NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 53 Number 3, December 2022 Pg. 255-262
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng

Agroforestry Practices and Mitigation Impact on Climate Change: Case Study of Umuahia South, Abia State, South East Nigeria

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Abstract
Studies on the status of agroforestry practices in Umuahia south were undertaken to identify the existing agroforestry systems, access their mitigation impact on climate change and constraints to productive and sustainable agroforestry systems. The intentional integration of trees and shrubs into crop and animal farming systems to create environmental, economic and social benefits are the goals of agroforestry. Variants of agrisilviculture – home gardens, random mix tree-arable crop mixtures, live fences, boundary planting and the bush fallow system are common in the area. Silvipastoral and agrosilvipastoral systems are practiced, especially for small ruminant (sheep and goat and piggery) production. The mean livestock holding and the mean sheep: goat ratio in the study area is 11 (4 sheep + 7 goats) and 1:1:5 respectively. Mushrooms, snail and honey are collected from the wild. The farmers interviewed indicated their willingness to utilize modern techniques in the production of these forest food resources in their agroforestry farms. The State government through the ADP's agroforestry unit has made little or no impact on the farmers interviewed. The paper further examines the role of Agroforestry practices in mitigating climate change impact and offers solutions to identified constraints to increased agroforestry productivity and recommends viable agroforestry practices for climate smart agriculture in Umuahia south. It further shows that agroforestry is a viable technology for increased food, wood and animal production as well as for sustainable climate smart agriculture and management of the environmental resources in Umuahia South.

Keywords: Agroforestry, Climate Change, Mitigation Impacts, Adaptation, Constraints, Umuahia south, Climate Smart Agriculture

Introduction

Most food crops in Nigeria are produced mainly by farmers in the rural areas using the shifting cultivation, bush fallow and mixed cropping systems (Okeke and Akachukwu, 2008). The shifting cultivation and bush fallow systems involve continuous destruction of forest and the bush through cutting and burning and depend on natural nutrient cycling for their sustenance. These systems are also characterized by low agricultural yields, low income and low investment potentials, poor transportation systems, and an unfavorable price relation between inputs (FAO, 2010). The systems create some challenges such as soil erosion, declining soil fertility and productivity, siltation of streams and rivers, All these predisposes the environment to climate change impact (Garnett *et al*., 2013 and Luedeling *et al*., 2014). Again, increasing human population and competing demand of land for industrialization, urbanization, mining, etc., have progressively shortened the fallow period and reduced the average size of farm per farming family, resulting to decline in soil fertility and crop yields (Okeke and Akachukwu 2008 and Neupane *et al*., 2021). Adapting to climate change requires a comprehensive approach that involves public and private lands. The private lands management approach provides opportunities for sheared stewardship on agricultural and forested lands, including those adjacent to public lands (Bentrup and Mac Farland, 2020). Agroforestry allows land managers to integrate productivity and profitability with environmental stewardship that will contribute to healthy and suitable landscapes. There is need to develop and utilize a multiple land-use system such as agroforestry, which will satisfy farmers' need for increased arable and tree (food and cash) crop productivity without degrading the environment. Agroforestry is the integration of woody perennials, crop plants (or grassed) and sometimes animals on the same unit of land (Eboh and Achike, 2010).

Most Agroforestry practices are designed to be multifunctional and include the following systems;

a. The tauagya or agrisilviculture for food and wood production
b. Silvopastoral –for wood and livestock production
c. Agrosilvopastoral – for food, wood and livestock production
d. Silvofishery or silvoaquaculture – for wood and fish production
e. Agrosilvofishery or agrosilvoaquaculture – for food, wood and fish production
f. Silviapiculture – for wood and honey production
g. Agrisilviapiculture – for food, wood and honey production
h. Silviheliculture – for wood and snail production
i. Agrosilviheliculture – for food, wood and snail production
j. Mushroom production in agroforestry systems
k. Multipurpose trees/shrubs (MPTS) – for the production of trees/shrubs with multiple uses, e.g., food, timber, stakes, fuel wood, fodder, gums, dyes, herbal medicines, soil fertility restoration, etc.
l. Home garden or compound farm – a variant of agrisilviculture or agrosylvopastoral system which is composed predominantly of farms in close proximity to the compound or home in which the farmer grows a variety of fruits and useful trees in combination with arable crops and some livestock.

