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Impacts of Agroforestry in Agricultural Sustainability and Food Security in Nigeria

A. O. Ogunsiji^{1*}, T. O. Ibrahim¹ and O. A. Oni¹

¹Forestry Research Institute of Nigeria, P.O. Box 5054, Jericho, Ibadan, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author AOO designed the study and wrote the first draft of the manuscript. Authors TOI and OAO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The first essential component of social and economic justice is adequate food production. Food plays a vital role in the life of mankind and it keeps the body functioning. Nigeria is a country richly blessed with abundant natural and human resources that if properly utilized can feed its people, yet it is experiencing persistent food crisis both in terms of quantity and quality. Food security is the ability of people to meet their required level of food consumption at all times. Food insecurity has been a major concern in Nigeria where peasant farmers lack the skill and capital to produce large quantity of farm produce that will meet the nation's need. Agroforestry which combines growing of trees with the production of other crops or animal has been a widely used system for combating food insecurity which also reduces the risk of crop failure during adverse conditions such as prolonged drought period and other natural calamities due to climate change. Through agroforestry practices, food production, improved soil fertility, health and increasing economic income of rural people can be properly tackled in the country. Research into agroforestry practices should be properly disseminated to rural farmers so that they can adopt the system. Also, government policies, research institute and other agricultural schemes that has been set up by the government should work towards making farmers adopt and apply agroforestry strategies in the country.

*Corresponding author: E-mail: adheholar@yahoo.com;

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1. INTRODUCTION

Nigeria is faced with huge food security challenges. About 70% of the population live on less than N100 (US\$ 0.70) per day, suffering from hunger and poverty [1]. Despite its reputation as petroleum resource dependent, Nigeria remains an agrarian economy. The sector provides over 40% of gross domestic product (GDP) with between 60 and 70% of the population productively engaged in farming.

Combining agroforestry tree species into an agricultural system is projected towards sustaining selected valuable trees and crops on the field. Making use of tree or shrub biomass (leaves and stem) as mulch on compacted soils would improve the organic matter and restore back a fertile soil structure required for a successful agroforestry farming system. Growing trees on farms reduce evapotranspiration which helps to retain water for crop use and provide protection to watersheds. Agroforestry systems has proven to increase income diversification [2], improve food security [3], increase diversity of species, help to replace cultivated tree products to be used as fuelwood, provides fodder for livestock feed and potentially reduce deforestation and environmental degradation through increased land use efficiency [4,5].

Conservation of soil, water, and forest products are essential in maintaining food security. Agroforestry has been reported by several authors to improve food security through the replenishment of soil fertility, enhanced crop yields, and supply of a vast variety of food and fuel products [6-12]. Conventionally, farmers have developed various agroforestry and soil conservation strategies which has been helpful in improving their livelihood. Trees on farms provide shade and also help to preserve the soil moisture content so that less water is lost into the atmosphere which enables crop to properly grow. Stocking et al. [13] stated that agroforestry is seen by many as a solution to environmental problems and as a sustainable enterprise that is especially suited to resource poor farmers. This, according to them, explains why agroforestry is presently receiving urgent attention as a means of avoiding what is perceived to be the failure of rural agricultural methods. The conservation and management of natural resources for sustainable agriculture production, for greater food security and nutrition should be the target of any

agricultural policy or strategy. Agroforestry seems to be meeting this target, as there has been a remarkable increase in the number of rural development projects that are involved in agroforestry [14].

Agroforestry systems are created and carried out in order to counteract soil erosion, degradation, to improve soil quality and health. Practicing agroforestry is a way to conserve soil, water and forest resources while improving livelihoods [15]. Lasco and Visco [16] defined agroforestry as the integration of multipurpose trees and shrubs with crops and livestock. Agroforestry systems can be more self-regulating, requiring fewer inputs, less maintenance, and less labor than monoculture plantations. As opposed to monoculture systems, the enhanced biodiversity and system complexity of agroforestry systems may reduce their susceptibility to pest and disease outbreaks, leaving households less vulnerable to such disturbances. Agroforestry systems can support feeding of livestock through the supply of fodder from fallen leaves, branches, and weeds, at little or no cost to the breeder.

