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CHALLENGES IN ADOPTION OF CLIMATE SMART AGRICULTURAL PRACTICE (Agroforestry) BY PEASANT FARMERS IN ALEIRO, KEBBI STATE

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ABSTRACT

Desertification and fuelwood shortages are greatly sped up by man's unbridled activities, such as deforestation and over grazing. The study was carried in Aleiro, Kebbi state to assess the adoption of agroforestry as climate smart agricultural practice (CSAP) by peasant farmers in Aleiro, north-western Nigeria. A multi stage sampling technique was used to arrive at the sample size of Two hundred and fifty (250) peasant farmers in the study area. Questionnaires with multiple answers (response) were used for the questions in section B. The respondents of the questionnaires are 68.8% adopted to CSA (Agroforestry), the main source of energy is fuelwood (97.09%) and charcoal (84.30%). Major CSAP Agroforestry system mostly adopted by the respondents is silvopostoral system, trees raised and tendered by respondents are fruit trees and main crops grown in the area are onions (98.83%), rice (95.93%), Guinea corn (90.70%), millet (92.44%), maize (89.95%) and cassava (84.30%). The main benefit of the CSA practice (Agroforestry) is fuelwood production (100%) and the main challenges facing Agroforestry adoption lack of NGO support (98.84%), lack of awareness and insufficient nursery stock and seedling (97.60%) also duration of reaping the benefit of tree (97.10%). The study recommends the promotion of other sources of energy such as modern stoves which use less fuelwood and reduce GHG emission, so also the integration of Agroforestry into farming system by providing assistance, incentives and subsidizing inputs to the farming families. Extension services should be encouraged through programs like tree planting campaigns, free seedlings, and farm competitions. The farmers need sincere sensitization to the awareness of climate variability and its effect to different lifeforms.

Keywords: Climate, Agroforestry, Silvopostoral, seedlings, planting, fuelwood, crops, farming, millet, peasant, smart and charcoal incentives, maize, onions

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INTRODUCTION

Peasant farmers play a pivotal role in the food and agricultural production of many developing countries. Globally, Subsistence farmers produce close to half of world's food (Network, 2018) they produce over 80 percent of the consumed food in Africa (Mpandeli, 2020). The contribution of subsistence farmers, therefore, cannot be overemphasized. Despite their major contribution to food security, smallholder farmers are the most impacted by the dangers and uncertainty related to climate change as they lack resources and abilities to adapt to climate change (Simon et al 2023). Subsistence farmers must deal with land degradation issues brought on by ineffective soil fertility management and continual cropping. Additionally, recurrent droughts and floods have destroyed smallholders' crops and livestock systems, leading to their household food insecurity.

Nigeria is likely to experience exacerbate floods, droughts, heat waves and hamper agricultural production in hotter and drier seasons (UNDP, 2020), being agriculture remains the mainstay of its economy, in spite of oil as it employs two-thirds of the entire working population (Onwutuebe 2019). The sector is fraught with challenges as agricultural production is still mainly rainfall and subject to weather vagaries. Farmers find it hard to plan their operations due to unpredictable rainfall vagaries (Onyeneke, et al 2019). Increase in the total amount of rainfall and extreme temperature would have more of a negative effect on staple crops productivity. However, in northern states such as Borno, Yobe, Kaduna, Kano and Sokoto most crops might benefit economically. Crops such as millet, melon, sugarcane that are grown in the north will most likely benefit from extreme temperature (Ajetomobi 2015).

Aliero was in semi-arid lands which is characterized by low and erratic rainfall, intense solar radiations, long and severe dry season, with low relative humidity and high wind velocity. During most parts of the year, the evapo-transpiration far exceeds precipitation. Besides the productivity potentials of the land is also usually low. The soil has poor structure and very coarse texture with low water holding capacity and poor nutrient status (Abdulrahman, A. et al., 2022). The mean annual rainfall is generally less than 700mm (Plan, 2001). The grass cover is more or less continuous inter sparse by short savanna trees. Intense cultivation together with over grazing and bush burning continue to degrade the sparse vegetation (Awodola, 1991).

