

**RURAL FARMERS' AGROFORESTRY PRACTICES IN
IMO STATE, NIGERIA**

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**DEPARTMENT OF AGRICULTURAL EXTENSION,
UNIVERSITY OF NIGERIA, NSUKKA**

NOVEMBER, 2014

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**A THESIS SUBMITTED TO THE
DEPARTMENT OF AGRICULTURAL EXTENSION,
FACULTY OF AGRICULTURE,
UNIVERSITY OF NIGERIA, NSUKKA**

**IN PARTIAL FULFILMENT FOR THE AWARD
MASTER OF SCIENCE IN AGRICULTURAL
EXTENSION (AGRICULTURAL PLANNING AND
EVALUATION)**

NOVEMBER, 2014

CERTIFICATION

UKAEGBU, Emmanuela Onyinye, a postgraduate student in the department of Agricultural Extension, University of Nigeria, Nsukka with registration number PG/MSC/12/64576, has satisfactorily completed the requirements for the course and research work for the Degree of Master of Science (M.Sc) in Agricultural Extension with specialization in Agricultural Planning and Evaluation.

The work embodied in this project is original and has not been submitted in part or full for other diploma or degree of this or any other university.

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DEDICATION

This research work is dedicated to God the Father, Son and Holy Spirit, who saw me through my academic pursuit and helped to make this work a success. To Him be all glory forever.

I equally dedicate this work to my lovely parents Chief and Lolo E. A. Ukaegbu and my siblings.

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ABSTRACT

The study was conducted to assess rural farmers' agroforestry practices in Imo State, Nigeria. The population for the study comprised all farmers involved in agroforestry practices in Imo state. Four local government areas (LGAs) were selected out of 27 LGAs in the state using simple random sampling technique. From the four LGAs, two town communities were purposively selected based on their involvement in agroforestry practices giving a total of eight town communities. From each of the eight town communities, four village communities were purposively selected because of their involvement in agroforestry practices making a total of 32 village communities. From the list of agroforestry farmers compiled in each of the village communities by extension agent, five farmers were selected using simple random sampling technique. In all, a total of 160 agroforestry farmers constituted the sample size for the study. Data for the study were collected through interview schedule. Percentage, charts, Mean statistics, Analysis of Variance (ANOVA), Duncan multiple range test and factor analysis were used in analyzing the data. Results showed that the average age of the farmers was 54 years. Majority (56.7%) of the respondents was male and married (73.1%). The average household size of the farmers was 7 persons. Majority (56.9%) of the farmers got their income from sale of farm products and 35.6% of them engage in trading as their secondary occupation. Majority (68.8%) of the farmers belonged to various organization. About 53% of the farmers had contact with extension agents in the last one year and the average extension contact was 2 times. The average size of land used for agroforestry practices was less than one hectare. Majority (96.9%) of the farmers practiced home gardens. There was an increase in the number of farmers involved in agroforestry practices in the last five years (47.5%). Majority (84.4%) of the farmers planted banana in their farm as the major tree component of agroforestry and majority (98.1%) of farmers cultivated yam as the crop components of the agroforestry practice. The average number of trees planted/protected in the homestead and farmstead varies significantly over the years. There was a decline in the average number of trees planted and/or protected both in the homestead and farmstead from the year 2009 to 2013. The result showed that pruning (87.5%) was the major management strategy used by farmers to maintain their trees while majority (98.8%) of respondents practiced agroforestry to improve soil fertility. Major constraints to agroforestry practices were grouped into knowledge constraints, tree growth constraints and market constraints. The major effective strategy for enhancing agroforestry practices was to increase the awareness of agroforestry practice through training and workshop.

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INTRODUCTION

1.1 Background information

One of the challenges facing Nigeria is the production of sufficient food and fiber to meet the need of her ever increasing population (Alao, & Shuaibu, 2011). With rapid population increase and land use pressure, natural fallows and shifting cultivation have been reduced to below the minimum threshold required for the system to sustain itself (Opio, 2001). These have led to land shortages and continuous arable cultivation without fallowing (Thangata, Hildebrand & Gladwin, n.d). As a result of this, land does not have enough time to replenish its fertility. However, attempts to resuscitate land and hence promote yield with the use of chemical fertilizers have resulted in soil toxicity and environmental pollution (Akpabio, Esu & Adedire, 2008).

It is imperative to introduce practices that would not only be an additive to traditional land-use practices, but also ensure the sustainability of production and socially acceptable without damage to the ecosystem (Akpabio, *et al.*, 2008; Amonum, Babalola, & Agera, 2009). Agroforestry practices represent such land use practices as it offers a solution to the problem posed by the high demand on land, and stands as a means of halting the vicious circle of deforestation, soil erosion and other environmental problems facing Nigeria. It is one of the sustainable agricultural practices in soil fertility practice that uses natural resource management principles to replenish soil fertility (Ajayi, Franzel, Kuntashula & Kwesiga (2003); Mercer, (2004)).

Agroforestry is an ancient practice in sub-Saharan Africa where farmers deliberately integrate and retain trees in their farmland. According to International Center for Research in Agroforestry (ICRAF) (1997) agroforestry is defined as a dynamic, ecologically based natural

resources management system that through the integration of trees on farmland and range land diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. Fagbemi (2002) sees agroforestry as the system of farming which combines agriculture with forestry in a rational approach and maintenance of sustainable production systems on the same piece of land, either simultaneously or sequentially. It is a collective name for all land use systems and technologies in which woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately combined on the same management unit with herbaceous plant (crops or pasture) and/or animals, in some form of spatial arrangement or temporal-sequence (Olujide & Oladele, 2011). Agroforestry involves the combination of trees and crops that increase the medicinal, environmental, and economic value of land with the much-needed profit and food security (ZinPing & Dawson, 2004). It includes both traditional and modern land-use systems where trees are managed together with crops and/or animal production systems in agricultural settings.

Through the ages, rural farmers in the tropics have devised several agroforestry practices, many of which are still in active use (Kang & Akinnifesi, 2000). Some of the agroforestry practices in the southeastern states of Nigeria include; homestead garden, alley cropping, trees on crop land, improved fallow, multistory crop combinations etc (Umeh, 2008). Plant species used in farming communities in many regions of developing countries especially Nigeria include; cereals, pulses, fibers, nuts, medicinal, timber and aromatic plants such as; Iroko (*Chlorophora excels*), melina (*Gmelina arborea*), local pear (*Dacryodes edulis*), orange (*Citrus species*), bitter leaf (*Vernonia amydalina*), scent leaf (*Ocinum gratisimum*) etc (Umeh, 2011).

Agroforestry practices have the potential of improving agricultural land use systems, providing lasting benefits and alleviating adverse environmental effects at local and global

levels. This technique as practiced in Nigeria has the potentials to address slash and burn agriculture and anthropocentric forces that are responsible for degradation. It provides a tool for accelerated economic improvement in rural livelihood in a country where over half of the population reside in the rural areas (Merem, 2005). It can help to ensure sustained productivity of the natural resource base by enhancing soil fertility, controlling erosion and improving the micro-climate of crop land, nutrient cycling, carbon sequestration, bio drainage, bio energy and bio fuel and providing grazing lands (Umeh, 2011). It is a land use option that increases livelihood security and reduces vulnerability to climate and environmental change. It is more profitable to farmers than agriculture or forestry for a particular area of land because it has the potential to provide rural households with food, fodder, fuel wood and other products (Tokey, 1997; Samra, Dhyani, & Sharma, 1999). By providing farmers with a means of producing fuel wood, timber, building poles and other forest products on farmland, agroforestry can significantly reduce the demand on forests and natural woodlands. It could therefore supplement forest restoration strategies (Michael, Gary, & Michele, 2011).

Agroforestry is also highly needed, especially by rural farmers in sub Saharan Africa where there are small land holdings and high cost of inputs and poor market structures (Mukadasi & Maxwell, 2008). In traditional land-use practices, agroforestry is important in maximizing and diversifying the productivity of highly fertile lands. As a land-use formula, it serves the diverse needs of individual farmers in harnessing the natural resources around them, as this cannot be reconciled by the traditional cropping system. Agroforestry equally provides raw materials for large-scale processing industries such as foods and beverages, confectioneries, flavorings, perfumes, medicines, paints and polishes, paper, packaging cases for industrial products and other purposes (Alao & Shuaibu, 2011).

1.2 Problem statement

The rapidly expanding population and consequent pressure on land for socio-economic, agricultural and industrial development as well as increasing human interference on the forests and the environment have put the future of Nigeria forest and agricultural land in great danger (Bifarin, Folayan & Omoniyi, 2013). As observed by Aweto (2000) increase in population has equally led to heavy dependence on fuel wood especially by rural people and urban poor in developing countries like Nigeria leading to increased deforestation.

Continuous depletion of the forest reserve base and agricultural land has major effects on the agricultural segments of Nigeria economy (Akpabio, *et al.*, 2008). It causes a decline in the productive capacity of soils, accelerated erosion, destruction of wildlife habitats and loss of plant genetic diversity, climate change, landslides, soil degradation, and unfavorable hydrological changes. With continuous deforestation, the humid forest of Southeastern Nigeria which is richly endowed with many under-utilized and neglected plants (such as *Irvingia wombolu*, *Irvingia gabonensis*, *Pentaclethra macrophylla*, *Piper guineense*, etc.) that have high nutritional, economic and medicinal values for man could become extinct (Nzekwe, Onyekwelu, & Uju, 2008).

According to Global forest resources assessment 2010 report by Food and Agricultural Organization (FAO) (2010) Nigeria is classified among the countries with low forest cover of less than 2.3% of the total land area. Food and Agricultural Organization further reported that between 1990 and 2010, Nigeria has lost 47.5% of its forest cover, or around 8,193,000 ha and it is considered as the highest in Africa (FAO, 2010). Considering the rate at which the country has been losing her forest and agricultural land areas, there is need for maintenance and enhancement of soil fertility for global food security and environmental sustainability. Therefore, the drive

towards ensuring food security should be channeled towards developing agricultural practices and system that will be environmentally friendly and also focus on productivity on the long term rather than immediate production and accruing returns (Bankole, Adekoya & Nwawe, 2012). Thus, improved production systems that can build on the resilience of the traditional systems by utilizing external inputs or improved materials, and are able to produce surplus, need to be developed in order to relieve pressure on natural resources and ensure sustainable agricultural development (Kang & Akinnifesi, 2000). Agroforestry holds great promise for contributing to sustainable land use systems which can overcome the problem of land degradation and the food crisis which is a pressing problem in Nigeria (Kang & Akinnifesi, 2000).

Umeh (2008) in her study noted different agroforestry practices that exist in Imo state which include; homestead garden, trees on crop land, improved fallow, multistory crop combinations. However, increased investment in the development of agroforestry practices has not been sufficiently addressed in policy formulation nor has it been integrated into land-use planning and rural development programmes (FAO, 2013). Nwosu (2014) noted that absence of articulated environmental and agricultural policies has led to the derailing of agroforestry initiatives and created impactful environmental degradation. This is evidenced with the continuous decline in forest and agricultural area. The questions therefore are: What agroforestry practices exist in Imo state? Do farmers derive any benefit from these agroforestry practices? What are the factors limiting practice of agroforestry? What are the possible measures to improve agroforestry practices?

1.3 Purpose of the study

The overall purpose of the study was to assess rural farmers' agroforestry practices in Imo State, Nigeria. Specifically, the study sought to;

1. ascertain agroforestry practices used by farmers;
2. assess perceived benefits of agroforestry practices to farmers;
3. determine factors limiting agroforestry practices; and
4. identify the possible measures to improve the agroforestry practices.

1.4 Significance of the study

This study will serve as a source of information on agroforestry practices to decision makers. It will help them to appreciate agroforestry as one of the ways of solving the problems of deforestation and land degradation and its role in rural development and agriculture. This could trigger the development of appropriate policy encouraging its practice. The findings will help NGOs to better understand the role they could play in agroforestry practices and thus be able to assist extension agents in the task of reaching rural communities and sensitize them on agroforestry.

The finding of the study could serve as a source of information to extension workers on agroforestry practices, the factors limiting its practice as well as the strategies for enhancing its practices. This will assist them to encourage farmers to adopt the practices as an alternative agricultural management practice. The study could increase farmers' awareness level of the benefits of agroforestry as a soil conservation strategy, means of improving livelihood and productivity and a way of conserving their forest resources. The study will equally add to existing knowledge on agroforestry and stimulate further research on the subject.

LITERATURE REVIEW

Literature for the study was reviewed under the following sub-headings;

2.1 Concept of agroforestry

2.2 Agroforestry practices in Nigeria

2.3 Benefits of agroforestry practices in Nigeria

2.4 Constraints to agroforestry practices

2.5 Strategies for improving agroforestry practices

2.6 Conceptual framework

2.1 Concept of agroforestry

Agroforestry is simply defined as the practice of growing trees with agricultural crops and/or livestock on the same piece of land (Anderson, Bidwell, & Romann, 1991). According to Dosskey, Bentrup, & Schoeneberger (2011), agroforestry is the integration of trees into agricultural systems to aid the management of the agricultural components. It combines the best attributes of forestry and agriculture, and is one of the most promising alternatives to the conventional approaches to increase agricultural productivity (Thrupp, 1994). Agroforestry practices can be used in crop lands where trees or shrubs are interspersed with annual crops, on contour strips and boundaries, where multipurpose trees provide numerous products including poles, fuel, fruits and fodder. It can be practiced on public or shared land where trees can be grown for wood, fodder, food or cash crops (Bankole, Adekoya, & Nwawe, 2012).

To be successful, agroforestry practice must be flexible, resilient, sustainable, economically attractive, and acceptable to local populations (<http://archive.unu.edu>). The sustainability and extent of soil productivity improvement in agroforestry practices depends on many factors including site characteristics, plant species and cultivar, cropping pattern and

management factors (<http://www.fao.org/docrep/t1696e/t1696e02.htm>). The choice of plant/tree species is the most important factor to be considered in agroforestry practices (Puri & Bangarawa, 1992). According to Foroughbackhch (1992), the choice of tree species to be used for agroforestry should be done after careful consideration of their adaptability for growth and benefit for rural populace. In order to achieve this, the tree species must be adaptable to agro climatic conditions (i.e., climate, soils, slopes, and elevation of farm sites) at the project site where the trees are to be planted. From the study carried out by Puri & Bangarawa (1992), characteristics of trees to be considered suitable for agroforestry include; high biomass production, high Nitrogen fixation, well developed rooting system, high nutrient content in biomass, including roots, fast or moderate decay of litter, absence of toxic substances in foliage or root exudates, and cyclone resistant.

All agroforestry practices should possess three major attributes which include: productivity, sustainability and adaptability. According to Food and Agricultural Organization (FAO, 2013) report, agroforestry when designed and implemented correctly, combines the best practices of tree growing and agricultural systems resulting in the most sustainable use of land. Its design should therefore strive to maximize positive interactions between trees and other elements (crops and animals) and minimize negative interactions. Designers should take into account the land and labour available for adding a tree component to existing farming systems and the tree component's impact on other agricultural and off-farm activities of the target population. The risks, benefits, and costs associated with planting and managing the tree component should be considered from the farmers' perspective. In areas where the trees are to be intercropped with food crops, the likely impact of the tree component on crop yields should also be considered. For example, if the trees are to be planted or harvested at the same time as crops,

the likelihood of reduced food production and other opportunity costs should be considered (Siew, 1989). Particular agroforestry designs depend on landowner objectives and can emphasize any combination of timber, row crops, livestock, fruit crop, firewood, wildlife, and recreational habitat. These agroforestry combinations are distinguished from traditional agriculture or forestry by a few key traits. First, an agroforestry design is intentionally managed as a whole system with intensive cultural practices for more than one crop and/or animal. Second, the landowner uses interactions between trees, crops, and/or animal components to achieve particular objectives while protecting resources (http://edis.ifas.ufl.edu/topic_agroforestry).

Agroforestry as practiced in Nigeria, includes a homestead farm, with multistoried crops; the top storey of coconut, middle storey of citrus, bananas etc. and ground storey of ginger, groundnuts, maize, melon and others. In the southeastern Nigeria compound farm, the tree component includes oil palm, coconut, kola nut, citrus, mango and guava grown with an under storey of cassava, yam, groundnuts, and vegetables (<http://unu.edu>). According to research carried out by Umeh (2008), the fruit and food tree species for compound farms in the forest area are either cultivated or semi-wild and protected. They are planted or retained as farm trees and interplant with arable crops, in close proximity to the homestead where they are protected.

According to a study conducted by Umeh (2011), he identified twenty-five (25) tree and shrub species as common woody components of agroforestry practice in the south-eastern zone which include: *Dacryodes edulis*, *Pterocarpus santalinoides*, *Vernonia amygdalina*, *Pterocarpus Soyaxii*, *Citrus Spp*, *Musa sp*, *Chrysophyllum albidum*, *Carica papaya*, *Kola spp*, *Newbouldia leavis*, *Irvingia gabonensis*, *Treculia africana*, *Plukenetia conophora* and *Ocimum gratissimum* among others.

Components of agroforestry

There are three major components in agroforestry:

1. Tree/shrub or woody perennial species
2. Crop species
3. Animal species.

1. Tree component of agroforestry

In agroforestry, particular attention is placed on multiple purpose trees or perennial shrubs. The most important of these trees are the legumes because of their ability to fix nitrogen and thus make it available to other plants (<http://www.echonet.org/>).