2. DISCUSSION

2.1 Challenges in Agroforestry

The total population in Nigeria was estimated at 182.2 million people in 2015, according to the latest census figures. Looking back, in the year of 1960, Nigeria had a population of 45.2 million people. The population of Nigeria represents 2.35% of the world's total population which arguably means that one person in every 43 people on the planet is a resident of Nigeria [17]. These figures is an indication that Nigerian population is amongst the fast growing population in the world and still food production increases marginally at a rate lower than population growth rate.

There have been so many reports on food insecurity in Nigeria, a country considered a major food exporter is now amidst the country of food importation. Agriculture in Nigeria [18] reported that in 2012, N155 billion was spent on importing rice. Authors have confirmed and stated that there are different opinions on the existence of food insecurity in Nigeria. Abdulrahman [19] stated that the amount budgeted to the sector is not enough for the sector to achieve its main objectives. Several authors [20,21] reported that

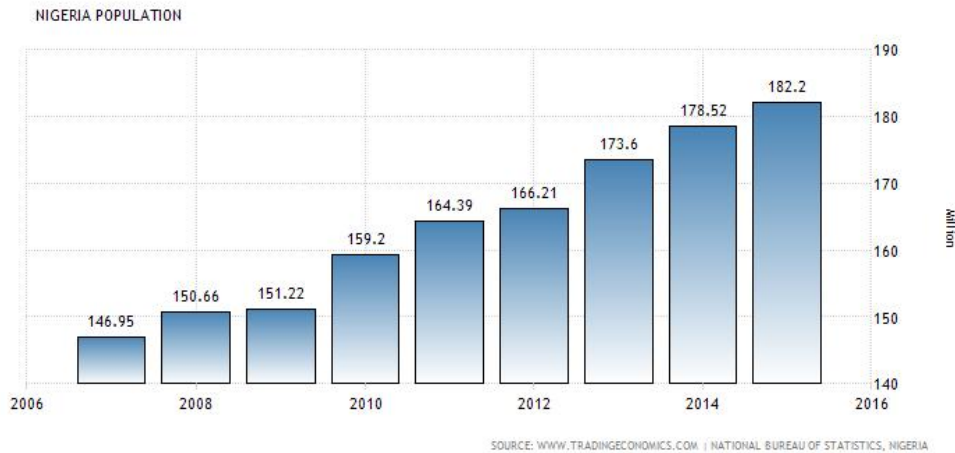


Fig. 1. Total population in Nigeria as it increases over the years

poor agricultural policies, programs and the procedures on how agricultural loans are given to the farmers are not encouraging and are responsible for low agricultural productivity. Nigerian government in 1973 started a National Food Program (NAFPP) which was a voluntary program introduced in Nigeria to make the country self-productive and food secured. In 1976, Operation Feed the Nation (OFN) was introduced, it is projected to increase local food production and as a result minimize the importation of food into the country, citizen were encouraged to plant crops on empty plot of lands to increase agricultural production. The Agricultural Development Project (ADP) was introduced in the mid-1970s when Nigeria's oil production revenues were rising, their vision was aimed at increasing crop production through rural development, improving technology, increase farm inputs supplies, and improve infrastructure [22]. The establishment of National Seed Service (NSS) in 1975 came with the directive of making certified seeds and to also arrange for seed certification. In 1992, the National Seed Policy (NSP) was created to give specification for the development of seed subsectors, to help in the improvement of crop varieties, testing, registration, release, multiplication of released seed varieties, and improve the quality of seeds sold to farmers. Agricultural Credit Guarantee Scheme (ACGS) was established in 1977 to provide guarantee on loans granted by banks to farmers to boost agricultural production and agro-allied processing [22]. Nigerian Agricultural, Cooperative and Rural Development Bank (NACRDB) was established in the year 2000 and tasked basically with financing at both the micro and macro levels, it was mandated to meet the