There is evident from temperature increase, rainfall variability (increasing in coastal areas and decline in continental areas). It is also reflected in drought, desertification, rising sea levels, erosion, floods, thunderstorms, bush fires, landslides, land degradation, more frequent, extreme weather conditions and loss of biodiversity (Olaniyini et al., 2019). All of which continues to negatively affect different lifeforms and also the Nigeria ecosystems (Dada and Muhammad (2014). Climate Impacts are categorised into four (4) viz.: potential impact; Residual impacts; Aggregate impacts and Market impact (IPCC TAR, 2001).

Climate Smart Agriculture practices consider both resilience and adaptation to climate change. The Food and Agriculture Organization of the United Nations (FAO) defines CSA as an approach that aims to assist those who manage agricultural systems in responding effectively to climate change (FAO, 2020). The triple gains of climate-smart agriculture are the sustainable increase in productivity and income, adaptation to climate change, and reduction in greenhouse gas emissions (FAO, 2020). Consequently, CSA helps guide actions to transform agri-food systems towards green and climate resilient practices.

Climate-smart agriculture (CSA) is an inventive approach based on the following three pillars:

1. sustainably increase agricultural productivity and incomes;
2. adapt and build resilience of people and agri-food systems to climate change; and
3. reduce or, where possible, avoid GHG emissions

CSA interventions have been implemented successfully around the world. This success is underpinned by the five action points of CSA implementation, as formulated by FAO (FAO, 2021a):

1. Expand the evidence base to identify the effects of climate change on food production and on agri-food systems as a whole; vulnerabilities in the agriculture sector that affect food security; institutional and financial barriers and possibilities; and also emphasized on climate-smart adaptation and mitigation options.
2. Supporting enabling policy frameworks by: developing relevant policies, legislation, plans and investments to support an enabling environment for CSA; modifying existing policies where needed; and coordinating policymaking processes to enable effective collaboration between institutions responsible for agriculture, climate change, food security and land use.
3. Strengthen national and local institutions through, supporting institutions so that they can empower, enable and motivate farmers; and building capacities of national policymakers so that they can effectively participate in international policy for a on climate change and agriculture, and engage with local public authorities.
4. Enhance funding and financing options by, accessing funding instruments such as the Green Climate Fund (GCF), the Global Environment Facility (GEF), official development assistance (ODA) and national sectoral budgets; and creating innovative links between climate finance and public and private agricultural investment; and integrating climate change in agricultural planning and budgeting.
5. Implement practices at field level through: selecting locally suitable CSA options by engaging local farmers' knowledge, requirements and priorities.

Agroforestry is a collective name for land use system in which woody perennials (Trees, Shrubs, etc.) are grown in association with herbaceous plants (Crops, pastures and or livestock in a spatial arrangement a relation or both and which there are both economic interactions between the tree and non-tree components of the system (Young, 1989). People are willing to plant more trees, but prefer multipurpose, economic and early maturing trees which can as well be inter cropped with the annual food crop (Lawal, 1992). Recently agroforestry has been hailed as a potentials solution to land use problems in tropical regions. The role of tree and forest in maintaining stability in ecosystem has come to the fore front in the search for solutions to environmental degradation (Brils et al; 1994).

International Council for Research in Agroforestry (ICRAF) is one of the major supporters of agroforestry in Africa. Its' support is on scientific knowledge, germplasm, networking, capacity building, and operations funds while governments contribute infrastructure, executive power, personnel, and tax rebates. Other important patrons in agroforestry include Canadian International Development Agency, IFAD, United Nations Development Program, European Development Fund, World Food Programme (WFP), Global Environmental Fund (GEF), World Bank, and the United Nations Environment Programme (UNEP) (Böhringer, 2001). Agroforestry system has been classified based on the type and nature of interaction between trees, crops and livestock, agroforestry can be classified as follows:

1. Agrosilvicultural system: - This is rising of agricultural crops with forestry and tree crops. Example: improved shirting cultivation system, alley cropping taungya system or shelter belts.
2. Silvopastoral System: - This is the rising of tree crops and livestock. Example: - Include multipurpose leguminous fodder trees and shrubs on or around farm land; living fence of folder ridge, integrated production of animal and wood products.
3. Agrosilvopastoral system: - This is in which land is managed for the current production of agricultural and forest crops and for rearing domesticated animals. Example: - Tree, livestock-crop mixture around the homestead (compound farming), multi-purpose trees.