Table 1: Tree/shrub or woody perennial species component of agroforestry practices

S/No	Botanical name	Local name	English name
1	<i>Pentaclethra macrophylla</i>	Ukpaka	Oil bean
2	<i>Treculia Africana</i>	Ukwa	Breadfruit
3	<i>Irvingia spp</i>	Ogbono	
4	<i>Dacryodes edulis</i>	Ube	Local Pear
5	<i>Annona muricata</i>		Soursop
6	<i>Pterocarpus santalinoides</i>	Uturukpa	
7	<i>Plukenetia conophora</i>	Ukpa	
8	<i>Baphia nitida</i>	Abosi	Camwood
9	<i>Pterocarpus soyauxii</i>	Ora/ oha	
10	<i>Citrus spp</i>	Oroma	Orange
11	<i>Musa spp.</i>	Unere	Plantain/banana
12	<i>Chrysophyllum albidum</i>	Udara	African star apple
13	<i>Carica papaya</i>	Unere ezi	Pawpaw
14	<i>Cola acuminata</i> or <i>C. nitida</i>	Orji	Kola nut
15	<i>Eleais guinensis</i>	Nkwu	Oil palm
16	<i>Chlorophora excels</i>	Oji	Iroko
17	<i>Newbouldia leavis</i>	Ogirisi	
18	<i>Mangifera indica</i>	Mangoro	Mango
19	<i>Psidium guajava</i>		Guava
20	<i>Irvingia gabonensis</i>	Ugiri	Bush mango
21	<i>Garcinia kola</i>	Akilu	Bitter kola
22	<i>Swietenia macrophylla</i>		Mahogany
23	<i>Triplochiton scleroxylon</i>	Obeche	
24	<i>Oxytenanthera abyssinica</i>	Achara or otosi	Bamboo
25	<i>Hevea brasiliensis</i>		Rubber tree
26	<i>Dennettia tripetaka</i>	Mmimi	

27	<i>Moringa oleifera</i>		Moringa
28	<i>Azadirachta indica</i>	Dogonyaro or Iba chorop	
29	<i>Xylopiacthiopica</i>	Uda	
30	<i>Monadora myristica</i>	Ehuru	
31	<i>Gongronema latifolium</i>	Utazi	
32	<i>Vernonia amygdalina</i>	Onugbu	Bitter leaf
33	<i>Ocinum gratisimum</i>	Nchanwu	Scent leaf
34	<i>Spondias mombin</i>	Ichikere	
35	<i>Brachystegia sp.</i>	Achi	
36	<i>Agaricus bisporus</i>	Ero	Mushroom
37	<i>Gnetum africana</i>	Okazi	

Source: Alao & Shuaibu, 2011, Umeh, 2011

2. Crop component of agroforestry

Any crop plant can be used in agroforestry systems. The choice of crop plants in designing such systems should be based on those crops already produced in a particular region either for marketing, feeding animals, or for home consumption, or that have great promise for production in the region. In keeping with the philosophy of agroforestry, however, other values to be considered in crops election include proper nutrition, self-sufficiency and soil protection (<http://www.echonet.org/>).

Table 2: Arable crop species component of agroforestry practices

S/No	English name	Local name	Scientific name
1	Yam	Ji	<i>Dioscorea Spp</i>
2	Cassava	Akpu	<i>Manihot esculenta</i>
3	Cocoyam	Ede	<i>Xanthosoma sagittifolia, Culocasia esculenta</i>
4	Pigeon pea	Fiofio	<i>Cajanus cajan</i>
5	Groundnut	Opupa/ahuekere	<i>Arachis hypogaea</i>
6	Bambara nut	Okpa	<i>Vigna subterranea</i>
7	Maize	Oka	<i>Zea mays</i>
8	Cowpea	Agwa	<i>Vigna unguiculata</i>
9	Pumpkin	g.	<i>Telferia occidentalis</i>
10	Spinach		<i>Spinacia oleracea</i>
11	Water leaf	Mborondi	<i>Talinum triangulare</i>
12	Melon	Egwusi	<i>Cucumis melo</i>
13	Okra	Okwuru	<i>Abelmoschus esculentus</i>
14	Garden egg	A/lara	<i>Solanum melongena</i>

Source: Umeh, 2011

3. Animal component of agroforestry

Any farm animal can be used in agroforestry systems. The choice of animal will be based on the value the farmer places on animal-derived benefits including income, food, labor, non-food products, use of crop residues, and manure (<http://www.echonet.org/>).

Table 3: Animal species component of agroforestry practices

S/No	English name	Local name
1	Goat	Ewu
2	Sheep	Aturu
3	Cattle	Efi/ ehi
4	Grass cutter/ cane rat	Nchi
5	Rabbit	Oke oyibo/ Oke bekee
6	Snail	Ejule
7	Bee	Añ _u
8	Fish	Az _u

Source: Umeh, 2008

2.2 Agroforestry practices in Nigeria

An agroforestry practice denotes a distinctive arrangement of components in space and time (<http://www.worldagroforestry.org>). Some of them include:

1. Multipurpose tree lot

This type of agroforestry involves farmers intentionally leaving few trees on the farms when clearing the land. The trees commonly left are those of economic importance to the farmers. The trees are deliberately grown and managed for more than one output. According to Amonum, *et al.* (2009) multipurpose tree lot may supply food in the form of fruit, nuts, or leaves that can be used as a vegetable; while at the same time supplying firewood, add nitrogen to the soil, or supply some other combination of multiple outputs.

2. Taungya system

The taungya system was the main agroforestry method practiced in the forest reserves since 1950 to date and is one of the oldest known agrosilvicultural systems. It is an agroforestry practice whereby food crops are interpolated with trees in a unit area of land for 2 - 3 years. Food crops cease to exist on the land when the tree crops close canopy. According to Oboho (1990), the Igbo of South eastern Nigerians practice this by planting melon, okra and vegetables under rubber and palm trees. The system can be considered as another step in the process of transformation from shifting cultivation to agroforestry. It consists of the simultaneous combination of the two components during the early stages of forest plantation establishment. Although wood production is the ultimate objective in the taungya system, the immediate motivation for practicing it is food production.

3. Integrated taungya

According to Rander (1988), the integrated taungya aims at invoking the idea of land use practice whereby the activities on the land are stretched all the year round. These include; thinning, pruning and other management schedules to the tree crop to reduce the intensity of overstorey shade and thus allow cultivation of crops. Under the integrated system, when tree canopy is closed, rising of agricultural crops is substituted by livestock grazing. The application of fertilizer and other soil management measures are to avoid the deleterious effects commonly associated with the conventional taungya and the social benefit to farmers is their continued stay on site.

4. Home gardens

The word "home garden" has been used rather loosely to describe diverse practices, from growing vegetables behind houses to complex multistoried systems. It is a system whereby more

than five crop types are often intercropped on a small farm land with some economic trees as well as providing food, vegetables, fruits and medicines (Oboho & Anyia, 1992). It is used here to refer to intimate association of multipurpose trees and shrubs with annual and perennial crops and, invariably livestock within the compounds of individual houses, with the whole crop-tree-animal unit being managed by family labour (<http://www.worldagroforestry.org>). Home gardens have a long tradition in many tropical countries. Tropical home gardens consist of an assemblage of plants, which may include trees, shrubs, vines, and herbaceous plants, growing in or adjacent to a homestead or home compound. These gardens are planted and maintained by members of the household and their products are intended primarily for household consumption; the gardens also have considerable ornamental value, and they provide shade to people and animals. It is more common in the southern and eastern part of Nigeria. According to the study by Umeh (2011) it was also revealed that more species were located in home gardens than in farm fields where they provide fuel, income as well as source of shade and fodder to livestock. Choice of species includes:

- a) Woody species: *Anacardium occidentale*, *Citrus spp*, *Psidium guajava*, *Mangifera indica*, *Azadirachta indica*, *Cocos nucifera*.
- b) Herbaceous species: Onion, cabbage, Pumpkin, Sweet potato, Banana, Beans.

5. Alley cropping

Alley-cropping (also known as alley-farming) was developed during the 1970s at the International Institute for Tropical Agriculture (IITA) to address the problem of soil depletion on land overused for traditional shifting cultivation and bush-fallow cultivation (Kang & Reynolds, 1986). According to Adedire (1992) it involves the cultivation of food crops such as upland rice, maize, yam, cassava, and other crop between rows of fast growing leguminous tree or shrubs.

The alley cropping technique involves growing annual crops in spaces (4- to 6- meter-wide "alleys") between rows of leguminous trees or shrubs maintained as hedges. The hedges are heavily pruned throughout the crop season to prevent them from shading the crops. The pruning and crop residues are used as mulch to conserve moisture and enrich the soil in the cultivated alleys. Soil nutrients and nitrogen fixed by the tree roots similarly enrich the soil in the alleys. The technique allows for continuous cultivation of food crops because soil productivity is restored throughout the cropping cycle, thus eliminating the need for a fallow period. Though alley farming was originally designed for use by small farmers, it is believed that it is sufficiently flexible to be adapted for mechanized farming using appropriate machinery. The International Livestock Centre for Africa has extended the concept of alley cropping to include livestock by using a portion of the hedgerow foliage for animal feed, calling the resultant system alley farming (Okali & Sumberg, 1985). Alley farming studies on acid and low-base-status soils in eastern Nigeria have shown good promise with species such as *A. barterii* and *Flemingia macrophylla*. In traditional fallow systems at Mbaise in Imo State of south-eastern Nigeria, farmers have already practiced some aspects of alley farming using *Acioa* on acid soils for a few generations (Kang, Wilson & Sipkens, 1981)

6. Border tree planting

Border planting is used to enhance the aesthetic value of the surroundings, demarcate boundaries, control water and wind erosion and supplement the supply of food, fodder and fuel wood. They are strips of trees or other vegetation planted on the edges of fields. It could be used for intercropping of trees or other woody plantation within farm crops to provide demarcation, or boundaries. Dwivedi (1992) reported that the woody species apart from preventing boundary disputes also provide fuel wood supplies.

7. Windbreaks (Shelterbelt)

Rows of trees grown in bands perpendicular to prevailing winds are called windbreaks or shelterbelts (Hintz & Brandle, 1986). These rows of trees and/or shrubs on agricultural land provide ecological goods and services e.g. shelter from the wind, wildlife habitat, carbon sequestration, filter for dust, noise or odor, and also produce timber and non timber products. This practice is utilized as part of a crop and/or livestock operation to enhance production, protect livestock and control soil erosion. The windbreak protects crops directly by shielding them against the scouring and drying effect of wind and indirectly by preventing erosion. In addition, soils under the tree canopy are enriched by micro organic life that thrives in the shade of the tree canopy and by the nutrients that are added to the soil as the fallen tree leaves decay. Studies have shown that when leguminous species are used for the windbreak, the nitrogen fixed by the tree roots further enriches the soil (Hintz & Brandle, 1986). Woody species used for this purpose include tree varieties that are wind-resistant and have a good ability to grow in height and branches.

8. Forest farming

Forest farming is the management of forest canopy for the production of specialty products in the understory. According to Dosskey, *et al.* (2011) product options such as food (berries, nuts and mushrooms), botanicals (herbs and medicinal), decorative (floral greenery and dyes), and handicrafts (basket and woodcraft materials), bee products (honey, bee pollen, beeswax, royal jelly, etc.), fencepost, firewood, maple syrup etc. can be cultivated using this practice. Forest overstorey is modified to provide the appropriate understory microclimate but not enough to greatly interfere with its contributions to wildlife habitat, erosion control, and

water filtering. The forest farming practice emphasizes the fact that both timber and other products can be grown simultaneously.

9. Riparian forest buffers

This practice involves establishing living filters comprised of trees, shrubs, forbs and grasses along water systems (<http://forestry.ky.gov/LandownerServices/Agroforestry.aspx>). These buffers enhance filtration of nutrients from surface run-off and shallow ground water. Riparian forest buffers protect the water quality of streams and lakes and are an effective tool for controlling erosion and providing food and cover for wildlife. Decorative woody floral, berries, native grasses and crops can be incorporated into the buffer. This practice requires establishing a series of specific zones - native trees, shrubs and grasses to protect the temperature and clarity of moving water and to keep agricultural chemicals and soil from eroding directly into stream water.

10. Improved fallow

Improved fallow is an agroforestry practice that has its origins in slash-and-burn agriculture. It involves planting fast-growing, preferably leguminous woody species during the fallow phase of shifting cultivation. According to Alavalapati, Mercer & Montambault (2004) the woody species improve soil fertility and may yield economic products. Farmers use improved fallow to accelerate the process of rehabilitation and thereby shorten the length of their fallow periods. The technology can be applied to any agricultural land that is not under cultivation in order to accelerate recovery, increase nutrient reserves, and improve the potential for future productivity on the site.

2.3 Benefits of agroforestry practices

Several studies in different parts of the Nigeria suggested that agroforestry is more profitable to farmers than agriculture or forestry for a particular area of land (Tokey, 1997 and Samra, Dhyani & Sharma 1999). Agroforestry practices of all types provide important direct and indirect benefits not only to the farmers who implement them, but to their communities and the global population as a whole. Some of the benefits are listed below.

1. Enhancing soil fertility

Nutrient mining from continuous cropping without adequately fertilizing or fallowing the land is often cited as the main constraint to increase in productivity in most countries across Africa. It is estimated that on average African soils have been depleted by about 22 kg nitrogen, 2.5 kg phosphorus, and 15 kg potassium per hectare of cultivated land over the past 30 years in 37 African countries – an annual loss equivalent to \$4 billion worth of fertilizers (Sanchez, 2002). Agroforestry practices have attracted considerable attention as an attractive and sustainable pathway to improve soil fertility. According to Sanchez, Izac & Buresh (1997) there are four ways through which trees can contribute to the improved nutrient supply -increase nutrient inputs to the soil, enhance internal cycling, decrease nutrient losses from the soil, and provide environmental benefits.

2. Soil conservation

According to Anitta & Sathya (2012) integrating trees on the fields act as natural sump for nutrients from deeper layers of soil, add bio-fertilizer, conserve moisture and enhance productivity of system. It provides surface soil cover and protects the soil from the damaging impact of rain drops. It also lowers surface soil temperature, increases soil moisture infiltration and retention, improves the physical properties of the soil and stimulates biotic and faunal

activities in the soil (Kang & Akinnifesi, 2000). Studies have shown that alley cropping with leguminous trees viz ., subabul (*Leucaena leucocephala*) has been most widely used on the field bunds for producing mulch material for moisture conservation and nutrient recycling. Alley cropping with *Leucaena leucocephala* was effective for erosion control on sloping lands up to 30% (Anitta and Sathya, 2013).

3. Enhancing water use efficiency

There is evidence that agroforestry have the potential for improving water use efficiency by reducing the unproductive components of the water balance (Kumar, Hooda, & Bahadur, 1998). Examples from run-off, soil evaporation and drainage show that simultaneous agroforestry practices could double rainwater utilization compared to annual cropping systems, mainly due to temporal complementarities. Lehmann (1998) noted that combination of crops and trees uses the soil water between the hedgerows more efficiently than the sole cropped trees or crops, as water uptake of the trees reached deeper and started earlier after flood irrigation than that of crop, whereas the crop could better utilize top soil water. Agroforestry can also be useful for utilization of sewage-contaminated wastewater from urban systems. Soils under different tree canopies are rich in organic carbon content, moisture availability and nutrient status (Kumar, *et al.*, 1998).

4. Microclimate improvement

The use of trees as shelterbelts in areas that experience high wind or sand movement is well established example of microclimate improvement that results in improved yields. Establishment of microï shelterbelts in arable lands, by planting tall and fast growing plant species such as castor on the windward side and shorter crop such as vegetables in the leeward side of tall plants will help to increase the crop yield (Venkateshwaralu, 1993). Experiment has

shown that crops that are protected from wind have higher yields than crops that are not protected from wind, when all other factors are equal (Brandle, Johnson & Akeson, 1992). The evidence for the beneficial effects of shade trees depends on the nature of the understorey crops.

5. Biodiversity conservation

Over exploitation of natural resources is a major challenge for sustainable production and livelihood security. Agroforestry is a diversity-enhancing land-use system, especially in the context of interspecies diversity, as it brings together crops, shrubs, trees and in some cases, livestock on the same piece of land (Atta-Krah, Kindt, Skilton & Amaral, 2004). With components like trees, agricultural crops, grasses, livestock etc. agroforestry provides all kinds of life support. Trees in agroforestry act as a refuge to biodiversity after catastrophic events such as fire (Griffith, 2000). According to Anitta & Sathya (2013) the traditional society practicing home gardens and sacred groves help in bio- diversity conservation by slowing the conversion of natural habitat to agricultural lands.

6. Bio-drainage

The bio-drainage technique is eco-friendly as the bio-drainage plantations purify the environment by absorbing greenhouse gases from the environment and releasing oxygen into the environment. Commonly drainage effluent has been disposed of into rivers. This practice is progressively becoming problematic as the drainage effluent contains drained nutrients, salts and residues of agro-chemicals and affects the health of reservoirs, rivers and inland seas into which it is discharged. According to the study carried out by Anitta & Sathya (2013) this problem was solved using agroforestry model of biodrainage. The biodrainage technique does not require any disposal of drainage effluent as the bio-drainage plantations drain out the filtered fresh water into the atmosphere by using their bio-energy (Anitta & Sathya, 2012). This agroforestry model of

biodrainage has proved a low-cost, socially-acceptable and environment-friendly technique for the reclamation of waterlogged areas.