funding requirements of Nigerians in the agricultural sector to foster increase food production and subsequent food security. Different Policies, Programs and Schemes right from colonial administration where put in place to enhance agricultural productivities but food crisis is still a major concern in the country. It can be said that one of the challenges faced in Nigeria in terms of food supply is lack of food storage. Post harvested crops lack proper handling and storage which results into losses of these crops. More measure should be taken in handling and storage of crops rather than production since available statistics shows that high percentage of crops produced in Nigeria are damaged at post-harvest storage level. As stated by FAO [23], when compared to other African countries, Nigeria has one of the highest per capital food output; it recorded 70% of world production of yams [24] and 19% of global market share for cassava [25]. According to Earth Trends [26] Nigeria produces 8.41%, 1.09%, 2.85% and 0.38% of World production of root and tubers, cereals, legumes, and meat respectively. Because agroforestry is considered to be a multidisciplinary study, it should thus be characterized by biological productivity, profitability and sustainability. The challenges faced in the agroforestry system in Nigeria is lack of proper training and dissemination of information to rural farmers. It is necessary to find out the views of farmers on agroforestry technologies, identify the adoption level and discover why farmers discontinued agroforestry adoption. Saliu et al. [27] carried out an analysis on the perception of farmers, adoption levels and comparison between vegetal cover and selected climatic variables and revealed that more than

75% of the respondents (farmers) had zero or little formal education. More than 60% of the respondents (farmer) had farm size between 1.1 to 3 hectares. Adoption of the technology was more significant between 2008 and 2010 but became less significant as it progressed into 2013. Inadequate knowledge about agroforestry and lack of market made many farmers to set aside the adoption. Adegbehin and Omijeh [28] stated that the most used agroforestry system adopted by farmers in Niger State, Nigeria are agro-silvo pastoral and the scattered farm trees systems. They further stated that 99.5% of agroforestry crops planted were fruit/vegetable products while the remaining 0.5% was designated for other purposes. Nonetheless, Aturamu and Daramola [29] stated that a negative but important relationship was observed between the adoption of agroforestry based technologies and frequency of extension visits and cooperative membership. This implies that agricultural extension work has not positively influenced the adoption of agroforestry or maybe the extension workers have not disseminated much information on adopting agroforestry technology. Jabbar [30] stated that the first and most important factor responsible for discontinuing the adoption of agroforestry was because of the ancient age, also, poor handling and poor crop performance are part of the reasons why the adoption of agroforestry technologies was also discontinued by farmers. This propose that farmers are keen on the adoption of agroforestry but due to some challenges which are not in their favor many discontinued the adoption of the technology. Lack of funds, insufficient land use, little or no understanding, cost of maintenance and poor storage discourages farmers from adopting agroforestry practices. The different Policies, Program and Scheme that has been put in place in tackling food insecurity should adhere to their functions and work hand in hand with farmers. Provision of proper storage facilities, establishment of small scale industries for the utilization of raw materials, training, seminars and workshop should be considered to help eradicate food insecurity and indirectly promote afforestation.

2.2 Benefits of Agroforestry to Sustainable Agriculture and Food Security

Agroforestry provides soil, spring, stream and watershed protection, animal and plant biodiversity conservation and carbon

sequestration and storage, all of which eventually affect food and nutritional security [31]. Agroforestry also offers a safe and environmentally sound approach to address rural communities' of food and fuel needs. Growing of trees increases soil fertility, fuel sources, and the production of nutritious fruits. In the World Bank Policy Study [32], food security is defined as the easy access by all people at all times to sufficient food for an effective healthy life. To the Economic Commission for Africa 2009, food security involves not only food availability through storage, and trade but also more importantly food access through domestic or home production. It is the opinion of the [33] that for a country to have sustainable food security, food supplies must keep pace with increase population and urbanization. Agroforestry contributes in different ways to sustainable agricultural production and food security. By promoting tree planting, agroforestry can be an economically and environmentally sustainable option for small-scale farmers. Agricultural production requires successful management of resources on sustainable basis to satisfy human needs, while maintaining environmental quality and natural resource conservation [34]. For hungry and food-insecure communities, agroforestry creates more resilient agricultural systems where the risk of crop failure is minimized and spread between diverse crops.