It is also possible to classify agroforestry system by socio-economic criteria such as scale of production, level of technology input and management. Based on the socio-economic criteria, agroforestry system can also be classified into three categories viz:

1. Commercial agroforestry system: -Aim at the production of saleable output such as commercial tree plantation with under planting of food crops.
2. Intermediate agroforestry system falls between commercial and subsistence scale of production and management.
3. Subsistence agroforestry system: -Are directed towards satisfying basic need and are managed by the owner /occupant and his family (Nair, 1993).

METHODOLOGY

THE STUDY AREA

Aleiro is a town in northern Nigeria, Kebbi state, located in the capital of the state. Aleiro is the headquarters of Aleiro local government area. Most people in Aleiro are agrarian with emphasis on an, especially onion and pepper. Aleiro covers a geographical land area of 412 square kilometers with an estimated population of about 125,783 (NPC, 2006). The topography is flat and slightly undulating with compact stony brown soil. The town has the largest onion market in Northwest Nigeria and is a major producer of onion in Nigeria. The climate of the study Area is characterized by a long dry season (October to April). With a short rainy season May to October (Singh, 1995). The minimum and maximum temperatures are 19°c and 34°c respectively with mean annual temperature of 27°c and relative humidity of 52% to 55%. The study Area is the Harmattan wind which is a dry cold dusty wind blowing from November to February. However, during the Harmattan season (November to February) the temperature can go down about 21°c and up to 40°C during April and June (SIG, 1995). The vegetation of the area falls within the Sudan Savanna a zone characterized by sandy soil loamy soil and some patches of Fadama land. Vegetation has however been altered in many areas by intensive cultivation, grazing, fuel wood, harvesting and bush burning giving rise to form of parkland dominated by trees. The soil of the study area is predominantly sandy loamy with low fertility level particularly poor in primary nutrients like nitrogen, phosphorus and potassium (Ambursa et al. 2023).

Source of Data

The data of this were obtained from the following source: Primary data was obtained through the administration of structured questionnaire to forest officers in the local government and some sampled farmers while secondary data was obtained from internet data base and relevant printed materials.

SAMPLING TECHNIQUE AND SAMPLE SIZE

Sampling procedure & sample size

A multistage sampling technique was used to select five wards, and from each ward fifty (50) were purposively from each wards selected out of each wards, given a total sample size of two hundred and fifty (250) respondents.

Data collection methods

The data for this study were generated through the use of structured questionnaires which were administered with the help of trained enumerators. The questionnaires distributed to the farmers were structured interview schedules and the questions were mostly to cover relevant information on general socio-economic characteristics of the farmers, such as age, sex, educational level, farm size, marital status; rate of adoption to Agroforestry, main source of energy, types of Agroforestry adopted, major trees raised and tendered in the study area, main uses of Agroforestry, main crops grown and associated with trees, assessment of benefits and challenges facing Agroforestry a CSA.

Method of Data Analysis

Description statistical analysis was used to achieve the objective for each parameter on the questionnaire. Using frequency count and percentage to present information related to personal characteristics of the respondents in the area or frequency distribution table was constructed and percentage for each variable was calculated

RESULT AND DISCUSSION

The reputation of agroforestry in Nigeria cannot be overstated as it provides environmental stability for conditioned food production also as their main source of energy (Chisika et al., 2022). Different literatures indicate that the shortage of fuel wood has resulted to the adoption of agroforestry and planting of trees to affluence the problem (Sikei et al., 2009). Other arising needs for agroforestry include fodder for livestock, shade, medicinal and ornamental purposes and as a measure to water and environmental conservation in the farms (Awazi & Tchamba, 2019).

1. **The rate of Adoption to CSAP (Agroforestry)**

Adoption	Rate	Proportion (%)
Adopted	172	68.8
Not adopted	78	31.2
	250	100

Source: Field survey 2023

Table 1. The rate (Number of farmers adopting) of Agroforestry practices in Aliero Local Government.