7. Carbon sequestration

Tree components in agroforestry can be significant sink of atmospheric carbon (C) due to their fast growth and high productivity. By including trees in agricultural production systems, agroforestry can, arguably, increase the amount of C stored in lands devoted to agriculture, while still allowing for the growing of food crops (Kurstien, 2000). A number of studies have estimated the potential of agroforestry systems to act as effective carbon sinks (IPCC, 2000; Albrecht and Kandji, 2003; Montagnini and Nair, 2004, Palm, Vosti, Sanchez, & Ericksen, 2005). Chaco, Marshall, and Milne (2002) and Tomich, de Foresta, Dennis, *et al.* (2002) using the data from the Alternatives to Slash and Burn (ASB) programme predicted how carbon sequestration payments would change the relative returns to alternative land use systems. Their results indicate that carbon payments could be sufficient to increase returns to smallholder agroforestry systems to levels comparable to those generated by oil palm plantations.

8. Agroforestry for bio-fuel and bio-energy production

Bio-fuels are renewable liquid fuels coming from biological raw materials and have proven to be good substitute for oil in the transportation sector. They are gaining worldwide acceptance as a solution for problems of environmental degradation, energy security, restricting imports, rural employment and agricultural economy. According to Anitta & Sathya (2013) 70-80% energy in rural areas, comes through biomass from trees and shrubs. The promotion of the use of oils could also provide a poverty alleviation option in the rural areas. Farmers can use vacant, waste and marginally used land for growing such trees and benefit from the annual produce, which will add as their income. With the increased green cover, the environment will

also benefit greatly. The use of oils is also CO₂ neutral, which would mitigate greenhouse effect (NRCAF, 2007).

9. Agroforestry for food and income

Indigenous fruit trees provide food, nuts and fruit during periods of hunger as well as timber and poles for building, non-timber products for crafts and medicine, fuel wood, charcoal, and fodder and shade for animals and farm workers from the wild (People & Agroforestry, 2011). Their fruits often mature at the time when maize shortage is most critical. They provide income generation opportunities (in processing and enterprise development) for rural women. According to Obasi (2007) many indigenous people depend on forests for their livelihood, edible and medicinal plants, bush meat, fruits, honey, shelter, firewood and many other goods, as well as for cultural and spiritual values. Agroforestry can also provide economic diversification that improves the financial well-being of families and communities, especially those of small-to-medium resource farmers (Henderson, 1991). A global review on the contribution of home gardens to food and nutrition of households found that up to 44% of calorie and 32% of protein uptake are met by the products from home gardens (Torquebiau, 1992). Besides meeting the subsistence needs of households, the role of home gardens in generating additional cash income cannot also be overlooked

10. Agroforestry as a climate change adaptation strategy

A large and growing body of scientific evidence indicates that climate change is a major threat to sustainable development and achieving the Millennium Development Goals (MDGs) (Intergovernmental Panel on Climate Change (IPPC), 2007). Shifting weather regime will have many adverse effects on agriculture, including more frequent drought, increased fungal outbreaks and insect infestations, reduction in ecosystem integrity and resilience, and decline in

biodiversity. However, according to Rao, Verchot and Laarman (2007) agroforestry practices could be used to adapt to, or mitigate, the predicted impacts of climate change on smallholder agriculture. The intensification and diversification functions of agroforestry practices can strengthen the socio-economic resilience of rural populations to climate change.

2.4 Constraints to agroforestry practices

1. Lack of advocacy/agricultural policies for agroforestry practices

There is a deficiency in comprehensive and specific policies to encourage the development of agroforestry practices (Powell, 2009). This is because they are integrated into other policies such as the land policy, the forest development policy, the rural development policy, and the poverty alleviation program. Some policies discourage farmers from growing trees or certain tree species on their farms. Consequently, many farmers do not consider it worthwhile to cultivate trees that they cannot cut for sale as timber or other uses, and they associate tree growing with government harassment (Siew, 1989). Similarly, policies and incentives for agriculture often promote monoculture systems, as in the promotion of oil palm plantations, and the amount of credit supporting this may impact negatively on agroforestry development.

2. Low awareness of agroforestry practices

As an integrated practice not tied exclusively to any single commodity or conservation interest, agroforestry does not fit neatly within conventional industry boundaries. Therefore, it is not widely recognized or understood among consumers, buyers, regulators, land management professionals and producer groups (Place, Ajayi, &Torquebiau, *et al.*, 2012). The opportunity of agroforestry technologies to provide some medium and long term benefits to individuals and the public simultaneously is not as yet well communicated to many stakeholders. According to Place *et al.* (2012) governments have not often been involved in awareness creation for agroforestry

practices, most likely due to the problems of agroforestry being neglected or not championed by a single government ministry.

3. Low production knowledge.

Although advances have been made through workshops, demonstrations and extension materials, the broader community of producers generally has low to moderate knowledge of agroforestry practices and lack basic information on production techniques, production potential and product standards (Powell, 2009). Special skill and sustained efforts are needed for undertaking the various management aspects of trees, about which many crop or livestock farmers may not be aware of. Nair (1984) noted that interaction between components, especially the hypothetical adverse effects of trees on crops, is an area about which farmers who are not experienced with such systems are very apprehensive, and researchers are not equipped enough to allay such apprehension.

4. Inadequate research in agroforestry

Most research and development efforts are focused on short-term monoculture cropping systems and less effort is placed on the potential for improved varieties in multispecies agroforestry practices. According to FAO (2013) breeding for agroforestry conditions (such as shade tolerance, root morphology, structure phenology) is virtually unexplored. Demand-driven, impact-oriented research institutions are needed to ensure a flow of innovations to rural areas. Yet frequently we find that research agendas are unresponsive to field realities and poorly linked to extension.

5. Unquantified economics

Data on costs and returns for agroforestry activities are still lacking and are needed as a basis for calculations of internal rate of return, elaboration of credit schemes in support of

agroforestry, and projection of large-scale investments (<http://unu.edu>). This limits the ability of prospective producers to make informed investment decisions, business plans or obtain insurance, financing or other credit instruments (Powell, 2009).

6. Poor market information and connections

Kang & Akinnifesi (2000) reported that there is a notable lack of information on marketing of agroforestry products. Lack of access to markets, farm inputs and management skills have been noted as the major constraints to growth of agricultural enterprises. Market information systems have recently been introduced in some countries, but they often do not include tree products. As such, markets for tree products are both less efficient and less developed than for crop and livestock commodities (FAO, 2013). Producers lack knowledge of agroforestry market opportunities and do not possess the general information and resources needed to make and maintain market connections. Food and Agricultural Organization (FAO) (1987) found that the processing and sale of commodities, which is a huge economic incentive for farmers to turn from agroforestry has had major constraints due to lack of markets, and inadequate organizational and management skills. If there is no market for goods produced, farmers may not see past the lack of economic gain in planting these trees.

7. Labour shortages/ labour cost

Labour is an important input in the business of agroforestry. Many agroforestry opportunities require reasonably-priced labour and shortages hinder adopting these practices. According to Kang & Akinnifesi (2000) labour distribution varies between regions, gender, systems and seasons, and constitutes an important socioeconomic factor in the development of agroforestry. Most agroforestry innovations are accompanied by changes in labour demands. The availability of labour is crucial for different tasks in agroforestry, especially seedling production,

tree establishment and management. The human capacity, infrastructures and institutional supports for agroforestry are usually not as well developed as for annual crop technologies (Gladwin, Peterson, Phiri & Uttaro, 2002). Kang, Reynolds & Atta-Krah (1990) found in a study on alley cropping that labour required for managing the *Leucocephala* trees rose by 50%. It takes labour to plant, prune, leaf strip and maintain trees. If family labour strategies are not enough, labour will have to be hired from outside at extra cost.

8. Lack of key infrastructure.

According to Powell (2009) lack of suitable infrastructure to sort, grade, stabilize, and add value through processing to non tree forest products (NTFPs), other specialty crops and niche production hinder the practice of agroforestry. There are only fragmented efforts to promote agroforestry products, often involving a small group of people in a given community. Aspects of quality control, storage, processing, and certification for agroforestry products are poorly disseminated among rural populations.

9. Lack of production materials.

Thangata & Alavalapati (2003) reported that one of the greatest constraints of some agroforestry technologies is the lack of farmers' access to quality seeds. According to Simons (1996) lack of seed, seedlings, and other planting material is frequently identified as the most important constraint to greater adoption of agroforestry. Planting stock and the propagation methods for many species of interest is lacking or not readily available. Seed collection, propagation and multiplication methods are poorly known and farmers often have no other option but to protect or transplant trees which have germinated spontaneously or depend on relatively ineffective public and private sectors (FAO, 2013). Most forest departments in developing countries which have the mandate for all tree seed supply have been neglected. This

has serious drawbacks for agroforestry species because resident forestry staff is few in the field and is not highly aware of needs of farmers (Place, *et al.*, 2012).

10. Land and tree tenure

A land tenure system is the body of rights and duties which regulates the use and control of land (Kang & Akinnifesi, 2000). Unsecured or ambiguous land tenure, common in developing countries, results in confusion about land delineation and rights. Rights to trees may be separate from rights to land and both land and tree tenure insecurity may discourage people from introducing or continuing agroforestry practices (FAO, 2013). According to Franzel (2001) constraints associated with tenancy are significant in many developing countries where large numbers of farmers cultivate communal land under traditional tenure arrangements that do not allow them to claim ownership or exclusive use rights to the trees on their fields.

11. Lack of incentives

Incentives and support for the development and adoption of production and conservation applications for agroforestry are not widely available or are perceived to be overly restrictive. According to Place *et al.* (2012) government agencies most often do not provide incentive to farmers and the result is that without government involvement in providing greater incentives, the level of private investment in agroforestry will be less than socially optimal. Therefore, incentive systems for farmers to produce at societal level benefits need to be established and clarified to farmers (Leimona, 2011).

12. Poor and inadequate extension services

Powell (2009) stated that the lack of full time, dedicated extension staff for agroforestry and other emerging industries was viewed by many as strong challenge to implementing new practices. Agroforestry extension has been problematic in Africa because of the lack of

rigorously validated and locally adapted extension messages, the general weakness and limited resources of public extension systems, lack of agroforestry training for extension workers, and the unclear assignment of responsibility for agroforestry among agricultural and forestry extension institutions (Scherr & Franzel, 2002). Even where extension agents are trained, they often are understaffed and cannot easily meet the time commitments required to fully train farmers on new farming methods like agroforestry.

The transmission of new management practices to frontline extension workers has long been acknowledged as a difficulty, especially in Africa. One of the studies from several countries in Africa have shown that sustainable land management practices such as agroforestry are not sufficiently known by extension agents and much less likely to be disseminated to farmers (Banful, Nkonya & Oboh, 2010). Moreover, some agroforestry practices are knowledge intensive and thus do not diffuse as quickly as other technologies.

13. Subsidies or support for other land use practices

According to Sanchez (1999) fertilizer tree technology was considered impractical or less economically rational to use in Nigeria because nitrogen fertilizers were a cheaper option. There is little argument that fertilizers are needed in agriculture, but by subsidizing them without commensurate support for other soil fertility measures such as agroforestry-based fertilizer trees, governments risk promoting a narrow technological package that is not compatible with long term soil health. Many governments support agriculture in some ways, but agroforestry is not often included as an agricultural enterprise for support (Place *et al*, 2012). Many governments have now improved market information systems for agricultural commodities but again, tree products are usually neglected.

14. Socio- cultural factors

The preferences of male and female farmers concerning tree crops often differ, reflecting their respective interests and roles in the farming system. A key lesson from experience is that most small farmers do not wish to grow trees exclusively for wood, but prefer species that serve a variety of other purposes as well, such as providing food, fodder, extracts, shade, or fertilizer or serving as a hedge (Powell, 2009). Traditionally, the pastoralists' life of moving with their herds and focusing on the immediate needs of forage and survival discourages them from planting, protecting, and managing trees and forests or the associated biodiversity thereof. Decision-making concerning tree species and techniques to be promoted should take into account farmers' preferences and customary beliefs and practices that might discourage farmers from growing trees or certain tree species.

15. Lack of coordination between sectors

In many countries, agroforestry is regarded as belonging to 'all sectors' such as agriculture, forestry, livestock, rural development, environment, energy, health, water and commerce in principle, but in practice, it belongs to none and rarely occupies a special line in a governmental body or has its own policy space (FAO, 2013). It falls between the agriculture, forestry and environment departments, with no institution taking a lead role in the advancement of agroforestry or its integration. Agriculture departments emphasize crop production on agricultural lands; thus agricultural policies directly contribute to excluding trees from farms and the landscape. Some forestry departments do not believe it is possible to grow good quality, widely-spaced timber on farms and have little interest in non-timber trees or the growing of trees with crops and/or livestock on the same plot of land (FAO, 2013).

16. Lack of involvement of farmers during the programme development

Researchers often fail to remember that each farm is site-specific and each farmer is unique. Forgetting this was the first mistake of the agroforestry developer (researcher), as he packaged this new system, and promoted it to farmers with a diverse range of circumstances. The result being that many beneficial systems which agroforestry developed were inflexible and unusable by numerous farmers (Powell, 2009). German, Kidane & Mekonnen (2005); Probst and Hagman (2003) stated that in order to ease the process of adoption of innovation, it is pertinent to seek the views of small scale local agroforestry practitioners in the planning of agroforestry programme.

17. Low production due to competition between trees and crops

When there is an interaction between organisms sharing the same pool of resources, there will either be positive interaction (complementarity) or negative interactions (competition) (Sanchez, 1995). Nair (1990) found moisture competition between trees and crops to be a problem. Too much shade, competition for nutrients and root space as well as allelopathic interactions may weaken crop yields (Nair, 1990). Many farmers do not know much about agroforestry to ensure that these negative interactions do not occur and are not willing to put themselves at risk.

18. Long period to obtain the yield of agroforestry

Bohringer (2001) stated that true benefits can only be reaped once trees have established themselves and reached their full biomass productivity. This is a deterrent to farmers who value short term gains and who are unable to support themselves over the transitional phase of change. For the years that the potential advantages of trees such as shelter, nutrient supplements, fodder and marketable products are not tangible, farmers will have to maintain the trees as well as

supplement his family with alternative income strategies and food supply where trees have reduced the output of food crops.

19. Land scarcity

A farmer with a small piece of land is generally less likely to plant woody perennials, as this would be taking up space that could be used for harvesting crops. Some agroforestry practices are only advantageous where land is not scarce such as with improved fallows (Bohringer, 2001). Farmers who do not possess such assets are physically limited and unable to practice this technique. Changing farm practices is also a higher risk for farmers owning limited land.

20. Incidence of pests

Pests have been claimed to be one of the most serious concerns of farmers. According to Franzel (1999) although agroforestry has the potential to curb pests, in certain conditions, may actually spark a pest attacks.

2.5 Strategies for improving agroforestry practices

Because so many limiting factors are now known as explained above, strategy can be developed which should be rooted in existing local practice and promote acceptable agroforestry systems appropriate to local and physical conditions (Salam, Noguchi & Koike, 2000).

1. Promote education and research efforts

Forested land areas in Nigeria's different ecozones have experienced enormous degradation due to human activities for decades. This threat can be minimized by building upon the success stories of these communities by providing training and assistance in managing the forests for sustainable uses (National Environmental Research Council (NERC), 2002). This can be attained through education and research programmes to acquaint farmers with the right

practices to boost food security and techniques suitable for their respective ecozone in addressing the problems. Therefore, providing more agroforestry technology training opportunities to government agricultural extension staff is necessary so as to help them provide information, and scale up the technologies to farm communities. According to Akpabio *et al.* (2008) sustained education and environmental awareness campaign on the importance of agroforestry to environmental conservation and poverty alleviation should be embarked on.

2. Organizing workshop for farmers

According to Kristjanson, Place, Franzel & Thornton (2002) organising farmer workshops are important means to find out farmers' views on the technologies and their potential impacts. It can also be a means for farmers to discuss issues related to new practices, exchange opinions and lessons, and come to consensus or clarify their differences. The workshops provide information on important effects of practices, indicators that farmers would use to evaluate the impact of adoption and clarification of possible constraints to adoption. The information provided by farmers in such workshops might be important new information which may be useful to researchers.

3. Encourage local involvement on agroforestry practices

Involving farmers in decision making is necessary because they have innovative ideas on agroforestry design that are appropriate to their needs. Village elders will be involved in passing resolutions and existing farmers groups should be built upon, giving them a sense of ownership in the process rather than coming from an outsider who could be seen as suspicious. This will be quite viable in communities that are yet to embrace the techniques of agroforestry (Haggar, Alejandro & Díaz, 2001). According to Binswanger (2000) empowering local communities to

plan their own development and mobilize resources is also fundamental to any successful development strategy.

4. Provide financial support and the right climate for income generation

Provision of adequate funding to secure a prompt supply of seedlings is highly indispensable in that it enables communities procure seedlings for tree planting initiatives. This effort can be supplemented by instituting programmes that help farmers and agroforestry teams gain knowledge and the skills to market their products in order to improve the socio-physical and economic situation of people living on forest and farming activities. This will enhance income-earning potentials from small holder production and sale of products (Bohringer, 2001).

5. Policy reforms

Raussen, Ebong & Musiime (2001) stated that policy incentives help promote adoption, and policy makers themselves may be engaged to promote or even finance scaling up activities. Mande, 2003; Aturamu, 2005; Federal Ministry of Natural Resources (FAMNR), 1996 a, b suggested that right instruments such as incentives for rural farmers in agroforestry programmes as well as a command and control mechanism to regulate land use activities should be incorporated in existing policies as part of the reforms. Empowerment and rights allow farmers to plan, select species, manage, harvest and market their crops on the open market, which increase incomes and reduce poverty. Agroforestry should be institutionalized as part of the official programme of activities in the ministries of agriculture food and cooperatives, livestock and fisheries, and natural resources and tourism.