The following are the great contributions of agroforestry to sustainable agriculture and food security.

2.2.1 Restoring soil fertility

Water and soil nutrients are the most important natural resources in the case of farm productivity [35] and when soil becomes poor in plant nutrients, food production is impaired [36]. Intensive agriculture, climate change and unsustainable use of resources are the main causes of resource degradation. In other words, continued agricultural production is dependent on the fertility of the land. But continued crop production on a piece of land leads to the depletion of soil nutrients which translate into poor yield. However, maintenance of forest cover on the land helps in restoring soil fertility hence resulting to increased yield of agricultural crops [36]. Trees improve soil by many processes. The most important are organic matter maintenance, nitrogen fixation, nutrient recycling and augmentation of nutrient uptake. Nitrogen fixing tree species can enhance productivity of

associated agricultural crops by improving soil water, soil organic matter and N availability in degraded lands [37]. Decade long trials in Malawi, in which maize was intercropped with a nitrogen-fixing tree, *Gliricidia sepium*, produced yields that averaged 3.7 tonnes a hectare compared to 1.1 tonnes on plots without *Gliricidia sepium*. Agroforestry research has shown conclusively that by applying integrated soil fertility management practices, farmers can reverse the trend of declining soil fertility by reducing soil erosion, increasing soil organic matter and nutrient cycling which increase their crop yields substantially with minimal cash inputs [38]. It also improves soil physical and chemical properties and reclaims degraded soils.

2.2.2 Prevents erosion

Soil erosion is a serious threat to continued agricultural productivity. Erosion whether by wind or water lead to the loss of top soil where soil nutrients are concentrated thus leading to the disruption of agricultural production and degradation of the soil. Current estimates are that up to 1 billion people are affected by soil erosion and land degradation due to deforestation and overgrazing [39]. Trees conserve the soil by protecting it from rain and wind, reducing soil erosion to a minimum. The canopy of trees shelters the ground from the impact of heavy downpours. The leaves drip water on the earth, giving it time to seep

underground, bringing nourishment to animal and plant living beneath the tree.

2.2.3 Food production

Finding solution to food and nutritional security requires lot of intervention from different agricultural approaches like improvements on production of staple crop, bio-fortification of staples, and planting of different species of edible plants that provide fruits, nuts, vegetable etc. for more diverse diets [40]. The variety and importance of food that people especially in the rural areas obtain either directly from the forest, or produce in an environment sustained and protected by trees are enormous. In the whole of West Africa for instance, forests and trees provide food sources in a variety of forms which include edible leaves, fruits, seeds, nuts, roots, tubers, sap, bark, mushroom, honey, gum, snails and insects. Trees are often the only reliable source of food for the family when crops fail or during the lean periods between harvests.

Apart from directly providing edible products, agroforestry trees are also important in providing shade and support to crop and animals and also improves soil fertility. Also, agroforestry play an important role in increasing the yield of vegetables thereby providing various and well balanced nutrition rather than just calories [41].