Table 1 above summarized and indicated that 68.8% of the respondents are adopted to CSAP (Agroforestry) in the study area while 31.2% are not adopted to the practices of agroforestry.

2. **Main Source of Energy used by the adopters of agroforestry Practices**

Source Of Energy	Frequency	Proportion
Fuelwood	167	97.09
Charcoal	145	84.30
Kerosene	23	13.37
Liquidified Natural Gas (LNG)	57	33.14
Electricity	78	45.35
Solar	11	6.40
Bio- Gas	0	0
Diesel	0	0

Source: field survey 2023.

Table 2: Rate of Source of Energy used by the adopters of agroforestry Practices

Mainly energy sources are significantly contributing to GHG emissions. As highlighted in the table below the major source of energy to the respondents is fuelwood (97.09%)s followed by Charcoal (84.30%). On the other hand, electricity (45.35%), and electricity (33.14%) are the other sources energy used apart of fuelwood this may be due availability and accessibility in Aliero metropolis, while kerosene (13.37%) and solar (6.40%) recorded least and bio-gas and diesel are not in use. The finding showed low level of clean adoption among the farming families. The finding is related to that of Simon *et al.* (2023) who reported fuelwood was most commonly used biomass fuel in Bangladesh. Being fuelwood as the main source of energy, there is awful need in promoting agroforestry as last option to farmers.

3. **Main Types of agroforestry system by the respondents**

The study investigated the major forms of agroforestry by the smallholder farmers in Aliero local government. The result in the table 3 indicated that agro-silvicultural, agrosilvopostoral, silvopostoral and others were the most widely adopted forms of agroforestry with 17.7%, 14.60%, 54.25% and 11.45% of the respondents, respectively. The major agroforestry practice adopted by the adopters is silvopostoral system. These findings are equivalent to those of Luvoni (2021) who found woodlots, boundary trees, and scattered trees as the main forms of agroforestry in Kenya. Other studies conducted in Bangladesh showed that the farmers engaged in border plantations, woodlot agroforestry, tree crop association, and mixed agroforestry with livestock under tree cover all around their estates. These results indicate that it was possible for smallholder farmers to have more than one form of agroforestry in their farms as Simon et al. related in 2023.

Adoption	Rate	Percentage
Agrosilvicultural system	17	17.70
Agrosilvopostoral System	14	14.60
Sillvopostoral System	54	54.25
Others	11	11.45

Source: Field survey 2023

Table 3: Main Types of agroforestry system by the respondents

4. **Types of major trees raised and tendered by the respondent**

This study acknowledged the major trees found in the area were savannah native species and fruit crops with few exotic that are used for ornamental purposes and urban forestry. The trees species found in the study area are: *Adansonia digitata, Mangifera indica, Khaya senegalensis, Sclerocarya birrea, Balanitea egyptiaca, Eucalyptus Citriodora, Melaleucaleu Dendron, Anacardium occidentale, Anogeissuss leiocarpus, Ficus iteophylla , Nauclea latifolia, Tamarindus indica, Bauhinia rufescens, Sterculia setigera, Citrus sinensis, Holarrrhena floribunda, Terminalia mollis, Lannea acida, Gmelina arborea, Combretum molle, Jatropha curcas, Neocarya macrophylla, Bombax, Buonopolens, Piliostigma thonningii, Psidium guajava, Vitellaria paradox, Ficus ovate, Prosopis africana, Diospyros mespiliiformis, Gueira senegalensis, Parkia biglobosa, Detarium microcarpum, Ceibapentandra, Azadirachta indica, Vitex doniana, Moringa oleifera, Ficus glucose, Ficuspolita, Cassia sieberiania, Khaya ivorensis, Acacia nilotica, Ficus platypylla, Citrus aurantifolia, Daniella oliveri, Calatropis procera, Khaya senegalensis, Sclerocarya birrea, Balanitea egyptiaca.* These findings coincide with **Yusuf, et al., 2023** that identified 45 trees species from 21 families used for treating different ailment in Kebbi state. Also the study vividly showed that the peasants farmers preferred management of fruits trees (97.67%) followed by shade trees (85.47%) and ornamental trees (83.14). Mango was being the major dominant fruit tree in the area and Neem tree, and Terminalia spp are the main shade trees. The available indigenous tree spp in the study area not raised initially for agroforestry, the respondents managed and maintained the indigenous trees for woodlots, shelters and farm live fenced as the study noticed

Tree types	Responses	Proportion
Fruit tree	168	97.67
Fodder trees	54	31.40
Medicinal trees	23	13.37
Fuelwood trees	62	36.05
Nitro-fixation trees	87	50.58
Ornamental	143	83.14
Shade trees	147	85.47
Others (specify)	22	12.79

Source: field survey 2023.