6. Promote communication between researchers and policy makers

Effective policy analysis does not only include rigorous assessments and sound recommendations, it also requires effective communication with policy makers. Little attention is

given to the area of communication between researchers and policy makers. This is indeed surprising, given researchers' frequent difficulties in influencing policy (Scherr & Franzel, 2002). Policy research is however, most effective when it informs policy makers about the implications of different options rather than simply advocating one policy over others. Policy makers therefore, need to be involved from the start in designing and implementing policy research. Scherr & Franzel (2002) reported that workshops involving researchers and policy makers are an effective means of improving consultation.

7. Provision of credit facilities

Access to credit is very important for adoption of innovations. Therefore farmers should be provided with loans preferably at market interest rates to solve farmers' problem of inadequate finance. However, according to Orisakwe & Agomuo (2011) the loans should be supervised to see that they are not diverted to wrong hands and ensure judicious utilization of such loans by farmers.

8. Provision of incentives to farmers

Farmers should be encouraged with incentives such as: providing secure land tenure, directing tree tenure programme to the poor, funding small community projects to improve living conditions (such as building graded trails or fish ponds, installing electricity generators, and forming cooperatives), and providing partial subsidies for farm inputs (Siew, 1989).

9. Promote marketing of farm-grown tree products

Having a marketable component contributed significantly to farm profits and to the incentive to expand agroforestry technologies. Development of new marketing channels, quality standards, efficient marketing practices and market information systems will be essential for improving smallholder participation and benefits from new tree product markets (Scherr &

Franzel, 2002). Better markets for agroforestry products provide a way for poor farming households to generate income. According to Dewees & Scherr (1996) linking farmers to markets and adding value to raw products have great potential for improving the incomes of smallholders and facilitating the scaling up process. The key challenge is to improve the structure, conduct, and performance of agroforestry tree product markets and to make those markets accessible to low-income producers.

10. Promoting information to farmers through extension services

It is important for farmers to have good information not only about species selection and tree establishment, but also on tree management. Different management practices are desirable for a given agroforestry technology under different conditions. Extension workers should be able to provide to farmers information relevant for decision making process (Scherr & Franzel, 2002).

11. Strengthening research, extension and farmers' linkage/ communication

Communication between extension staff and researchers is particularly crucial when the agroforestry technique to be introduced is unfamiliar to farmers or requires substantial modification of existing farming practices (e.g., from shifting cultivation to alley-cropping or contour hedgerow farming) (Siew, 1989). There is need to set well linked communication channels, for example mass media, and provide in service training to agricultural extension officers in order to pass information on agroforestry benefits to many stakeholders (Parwada, 2010).

Extension staff should work closely with farmers to familiarize themselves with actual conditions on project sites. They have to understand how farmers receive, analyze, and disseminate information in order to facilitate it (Franzel, Denning, Lillesø, *et al.*, 2004). One effective strategy has been to locate residential extension staff on project sites. Another effective

strategy, used by the International Council for Research in Agroforestry (ICRAF), is to encourage extension staff and farmers to work closely not only with one another but also with researchers to help the latter adapt the project-supported technology and extension programme to local conditions (Siew, 1989). Including extension staff and farmers in the applied research stages and during implementation of a project is equally important because their knowledge can provide feedback on the research, thus enabling researchers to refine their selection of tree species and technologies for testing.

12. Awareness creation

Awareness creation for agroforestry should involve a variety of actors including NGOs, government institutions (such as ministry of agriculture and forestry), private organizations, extension workers, and farmers. It also involve the establishment or strengthening of school community links and sensitizing policy-makers about agroforestry benefits by producing policy briefs and use of public media channels and events (local radio, TV programmes, documentaries, field days, agricultural shows etc) (Ajayi & Kwesiga, 2003). According to Powell (2009) awareness can be created through: website and links to the Ministry of Agriculture and Lands Info Basket, newsletter and electronic mailing list, information brochures, workshops and information sessions, tours of agroforestry demonstration sites, extension notes, peer training network etc.

13. Provision of quantifiable economic information

Adoption of agroforestry for diversification, or as the primary means of production, will not advance significantly without quantifying the basic economic information to guide financial decisions (Kang and Akinnifesi, 2000). The intended outcome of this activity is to create a library of practical, enterprise-level agroforestry cost-benefit information and templates, of

sufficient scope and detail to allow current and prospective producers to create workable business plans or perform other financial and risk management planning.

14. Minimizing competition between trees and crops

To solve the problem of competition, trees can be chosen which minimize this competition with other components. Nair (1990) suggested specific groups of practices for different ecozones of Africa, which could be adopted so as to minimize competition between trees and crops for instance, use of alley cropping; improved fallow; multistory tree gardens; plantation crop combinations; homegardens in humid lowlands of West Africa.

2.6 Conceptual framework

The conceptual framework for the study is represented by the schema in figure 1. Circle A shows agroforestry practices that exist in Nigeria which include: row/hedges, trees on farm land, scattered tree on farm land, wind break, home garden, taungya, shelter belts, alley cropping; bounding trees, dune fixation, and aquaforestry. Some of these agroforestry practices are used by rural farmers in Imo state as reported in the literature. They include; home garden, alley cropping, taungya system, improved fallow which are outlined in circle B. These agroforestry practices when properly practiced and efficiently managed could result in several benefits such as conserving soil by providing moisture to soil for plant growth, improvement of soil fertility, generation of additional income, provision of fuel wood and raw materials for both families and industries as shown in block C.

However, rural farmers could be hindered from practicing and/or benefitting from these agroforestry practices by a number of factors which include: land tenure system, inadequate knowledge of agroforestry practices by extension agents, lack of planting material, low levels of awareness of agroforestry practices as shown in block D. On the other hand, these constraints

could be prevented or controlled by employing the strategies that are outlined in block E which includes: increasing awareness of agroforestry practice through training and workshop, policy reform to encourage the practice among farmers, subsidizing the cost of planting materials. When these measures are properly implemented the practice of agroforestry will be enhanced resulting in overall improvement in agricultural production in the State and Nigeria in particular.

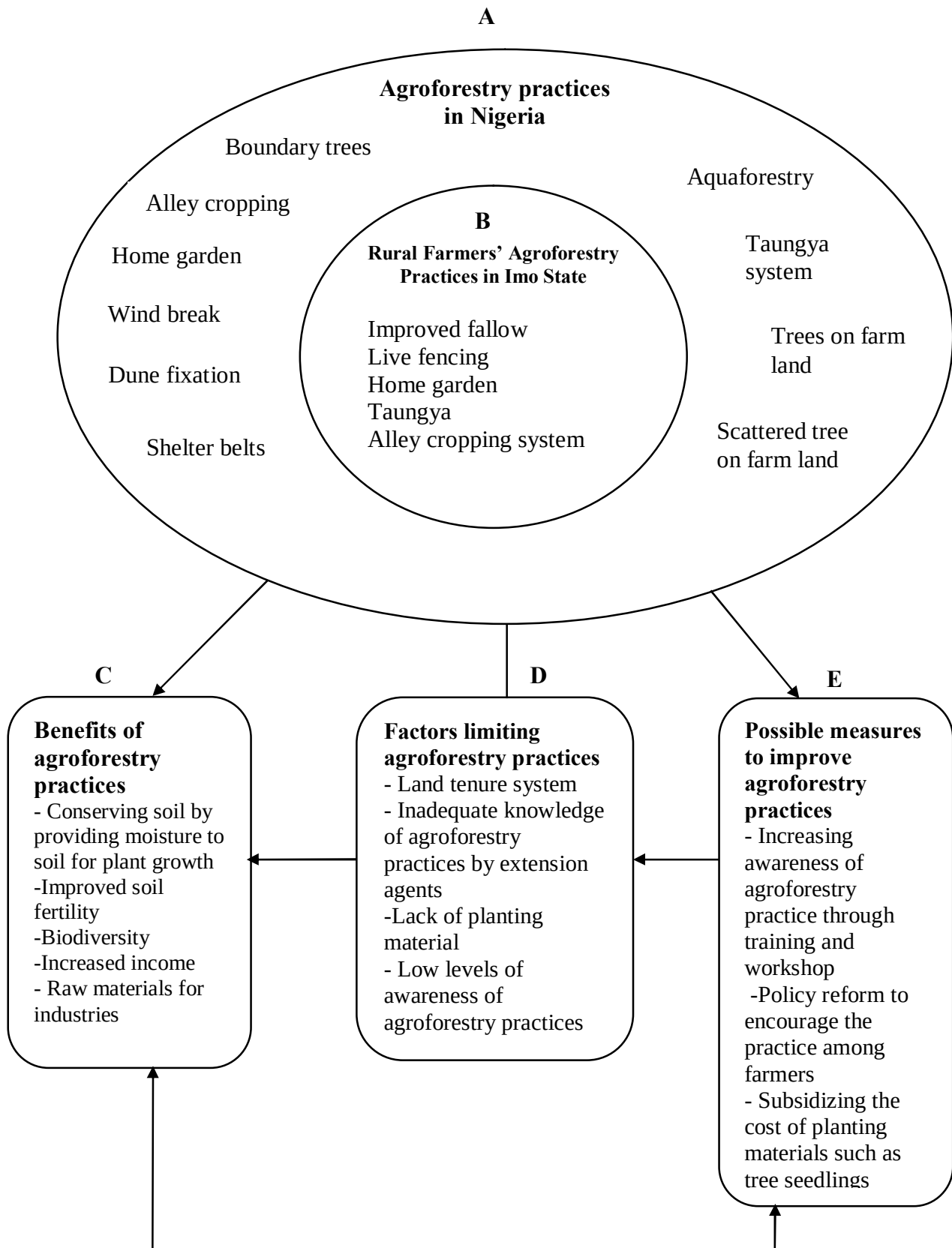


Figure 1: Schema for examining rural farmers' agroforestry practices in Imo State

METHODOLOGY

3.1 Study Area

The study was carried out in Imo State, Nigeria. Imo state is located in Southeast of Nigeria and shares common boundaries with Abia state on the east and northeast, Rivers state on the south, and Anambra state on the west and northwest. The state lies within latitude 4°45'N and 7°15'N, and longitude 6°50'E and 7°25'E with an area of 5,100 sq km (Imo state ADP, 1990). Imo state is divided into three (3) agricultural zones of Owerri, Okigwe and Orlu. Owerri zone comprise Aboh Mbaise, Ahiazu Mbaise, Ezinihitte, Ikeduru, Mbaitoli, Ngor Okpala, Owerri Municipal, Owerri North and Owerri West; Okigwe zone comprise Ehime Mbano, Ihitte /Uboma, Isiala Mbano, Obowo, Okigwe, Onuimo and Orlu zone comprise Ideato, Ideato South, Isu, Njaba, Nkwerre, Nwangele, Ohaji/Egbema, Oguta, Orlu, Orsu, Oru East, and Oru West. The state is made up of twenty seven (27) Local Government Areas (LGAs).

The state is in the tropical rainforest zone of Nigeria which makes her vegetation habitable for many forest and livestock. The vegetation of the area encourages the practice agroforestry. Major crops cultivated include, cassava, yam, cocoyam, vegetables, oil palm etc, while major livestock reared are poultry, goat, sheep and cattle. Economically exploitable flora like the iroko, mahogany, obeche, bamboo, rubber tree and oil palm predominate in the state. (Orisakwe, & Agomuo, 2011).



Figure 2: Map of Imo State showing the different LGA

Source: <http://zodml.org/Nigeria/Geography/Imo%20State/>

3.2 Population and sampling procedure

The population for the study comprised all farmers involved in agroforestry practices in Imo state. Four local government areas (LGAs) were selected out of 27 LGAs in the state using simple random sampling technique. They include Orsu (with 21 communities), Ihitte Uboma (with 19 communities), Isiala Mbano (with 27 communities) and Owerri North (with 12

communities). From the 79 town communities in the four LGAs selected, two town communities were purposively selected based on their involvement in agroforestry practices giving a total of eight town communities. From each of the eight town communities, four village communities were purposively selected because of their involvement in agroforestry practices making a total of 32 village communities. From the list of agroforestry farmers compiled in each of the village communities by extension agent, five farmers were selected using simple random sampling technique. A total of 160 farmers constituted the sample for the study.

Table 4: Names of the sampled communities in Imo State

LGA	Town communities	Village Communities
Orsu	Umuhu Okabia	Umuerem, Ogbusi Ofeahia, Umunabochi and Ofeke
	Elugwu Okabia	Amaimo, Umunkata, Okwuetiti and Okwu
Ihitte Uboma	Lowa	Eluama- umuokoro, Umudiebele- umuike, Uhuala- umuokoro and Odonu- umuike
	Uzinomi	Egwuleze, Umukara, Umuobike and Umuzi
Isiala Mbano	Ogbor	Umuonyene, Umuagwu, Umuehie and Umuwari
	Umuduru	Umueze, Umuegbe-owerre, Orji and Umudike
Owerri North	Emekuku	Azaraegbelu, Egbelu, Ubowola and Ezedibia
	Uratta	Umunahu, Umuoba, Orji and Okwu

3.3 Instrument for data collection

Data were collected through structured interview schedule which contained relevant questions on each of the objectives of the study. The instrument was validated by two experts in

the field of agroforestry in ADP in Imo state and all lecturers in the Department of Agricultural Extension, University of Nigeria, Nsukka.

3.4 Measurement of variables

Information on the socio-economic characteristics of the respondents examined the following:

Sex: the sex of the respondents was measured as male and female.

Age of the farmers: the respondents were asked to give their ages in years. The actual age in years was later grouped.

Marital status: the respondents were asked to indicate their marital status as single, married, widowed, divorced and separated.

Educational level: The categories of the educational level were as follows: no formal education, primary school incomplete, primary school completed, secondary school incomplete, secondary school completed and higher/tertiary education.

Household size: this was defined as the number of persons eating from the same pot. This was grouped later.

Source of income: the respondents were asked to indicate the source of their income as salary (both government and private), sale of farm product, sale of tree products, and others.

Farm size: the respondents were asked to indicate their farm size in plot (100ft x 50ft) which was later converted to hectares (ha).

Membership of social group: the respondents were asked to indicate whether they belong to any group. Those that belong to a group were further asked to indicate the type of social group they belong.

Extension visits: the respondents were asked to indicate whether they have been visited by extension agents in the last one year. For those that answered yes they were further asked to indicate the number of visit in the last one year.

Years of experience in agroforestry practices: the respondents were asked to indicate the number of years of experience in agroforestry practice.

To ascertain different agroforestry practices used by farmers (Objective one) a list of agroforestry practices such as taungya system, home garden, alley cropping etc were provided for the respondents to tick *ñused* or *ñnot using* against each of the agroforestry practices. They were also asked to indicate other agroforestry practices which they practice but not included in the list. To ascertain the current state of agroforestry practices respondents were asked to describe changes in agroforestry practices in their community in the last *five years* whether they are decreasing, no change or increasing. To assess the type of tree and crop species planted by farmers in their agroforest farm, a list of tree and crops such as coconut, oil palm, melina, bitter leaf, yam, rice etc were provided for the respondents to tick whether planted, protected or not available for each of the species.

To assess the perceived benefits of agroforestry practices (objective two), a list of perceived benefits of agroforestry were provided for respondents such as: increasing soil fertility, provision of income, provision of food, provision of fuel wood etc. to tick yes or no to the items they perceived as being beneficial to them. The respondents were also asked to list other perceived benefits of agroforestry.

To determine factors limiting the practice of agroforestry among farmers (Objective three) a list of possible constraints to agroforestry practices such as: high cost of establishment of agroforestry, low levels of awareness of agroforestry practices among farmers, limited local

market for sell of tree products, lack of knowledge and skill on agroforestry practices etc were provided. Respondents were asked to rate on a 4-point Likert-type scale, (to a very great extent (3), to a great extent (2), to some extent (1) and to no extent (0)) the extent they considered an item as a limiting factor to the practice of agroforestry.

To identify the possible measures for improving the agroforestry practices (Objective four), a list of possible measures such as: subsidizing the cost of planting materials such as seed and seedling, increase awareness of agroforestry practices, etc were provided for respondents to indicate whether they are possible measures or not. The respondents were also asked to list other possible measure for improving agroforestry practices.

3.5 Data analysis

The socio-economic characteristics of the respondents and objective one were presented using frequency count, percentage, chart, and analyzed using mean statistic, ANOVA, Duncan multiple and range test. Objectives two and four were presented using frequency count and percentage. Objective three was analyzed using mean statistic and factor analysis using principal component model with varimax rotation in grouping the constraint variables into major constraint factors. Only variables with loadings of 0.40 and above were used in naming the factors (Comrey, 1962 in Chukwuone, Agwu & Ozor, 2006).

RESULTS AND DISCUSSION

4.1 Socio-economic characteristics of respondents

Age (years)

Data in Table 5 indicated that majority (55.6%) of the respondents were in the age range 41-60 years while 30.0% were within the age bracket of 61-80 years. Smaller proportions (14.4%) were in the age range of 20-41 years. The mean age of the farmers was 54 years. This finding was in support of the finding of Obasi, Okparadim and Henri-Ukoha (2012). In their study, the mean age of agroforestry farmers in Imo state of Nigeria was 50 years. This showed that the respondents were young and energetic and could actively participate in crop farming and tree planting. The implication of this result is that middle aged farmers who are less conservative and could adopt agroforestry technologies more than any other group were involved in agroforestry farming in the state.