Table 1. Benefit of agroforestry in the FCT

Nature of benefit	Number of farmers/Area council													
	Abaji		AMAC		Bwari		G/Lada		Kuje		Kwali		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Improvement in income	48	78.7	39	54.9	52	65.8	48	76.2	81	86.2	3	73.2	309	72.9
Manure from livestock	18	29.5	36	50.7	52	65.8	29	46.0	49	52.1	42	75.0	226	53.3
Increased variety of food	30	49.2	42	59.2	39	49.4	24	38.1	64	68.1	24	42.9	223	52.6
Availability of fuelwood	10	16.4	21	29.6	23	40.5	14	22.2	30	31.9	13	23.2	120	28.3
Provision of shade	13	21.3	18	25.4	18	22.8	15	23.8	30	31.9	10	17.9	104	24.5
Improves soil quality	15	24.6	18	25.4	9	11.4	3	4.8	36	38.3	3	5.5	84	19.8
Fodder for animals	6	9.8	10	14.1	18	22.8	8	12.7	9	9.6	4	7.1	55	13.0
Ecosystem stability	1	1.6	18	25.4	6	7.6	6	9.5	9	9.6	12	21.4	52	12.3
Extraction for medicine	8	13.1	4	5.6	10	12.7	6	9.5	14	14.9	4	7.1	46	10.8

Source: Chup, 2004

Table 2. Volume of Nigerians production of some agricultural commodities compared with the Worlds

Commodities	Years	World	Nigeria	% of Nigerians' production in World production
Root and tuber	1996-1998	638,438	53,717	8.41%
Cereals	1999-2001	2,075,387	22,729	1.09%
Legumes	1996-1998	55,469	1,583	2.85%
Meat	1999-2001	233,218	894	0.38%

Source: Adegbola et al. [22]

Table 3. Estimate of losses in stored food products in Nigeria

Crop	Estimated % losses
Legume	30-40
Maize	20-30
Rice	5
Cassava	10-25
Yam tubers	20-67
Dried yam	5-10

Source: Adegbola et al. [22]

Table 4. Estimate of losses due to handling and storage of fruits and vegetables in Nigeria

Commodity	Estimated loss in %
Plantain	35-100
Banana	20-80
Citrus	20-95
Tomatoes	20-50
Pineapple	0-70
Pawpaw	40-100

Source: Adegbola et al. [22]

2.2.4 Source of income

Smallholder tree production can make a significant contribution to improving rural livelihoods and strengthening national economies, yet this is neglected by policy-makers and politicians. Agroforestry systems provide diverse products, which gives assistance against failures in monoculture systems. Aju and Uwalaka [42] report that there are many forest products which rural people gather, produce and trade in order to derive income among which are fuel wood, dyes, rattan, fibres, fruits, nuts, leaves, mushrooms, bamboo, medicines, gums, and forest game. The income from woody components during adverse conditions improves financial condition of small farmers from rural areas. Growing of medicinal plants and cash crops in agroforestry systems enhances the rural income significantly [35]. In West Africa, the trees most highly valued by farmers are not, as one might expect, mahogany and other commercially important timber species. They are indigenous fruit trees, such as bush mango (*Irvingia gabonensis*), African plum (*Dacryodes edulis*) and the African nut (*Ricinodendron heudelotii*). In the mid-1990s, researchers recognized that if these species could be domesticated and commercialized, there would be tremendous benefits for the rural poor. This is precisely what has been done. There are now hundreds of farmer nurseries in the region, using propagation methods that was specifically adapted for rural conditions.

2.2.5 Source of fuel

Traditional energy sources have been neglected in current energy debates but fuelwood and charcoal derived from trees are essential for the survival and well-being of perhaps two billion people, allowing them to prepare food which makes it safe and palatable for consumption and to release the energy within it [43].

3. CONCLUSION

Agroforestry is a vital key in the sustainability of agricultural production and enhancement of food security. The agricultural sector in the country needs sustainable growth which will benefit rural farmers and also help alleviate rural poverty and food insecurity, therefore, deliberate attempts should be made to initiate scientific approaches to growing of trees on farmland. Practicing agroforestry needs to be disseminated to rural farmers to help better their livelihood, therefore, experts from agriculture and forestry should work hand in hand in providing a proper training, seminar and workshop for rural farmers.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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