Table 4: Types of major trees raised and tendered by the respondent

5. **Main uses of agroforestry**

This study required to establish the major uses of agroforestry trees by the peasant farmers in the study area. The table below indicated the main uses of agroforestry in the study area are: Fuelwood (100%), shades (100%), fruits (95.93%), fodder (90.70%), medicinal (83.14%) and timber and poles recorded (0%), the respondents utilized their agroforestry mainly for fuelwood, shades and fruiting. This could be due to, they already met indigenous tree in their farms. These findings are comparable to those of De Giusti et al. (2019) who noticed peasant farmers use of agroforestry as poles, timber, trunks, fuelwood, charcoal and fruits. These results labelled that agroforestry can be proficient for different uses thus clarifying the high level of its adoption.

Uses	Responses	Percentage
Fuelwood	172	100
Fruits	165	95.93
Fodder	156	90.70
Medicinal	143	83.14
Shades	172	100
Ornamental	104	60.47
Timber and poles,	0	0

Source: field survey 2023.

Table 5: Main uses of Agroforestry

6. Main crop Grown in the study area

The peasant farmers that were interviewed are silvopastorolist who rear livestock and grow many types of crops. This study investigated that onions (97.67%), and other vegetables are the major crops grown in the study area. They almost all engaged into irrigated farming, followed by significant number fully engaged into cereals farming, thus, rice 95.93%, Millet 92.44%, Guinea corn (90.70%) and maize (89.95%). Similar studies indicate that cereals were the main crops grown in Kebbi state.

Crops	Responses	Percentages
Millet	159	92.44
Guinea corn	156	90.70
Maize	153	89.95
Rice	165	95.93
Onions	170	98.83
Sesame	54	31.40
Bambara nut	76	44.19
Soya beans	34	19.77
Cowpea	89	51.74
Cassava	145	84.30
Potatoes	132	76.74
Tomatoes	167	97.09
Sugar cane	118	68.61
Finger millets	143	83.14
Cucumber	22	12.79
Cabbage	34	19.77
Salad	81	47.09
Pepper	169	89.53
Garden egg	121	70.35
Spinach	111	64.54

Source: field survey 2023

Table 6: Main Crops grown in the study area

7. Main Crops Grown by peasants Farmers Under Agroforestry Plots

Other crops grown using agroforestry CSA technology were investigated and highlighted in Table 13. The other major crops grown in agroforestry include Tomatoes (97.08%), Cassava (84.30%); finger millets (83.14%); maize (77.90%); potatoes (76.74%); guinea corn

(62.79%); millet (59.30%) cowpea (51.74%) and sesame (31.40 while was recorded soya beans (19.77%). These findings indicate that different food crops could be grown in association with agroforestry.

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Crops	Responses	Percentages
Millet	102	59.30%
Guinea corn	108	62.79
Maize	134	77.90
Sesame	54	31.40
Bambara nut	76	44.19
Soya beans	34	19.77
Cowpea	89	51.74
Cassava	145	84.30
Potatoes	132	76.74
Tomatoes	167	97.09
Finger millets	143	83.14

Source: field survey 2023

Table 7 Other Crops grown under Agroforestry CSA practice

8. Main Benefits derived by the peasant farmer from CSAP (agroforestry).

Agroforestry has abundant rewards for the farming community. Table 8 abridges the main benefits as perceived by peasant agroforestry farmer's fuelwood i.e heat energy. A substantial number 168 (97.67%) of the respondents cited agroforestry as their main source of energy. Other advantages cited by peasant farmers include shade provision (93.65%), soil fertility improvement (84.88%) windbreak (80.3 per cent), and significant number of the respondent 154 noticed other benefit could be derived from agroforestry CSA practice. Studies conducted in elsewhere found that farmers engage in agroforestry for such reasons as economic value, ecosystem services, and the survival of different lifeforms (Amare et al., 2019). Studies by Jahan et al. (2022) found that in addition to growing fruit for food, farmers also appropriated in agroforestry as a means of income for livelihood.