Farm-based agroforestry aims at incorporating multipurpose woody perennials, primarily leguminous trees/shrubs, to improve crop yields without costly inputs, prevent soil erosion, improve water retention in the soil, provide fruits/food (including leafy vegetables) fodder, fuel wood, stakes, poles, timber, etc (Ong and Kho, 2015). Understanding traditional agroforestry practices in farms is an area of research interest that can benefit resources development efforts in south-eastern Nigeria There is therefore; the need to study the present status of agroforestry in specific regions areas in Nigeria threatened by environmental related challenges.This paper reports the result of a survey of farm-based agroforestry research and extension practices in Umuahia south, Abia State. It further highlights the mitigating impact of agroforestry systems on climate change and some constraints militating against the success of the practices and offers some solutions and recommendations.

Material and Methods

***The study area*:** Umuahia South located in Abia State of Nigeria, has a total population of 139,058 (NPC, 2006) and a land area of 141.6 km^2. It consists of three major clans or geographical blocks namely: Olokoro, Ubakala and Umuokpara. Table 1 summarizes the site characteristics.

Experimental procedures

Structured questionnaires followed by field visits and oral interviews were used in this study. The three major geographical blocks or clans in Umuahia South were selected for the study; five towns/villages were randomly selected from the list of villages or communities in each Clan or geographical blocks. A total of fifteen (15) villages were randomly sampled for this study. Within each village or community, ten (10) farmers were again randomly selected for questionnaire distribution. Thus, one hundred and fifty (150) questionnaires were administered to farmers fifty (50) per Clan or geographical blocks between September and November 2022 with the assistance of some political ward leaders and some personnel from Umuahia South department of agriculture. Table 2 describes the list of sampled towns in the study location. The questionnaires were analyzed using simple arithmetic means and percentages.

Results and Discussion

Background Information of Farmers

The percentage of respondents (100%) to the questionnaire is shown in Table 3. The level of response was made possible due to the assistance of some Umuahia South political ward leaders and some staff of Umuahia South Agric Department and the authors' familiarity with the Zone. The average family land holding and mean family size of the farmers in the sampled sites were about 1.2 and 6.33ha respectively. The highest mean family size was found in Ubakala. Olokoro and Umuopara clans which have similar family size (6 each). The average size of farmland per farmer ranged from 1.5ha, in Umuopara clan to less than 1ha in Olokoro clan. The mean family land holding in Umuahia South is 1.2ha. However, farm size in the area seems to increase with increasing family size. Hired labour and sometimes free labour are used to supplement the primary labour force mainly family members in the farm. The average distance of farmlands from the farmers' homes is usually less than 500m.

Agricultural Crops used in Various Agroforestry Systems in Umuahia South

Table 4 shows the common arable and important cash and food tree crops in agroforestry farms in the study area. Among the food crops, cassava, yam and maize ranked highest being cultivated by all the farmers. *Gnetum africana* (okasi), a vegetable delicacy in the sampled sites, is presently being cultivated by farmers in their home gardens. Oil Palm is popular in the study area with many farmers owning various sizes of oil palm plantations. Orange, kola nuts and bitter kola are favored cultivated cash crop. The farmers indicated their willingness to plant improved cultivars of *Irvingia wombulu* (Syn. I. gabonensis var. excelsa "agbono") and *Theobromo cacao* (cocoa) *Dacryodes edulis* (African pear "Ube") in the study area if they can get the necessary inputs and support from government.

Common Forest Trees in Farmlands in Umuahia South

The common forest trees found in farmlands include Oji (*Milicia exeslea*), egbu (*Alstonia boonei*), ijikara (*Spondias mombin*), akpu (*Caiba pentandra*), *Gmelina arborea* neem (*Azadirachta indica*), and bamboo (*Bambusa vulgaria*). A few ugba (*Pentaolethra macrophylla*) trees are also planted. These trees, except for neem and ugba, are volunteer specie which are deliberately encouraged and often guarded in the farmlands. They assist the farmers to grow their relished semi-wild, shade-loving vegetable and condiment species such as okazi, utazi, uziza, ukpo. Most of the farmers (60%) indicated their willingness to cultivate the semi-wild vegetable/spice species.