Sex

Majority (56.2%) of the farmers were male. Thus, male headed households engage in agroforestry more than female headed households. This could be due to the socio-cultural milieu of the area which gives males the access to production resources like land where agroforestry is practiced more than females. This is in line with the findings of Orisakwe & Agomuo (2011); and Ogunsumi (2007). In their findings, male engaged in agroforestry practices in Imo state and Southwest Nigeria, respectively. The implication of this is that the involvement of the males in active agroforestry farming would enhance productivity, since the males are more energetic, and may adopt new technologies faster, thereby leading to economic viability of agroforestry farming in the area.

Table 5: Distribution of respondents based on their socio-economic characteristics

Socio-economic characteristics	Percentage (%) n=160	Mean
Age (years)		
21-40	14.4	53.67
41-60	55.6	
61-80	30.0	
Sex		
Male	56.2	
Female	43.8	
Marital status		
Single	4.4	
Married	73.1	
Separated	1.2	
Divorced	2.5	
Widowed	18.8	
Educational level		
No formal education	5.6	
Primary school attempted	10.0	
Primary school completed	16.2	
Secondary school attempted	13.1	
Secondary school completed	23.8	
OND/NCE	11.9	
HND/First degree	12.5	
Higher degree	6.9	
Household size (number)		
1-5	36.9	7
6-10	51.2	
11-15	11.9	
*Sources of household income		
Salary	36.2	
Sale of tree products	46.2	
Sale of farm products	56.9	
Trading of non farm products	8.8	
Pension	3.8	
Oil mill	0.6	
Membership of social organization		
Yes	68.8	
No	31.2	
Social organization		
Men/ women religious group	21.9	
Co-operative society	10.6	
Social club	36.9	
Extension visit		
Yes	52.5	
No	47.5	
Number of extension visit (in the last one year)		
1-5	51.2	2.18
6-10	6.9	
11-15	15.0	
16-20	26.9	
Size of farm land use for agroforestry (ha)		
0.01-1.00	78.1	0.87
1.01-2.00	15.6	
2.01-3.00	6.2	
Years of experience in agroforestry		
1-20	55.0	15.75
21-40	32.5	
Above 40	12.5	

*multiple response

Marital status

Majority (73.1%) of farmers were married while 18.8% were widowed. About 4.4% were single, 2.5% divorced and 1.2% separated. This implies that greater proportion of farmers in the area were married individuals. Consequently, it increases access to production variables such as land and labor which are traditionally owned and provided by husbands. Obasi *et al.* (2012) and Orisakwe, & Agomuo (2011) revealed in their separate studies that majority of agroforestry farmers in Nigeria were married. This shows that married people dominates agricultural production in the area. This may be as a result of high labor requirement in agricultural production in which they use members of their family as labor force and partly due to the expected benefits derived in feeding members of their family from what they produced.

Educational level

About 24% had secondary education as their highest educational level, 16.2% had primary education, 12.5% had first degree, and 6.9% had higher degree as their highest educational level while 5.6% had no formal education. According to Henri-Ukoha, Orebiyi, Obasi *et al.* (2011) the level of education of a person not only increases his farm productivity but also enhances his ability to understand and evaluate new production technologies. Okoye, Okorji, & Asumugha (2004) also noted that educated farmers are expected to be more receptive to new and improved technologies than farmers with informal level of education or no formal education. This implies that adoption of innovations like agroforestry would be favoured as education affects adoption of new technologies positively.

Household size

Majority (51.2%) of the farmers had household size between 6 and 10 persons. A smaller proportion (36.9%) had household size between 1 and 5 while the remaining 11.9% had above 11

persons as their household size. The mean number of persons per household was 7 persons. This agrees with the findings of Orisakwe and Agomuo (2011) they inferred that large household is advantageous in farming as labour may be derived from the members. The implication is that there is greater economic viability for agroforestry farming since the farmers have more labor to help in farm work. Hence more food will be produced resulting in food security among the rural households.

Sources of household income

Higher proportion (56.9%) of the agroforestry farmers got their income from sale of farm products while about 46% of them got their income from sale of tree products. This implies that most of the respondents rely on farm products (such as yam, pumpkin, cassava) and tree products (such as fruits, timber, herbs) as their major source of food and income. According to Okigbo (1990) tree crops produced in agroforestry in Southern Nigeria accounted for 60% of family cash income. However, 36.2%, of the agroforestry farmers obtain their income from salary while 8.8% of them got their income from trading of nonfarm product. Smaller proportions (0.6%) got their income from oil mill. This implies that agricultural production was a major means of livelihood regardless of peoples earnings from non-agricultural sources.

Membership of social organization

Majority (68.8%) of agroforestry farmers belonged to one form of social organization or the other. The organizations they belonged to included: social club (36.9%), religious groups (21.9%), and co-operative society (10.6%). The possible reasons why majority joined social organization could be as a result of satisfying their basic need which sometimes could be achieved collectively as opined by Ekong (2010). Membership in organizations is expected to favor use of agroforestry practices, because the members are assumed to have more access to

sources of information and knowledge on new agroforestry practices, credits and other inputs needed for production. The implication is that social interaction, could serve as a forum through which farmers might exchange ideas about new agroforestry practices.

Extension visit

Greater proportion (52.5%) of the farmers affirmed to have had contact with extension agent while the remaining 47.5% have not had contact with extension agents. Extension visit encourages the development of receptive attitude in the farmers to accept technological changes in their farming practices, and also equips them with managerial skill, through informal education and demonstrations, to be able to sustain accepted technologies. Orisakwe & Agomuo (2011) noted that regular contact with extension agents motivates and exposes the farmers to innovations and gives them information on how to use the technologies. With persuasion and conviction from the extension agents, adoption of agroforestry practices is likely to increase.

The result further shows that out of those that had contact with extension agent, about 51% of them have had contact with extension agent between 1 and 5 times while 26.9%, have had contact with extension agents between 16 and 20 times in the last one year. Furthermore, about 15% of the respondents have had contact with extension agents between 11 and 15 times and 6.9% have had contact with extension agent, between 6 and 10 times in the last one year. The mean number of extension visits was approximately 2 times in a year. This was considered very low. This low number of extension visit could be a reflection of the nature of extension services delivery which is characterized by poor information dissemination as noted by Okoro (2012). Poor extension visits could stem from poor funding of extension service and/or lack of qualified extension personnel. The implication is that farmers may not be properly informed about agroforestry practices and other improved farm practices.

Size of farm land used for agroforestry

Majority of agroforestry farmers (78.1%) had farm size between 0.01 and 1.00 hectares. About 16% had farm size between 1.01 and 2.00 hectares while 6% had farm size between 2.01 and 3.00 hectares. The mean size of farm land use for agroforestry was 0.87 hectares. This implies that agroforestry farmers in the study area are mainly smallholder farmers operating on less than 1ha of farmland. This agrees with Orisakwe & Agumuo (2011) who noted that most agroforestry farmers in Southeastern Nigeria own farm lands that are hardly more than 1.0 hectare. This could be as a result of land tenure system predominant in the area or due to the increasing population. Farm lands in the traditional Igbo society are not communally owned and this leads to fragmentation, leaving farmers with small farm land. This small landholding is not really favorable for agroforestry practices.

Years of experience in agroforestry

Majority (55.0%) of the agroforestry farmers have had 1-20 years experience in agroforestry while 32.5% have also had between 21 and 40 experience in agroforestry. The remaining proportions (12.5%) of the farmers have had above 40 years of experience in agroforestry. The mean year of experience in agroforestry was 15.7 years. This finding is in line with the result obtained by Onuekwusi & Atasi (2011) that the mean farm experience of agroforestry farmers was 15.5, which implies that the farmers have acquired enough experience in agroforestry activities as a result of farming for a long time. Therefore, farmers in the area were well experienced in agroforestry and this has implications for high productivity.

4.2 Types of agroforestry practices by farmers

4.2.1 Types of agroforestry practices

Data in Table 6 show the distribution of respondents according to types of agroforestry they practiced. Majority (96.9%) of respondents practiced home garden. Home garden is a land use systems involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and livestock within the compounds of individual houses. It is a prominent feature of traditional farming systems, especially in region of high population density and decreasing availability of crop and lands. It was observed by the researcher that home gardens in the study area had a characteristic multi-layered structure with bananas and fruit trees (such as mango) forming the upper strata. The middle strata were dominated by annual food crops such as maize, yam together with fruits like guava, orange while the lowest strata had vegetables and root crops such as cocoyam and cassava. The proximity of the fruit trees to the house minimizes theft of fruits, and could also serve as windbreak and provide shade for people and animals apart from serving as source of income. According to Fernandes & Nair (2006) food production is the primary function of most home gardens and much of what is produced is consumed by the household. This indicates that it is practiced for the purpose of satisfying the farmers' basic needs because it has the ability to produce food throughout the year. The implication of this is that with relatively low labor inputs, crops with different production cycles and rhythms are combined to provide a year round supply of food.

Border planting was practiced by 83.1% of the respondents. It is the practice of growing tree along farm boundaries or demarcation within farms. From observation trees such as oil palm, coconut, mango, orange and shrubs such as bitter leaf were used as boundary marker in the study area. Odurukwe (2004) reported in her study that respondents use border planting to

enhance the aesthetic value of their surroundings, demarcate boundaries, control water and wind erosion, and supplement their supply of food, fodder and fuel wood. It is mostly practiced in areas where land is scarce and trees are primarily meant for production of poles and timber. This implies that border planting has the capacity of supplying food, fodder and fuel wood to farmers.

Table 6: Distribution of agroforestry practices used by respondents

Agroforestry practices*	Percentage n=160
Home garden	96.9
Border planting of trees	83.1
Multipurpose trees on cropland	83.1
Live fencing	77.5
Alley cropping	70.0
Improve tree fallow	66.9
Plantation crop combination	58.1
Taungya system	56.9
Silviolericulture	40.6
Silvipasture	38.1

*Multiple response

Multipurpose trees on cropland were practiced by 83.1% of respondents. It is practiced in agriculturally less productive sites or on sites susceptible to high erosion. Thus, these tree gardens served both economic and ecological functions. The researcher observed that the main tree species planted under this system of agroforestry in the study area were citrus, oil palm, coconut, mango, African pear and guava. Annual crops such as maize, cassava, yam, okra and garden egg are planted in combination with the vegetables such as pumpkin, spinach. The use of multipurpose trees and integrated approaches can enhance the profitability of agroforestry. According to Aladi & Olagunju (2014) multipurpose trees on crop land can supply to people's diets in almost all rural areas by adding diversity and flavoring as well as providing essential minerals to human diet. Neupane & Thapa (2001); Assogbadjo, Kakaï, Vodouhê *et al.* (2012) in their separate studies stated that multipurpose trees can be sources of fodder, 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, Dawson & Luedeling, (2012) opined that they can act as windbreak and cannot destroy soil and therefore can be grown with crops. This implies that multipurpose trees on crop land have the capacity to provide a substantial and recognizable contribution to the sustainability of yields, increase of outputs and/or reduction of input and ecological stability of this system. Therefore, it is commonly used by most farmers because they could contribute directly to their food security by providing fruits, nuts and other edible foods.

Live fence is another agroforestry practice used by the farmers. About 78% of them planted live fence in their farm. The choice of trees used as live fence as observed included; bitter leaf, Ogirishi (*Newbouldia laevis*). Kelly (2010) stated that live fence is highly practiced and appreciated in the rural areas where the concrete fencing is not affordable. Therefore it provides permanent boundary demarcation which gives security to the homestead. The choice of this practice could therefore be because they are long lasting and can perform several functions on the farm such as; control of soil erosion, control of animal movement, keeping off animal from the farm, for firewood, beautification and security in the compound.

Others agroforestry practices by the respondents include: alley cropping (70%), improved tree fallow (66.9%), and taungya system (56.9%). Alley cropping involves growing crops (e.g., grains, forages, and vegetables) between trees planted in rows. From observation by the researcher, crops such as yam, maize, cassava, cocoyam and pumpkin are usually intercropped with trees in the farm land such as *Leucaena leucocephala* and *Gliricidia sepium*. Ajekigbe, Odewo, Adebago *et al.* (2012) noted that it is usually practiced in areas with high population pressure on land. It is an important conservation farming practice for small holders and resource-poor farmers. Alley cropping is commonly used by farmers because it improves soil structure, provides good soil erosion control and reduces the need for chemical fertilizers. Fanish & Priya

(2013) opined that alley cropping has been widely used on the field for producing mulch material for moisture conservation and nutrient recycling. Integrating trees and shrubs in alley cropping with other enterprises on a farm can create additional sources of income, spread farm labor throughout the year, and increase the productivity of those other enterprises while protecting soil, water, and wildlife. This implies that the goal of sustainable food production and environmental conservation as well as income could be achieved with the use of alley cropping.

Improved tree fallow which is a practice of leaving trees or shrubs in natural fallows in order to improve soil fertility was equally one of the common agroforestry practices in the state. In the study area, with introduction of improved fallow the length of fallow had been shortened to two years as against three to five years. Trees such as *Leucaena leucocephala*, *Gliricidia sepium*, *Acioa barteri* were the major trees used in this practice from researcher's observation. They play an important role in arresting and reversing land degradation via their ability to provide permanent cover, improve organic carbon content improve soil structure, increase infiltration, enhance fertility and biological activity. According to Raintree (2011) the ideal multipurpose trees have high nitrogen fixing, capacity of fast growth, ability to restore fertility and suppress weed in a shorter time than natural bush fallow, ability to control soil erosion, ease of establishment, ease of eradication, tolerance to drought etc. This implies that this type of agroforestry practice helps land to regain its fertility within a shorter period than natural fallows and therefore contribute to the rural livelihoods and ecosystem functioning of land use systems.

Taungya system which is the cultivation of annual crops among young trees was among the agroforestry practice used by most agroforestry farmers. The system has been instrumental in preserving forests and agricultural land. In the study area, agricultural crops such as maize, cassava, cocoyam, vegetables are planted to make the best use of the improved soil fertility built

up by the woody plant component such as cashew, Melina in Tanugya system. Enabor, Okojie, and Verinumbe (n.d) in their studies noted the positive role of the taungya system in augmenting food supplies and fostering the socioeconomic improvement of rural communities in tropical countries. This implies that rural household food security can be enhanced and the rate of hunger and poverty among the rural dwellers can be reduced if not eliminated through this practice.

However, silvipasture was only practiced by few respondents (38.1%). It was not a common agroforestry practice in the area as compared to other practices because the people practice free range grazing and therefore does not plant feeds for their livestock. According to UMCA 2010; and Franzel, Wambugu and Tuwei (2003) the only major benefits of the practice are source of feeds for livestock and controlling soil erosion. This may not be the major interest of the rural farmers. Nevertheless, integrating livestock production in the farming system could promote farm product diversification and improves food security.

4.2.2 Changes in number of farmers involved in agroforestry practices

Figure 3 shows whether there was a decrease or increase in the rate the respondents were involved in agroforestry practices in the last five years. Greater proportion (47.5%) indicated that the practice of agroforestry is increasing. This implies that there is an increase in the involvement of farmers in agroforestry practice in the last five years. The reason could be as a result of increasing awareness on the benefits of agroforestry practices due to training and exposure since most of the respondents are literate.

However, about 37.5% of respondents asserted that the rate of practicing agroforestry was decreasing in the last five years. This could be attributed to poor extension visits as observed in the earlier finding on extension visitation. With poor extension visits information on new practices such as agroforestry practices may not be disseminated to farmers. The remaining 15%

reported no change in the rate of involvement in agroforestry practices in the last five years. This shows that their involvement in agroforestry practice has neither improved nor declined in the last five years. There are so many reasons that could result from this. The farmers may be satisfied with the one they were involved or could be as a result of lack of information on other agroforestry practices.

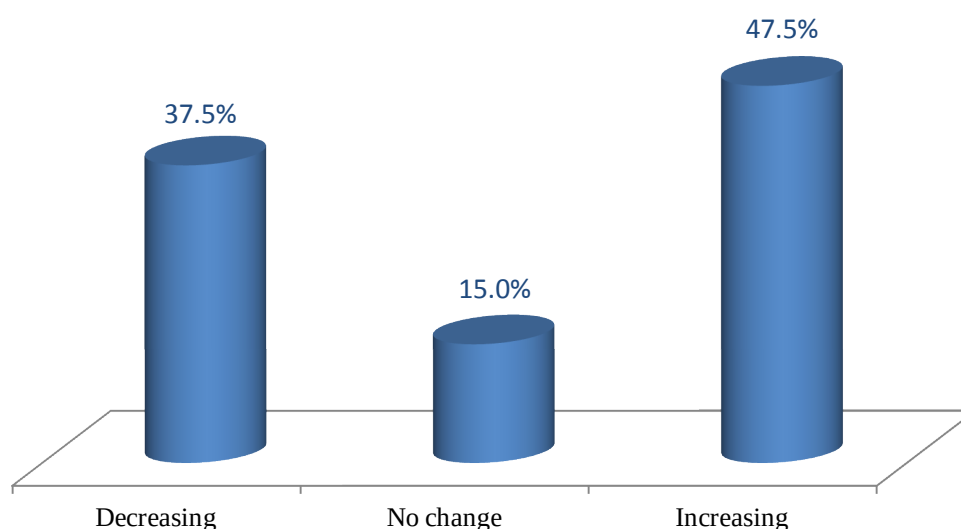


Figure 3: Changes in agroforestry practice from 2009- 2013

4.2.3 Reasons for changes/ no changes in agroforestry practices

Figure 4 show the reasons for changes in agroforestry practices. Greater proportion indicated that training (27.5%) was the major reason why there was an improvement number of farmers involved in the practice of agroforestry in the last five years. This implies that farmers may have received training on agroforestry practices from extension agents, friends, NGOs. In other words, since majority of the agroforestry farmers are young and literate, they will be more receptive to new practices like agroforestry and have greater ability to understand complex issues.