Benefits	Responses	Percentage
Soil fertility	146	84.88
Shade provision	161	93.65
Fuelwood & timber	168	97.67
Windbreak	145	84.30
Others	154	89.54

Source: field survey 2023

Table 8: Benefits that Smallholder Farmers Derive from Agroforestry Practice

9. Challenges facing smallholder farmers in agroforestry practice

Table 9 summarizes the major challenges faced by study respondents in agroforestry practice. The low survival rate of certain tree species, the long time it takes to realize the benefits of agroforestry, and a lack of necessary seeds and seedlings are some of the main challenges faced by agroforestry farmers, as identified by 57.7 per cent, 57.4 per cent, and 50 per cent of respondents, respectively. About a third (33.8 per cent, 32.2 per cent, and 31.9 per cent) of

the respondents reported a lack of resources to implement the technology, tree theft, and the shade effect of some agroforestry trees on crops. Other challenges identified include the project's completion (26.3 per cent), lack of support from the technology-promoting NGO (24.5 per cent), and lack of knowledge and information on how to implement (20.5 per cent). Similar studies by Jahan et al. (2022) showed that agroforestry farmers in Bangladesh had to grapple with long waiting times before getting benefits of agroforestry, high investment costs and limited advisory services.

Challenges	Response	Proportion
Lack of Capital and to implement	157	91.28
Inadequate extension services	154	89.54
Access to farm inputs	143	83.14
Unavailability of labor	137	79.65
Lack of nursery improved stocks	166	96.51
Pest and diseases	156	90.69
Lack of seeds and seedlings	167	97.09
Management of seedlings	145	84.30
Herdsmen encroachment	123	71.51
Poor topography	122	70.93
Weather condition	128	74.42
Unavailability of land	123	71.51
Lack of government supports	168	97.10
Lack of NGO support	170	98.84
Lack of incentive and motivation	122	70.93
Duration of reaping the program benefits	168	97.10

Source: field survey 2023

Table 9: Challenges facing smallholder farmers in agroforestry practice

CONCLUSION & RECOMMENDATIONS

Conclusions

The study's objective was to assess the challenges of adopting CSAP (Agroforestry) among peasant farmers in Aleiro local government, Kebbi state. This study found out that fuelwood and charcoal were the main sources of energy used for peasants agroforestry farmers followed by charcoal, solar energy devices, electricity, and kerosene. It has been established that CSA practices, the research shown that less concern was given to the awareness and s campaign on promoting agroforestry practices in the study area. It was added that the main uses of CSAP (agroforestry) is for energy fuelwood. Other uses of agroforestry as identified by the study include ornamental uses and urban forestry.

Recommendations

This study recommends integration of agroforestry in farming systems must be promoted. This can be done through promotion and provision of other sources of energy such as modern stoves which use less fuelwood and reduce GHG emission, so also the integration of Agroforestry into farming system by providing assistance, incentives and subsidizing inputs to the farming families. Extension services should be promoted and encouraged, program like tree planting campaigns, free seedlings and farm competitions should enhanced through government and non governmental agencies. The farmers need sincere sensitization to the awareness of climate variability and its effect to different lifeforms.

REFERENCES

A.B Gwaram, (2002). Evaluation of parkia biglobosa (jacq) FBR.Xe. G don Based Agroforestry system in Sudan savanna zone Nigeria, Unpublished Ph.D Thesis submitted to the post graduate school Usman Danfodio University Sokoto pp11.

Ajetomobi, Joshua (2015). "The potential impact of climate change on Nigerian agriculture". International Food Policy Research Institute. Archived from the original on 2018-08-14. *Retrieved 2020-12-01*.