Common Agroforestry Practices in Umuahai South

i) Agrisilviculture (Trees in Farmlands – Traditional Taungya System)

Integration of food crops with forest trees, including food/fruit trees, left in farmlands are common in the study sites. The trees are scattered and widely dispersed to avoid shading and competition with the food crops. The farmers interviewed noted that the trees serve as poles, timber, sources of herbal/traditional medicine, leafy vegetables, fodder, soil enrichment via litter fall and nutrient cycling, etc. The findings of this survey support the reports of some writers. Ebo and Achike (2010) observed that three variants of the taungya system are practiced in several parts of south-eastern Nigeria. He noted that the first variant includes forest trees commonly left in farmland; the second comprises of the home garden or compound farm system, while the third involves intercropping food crops with plantation/cash crops or food/fruit trees. All these variants of the taungya system exist in Umuahia South. Okeke and Akachukwu (2008) observed that where agroforestry (ie. The taungya system) is practiced outside the forest reserve; the main objective is on food crop production while tree crops play a secondary role. Small-scale farmers were advised to profitably engage in fruit/food tree crop taungya variant as there are presently a growing market for agbono, ukwa, and other fruit trees in Umuahia.

ii) The Bush fallow System

The bush fallow system is the predominant farming system in Umuahia south, being practiced by all the sampled farmers. However, the fallow period is becoming increasingly short, being at present three years or less. This is due to; inter alia, population pressure, other land use competitors (such as road construction, rural electrification projects). Koohafkan *et al.* (2012) also noted that shifting cultivation, including the bush fallow system depends on relatively small farming population. The common fallow species in farmlands in Umuahia south include *Dactyladenia barteri* ("icheku/ahaba"), bamboo (achara), *Anthonatha macraphylla, Dialium guineense, Alchornia cordifolia, Millette thoningii,* etc.

iii) Silvopastoral and Agrosylvopastoral System

The farmers (80%) keep small ruminants (sheep and goats) in pens; other animals found in the study site include piggery, poultry, grass cutter and large ruminant (cattle) under the cut-and-carry or zero grazing system. Forage (mainly grass and browse) are cut from bush fallow and fed to the livestock. Table 3 summarizes the mean livestock holding and sheep/goat ratio per farmer in the sampled geographical blocks. Sometimes, some farmers (20%) tether their stock on some young fallows. The farmers complained of inadequate fodder during the dry season. They, however, encourage the use of the cut-and-carry system to avoid livestock destroying food crops and browsing food/fruit trees in farmlands, thereby escalating conflicts in the farming community.

iv) Silviapiculture and Agrisilviapiculture

These systems which involve the incorporation of apiculture into agroforestry farms are presently practiced by 10% of farmers in the study area; they build Bee hives and establish Apiaries in many of their home gardens and distant farms. However, a few residents (11%) harvest honey from bee colonies in the wild especially on Ugba trees (*Pentaclathra macrophylla*), using the destructive harvesting system with fire. Okeke and Akachukwu (2008) identified the following constraints to apicultural practices in agroforestry: the destructive methods of harvesting honey by using fire to kill the bees, fear of bee stings, lack of adequately trained personnel in bee keeping, etc. These constraints are equally applicable in Umuahia south. The farmers, however, indicated great interest in modern techniques of apiculture for the small-scale farmer. Apiculture can create job opportunities for the rural people, help to stem the rural-urban migration and keep agroforestry operators busy during idle or less intensive periods.