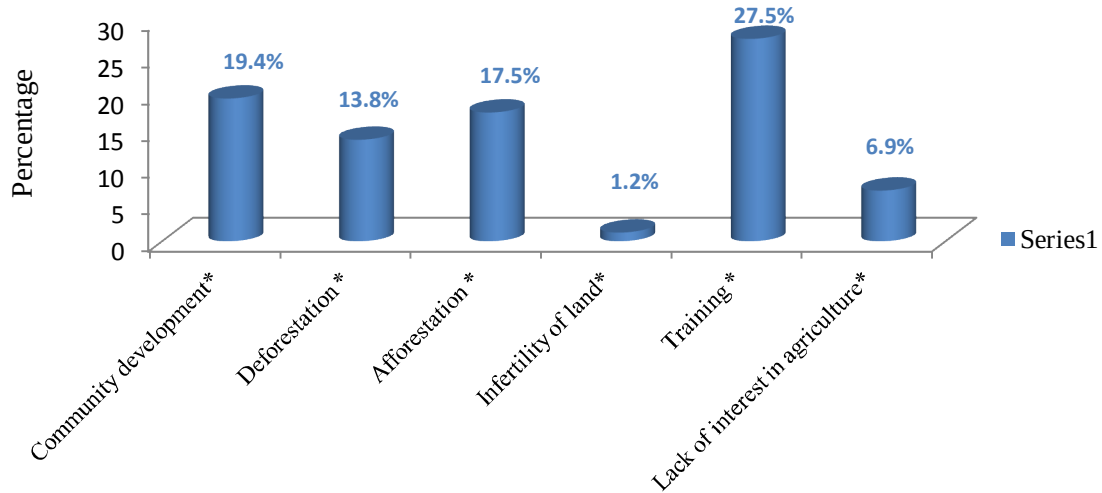


Figure 4: Reasons for changes/no changes in agroforestry practices

Community development (19.4%) was considered as one of the reasons why there was a decrease in agroforestry practices. Community development involves conversion of agricultural land to non agricultural uses such as provision of social amenities like markets, health centre, church, school, electricity, road, pipe borne water etc. According to Bifarin *et al.* (2013) rapidly expanding population and consequent pressure on land for socio-economic, agricultural and industrial development as well as increasing human interference on the forests and the environment have resulted in deforestation. Deforestation can lead to decline in the productive capacity of soils, accelerated erosion, destruction of wildlife habitats and loss of plant genetic diversity, climate change, landslides, soil degradation as noted by Akpabio *et al.* (2008). It could equally reduce the size of land under cultivation resulting in low agricultural productivity. The reason for this could be that the respondents are not well informed about the implications of deforestation and other unsustainable land uses.

Other reasons include; afforestation (17.5%), deforestation (13.8%). About 6.9% of farmers attributed no change in agroforestry practices to lack of interest in agriculture and infertility of land (1.2%).

4.2.4 Trees and shrubs available in farm

Data in Table 7 show the tree/shrubs species planted and/ or protected by the respondents on farmlands. The trees planted by majority of the farmers included; banana (*Musa sapientum*) (84.4%), orange (*Citrus species*) (83.8%), plantain (*Musa paradisiaca*) (78.1%), guava (*Psidium guajava*) (71.2%), coconut (*Cocos nucifera*) (68.8%), bitter leaf (*Vernonia amygdalina*) (68.8%), African basil (*Ocimum gratissimum*) (65.0%), mango (*Mangifera indica*) (63.1%), oil palm (*Elaeis guineensis*) (62.5%), utazi (*Gongronema latifolium*) (61.2%) and African pear (*Dacryodes edulis*) (53.8%).

Out of these trees planted by the farmers, seven of the species belong to the fruits category (Mango, oranges, guava, coconut, plantain, banana and African pear) while four of them belong to the oil and shrub (oil palm, bitter leaf, utazi, African basil). The predominance of citrus, mango, cashew, guava and other fruit trees in nearly all homestead and farmland throughout the study area indicated a preference for fruit trees. They are mostly planted because of their multipurpose use. The survey carried out by Sale & Olujobi (2014) revealed that farmers generally prefer to grow fruit trees because they can provide income, timber, fuel and fodder for their live stocks. This implies that food, fuel wood as well as income generation is the major reasons for the choice of trees in agroforestry practice.

Some protected trees by the respondents belonged to fire wood, staking and construction materials category such as oil bean (*Pentaclethra macrophylla*) (42.5%), icheku (*Dialium guineense*) (42.5%), uturukpa (*Pterocarpus santalinoides*) (40.0%). These trees are protected in the farm because of its economic importance. The study carried out by Alam and Masum (2005) revealed that fruit trees dominated over timber trees planted in the farm land. The farmers concentrate on fruit species because of their subsistence and cash need. This shows that the need

to ensure regular sources of food and fuel wood is the major consideration in the choice of tree/shrub species for planting and/or protection on homestead and farm lands. Besides the consumption of fruits, it also generates income to the farmers.

Table 7: Distribution of available trees and shrubs in the respondents' farm

Trees and shrubs	Not available	Available (Planted)	Available (protected)
	Percentage	Percentage	Percentage
Banana (<i>Musa sapientum</i>)	8.1	84.4	7.5
Orange (<i>Citrus species</i>)	8.8	83.8	7.5
Plantain (<i>Musa paradisiaca</i>)	6.9	78.1	15.0
Guava (<i>Psidium guajava</i>)	17.5	71.2	11.2
Coconut (<i>Cocos nucifera</i>)	23.8	68.8	7.5
Bitter leaf (<i>Vernonia amygdalina</i>)	12.5	68.8	18.8
African basil (<i>Ocimum gratissimum</i>)	13.1	65.0	21.9
Mango (<i>Mangifera indica</i>)	16.2	63.1	20.6
Oil palm (<i>Elaeis guineensis</i>)	3.1	62.5	34.4
Utazi (<i>Gongronema latifolium</i>)	14.4	61.2	24.4
African pear (<i>Dacryodes edulis</i>)	20.0	53.8	26.2
Kola nut (<i>Cola spp</i>)	25.0	48.8	26.2
Raffia palm (<i>Raphia spp</i>)	25.0	38.1	36.9
Bitter kola (<i>Garcinia kola</i>)	26.9	35.6	37.5
Moringa (<i>Moringa oleifera</i>)	33.8	34.4	31.9
Bush mango (<i>Irvingia gabonensis</i>)	33.1	31.9	35.0
African star apple (<i>Chrysophyllum albidum</i>)	35.6	31.2	33.1
African walnut Ukpa (<i>Plukenetia conophora</i>)	46.9	30.6	22.5
<i>Leucaena leucocephala</i>	20.0	30.0	50.0
Uturukpa (<i>Pterocarpus santalinoides</i>)	32.5	27.5	40.0
Oil bean tree (<i>Pentaclethra macrophylla</i>)	32.5	25.0	42.5
Cashew (<i>Anacardium occidentale</i>)	55.6	24.4	20.0
Mmimi (<i>Dennettia tripetala</i>)	52.5	24.4	23.1
African border tree (<i>Newbouldia laevis</i>)	30.0	20.5	45.5
Neem tree (<i>Azadirachta indica</i>)	53.8	18.8	27.5
African nut meg (<i>Monodora myristica</i>)	56.2	17.5	26.2
Mushroom (<i>Agaricus spp</i>)	53.8	15.0	31.2
Bamboo (<i>Oxytenanthera abyssinica</i>)	53.8	13.8	32.5
Ichikere or Ijikara (<i>Spondias mombin</i>)	53.1	13.8	33.1
Icheku (<i>Dialium guineense</i>)	43.8	13.8	42.5
Melina (<i>Gmelina Arborea</i>)	73.8	12.5	13.8
Iroko (<i>Chlorophora excelsa</i>)	78.8	10.6	10.6
Uda (<i>Xylopia aethiopica</i>)	58.8	10.6	30.6
Rubber tree (<i>Hevea brasiliensis</i>)	71.9	10.0	18.1
Gliricidia (<i>Gliricidia sepium</i>)	73.1	9.4	17.5
Achi (<i>Brachystegia sp</i>)	74.4	8.8	16.9
Ahaba (<i>Acioa barterii</i>)	58.8	7.5	33.8
Obeche (<i>Triplochiton scleroxylon</i>)	83.8	4.4	11.9
Mahogany (<i>Swietenia macrophylla</i>)	86.2	2.5	11.2

However, few proportion of the respondents either planted and/or protected trees of high timber and latex quality such as; Mahogany (*Swietenia macrophylla*), Obeche (*Triplochiton scleroxylon*), Iroko (*Chlorophora excelsa*), Melina (*Gmelina arborea*) and Rubber tree (*Hevea brasiliensis*) in their homestead and farmstead. This could be due to the time taken for timber trees to mature. Farmers prefer those species, which give quick and regular cash and have a long returns, required little space, and would not cast heavy shade that might cause conflict with neighbors than those that takes longer period to mature.

4.2.5 Trees planted/protected in the homestead and farmstead from 2009-2013

Entries in Table 8 show the average number of trees planted/protected in the homestead and farmstead from the year 2009 to 2013. In year 2009, an average of 3 trees were planted, there was a reduction along the years till year 2013 where an average of 2 trees were planted in the homestead. The result further shows that there was a significant difference ($F=3.295$, $P\leq 0.05$) in the number of trees planted in homestead in the five years (2009-2013). This implies that the average numbers of trees planted in homestead vary across the year. This variation from further analysis started from 2010 after which there was no significant difference. This could be as a result of limited land within the compound as a result of land fragmentation resulting from land tenure system which is a common practice in the area. It could equally imply that more land is being converted to non agricultural activities such as building of family houses.

Table 8: Average number of trees planted/protected in the homestead and farmstead from 2009 to 2013

	2009	2010	2011	2012	2013	F- value
Mean of trees planted in homestead	3.08 ^a	2.48 ^b	2.11 ^b	2.36 ^b	2.21 ^b	3.295*
Mean of trees protected in homestead	3.04 ^a	2.20 ^b	1.98 ^b	1.94 ^b	2.12 ^b	4.300*
Mean of trees planted in farmstead	5.95 ^a	4.46 ^b	3.22 ^{bc}	3.42 ^{bc}	3.11 ^c	7.261*
Mean of trees protected in farmstead	5.30 ^a	3.68 ^b	3.62 ^b	2.39 ^{bc}	2.13 ^c	8.176*

* $P\leq 0.05$, means with the same alphabet across the rows show no significant difference across the years

The table further shows the average number of trees protected from 2009-2013 in the homestead. There was a decrease in the average number of trees protected in the homestead from 3.08 in 2009 to 2.21 in 2013 trees. The test of difference in the number of trees protected in the homestead in the five years showed that there was a significant difference ($F=4.300$, $P\leq 0.05$). This implies that, the number of trees protected over the years were not the same. Further analysis indicated that the difference started after 2009. From 2010 there was no significant difference in the mean of trees protected in the homestead indicating that they do not vary significantly. The small number of trees protected by farmers may be an evident that majority of them though aware of the benefits of agroforestry and are trained are not yet convinced about the practice or how it works. It could also be that they do not have sufficient resources and knowledge for its practice. This could be the consequence of low extension visits discussed in Table 4 or lack of interest in agroforestry by the government. Increased extension visits could help them to understand better the benefits of incorporating trees into their farming and thus encourage them to plant more trees.

The result further indicate that more trees were planted in the farmstead ($M=5.95$) in 2009. However, this declined over the years to an average of 3 trees in 2013. The result further showed that there was a significant difference ($F=7.261$, $P\leq 0.05$) in the trees planted in the farmstead from the year 2009 to 2013. Further analysis in the mean number of trees planted in farmstead from 2009- 2013 showed that the significant difference was in 2009 indicating that the mean number of trees started declining after that. However, mean number of trees planted from 2010- 2012 did not differ significantly which means that they are statistically the same. Likewise the mean of trees planted in 2013 differ significantly from the number of trees in 2010 but did not differ significantly from 2011-2012. This could imply that as the year progresses, people

started losing interest in tree planting which might be as a result of long period to reap the benefit from tree and land scarcity due to increasing population.

The table further shows the number of trees protected in the farmstead from the year 2009 to 2013. More trees were protected in 2009 ($M= 5.30$) while least number of trees were protected in 2013 ($M= 2.13$) which is significantly different ($F=8.176$, $P\leq 0.05$). The result of further analysis indicated that the difference started after 2009. Conversely, the mean number of trees protected from 2010-2012 were statistically the same. On the other hand, mean number of trees protected in 2013 was significantly different from those in 2010 and 2011 but statistically the same with mean of trees protected in 2012. This implies that the major decline in mean number of trees protected in farmstead was in 2013.

It can be deduced from the result that more trees were planted/ protected in the farmstead than in the homestead as indicated in the table above. There was a general decline in the number of trees planted/ protected both in the homestead and farmstead in the last five years. This could be attributed to land scarcity as a result of population increase, lack of interest due to inability to wait for long term benefits accruing from tree planting, poor extension visits, community development and lack of interest by government.

4.2.6 Arable crops combined with tree in agroforestry farm

Results in Table 9 indicated that yam (98.1%), maize (95.0%), cassava (90.6%) and fruited pumpkin (90.0%) were the most common arable crops the farmers usually combined in their agroforestry farms. These are major staple food available in most southeast Nigeria. Yam for example is considered as the king of all crops in the area because of the position it occupies in peoples diet. It is a good source of carbohydrate, vitamin B6 and low fat and a source of income to the farmers. Umeh (2011) noted in her study of distribution of agroforestry species in

southeast Nigeria that yam was the most common arable crop component of agroforestry practice.

Maize is a source of carbohydrate and protein. Obasi, Henri-Ukoha, Ukwuihe & Chidiebere-Mark (2013) in their study included maize as one of the major crops cultivated in Imo state. It serves as feed for animals. Its preference could be due to the benefits obtained from it such as food and fodder for livestock.

Cassava is important, not just as a food crop but even more so as a major source of income for producing households. It is an important staple crop particularly in the more tropical countries as the crop has a high potential of feeding rapidly increasing population and is generally more affordable when compared to other staples. According to Nweke, Ugwu, Dixon *et al.* (1997) cassava is considered one of the important staples food of rural and urban households in southern eastern Nigeria. It is a major source of cheap calories which can be processed and consumed in various forms and equally be used as ethanol for fuel, energy in animal feeds and starch for industry.

Traditional vegetables such as pumpkin offer variety and have been noted to contribute to broadening the food base of African people. According to Enabulele & Ilavbarhe (2001) it is an important component of the traditional farming systems and daily diet of Nigerians. Pumpkin is very important in the diet of children, men, women, nursing mothers as well as livestock due to its high nutritive value.

Cocoyam is also one of the major crop components of agroforestry practice. It is an important staple in Nigeria and ranks third in importance after cassava and yam among the root and tuber crops cultivated and consumed. Cocoyam is preferred to most other root and tuber crops because of its availability all the year round and plays a significant role in bridging the

food gap between the time of plenty and scarcity, with all the vegetative parts used as food in one form or the other. Oguniyi (2008) noted that it is a major source of food and income especially in the rural areas, resistant to drought, pest and diseases and tolerant to a variety of climatic and soil conditions.

Besides, the ability of these arable crops to provide food, income and fodder to both man and livestock, they can thrive well when combined with trees. According to Adedire (1992) cultivation of food crops such as maize, yam, cassava, and other crop between rows of fast growing leguminous tree or shrubs increases yield. In addition, trees can provide materials for supporting crops (e.g. yam and pumpkin). This means that these tuber crops and leafy vegetable are carefully selected for integration with trees in order to optimize the production and positive effects of agroforestry and to minimize negative competitive effects.

Smaller proportion cultivated rice (23.8%), bambara nut (21.2%), groundnut (25.6%), okra (6.2%), garden egg (6.9%), three leaf yam (9.4%). This indicated that these crops are not common to agroforestry farmers in the study area. The result implies that tuber and vegetable crops formed components of agroforestry practices in the study while cereals were less associated with the practice in the area.

Table 9: Distribution of arable crops combined with trees by respondents

Arable crops*	Percentage (n=160)
Yam	98.1
Maize	95.0
Cassava	90.6
Pumpkin	90.0
Cocoyam	83.1
Water leaf	61.9
Cowpea	54.4
Spinach	40.0
Groundnut	25.6
Rice	23.8
Pigeon pea	21.9
Bambara nut	21.2
Three leaf yam (Onah)	9.4
Garden egg	6.9
Okra	6.2

* Multiple responses

4.2.7 Reasons for combining crops with trees

Result in Table 10 shows that the major reasons why farmers combined crops with tree were to serves as additional food (44.4%) and also to improve soil fertility (25.0%). Combining trees such as multipurpose trees with crops could contribute directly to food security by providing fruits, nuts, and other edible foods. These contribute to people's diets by adding diversity and flavouring as well as providing essential minerals to the human diet. Research conducted by Boatang (2008) found that a greater proportion of households (97%) had improved food security after adopting the practice of combining crops with trees. This was partly due to the fact that most farmers used money accruing from the sales of tree crops/products in purchasing food items to supplement food in the household. Combining trees with crops can also help to improve soil fertility. Since land is scarce, farmers need to maximize the available land and they believe it could be achieved by combining trees with crops.