Amare, A., Simane, B., Nyangaga, J., Defisa, A., Hamza, D., &Gurmessa, B. (2019). Index-based livestock insurance to manage climate risks in Borena zone of southern Oromia, Ethiopia. Climate Risk Management, 25, 100191.

Awazi, N. P., &Tchamba, N. M. (2019). Enhancing agricultural sustainability and productivity under changing climate conditions through improved agroforestry practices in smallholder farming systems in sub-Saharan Africa. African Journal of Agricultural Research, 14(7), 379-388.

Awodola, A.M. (1991): Soil moisture nutrients relations of parkiabiglobosa (jacq) B.BR ex 6 Don in the semi-aridzone of Nigeria,Unpublished Ph.D Thesis Department of Forestry resources management, Univresity of Ibadan Nigeria.

Böhringer, A. (2001). Facilitating the wider use of agroforestry for development in southern Africa. Development in Practice, 11(4), 434-448.

Brils,C.PEnde, B. Deleed and P.Panp.(1994): Agro forestry :Technical center Agriculture and Cooperation , Agradok series No. 16 pp60.

Buyinza, J., Nuberg, I. K., Muthuri, C. W., & Denton, M. D. (2020). Assessing smallholder farmers' motivation to adopt agroforestry using a multi-group structural equation modeling approach. Agroforestry Systems, 94(6), 2199- 2211.

Chisika, S., Park, J., Park, H., &Yeom, C. (2022). Farmers' Perception of Ecosystem Services from Agroforestry Practices in Kenya: The Case of Kakamega County. Journal of Sustainability Research, 4(4), e220016. https://doi.org/10.20900/jsr20220016

Dada, A. A.; Muhammad, U. (2014-12-29). "Climate Change Education Curriculum for Nigeria Tertiary Education System". Sokoto Educational Review. 15 (2): 119–126. doi:10.35386/ser.v15i2.175. ISSN 2636-5367.

De Giusti, G., Kristjanson, P., &Rufino, M. C. (2019). Agroforestry as a climate change mitigation practice in smallholder farming: evidence from Kenya.Vol. 4 (Iss. 2) 2023, pp. 1157-1173 African Journal of Empirical Research https://ajernet.net ISSN 2709-2607 1172 Licensed Under Creative Commons Attribution (CC BY-NC)

FAO. (2020). Food and Agriculture Organization of the United Nations. Climate-Smart Agriculture. http://www.fao.org/climate-smart-agriculture/en/

FAO. 2021a. Climate Smart Agriculture Sourcebook. In: Food and Agriculture Organization of the United Nations [online]. Rome. [Cited 24 January 2021]. www.fao.org/climate-smart-agriculture-sourcebook

Hassan, M. K., Halder, P., Pelkonen, P., &Pappinen, A. (2013). Rural households' preferences and attitudes towards biomass fuels-results from a comprehensive field survey in Bangladesh. Energy, sustainability and Society, 3(1), 1-14.

Hughes, K., Morgan, S., Baylis, K., Oduol, J., Smith-Dumont, E., Vågen, T.-G., &Kegode, H. (2020). Assessing the downstream socioeconomic impacts of agroforestry in Kenya. World Development, 128, 104835.

IPCC TAR (2001). Climate Change 2001: Impacts, Adaptation and Vulnerability. IPCC ThirdAssessment Report, Cambridge University Press.

IPCC. (2007). Intergovernmental Panel on Climate Change. The physical science basis. Contribution of working group I to the fourth assessment report of the Intergovernmental Panel on Climate Change. 996(2007), 113-119. (J Cambridge University Press, Cambridge, United Kingdom)

Jahan, H., Rahman, M. W., Islam, M. S., Rezwan-Al-Ramim, A., Tuhin, M. M.-U.-J., & Hossain, M. E. (2022). Adoption of agroforestry practices in Bangladesh as a climate change mitigation option: Investment, drivers, and SWOT analysis perspectives. Environmental Challenges, 7, 100509.

Lawal, U.B (1992): An evaluation of farm forestry programme of the sokoto state afforestation project Unpublished Msc Thesis. Department of Forest Resources Management, University of Ibadan, Nigeria.