v) Living fences – Boundary Planting

Farmers (100% of respondents) utilizes live fences and boundary planting with mainly multipurpose (food/fodder, medicinal) trees and shrubs. Species thus used in farmlands and home gardens are usually MPTS and include: Abosi (*Baphia nitida*), Odu (*Dracyania* spp.), Ijikara (*Spondias mombia*), ogirisi (*Newbouldia laevia*), aturukpa (*Peterocarpus Santalinoides*), oha (*P. osun*) etc. These techniques are popular in Umuahia south. Preferred species should have good coppicing qualities, be fast growing, deep rooting, produce fodder and/or fruits, leafy vegetables, stakes, etc.

vi) Mushrrom Farming, Snailry and Fishculture in Agroforestry Farms

Mushrooms are highly priced natural resources in the study area. All the farmers collect mushrooms from the wild, especially in some years with heavy mushroom production in the wild. Some plants which the farmers believe are associated with mushroom production include ubaba (*Anthonatha macrophylla*), dead oil palm and raphia palms, uba (*Dacryodes adulis*) and akparuaka (*Canarium schweinfurtii*). The farmers requested for techniques of mushroom and Snail farming in their home gardens. Snails are consumed by most farmers in Umuahia and are collected in the wild also. Some plants also believed (by the farmers) to be associated with snail include *Chromolaena_odorata*, sweet potatoes, etc. Fish culture is becoming popular in the sampled areas. Fish ponds of various sizes were seen in some homes visited, the farmers complained of the high cost of setting up a fish farm and provision of a steady source of water supply and high cost of fish feed. The farmers interviewed are willing to adopt these practices in their agroforestry farms. Most of them do not know that the Abia State ADP (Agricultural Development Programme) have agroforestry component that should teach them these useful techniques.

vii) Home Gardens

These are also a common agroforestry system in Umuahia South, utilizing trees/shrubs and arable crops common in agroforestry farms. They represent an intensive management system in which soil fertility is maintained by the use of crop residues and house-hold refuse while the presence of trees and shrubs is a common feature in a multi-story plant system (Eboh and Achike, 2010).

viii) Alley Cropping/Farming and Other Spatial Arrangements of Crops in Traditional Agroforestry

About 20% of the respondents have heard of, but none of the farmers interviewed has ever practiced alley cropping/farming due to inadequate information on the system from the extension staff of the Abia State ADP. The random mix model is the main spatial arrangement of food and tree crops in agroforestry farms. Volunteer or planted trees are found at random in farms in Umuahia. This random mix planting model creates enough space for the trees/shrubs and food crops, reduces competition for light, soil nutrients and water between the trees and arable crops and ensures that trees do not mainly occupy the scarce farmlands. Trees usually left in such farms have multipurpose values e.g fruits, leafy vegetables, stakes, poles, timber, fodder, medicine etc. The Abia State ADP has not made any impact on the farmers in agroforestry in Umuahia based on the present study. Some constraints to successful agroforestry research and extension in South- Eastern Nigeria have been discussed by Eboh and Achike (2010).These include the recruitment of A D P agroforestry personnel with little or no formal training and experience in agroforestry, lack of interest in agroforestry trials by many extension agents, over-concentration of trials and extension works on purely agronomic segments of agroforestry to the detriment of the woody crop component. Due to the varied disciplines and in adequate knowledge of the ADP extension agents on agroforestry, there is poor execution of agroforestry projects. These features have been responsible for failure or non-execution of agro-forestry on-farm applied research (OFR) and on-farm adaptive research (OFAR) trials. The ADP does not also grant adequate logistic support, eg., transportation, to its subject matter specialists (SMS), leading to abandonment of several agro-forestry and other crop component projects by the SMS and other extension field personnel. Late release of funds for agroforestry extension duties also contributed to the non-execution of agro-forestry projects and, consequently, the farmers' lack of awareness of improved agroforestry practices in Umuahia. However, the farmers interviewed displayed great interest in utilizing various improved agroforestry systems. The ADP should, therefore, be involved in the realization of the farmers' interests in agroforestry.