However, smaller proportion practiced agroforestry as a source of income (12.5%). This could be as result of small land size which makes it difficult for the farmers to produce on a large

scale. This implies that the farmers were mostly subsistent farmers who produce only for themselves and their family with little or nothing to sell. Other reasons for combining trees with crops include staking material (11.2%), reduction of solar intensity (6.2%), land scarcity (6.2%), erosion control (4.4%), wind break (2.5%) and weed control (2.5%).

Table 10: Respondents' reasons for combining crops with trees

Reasons*	Percentage (n= 160)
Food	44.4
Improve soil fertility	25.0
Source of income	12.5
Staking material	11.2
Reduction of solar intensity	6.2
Land scarcity	6.2
Erosion control	4.4
Wind break	2.5
Weed control	2.5

*multiple response

4.2.8 Management strategies for maintaining trees

Entries in Table 11 show the management strategies used by farmers in maintaining trees in their agroforestry farm. Majority of agroforestry farmers (87.5%) used pruning to maintain trees in their farm. Pruning which is the removal of tree branches so that they will not shade the crops, could help to improve the value of fruits, shape, stability and life span of a tree. Juo, Caldwell, & Kang (1994) opined that leaves from pruned branches could be used as green manure for enriching the soil, as fodder during the dry season and as mulching material. The woody portion of the pruning can also be used as fuel wood or stakes for yams. The addition of high-quality tree prunings (i.e. high in Nitrogen but which decay rapidly) leads to large increases in crop yields. This implies that with proper management strategies, trees can supply useful nutrients to the soil leading to increased food supply.

Table 11: Management strategies used by respondents in maintaining trees in their agroforestry farm

Management strategies*	Percentage n= 160
Pruning	87.5
Pollarding	74.4
Weeding	68.1
Manure application	63.8
Coppicing	59.4
Watering	26.9
Mulching	5.0
Use of gamalin	1.9

*multiple response

Other management strategies used by farmers included; pollarding (74.4%), weeding (68.1%), manure application (63.8%) and coppicing (59.4%). Pollarding involves cutting off the crown of the tree and leaving it to send out new branches from the top of the remaining stem. The advantage of this is that the new shoots are high and therefore more apt to be protected from animal and fire damage. The preference of pollarding by most agroforestry farmers could be because it allows for the harvesting of firewood or fodder from trees without killing them. This is in line with the findings of Packham, Harding, Hilton & Stuttart (1992); Thomas & Packham (2007) that pollarding or coppicing were used for firewood and fodder production. Equally Sebek, Altman, Platek, Cizek (2013) opined that stands of pollarded trees usually host rich assemblages of animal species. This implies that agroforestry practice has the ability to reduce pressure on forest by supplying fuel wood and fodder required by rural farmers and a source of biodiversity.

Weeding, which is removal of weeds, is important in tree management especially for young seedling because it minimizes the competition between the tree seedling and weeds. On the other hand manure application is necessary as it supplies the trees especially while still in the nursery or when newly established in the farm with nutrients that will enable them to survive.

Coppicing involves cutting the tree down to its stump and allowing it to regrow. It normally sends up a number of shoots instead of the original single stem. The reason for using this method could be because it enhances the quality of fruit obtained and also the ability to harvest fruit with ease since the practice reduces the height of the tree. According to Thomas & Packham (2007) the practice encourages abundant harvests of straight poles for fencing, firewood, furniture, charcoal, rapid re-growth from established (and mature) root systems, with repeat harvests along regular cycles. No labor is needed for replanting. The use of coppicing enables fuel wood or timber needed by households to be obtained on a sustainable basis from trees growing on agricultural land. This has important implications for the design of programmes to maintain increased fuel wood supplies.

However, smaller proportions of farmers use watering (26.9%), mulching (5.0%), and use of gamalin (1.9%) as a strategy for maintaining their trees.

4.3 Benefits of agroforestry practices

Data in Table 12 show that major benefits of agroforestry practices as expressed by the farmers were improving soil fertility (98.8%), protecting soil from damaging impact of rain (96.2%) and maintaining soil organic matter (96.2%). Agroforestry practices have potential to improve soil fertility. This implies that the use of agroforestry practices could help the soil to regain its fertility without the use of inorganic fertilizer. According to World Agroforestry Centre (2013) Nitrogen-fixing trees increase soil fertility and by incorporating more biomass into soils, enables more efficient use of inorganic fertilizers.

Incorporating trees with crops helps in protecting soil from damaging impact of rain. Trees are able to prevent wind and water erosion by acting as wind break and by intercepting the raindrop impact on the soil. According to Akpan (2000) some forest tree crown cover reduces the

intensity of rain water on the soil which invariably reduces the impact of washing away of the organic matter in the soil. Therefore, farmers practice agroforestry because it helps to minimize the impact of rain on the crops, prevent erosion and improve crop yield.

Table 12: Perceived benefits of agroforestry practices

Perceived benefits	Percentage (n= 160)
Increase soil fertility	98.8*
Protect soil from damaging impact of rain	96.2*
Maintaining soil organic matter	96.2*
Source of many herbal remedies and traditional medicines	95.6*
Providing fuel-wood and charcoal for cooking	95.0*
Providing income to rural farmers	94.4*
Providing fibre for making ropes, mats, baskets and musical instrument strings	94.4*
Providing fodder for livestock	94.4*
Lowering of surface soil temperature	92.5*
Providing food to rural farmers	92.5*
Providing shade for farm workers and animal in harsh weather	89.4*
Providing raw materials for industry	85.6*
Conserving soil by providing moisture to soil for plant growth	85.6*
Controlling soil erosion	85.6*
Reducing weeds	84.4*
Biodiversity conservation	81.9*
Means of adaptation to climate change	76.9*
Enhancing water use efficiency of soil	76.2*
Reducing insect pests and associated diseases	34.4
Improves soil structure	1.9
Reducing impact of wind	1.2
Increases soil aeration	1.2
Benefits*	

Furthermore, maintenance of soil organic matter was equally one of the major benefits of agroforestry practices as perceived by farmers. Soil organic matter could also be obtained from dead leaves and branches. Bertin, Yang & Weston (2003) noted that trees can add organic matter to the soil system in various manners, such as litter fall or as root exudates in the rhizosphere. These additions are the chief substrate for a vast range of organisms involved in soil biological

activity and interactions, with important effects on soil nutrients and fertility. This implies that soil organic matter management is a key factor in achieving successful long term sustainability.

The farmers also asserted that practicing agroforestry served as a source of herbal remedies and traditional medicines (95.6%), provide fuel-wood and charcoal for cooking (95.0%) and provide income (94.4%). Trees and shrubs were important source of many herbal remedies and traditional medicines. According to Garrity (2004) more than 80% of the rural communities in sub-Saharan Africa depend on medicinal plants for most of their health needs and also for income generation. Syampungani, Chirwa, Akinnifesi *et al.* (2009) further stated that local communities have used leaves for treating several ailments, such as constipation, toothache, cold and cough, fever, pains, measles and Malaria. A study carried out by Kalaba, Chirwa, Prozesky *et al.* (2009) has shown that almost two-thirds of the rural households use some indigenous fruit trees for medicinal purposes. This explains why farmers view it as a benefit derived from use of agroforestry practices because they obtain herbs for treatment of different ailment which they perceive as better option to orthodox medicine.

Providing fuel wood was also one of the major benefits of agroforestry practices. In rural areas, 70-80% energy comes through biomass from trees and shrubs. According to Syampungani *et al.* (2009) fuel wood accounts for high percentage of the total household energy requirements. This implies that agroforestry practices such as home garden have the potential of providing fuel wood to the farmers.

Additionally, agroforestry practices have the potential to provide income to farmers. Trees planted and/or protected in the homestead and farmstead tree products are among the source of household income to farmers. Several studies indicated that farmers can increase their incomes by utilizing and marketing tree products from forests and horticultural tree crops grown

on-farm (Akinnifesi, Kwesiga, Mhango, *et al.*, 2006; Mithofer, 2005; Schreckenberg, Awono, Degrande, *et al.*, 2006). Rao, Verchot & Laarman (2007) in their research have demonstrated that agroforestry practices can generate substantial environmental benefits while meeting the immediate requirements of food and income, when implemented with carefully selected species that meet end user requirements. The income generated could serve as a source of relief in times of seasonal and emergency food and cash shortages.

Other benefits include: providing fiber for making ropes, mats, baskets and musical instrument strings (94.4%), providing fodder for livestock (94.4%), controlling soil erosion (85.6%), biodiversity conservation (81.9%) among others. Farmers rely on trees to provide fiber to make ropes, mats, baskets, coverings, woven goods and even musical instrument strings. Aju (2014) noted that materials for making baskets used in carrying and marketing produce, racks for crop drying and storage (e.g., yam barns and maize cribs), pestle and mortars used for pounding the staple food, and sieves for crop processing can be obtained through agroforestry practices. He further stated that in the Igbo speaking areas of south eastern Nigeria for example hoe, axe, machete and digger handles, are made of materials taken from *Pentaclethra macrophylla*. This implies that farmers can obtain material for farm implements and other uses from trees planted around their home and farms.

Provision of fodder was also a major contribution of agroforestry practice. Successful agroforestry practices are beneficial to farmers in that it could provide a variety of products such as fodder, medicinal herbs and food for livestock and man respectively. Aju (2014) also noted that fodder trees contribute in several ways to the overall food security of households. They contribute in maintaining drought animals and producing manure for organic fertilizer thereby supporting agricultural production. Fodder trees and shrubs have an important advantage over

fodder grasses and herbaceous legumes; they can tap deep, underground moisture reserves when the upper soil layers have dried out. This means that trees can continue to produce fodder even when grasses and annual crops have ceased to grow, conserve the soil and supply fuel wood. In other words, it has the ability to produce fodder all year round.

Control of soil erosion was another benefit obtained from agroforestry practices. Soil erosion whether by wind or water leads to the loss of top soil where soil nutrients are concentrated thus leading to the disruption of agricultural production and degradation of the soil. However, this could be controlled through the practice of incorporating trees in the farmland. According to Aju (2014) trees conserve the soil by protecting it from rain and wind, thereby reducing soil erosion to a minimum. The leaves drip water on the earth, giving it time to seep underground, bringing nourishment to animal and plant life beneath the tree. This implies that soil erosion could be controlled through agroforestry practices. It will invariably lead to increased food production and environmental sustainability.

Biodiversity conservation was also one of the benefits obtained from agroforestry practices. Agroforestry with components like trees, agricultural crops, grasses, livestock etc. provides all kinds of life support. Akinnifesi, *et al.* (2008) noted that the use of agroforestry technologies mitigate biodiversity loss and provide opportunities for improving diversification and range of livelihood options for rural households. According to Griffith (2000), trees in agroforestry practices act as a refuge to biodiversity after catastrophic events such as fire. Shibu (2009) in his study observed that agroforestry practices harbored bird assemblages that were as abundant, species-rich, and diverse as forests. Trees in agroforestry practices provide habitat for wildlife and other desirable organisms. This means that agroforestry can provide shade and

habitats for mammals, birds, insects and other life forms as well as improve the livelihood of the rural people.

However, reducing insect pests and associated diseases (34.4%), improves soil structure (1.9%), reducing impact of wind (1.2%) and increases soil aeration (1.2%) were not perceived as major benefits of agroforestry by majority of the respondents.

4.4 Constraints to agroforestry practices

The major constraints to agroforestry practices as opined by the respondents in Table 13 were problem of land tenure system (M=2.11) and lack of knowledge and skill in agroforestry practices by farmers (M= 1.94). Land tenure system was viewed as a major constraint by respondents. Constraints associated with land tenure could be a problem in agroforestry practices especially in areas where farmers cultivate communal land under traditional tenure arrangements that do not allow them to claim ownership or exclusive use rights to the trees on their fields. Food and Agriculture Organization (FAO) (2013) document on land tenure and tree rights stated that rights to trees may be separate from rights to land and both land and tree tenure insecurity may discourage people from introducing or continuing agroforestry practices. Akinnifesi, Sileshi, Ajayi *et al.* (2008) noted that tree based agroforestry practices are more negatively affected by land tenure arrangements. Therefore, farmers with insecure land rights are unable or unwilling to plant trees. This could discourage farmers from planting new trees since they may not be the ones to harvest them after establishing them in the farm.

Lack of knowledge and skill in agroforestry practices, was another major factor that constraint agroforestry farmers from using agroforestry. Insufficient knowledge and skills in different agroforestry practices can affect the use of the practice by agroforestry farmers. Agroforestry farmers often lack skills to establish tree and shrub nurseries, pre-treat the seeds

and carry out tree pruning activities. According to Obidike (2011), when rural farmers lack access to knowledge and information that would help them achieve maximum agricultural yield, they not only grope in the dark but are also driven to the urban centres in search of formal employment, as the only option for survival.

Table 13: Distribution of respondents according to constraints to agroforestry practices

Constraints to agroforestry practices	Mean	S.D
Land tenure system	2.11*	0.851
Lack of knowledge and skill by farmers	1.94*	1.023
Low levels of awareness of agroforestry among farmers	1.85*	1.017
Lack of interest by farmers	1.78*	1.044
Inadequate knowledge of agroforestry by extension agents	1.76*	1.045
Long gestation period to reap the benefit of agroforestry practice	1.75*	0.869
Lack of labor	1.69*	0.966
High cost of establishment	1.68*	0.974
Cultural and social resistance	1.52*	1.058
Lack of planting materials (tree seed and seedlings)	1.47	0.924
Damage to food crop during tree harvesting	1.36	0.894
Limited local market for tree products	1.33	0.969
High mortality of tree seedlings	1.32	1.107
High incidence of bush fire	1.29	1.073
Shading of crops by tree	1.10	1.128
Theft	0.76	1.031

*Constraints

Others constraints included: low levels of awareness among farmers (M=1.85), inadequate knowledge of agroforestry practices by extension agents (M=1.76), long gestation period to reap the benefits of agroforestry practice (M=1.75%) among others. Lack of awareness was one of the major constraints of agroforestry practices. Agroforestry practices may not be widely recognized or understood by farmers. Ajayi, Akinnifesi, Mullila-Mitti *et al.* (2006) noted that the opportunity of agroforestry practices to provide some medium and long term benefits to individuals and the public simultaneously is not as yet well communicated to many stakeholders. This implies that lack of awareness and lack of interest could be one of the reasons for farmers' inability to assess the profitability of agroforestry practices in relation to other alternatives. Farmers therefore, need more information and training on agroforestry relative to other

agricultural activities, which limits the spread of some practices, in order to increase their awareness and interest in agroforestry practices.

Inadequate knowledge of agroforestry practices by extension agents is another problem constraining the practice of agroforestry practice. Studies from several countries in Africa including Nigeria have shown that sustainable land management practices such as agroforestry are not sufficiently known by extension agents and much less likely to be disseminated to farmers (e.g. in Zimbabwe - Chitakira & Torquebiau, 2010; in Nigeria -Banful, Nkonya, & Oboh, 2010). This implies that poor and inadequate extension services that can handle complex problems such as agroforestry as a result of insufficient knowledge could limit the possibility of scaling up innovations in agroforestry for improved land use systems.

Long gestation period to reap the benefit of agroforestry practice was a constraint in agroforestry practices. The inability to wait for longer years to see the benefits could discourage farmers from practice of agroforestry. Snapp, Mafongoya, & Waddington (1998) noted that the relative advantage of agroforestry practices is considerably reduced when considered in terms of the slow growth rate of most tree crops and the considerably lengthened time span over which benefits are realized. Farmers are more concerned with short term gains and are not interested in non measureable advantages like prevention of erosion, soil conservation etc.

However, shading of crops by tree (M=1.10), theft (M= 0.76), high mortality of tree seedlings (M= 1.32), high incidence of bush fire (M= 1.29), damage to food crop during tree harvesting (M= 1.36), limited local market for tree products (M= 1.33), and lack of planting materials (tree seed and seedlings) (M=1.47) were not considered to be major constraints to agroforestry practices.

4.4.1 Constraints to agroforestry practices

Data were further subjected to exploratory factor analysis in order to group the constraints variables for policy implications. Table 14 shows the result of the rotated components matrix showing the extracted factors. Three constraining factors were extracted based on the response of the farmers. Factors 1, 2, and 3 were named knowledge constraint, tree growth constraint and market constraint.

Factors that loaded under knowledge constraints were; land tenure system (0.529), inadequate knowledge of agroforestry by extension agents (0.682), low levels of awareness of agroforestry among farmers (0.753), lack of labor (0.578), lack of interest by farmers (0.587), and lack of knowledge and skill in agroforestry practice (0.583). Lack of full time, dedicated extension staff for agroforestry and other emerging industries could be viewed as a strong challenge to implementing new practices. According to Lassoie, Teel & Davies (1991) the advancement of agroforestry is constrained by the organizational structure of extension services and agencies. These organizations are oriented towards transferring technical information through extension staff that are highly trained in certain disciplines, but lack the skills, tools, and competence to address interdisciplinary issues.

Factors that loaded under tree growth constraints included; damage to food crop during tree harvesting (0.685), high incidence of bush fire (0.519), and high mortality of tree seedlings (0.745). Moisture competition between trees and crops to be a problem and too much shade, competition for nutrients and root space as well as allelopathic interactions may weaken crop yields. According to Franzel (1999) although agroforestry has the potential to curb pests, in certain conditions, may actually spark a pest attacks. This could discourage farmers from practicing agroforestry.