Luvoni, T. K. (2021). Social determinants of adoption of on-farm tree planting and its contribution to household income in Shinyalu, Kakamega, Kenya.

Maishanu, H.M (1994) Socio Economic Survey of selected Economic Tree species in Sokoto State, Unpublished Msc Thesis, Department of Forest Resources and Management University of Ibadan, Nigeria.

Mpandeli, S. N. H.-G. a. N. S. (2020). The Role of Small-Scale Farmers in Ensuring Food Security in Afri. In. IntechOpen. https://doi.org/10.5772/intechopen.91694

Naerls (National Agricultural Extension and Research LiasonServices) (1991): Agroforestry practices in Nigeria Extension and Research Bulletin No.52. Nearls ABU Zaria, Agroforestry series No. 1 pp38.

Nair, P.K.R. (1989):" Agroforestry Systems practices and Technologies *: Agroforestry system in ther tropic* Kluwer academic publishers, Dordrecht pp53 -62.Nigeria. In akinsanni, F.A (d) Our Forest Envirnment and Heritage:Challenge for our people proceeding of the 22nd Annual conference of the forestry Association of Nigeria 2nd – 7th November, 1992. Pp218 – 228

Nyaga, J., Barrios, E., Muthuri, C. W., Öborn, I., Matiru, V., & Sinclair, F. L. (2015). Evaluating factors influencing heterogeneity in agroforestry adoption and practices within smallholder farms in Rift Valley, Kenya. Agriculture, Ecosystems &EnvironmentVol. 4 (Iss. 2) 2023, pp. 1157-1173 African Journal of Empirical Research https://ajernet.net ISSN 2709-2607

Olaniyi O.A., Olutimehin I.O. and Funmilayo O.A. (2019). "Review of Climate Change and Its effect on Nigeria Ecosystem". International Journal of Rural Development, Environment and Health Research. 3 (3): 92–100. doi:10.22161/ijreh.3.3.3.

Onwutuebe, Chidiebere J. (2019). "Patriarchy and Women Vulnerability to Adverse Climate Change in Nigeria". SAGE Open. 9 (1): 215824401982591. doi:10.1177/2158244019825914. ISSN 2158-2440. S2CID 150324364.

Onyeneke, R. U. Nwajiuba, C. U., Tegler, B. and Nwajiuba, C. A. (2020), "Evidence-Based Policy Development: National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN)", African Handbook of Climate Change

Adaptation, Cham: Springer International Publishing, pp. 1–18, doi:10.1007/978-3-030-42091-8_125-1, ISBN 978-3-030-42091-8

Rois-Díaz, M., Lovric, N., Lovric, M., Ferreiro-Domínguez, N., Mosquera-Losada, M. R., Den Herder, M., . . . Pisanelli, A. (2018). Farmers' reasoning behind the uptake of agroforestry practices: evidence from multiple case-studies across Europe. Agroforestry Systems, 92, 811-828.

Shankarnayan, K.A; L.N. Hargh;S.Kathju (1987). Agroforestry in the Arid zone of India. Agroforestry systems an international journal.

Sikei, G., Mburu, J., &Lagat, J. (2009). Rural households' response to fuelwood scarcity around Kakamega forest, Western Kenya. U. o. Nairobi http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCsQFjAA&url=http%3A% 2F%2Fwww.esee2009.si%2Fpapers%2FSikei-Rural_households-response.pdf&ei=ub_vUcCbOiL7AbBn4CIDA&usg=AFQjCNFspwb2jrxY6LWQgIM7GNfx_1ITxw&bvm=bv.49641647,d.ZGU

Simon N.,Vitalis O., Moses T. & Philip W. (2023). Adoption of Agroforestry as a Climate Smart Agriculture Practice among Smallholder Farmers in Kakamega County, Kenya.Vol. 4 (Iss. 2) 2023, pp. 1157-1173 African Journal of Empirical Research https://ajernet.net ISSN 2709-2607

UNDP (2020). *"Nigeria must lead on climate change". UNDP. Retrieved 2020-11-29.*Vol.5 (1)69 -88.

Yong, A. (19890: Agroforestry for soil conservation international Science and practice of agroforestry No: 4. Pp 276.