Achieving Mitigation and Adaptation to Climate Change through Sustainable Agroforestry Practices in Rural Communities of Umuahia South

Agroforestry contributes to climate change mitigation in three (3) ways: Sequestering carbon in biomass and soil, reducing greenhouse gas emissions and avoiding emissions through reduced fossil fuel and energy usage on farms. For a wind break, the growing trees store carbon directly in their biomass and in the soil. At the same time, the system releases fewer greenhouse gases like nitrous oxide because the trees take up extra nutrients and also because less area is fertilized (Nsabimana *et al*., 2008).Finally less fossil fuel and energy are used in these agricultural operations because some of this field is no longer cultivated. All these components contribute to the climates change mitigation that can come from adding agroforestry practices to Umuahia South agricultural and forested landscapes. Agroforestry practices have very many benefits like increased yield, reduced risk, improved pollinators and improvement on wild life habitats or increased capacity to adapt to climate change (Eboh and Achike, 2010) This makes agroforestry more appealing to farmers who are working towards multiple outcomes. Agroforestry practices can also work in cooperation with other carbon sequestration practices and make them more risk resilient. For example wind break and cover cropping can work together. The reduced wind speed may make cover crop establishment easier in challenging situations or conditions (Luedeling *et al*., 2014) Agroforestry can sequester carbon, while leaving most of the field in agricultural production, instead of converting it to forests or other land uses. This is especially true for agroforestry practices that take place at this edge of Fields, such as wind breaks, live fence, and riparian forest buffers. Even if only a small percentage of farms add agroforestry production, this potential carbon sequestration can be significant. (Pandey, 2002; Kumar and Nairi, 2012; Bentrip and Mac.Farland, 2020)

Agroforestry and Sustainable Food Production

The use of multipurpose trees and integrated approaches can enhance the profitability of agroforestry, e.g., tree can be a source of fodder which in turn is converted into valuable plant nutrient. Trees on farm can provide wild edible fruits and non-timber products that serve as alternative food source during periods of deficit and primary sources of income (Lott*, et al*., 2009 and Ong and Kho, 2015). For many rural communities with food shortages and increased threats of climate change, interest in Agroforestry is gathering for its potential to address various on-farm adaptation needs. Agroforestry provides assets and income from carbon, wood energy, improved soil fertility and enhancement of local climate conditions, (Lasco *et al*., 2015). It provides ecosystem services and reduces human impact on natural forest. Most of these benefits have direct benefit for local adaptation, while contributing to global effort to control atmospheric greenhouse concentration (Ajayi *et al.*, 2013). Agroforestry in general may increase farm profitability through improvement and diversification of output per unit area of tree/crop and livestock, through protecting against damaging effect of wind on water flow, and through new products added to the financial diversity and flexibility of the farming enterprise (Nguyen *et al.*, 2013).

Agroforestry and Micro climate improvement:
Agroforestry practices offer a buttering impact on temperature and atmospheric saturation. (FAO, 2010) This has a major impact on crop performance as trees can butter climatic extremes that affect crop growth. The shading effect of agroforestry trees can buffer temperature and atmospheric saturation deficit by reducing exposure to supra-optimal temperature under which physiological and developmental processes and yield become increasing vulnerable (Koohafkan *et al*., 2012). Scattered trees in agroforestry farm can enhance the understory growth by reducing incident solar radiation and soil temperatures while improving water status, gas exchange and water use efficiency (Josson *et al*., 2020).
Silvopasture systems that add trees to pasture may have the greatest potential among agroforestry practices to mitigate climate change. Silvopasture may also help reduce methane emissions, an important contribution to greenhouse gas emissions and can reduce methane emission by using a grazing strategy of moving cattle, sheep or goat in a rotational stocking system. Another factor leading to lower methane is more digestible feed and greater overall gain from feed efficiency due to shade induced microclimate changes (Pandey, 2002).

Agroforestry Role in Mitigation Water Shortage and Drought
Agroforestry contributes to ecosystem function in water recycling by increased rainfall utilization compared to arable cropping system. Lott *et al*. (2009) reported that about 25% of water transpired by trees is used during the dry season, indicating that they are able to utilize off-season rainfall (compromising 15-20% of the total annual rainfall) and residual soil water after the cropping period with the rest being lost by evaporation (40%) or deep drainage (37-40%). The complementarity between trees and annual crops extends possibilities of soil moisture uptake, hence making soil resources utilization more efficient than in pure mono culture (Okeke and Akachukwu, 2008).