Table 14: Constraints to agroforestry practices

Constraints to agroforestry practices	Factor 1 Knowledge constraints	Factor 2 Tree growth constraints	Factor 3 Market constraints
Land tenure system	0.529	0.066	-0.025
Limited local market for tree products	0.120	0.157	0.607
Cultural and social resistance	0.141	0.543	0.495
Inadequate knowledge by extension agents	0.682	0.039	0.045
High cost of establishment	0.491	0.441	0.056
Low levels of awareness among farmers	0.753	-0.107	0.102
Lack of planting material (tree seed and seedlings)	0.370	0.342	-0.072
Lack of labor	0.578	0.233	0.156
Lack of interest by farmers	0.587	0.053	0.061
Long gestation period to reap the benefits of agroforestry practice	0.315	0.082	0.466
Lack of knowledge and skill in agroforestry practice by farmers	0.583	0.016	0.167
Damage to food crop during tree harvesting	-0.045	0.685	0.067
High incidence of bush fire	0.065	0.519	0.039
High mortality of tree seedlings	0.080	0.745	-0.053
Theft	-0.134	0.030	0.032
Shading of crops by trees	0.241	-0.232	-0.445

Extraction method: Principal Component Analysis.

Rotation method: Varimax with Kaiser Normalization

Market constraints had three loading these include; limited local market for tree products (0.607), long gestation period to reap the benefits of agroforestry practice (0.466), and shading of crops by trees (-0.445). Lack of access to markets, farm inputs and management skills could be one of the major constraints to growth of agricultural enterprises. According to FAO (2013) markets for tree products are both less efficient and less developed than for crop and livestock commodities. This could discourage farmers from going into agroforestry practices.

4.5 Strategies for enhancing agroforestry practices

Data in Table 15 show that majority of farmers perceived increasing awareness of agroforestry practice through training and workshop (95%), subsidizing cost of planting materials such as tree seedlings (95%), providing more agroforestry practice training

opportunities to government agricultural extension staff (93.1%) as major possible measures for enhancing agroforestry practices. Increasing awareness of agroforestry practice through training and workshop could enhance agroforestry practices. Therefore, environmental awareness campaign and sustained education on the importance of agroforestry to environmental conservation and poverty alleviation should be embarked on. This will enable farmers to acquire the skills to embark on independent agroforestry activities on personal plots of land. Kristjanson, Place, Franzel, & Thornton (2002) discovered that organizing farmer workshops are important means to find out farmers's views on the practices and their potential impacts. It can also be a means for farmers to discuss issues related to new practices, exchange opinions and lessons, and come to consensus or clarify their differences. This implies that agroforestry farmers should be exposed to training programmes on the practical intricacies of agroforestry including nursery establishment, seed pre-treatment and tree pruning activities among many others. Equally, extension strategies, including field schools, exchange visits and farmer training, are effective ways of disseminating needed information.

Subsidizing the cost of seedling was a major strategy for improving agroforestry practices. Government and project interventions are needed to promote tree planting, provide information and technical assistance and fill other gaps such as supplying tree seeds where they are not available. The successful implementation of agroforestry programs requires availability of seedlings. Merem (2005) opined that the provision of adequate funding to secure a prompt supply of seedlings is highly indispensable in that it enables communities procure seedlings for tree planting initiatives. This invariably will enhance the practice of agroforestry.

Table 15: Respondents perceived strategies for enhancing agroforestry practices

Strategies for enhancing agroforestry practices	Percentage (n=160)
Subsidizing cost of planting materials	95.0
Increasing awareness of agroforestry	95.0
Training agricultural extension staff	93.1
Linking agroforestry farmers with markets	91.2
Improving access to planting materials by expanding seed supply	85.6
Use of correct spacing to reduce competitive effects of trees on food crops	83.1
Creating ownership to agroforestry products (i.e. rights to manage and harvest both timber and non-timber products)	81.2
Making policies to enhance agroforestry practices	73.8
Increasing extension services to farmers	73.1
Involving farmers in decision making	62.5

Furthermore, providing more agroforestry practice training opportunities to government agricultural extension staff was another major strategy for enhancing agroforestry practices. Providing training opportunities for extension workers will help to improve their knowledge and skills in different types of agroforestry practices. According to Cordero and Boshier (2004) major effort should be taken to improve the technical skills of extension agents in agroforestry. Agricultural extension staff should have better understanding of farming systems and potential importance of integrating trees on farms. This will help to promote agroforestry practices among farmers and thus scale up the practices in farm communities.

Other strategies included: linking agroforestry farmers with markets (91.2%), promoting information on agroforestry to farmers through extension service (90.6%), making policies to enhance agroforestry practices (73.8%) among others. Linking agroforestry farmers with market was one of the major strategies for improving agroforestry practices. According to Dewees and Scherr (1996) linking farmers to markets and adding value to raw products have great potential for improving the incomes of smallholders and facilitating the practice of agroforestry. It is profitable to assist farmers to sell their produce locally before they attempt to enter a more

competitive export market, and to help them strengthen their links with the private sector as part of market development. Therefore, training in entrepreneurship and business skills will be highly beneficial to farmers, and farmer organizations can have an important role in assembling produce, bargaining collectively and reducing transaction costs.

Promoting information on agroforestry to farmers through extension service was equally one of the strategies for enhancing agroforestry practices. According to Scherr & Franzel (2002) extension workers should be able to provide to farmers with information relevant for decision making process. Therefore, communication process is a primarily key to enhancing agroforestry practices and change agents have to understand how farmers receive, analyse, and disseminate information in order to facilitate the agroforestry practices.

Making policies to enhance agroforestry practices was another strategy for improving agroforestry practices. Policy-makers need to be informed about the benefits of agroforestry so that they can use it to support rural development and provide environmental services. This will enhance the productivity level and increase the agricultural sector of the country. According to the research carried out by World Agroforestry Centre (2013) better policies, human and institutional capacity and technological innovations are imperatives for enabling further agroforestry developments and even greater tree cover for wider benefits.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the findings

The overall purpose of the study was to assess rural farmers' agroforestry practices in Imo State, Nigeria. Specifically, the study ascertained agroforestry practices adopted by farmers; assessed the perceived benefits of agroforestry practices to farmers; determined factors limiting agroforestry practices; and identified possible measures to improve the agroforestry practices. The study was carried out in Imo state, Nigeria. A total of 160 agroforestry farmers constituted the sample size for the study. Data for the study were collected through structured interview schedule. Percentage, Charts, Mean statistics, Analysis of Variance (ANOVA), Duncan multiple range test and Factor analysis were used in data analysis.

Result showed that the average age of the farmers was 54 years. Majority (56.7%) were males and 73.1% married. The respondents were literate as majority of them had acquired one form of formal education or the other. Average household size of the farmers was 7 persons. Majority (56.9%) of the farmers got their income from sale of farm products and 35.6% of them engage in trading as their secondary occupation. Majority (68.8%) of the farmers belonged to various organization. About 53% of the farmers had contact with extension agents in the last one year and the average extension contact was 2 times. The average, the size of land used for agroforestry practices was less than one hectare.

Majority (96.9%) of the farmers practiced home gardens. There was an increase in the number of farmers involved in agroforestry practices in the last five years (47.5%). This was as a result of training (27.5%). Majority (84.4%) of the farmers planted banana in their farm as the major tree component of agroforestry and majority (98.1%) of farmers cultivated yam as the crop components of the agroforestry practice. The average number of trees planted/protected in the

homestead and farmstead varies significantly over the years. There was a decline in the average number of trees planted and/or protected both homestead and farmstead from the year 2009 to 2013. The result showed that pruning (87.5%) was the major management strategy used by farmers to maintain their trees while majority (98.8%) of respondents practiced agroforestry to improve soil fertility. Major constraints to agroforestry practices were grouped into knowledge constraints, tree growth constraints and market constraints. The effective strategies for enhancing agroforestry practices include increasing awareness of agroforestry practice through training and workshop.

5.2 Conclusion

Based on the findings of the study, the following conclusions were made;

Majority of the agroforestry farmers practiced home garden. The number of farmers involved in agroforestry increased in the past five years as a result of training. Majority of farmers planted banana as the tree component of the agroforestry practice and yam as the crop component of the practice. Food was the major reason for combining trees with crops. There was a decline in the average number of trees planted and/or protected by farmers from the year 2009 to 2013 and they vary significantly over the years. The benefit of agroforestry practice as perceived by respondents included improvement of soil fertility. Knowledge constraints, tree growth constraints and market constraints were the major constraints to agroforestry practice. Increasing awareness of agroforestry practice through training and workshop was the major strategy for improving agroforestry practices.

5.3 Recommendations

1. Awareness campaign on increasing the number of trees to be planted in homestead should be embarked upon by extension agents through personal contact and mass media, since the number of trees planted and/ or protected were reducing annually. The efforts of the extension agents in creating awareness could also be complimented by the various organizations working with farmers's organizations and government agencies in rural areas.
2. Planting of fruit trees should be promoted since they are the most common types of tree planted by most of the respondents as an agroforestry component. In view of this, the cultivation of fruit trees should be encouraged by the state government through Agricultural Development Programme in the state by providing free fruit seedlings to the farmers on yearly basis. This will not only improve the fruit trees available but also help in conserving the environment particularly at this period of climate change.
3. The number of extension visit to farmers is not encouraging and this could affect dissemination of agroforestry practices. Therefore, there is need for the three tiers of government to improve the extension-farmers ratio so that more farmers could be reached and the contact period could be enhanced for sustained production.

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RURAL FARMERS' AGROFORESTRY PRACTICES IN IMO STATE, NIGERIA

I am M.Sc student of the Department of Agricultural Extension, University of Nigeria, Nsukka carrying out a research project on the above named topic.

Thanks in advance for your maximum cooperation.

SECTION A: Personal Characteristics of the Respondent

1. Local Government Area é é é é é é é é é é é é é é é é .
2. Town community é ..
3. Village community é ..
4. Sex: (1) Male () (2) Female ()
5. What was your age at your last birthday é é é é (years)
6. Marital status: (1) Single () (2) married () (3) separated () (4) divorced () (5) widowed ()
7. Educational level: (1) No formal education () (2) primary school attempted () (3) primary school completed () (4) secondary school attempted () (5) secondary school completed () (6) OND/NCE () (7) HND/First Degree () (8) Higher Degrees ()
8. No of years spent in school é é é é é é é é é é é .
9. Household size é é é é é é é é é é é é é é é (number)
10. Sources of household income: Salary () sale of tree products () sale of farm products () others (specify) é é é é é .
11. Secondary occupation: (1) Trading () (2) Civil/public service () (3) Artisanship () (4) Others (specify) é é é é é é é é ..
12. Do you belong to any social organization/group? (1) Yes () (2) No ()
13. If yes which of them? é é é é é é é é é é é é é é é é é é é ..
14. Do extension agents visit you? (1) Yes () (2) No ()
15. If yes how many times in the last one year? é é é é é é é é é é é é é é é é
16. Size of farm land use for agroforestry practices in plot (100ft x 50ft) é é .é é .é é é é é é é
17. Years of experience in agroforestry? é é é é é é .. (years)

Section B: kindly tick (✓) the different agroforestry practices you use
What type of agroforestry practices do you use in your farm?

S/N	Agroforestry practices	Use	Not using
1	Cultivation of annual crop among young trees (Taungya system)		
2	Growing of trees, shrubs and herbaceous plants around the home compound (Homegardens)		
3	Intercropping of food crops and woody species in the same land (Alley cropping)		
4	Planting trees for aesthetic value, to demarcate boundaries, control water and wind erosion, supply of food, fodder and fuel wood (Border planting of trees)		
5	Leaving few fruit bearing trees on the farms when clearing the land (Multipurpose trees on cropland)		
6	Growing tree and vegetables in the same land (Silviolericulture)		
7	Growing trees and keeping of pasture/animals in the same land (Silvipasture)		
8	Trees in plantation and arable crops (Plantation crop combination)		
9	Leaving trees or shrubs in natural fallows in order to improve soil fertility (Improved tree fallow)		
10	Using trees /shrubs as fence (Live fencing)		
	Others please specify		
11			
12			

What is the current state of agroforestry practices in your area?

- How will you describe changes in agroforestry practices in your community in the last *five years*? Decreasing () No change () increasing ()
- Why? ..

Please indicate the number of tree planted over the year as indicated in the table below:

S/N		2009	2010	2011	2012	2013
3	Number of trees planted in the homestead					
4	Number of trees protected in the homestead					
5	Number of trees planted in the farmstead					
6	Number of trees protected in the farmstead					

Which of these tree/fruit/shrub species do you plant or protect in your agroforestry farm?

S/N	Tree species/ fruit/ shrub	Not available in the farm	Available	
			Planted by you	Not planted by you (protected)
1	Coconut			
2	Orange			
3	Banana			
4	Oil palm			
5	Kola nut			
6	Mango			
7	Guava			
8	Plantain			
9	Iroko (oji)			
10	Melina			
11	Local pear (ube)			
12	Cashew			
13	Oil bean tree (ukpaka or ugba)			
14	African star apple (udara)			
15	Bush mango (ugiri)			
16	Bitter kola (akilu)			
17	Bitter leaf (Onugbu)			
18	Achi			
19	Mahogany			
20	Obeche			
21	Bamboo (achara or otosi)			
22	Rubber tree			
23	Mmimi			
24	Ukpa			
25	Ichikere			
26	Uda			
27	Dogonyaro or iba chorop			
28	Scent leaf (Nchanwu)			
29	Utazi			
30	Ehuru			
31	Icheku or chereku			
32	Raffia palm (Nkwo)			
33	Uturukpa			
34	Moringa			
35	Mushroom			
36	Ohaba			
37	African nut tree (Okwe)			
	Others please specify (i)			
38				
39				

Which of these types of arable crops do you combine with trees in your agroforestry farm?
Please indicate

S/N	Arable crops	Yes	No
1	Rice		
2	Yam		
3	Cassava		
4	Maize		
5	Cowpea		
6	Pumpkin		
7	Spinach		
8	Water leaf		
9	Cocoyam		
10	Groundnut		
11	Bambara nut		
12	Pigeon pea (Fiofio)		
	Others please specify		
13			
14			

What is/are your reason (s) for combining this/these crops with trees?

Which of these management strategies do you use in maintaining tree crops in your agroforest farm?

S/no	Management strategies	Use	Not in use
1	Cutting the tree down to its stump and allowing it to regrow (Coppicing)		
2	Cutting off the crown of the tree, leaving it to send out new branches from the top of the remaining stem (Pollarding)		
3	Watering		
4	Weeding		
5	Manure application		
6	Removing the branches so they will not shade the plants/crops (Pruning)		
	others please specify		
7			
8			
9			
10			
11			
12			
13			

Section C: Which of these do you perceive as benefit of agroforestry practices? Please indicate

S/N	Perceived benefits	Yes	No
1	Increasing soil fertility		
2	Conserving soil by providing moisture to soil for plant growth		
3	Protecting soil from damaging impact of rain		
4	Lowering of surface soil temperature		
5	Enhancing the water use efficiency of the soil		
6	Biodiversity conservation		
7	Providing food to rural farmers		
8	Providing income to rural farmers		
9	Providing raw materials for industry		
10	Providing fuel-wood, timber and charcoal for cooking		
11	Providing shade for farm workers and animal in harsh weather		
12	Means of adaptation to climate change		
13	Controlling soil erosion		
14	Providing fibre for making ropes, mats, baskets, coverings, woven goods and musical instrument strings		
15	Source of many herbal remedies and traditional medicines		
16	Reducing weeds		
17	Reducing deforestation and pressure on woodlands by providing farm-grown fuel wood		
18	Providing fodder for livestock		
19	Maintaining soil organic matter		
20	Reducing insect pests and associated diseases		
	Others specify		
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Section D: To what extent do you perceive the following as constraints to the practice of agroforestry in your area?

S/N	Perceived constraints	To a very great extent (3)	To a great extent (2)	To some extent (1)	To no extent (0)
1	Land tenure system				
2	Limited local market for tree products				
3	Cultural and social resistance				
4	Inadequate knowledge by extension agents				
5	High cost of establishment				
6	Low levels of awareness among farmers				
7	Low dissemination among farmers				
8	Lack of planting material (tree seed and seedlings)				
9	Lack of labor				
10	Lack of interest by farmers				
11	Long gestation period to reap the benefits of agroforestry practice				
12	Lack of knowledge and skill in agroforestry practice by farmers				
13	Damage to food crop during tree harvesting				
14	High incidence of bush fire				
15	High mortality of tree seedlings				
16	Theft				
17	Shading of crops by trees				
	Others specify				
18					
19					
20					
21					

Section E: Please indicate which of these possible measures can be use in improving agroforestry practices in your community?

S/ N	Possible strategies	Possible measure (2)	Not a possible measure (1)
1	Subsidizing cost of planting materials		
2	Increasing awareness of agroforestry		
3	Linking agroforestry farmers with markets		
4	Use of correct spacing to reduce competitive effects of trees on food crops		
5	Making policies to enhance agroforestry practices		
6	Creating ownership to agroforestry products (i.e. rights to manage and harvest both timber and non-timber products)		
7	Increasing extension services to farmers		
8	Involving farmers in decision making		
9	Improving access to planting materials by expanding seed supply		
10	Training agricultural extension staff		
	Others please specify		
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