008). Can the poor participate in payments for environmental services? Lessons from the Silvopastoral Project in Nicaragua. *Environment and Development Economics*, 13:299-325, ISSN 1355770.

Singh, N.R., Jhariya, M.K. and Raj, A. (2013). Tree crop interaction in agroforestry system. *Readers Shelf*, 10(3):15-16.

Verchot, L.V., Noordwijk, M.V., Kandji, S., Tomich, T., Ong, C., Albrecht, A., Mackensen, J., Bantilan, C., Anupama, K.V. and Palm, C. (2007). Climate change: linking adaptation and mitigation through agroforestry. *Mitigation Adapt Strat Global Change*, 12:901-918.

Young, A. (2002). *Agroforestry for Soil Management*. CAB International, ISBN 0851991890, Wallingford, UK.

Yusuf, S. (2015). Kaduna: Physical and Human environment.

Table1: Socio economic characteristics of the farming households

Variables	Frequency	Percentage %
Sex		
Male	0	69.8
Female	20	30.2
Marital Status		
Single	29	22.10
Married	67	77.90
Age		
15-25	6	7.00
26-35	19	22.10
36-45	32	37.20
46-55	24	27.90
56-65	5	5.80
Educational Status		
Primary	39	45.30
Secondary	22	25.60
Tertiary	17	19.80
Non Formal	6	7.00
Others	2	2.30
Total	**86**	**100.00**

Source: Field Survey, 2022

Table 2: Access to Climatic Information

Variables	Frequency	Percentage %
Source of Climatic Information		
Airport	13	15.1
Radio	16	18.6
Family	2	2.3
Friends	1	1.2
News	10	11.6
No response	33	38.4
Printed media	1	1.2
Radio/television	3	3.5
Television	7	1.2
Preferred source of Information		
Extension Agent	23	12.3
Radio/Television	50	26.7
Education	16	8.6
Government agency	12	6.4
Friends/Family	48	25.7
Printed Media	28	14.9

Source: Field Survey, 2022

Table 3: Perception of Farmers towards Climate Change

		Strongly Agree		Agree		Undecided		Disagree		Strongly Disagree	
S/N	**Variables**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
1.	No Experience of climate change	7	8.1	5	5.8	8	9.3	25	29.1	41	47.7
2.	Advantages of climate change in farming activities	9	10.5	23	26.7	22	25.6	22	25.6	10	11.6
3.	Effect of climate change on prod/farming activities	5	5.8	0	0.0	13	15.1	34	39.5	34	39.5
4.	Crop failure due to climate change	39	45.3	19	22.1	13	15.1	10	11.6	5	5.8
5.	Low yield/productivity due to climate change	21	24.4	37	43.0	13	15.1	11	12.8	4	4.7
6.	Increase in Temp/drought due to climate change	29	33.7	19	22.1	12	14.0	19	22.1	7	8.1
7.	Farming activities does not affect by climate change	2	2.3	12	14.0	10	11.6	29	33.7	33	38.4
8.	Farmers perceived in climate change	8	9.3	32	37.2	29	33.7	13	15.1	4	4.7
9.	Crop in Agriculture affected by climate change	7	8.1	24	27.9	17	19.8	23	26.7	15	17.4
10.	Climate change does not affect livestock production	7	8.1	7	8.1	14	16.3	43	50.0	15	17.4
11.	Positive relationship between production and climate change	7	8.1	28	32.6	19	22.1	25	29.1	7	8.1
12.	Negatives relationship between livestock and climate change	29	33.7	24	27.9	22	25.6	8	9.3	3	3.5
13.	Climate change can easily handle in Livestock production	48	33.7	28	32.6	15	17.4	12	14.6	2	2.3
14.	Effect of climate change is highly deleterious in livestock production	48	55.8	17	19.8	10	11.6	4	4.7	7	8.1

Source: Field Survey, 2022

Table 4: Adaptation Strategies Using Agroforestry Practices

		Strongly Agree		Agree		Undecided		Disagree		Strongly Disagree	
S/N	**Variables**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
1.	**Improved Fallow in Shifting Cultivation**	38	44.2	19	22.1	12	14.0	12	14.0	5	5.8
2.	**Taungya Cropping**	13	15.1	40	46.5	25	29.1	6	7.0	2	2.3
3.	**Alley Cropping**	26	30.2	28	32.6	22	25.6	9	10.5	1	1.2
4.	**Alley Farming**	13	15.1	41	47.7	26	30.2	5	5.8	1	1.2
5.	**Multipurpose Trees & Crops**	29	33.7	18	20.9	19	22.1	18	20.9	2	2.3
6.	**Tree & Crops for Reclaiming bared soil**	18	20.9	31	36.0	27	31.4	5	5.8	5	5.8
7.	**Trees & Grasses grow together on a pasture land**	32	37.2	20	23.3	14	16.3	16	18.6	4	4.7
8.	**Tropical Shelter Wood system & Crop Production**	17	19.8	24	27.9	22	25.6	13	15.1	10	11.6
9.	**Aqua-Silviculture**	21	24.4	23	26.7	23	26.7	11	12.8	8	9.3
10.	**Shelter-belt/Wind Break**	17	19.8	37	43.0	18	20.9	7	8.1	7	8.1

Source: Field Survey, 2022

Table 5: Constraints Faced by Farmers towards the adoption of Agro-forestry to Climate Change Adaptation Approaches

S/N	Variables	*Frequency	Percentage %
1.	Lack of Technical know-how	49	16.7
2.	Inadequate Finance	56	19.2
3.	Inadequate knowledge of the choice of Tree Sp.	65	22.3
4.	Inadequate knowledge of predicting the climate change	70	23.9
5.	Inadequate knowledge of the principle of Agroforestry	52	17.8

***Multiple Responses**
Source: Field Survey, 2022