Agroforestry in Managing Soil Fertility and bridging Food Productivity Gap
Agroforestry have the potential to improve the soil fertility. This is mainly based on increase in soil organic matter and biological nitrogen fixation by leguminous trees on farm land. It also facilitate tighter nutrient cycling than monoculture systems and enrich the soil with nutrient and organic matter while improving soil structural properties. (Neupane *et al*., 2021) Therefore water tapping by tress and prevention of leaching help the soil recover nutrients, conserve soil moisture and improve soil properties. Hence through water tapping and prevention of nutrient leaching trees help recover nutrient, conserve soil moisture and improve soil organic matter for many Rural Communities. (Vercoti *et al*., 2007 and Neupane *et al*., 2021).

Constraints to Agroforestry Practices in Umuahia South
The generally small farm size in the study area (< 1ha) is a constraint which the small scale farmer grapples with. The average Umuahia farmer views trees in farm lands from two perspectives as a useful natural resource and as a constraint to maximal utilization of his scarce land. He sees trees as sometimes unwanted occupant of useful agricultural land which may negatively affect crop productivity via shade casting, competition with arable crops for light, water and soil nutrients, and act as a harbinger of peats, e.g., birds that may ravage his crops (maize and rice), etc. Thus, most of the farmers cut down the trees. The usual consequence is soil erosion, reduced crop productivity and loss of valuable tree-based companion biodiversity. Land tenure is a major problem militating against agroforestry practices in Umuahia south. Most (>60%) of the land (farms) are owned by the kindred or community. This land tenure system does not encourage agro-forestry as the same site may not be used by the same farmer after a few years. Accordingly, this tenure system does not encourage tree planting as tree crops usually have long gestation periods.

Conclusion
The study highlighted the present status and constraints of agroforestry systems in Umuahia South, shown how agroforestry system readily bundle both mitigation and adaptation strategies and provide several pathways to securing food security for poor farmers, while contributing to Climate change mitigation. It also recommended potentially viable agroforestry practices for the area, stresses the need for agroforestry research and extension and supports multidisciplinary approach to research in agroforestry to involve foresters, agronomists, fishculturists, and animal and soil scientists. Finally, the study has shown that agroforestry is a viable technology in Umuahia South, Abia State, Nigeria. Alley cropping should therefore be introduced to the farmers to substitute for the bush fellow system, help minimize soil erosion and improve soil fertility. Planted fallows with fast growing leguminous, nitrogen-fixing plants should be used in all the Clans. Useful MPTs should be used also to provide food, fruits, fodder, stakes, medicines, etc. Small ruminant production should be encouraged using the stall feeding (Zero grazing) system. This, therefore, calls for the use of improved forage production systems, including alley farming, intensive feed gardens, etc. The adoption of

fish culture and apiculture by rural farmers will not only increase fish and honey production but will also greatly improve the rural farmer's income. The urgent need for government's intervention in agroforestry extension service to be staffed mainly by trained agroforestry personnel is recommended. Government should adequately fund the ADP to provide logistic and extension support to the ADPs agroforestry personnel. This will ensure regular contact with the farmers. Universities and research institutes also should develop simple adaptable agroforestry for the small scale farmer. On-station and on-farm agroforestry research trials should be undertaken on appropriate types and density of woody species per farm for optimum arable crop production. Various incentives, e.g. provision of free seedling, equipment, etc, should be provided to the rural farmers to facilitate their adoption of agroforestry technologies such as alley cropping, apiculture, snailry, mushroom production, so as to realize the full potential of Agroforestry in climate change mitigation, adaptation and productivity

References

Altieri, M.A. (1999): The ecological role of biodiversity in agro ecosystems. *Journal of Agric Ecosyst and Environ.,* 7(4):74-81.

Ajayi, O.I., Detteysen, G,. Placee, F., and Torquebiau, E. (2013): Advancing Agroforestry on the policy Agenda: A guide for decision makers. In Agroforestry working papers no 1. Food and Agricultural organization of the United Nations Rome.

Bentrup, G. and MacFarland, K. (2020). Agriculture, Forestry services and climate change Resources: Agroforestry US department of Agriculture centre:www,fr.usda.gov/ocrc/topic/agroforestry.

Eboh, E.C. and Achike, A.I. (2010). Agroforestry Potential for combating Forest and Environmental Degradation: Reflection on south eastern Nigeria. *J. of Agric and Food Sci.,* 8(2).

Enwezor, W.O., Ohiri,A.C., Opuwaribo, E.E. and Udo, E.I. (2000). Climate of south eastern Nigeria; Report on Soil fertility investigations and National resource, Lagos ,Nigeria.

FAO, (2010). Global Forest Resources Assessment: Food and Agricultural Organization, Rome ,Policy Paper, 9:85-89.

Garnett, T., Appleby. C.M., Balmfold, A., Bateman, J.I. and Benton G.T. (2013). A review of Sustainable intensification in agriculture: *J. of Premises and Policies Science*, 341: 33 -34.

Jonsson, K.S., Ong, C.K.I. and Odongo, J.C.W.S (2021): Influence of Scattered Neem and kasite trees on microclimate, soil fertility and millet yield in Burkina faso*: J of Exp. Agric*., 35:39-53.

Koohafkan, P.S., Attieri, A.M. and Gimenezi, H.E. (2012). Green agriculture: Foundation for Biodivercity, resilience and productive agricultural systems. *Int.J.Agric Sustain*., 10:61-75.

Kumar, B.M. and Nair, P.K.R (2012). Carbon sequestration potential of agroforestry systems: Opportunities and Challenges: Springer eds.

Lasco, R.D., Delfino, R.J.P. and Espaldon, M.C.O. (2014). Agroforestry Systems: Helping small Holders Adopt to Climate Change risk while Mitigating Climate: Wiley interdisciplinary Rev: *Climate Change*, 5(6):826-833.

Lott, J.E, Ong, C.K. and Black, C.R. (2009). Understorey microclimate and crop Performance in a Grevillea robusta – based agroforestry system in semi-arid Kenya*: J, of Agric forest Meteor.,* 149: 1140-1151.

Luedeling, E., Kindt, R., Huth, N.I. and Koenig, K. (2014). Agroforestry System in a changing climate – change in projecting future performance *Curr. opin Environ sustain*., 6(4): 1-7.

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

Neupane, R.P. and Thapa, G.B., (2021): Impact of agroforestry intervention on soil fertility and farm income under the subsistence farming system of the middle hills, *Nepal J. of Agric Ecosyst. and Environ*., 84: 157-167.

Nsabimana, D.S., Klemedtson, L., Kaplin, B.A. and Wallin, G.S. (2008). Soil Carbon and nutrient accumulation under forest plantations in Southern Rwanda. *Afr.J. Eviron Sci. Technol*., 2:142-149.

NPC (2006). National Population Commission of Nigeria: National office of Statistics (web) www.population.gov.ng/index.php/publication/140-popn-sex-state-jgas-2006

Okeke, A.I. and Akachukwu, C.O (2008). Some viable technology for improved yield in Home gardens of South eastern Nigeria: In. L Popoola J.E, Abu and Oni (eds). Forestry and National Development. Proceeding of the 27th Annual conference of the forestry Association of Nigeri. Pp. 308 -318.

Opara- Nadi, O.A. (2000). *Soil Resources and agricultural productivity in Nigeria. Food and Fibre Production in Nigeria in 21st Century*.2nd ed., University press, Ibadan, Nigeria.

Ong, C. and Kho, R. (2015), A frame work for quantifying the various effect of tree-crop Interaction: Agroforestry in changing climate CBBI,1-23

Pandey,D.N .(2002).Carbon sequestration in Agroforestry Systems climate Policy, 2:367-377.

Powell, J.M., Rivera, E.S., Hiernaux,D.C. and Tuner, M.D. (1996): Nutrient Cycling in integrated Rangland/crop land systems of the Sahel: *J. of Agric Ecolo Syst*., 52, 143-170.

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

Table 1: Characteristics of the study site –Umuahia south, Abia State, Nigeria

Vegetation	Altitude	Soil type	Latitude and Longitude	Climatic Data Rainfall	Temperature (°C)	Relative humidity
Humid Tropical region with lowland Rainforest and mixed deciduous (Enwezor *et al*, 2000 and Opara-Nadi, 2002)	159m (522 feet) above sea level	Highly weathered fragile acidic soils that are sandy clay or sandy clay loam, derived from sandy deposits and are of the Ultisol series (NRCRI, 2000)	Lat:5°,25′-5°,39'N & Long:7^0 24′ –7^0 33′E (NRCRI, 2002)	Mean annual:2238mm	Min:23 Max:32 NRCRI, 2002)	65-85%

Table 2: List of sampled villages/communities and geographical blocks or clans in Umuahia south, Abia State of Nigeria

S/No.	Geographical block or Clan	Sampled communities or villages
1	Olokoro clan	Amakama, Umuntu, Umuajata, Okwu and Umuoparauzara
2	Ubakala clan	Nsukwe, Umuosu, Nsurimo, Ipupe and Eziama
3	Umuokpara clan	Ezeleke, Ogbodiukwu, Ekenobizi, Umunwawa and Ehume

Table 3: Percentage of respondents to questionnaires per sampled geographical block or Clan in Umuahia South, Abia State of Nigeria

S/No.	Geographical block or Clan	No. of Questionnaire Distributed	No. of Respondents	Percentage of Respondents (%)
1	Olokoro	50	50	100
2	Ubakala	50	50	100
3	Umuopara	50	48	100
Total		**150**	**148**	**100**

Table 4: Common arable and important cash and food tree crops in agroforestry farms

Common Arable Crops	Common Cash/Food Tree crops
Yam	Oil palm (*Elasia guinensis*)
Cassava	Raphia palm (*Raphia hookeri*)
Melon	Coconut (*Cocos nucifera*)
Cocoyam	Colanut (*Cola nitida*)
Maize	Ube (*Dacryodes adulis*)
Okra	Oha (*Pterocarpus savanusii*)
Garden egg	Nturukpa (*P. santuliniodes*)
Ukpa	Udara (*Chryaophyllum albidum*)
Pineapples	Akilu (*Garuinia cola*)
Tomatoes	Oranges (*Citrus* spp.)
Pepper	Mango (*Manifera indica*)
Other vegetables	Nmimi (*Dernattia tripatala*)
Bitter leaf	Ogbono (*Irvincia wombulu*)
Okazi	Cashew (*Anaroadium occidentalis*)
Uziza	Plantain and Banana (*Musa* spp.)

Table 5: Mean livestock holding and sheep:goat ratio per farmer in sampled Clans in Umuahia, Abia State of Nigeria

	Mean No. per farmer		**Sheep: Goat**
Geographical blocks or Clan	Sheep	Goats	Ratio
Olokoro	3	9	1:3:0
Ubakala	5	11	1:2:2
Umuopara	5	7	1:1:4

Appendix 1

Objective of Agroforestry systems	**Example of Feasibility**	**Limits of the influence factors**	**References**
Increased soil fertility- low input fertilizer	Using nitrogen fixing trees wind breaks and erosion control, long fallows	Integrated nutrient management (balance with other sources of nutrient)	Eboh and Achike (2010)
Increase availability of Water	Conservation Agriculture (CSA) with trees, shade trees to reduce evaporation	Tree diversity selection of species.	Ong and Kho (2015); Pandey, (2002)
Fruit Production	Fruit trees of high market value (shea butter, ugba, ukwa etc)	Age of trees in park lands productivity.	Kumar *et al*. (2012)
Ecosystem health	Shade tree, promotion of agro biodiversity/ forest corridors	Dominance of cash crops, limited lands for food crops.	Nsabimana *et al*. (2008) and Powell *et al*. (2006); Altieri (1999)
Animal Husbandry	Fodder trees, grass land management	Pressure on selected fodder trees, available land for animals.	Okeke and Akachukwu, (2008)