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Balancing Food Production and Forest Conservation in Nigeria: The Agroforestry Option.

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Abstract: *This paper examined the concepts, types and benefits of agroforestry as a veritable land use system that supports food and nutrition through the direct provision of food, by raising farmers' income and providing fuel for cooking and through various ecosystem services. It also identified agroforestry as one of mankind best hopes to create a climate-smart agriculture, increase food security, alleviate rural poverty and achieve a truly sustainable development. It highlighted the importance of balancing the production of food and creating as well as maintaining good ecological environment for sustainable production and management of other forest resources. The paper concluded by advocating the involvement and mobilization of all stakeholders (government and farmers) towards the implementation of an effective and efficient agroforestry system that will reduce the necessity to cut down additional forest and encourage a fuller use of natural forest ecosystems for the products and services which they only can provide.*

Key words*: sustainable development, food production, natural forest systems, Forest conservation, Nigeria*

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I. Introduction

Food is a basic requirement of man for his survival and well being and the need to produce food therefore is a major preoccupation of man all over the world. Producing food to feed the ever-increasing population occupies a top priority in the agenda of many countries especially the developing ones. From a population figure of about 255 million in 1960, Africa's population now stands at over 1.2 billion people in 2016 making it the continent with the highest rate of growth after Asia. As population is increasing, so also is the need to increase food production. Already, in most part of the world especially in the Third world countries there is food deficit due to the inability of these countries to meet the food requirement of the people resulting in hunger and malnutrition. As revealed in Table 1 below, Nigeria is faced with a food deficit situation in an attempt to feed her teeming population which presently stands at over 190 million people [1]. The simple implication is that to feed the people more food has to be produced.

Table 1: Demand-supply gap in Nigeria food crop production

Crop	Supply (MT)	Demand (MT)	Demand- Supply gap (MT)
Yam	40,000,000	60,000,000	20,000,000
Cassava	42,000,000	53,800,000	11,800,000
Irish potato	900,000	8,000,000	7,100,000
Sweet potato	1,200,000	6,000,000	4,800,000
Wheat	400,000	4,000,000	3,600,000
Rice	5,300,000	7,200,000	1,900,000
Maize	10,500,000	15,000,000	4,500,000
Local soybean	750,000	2,000,000	1,300,000
Beni seed	78,000	187,000	109,000
Sesame	200,000	600,000	400,000
Wheat	200,000	1,400,000	1,200,00
Tomato	2, 500,000	6,000,000	3,500,000
Sorghum	11,000,000	12,500,000	1,500,000

Source: Business Day (2017)

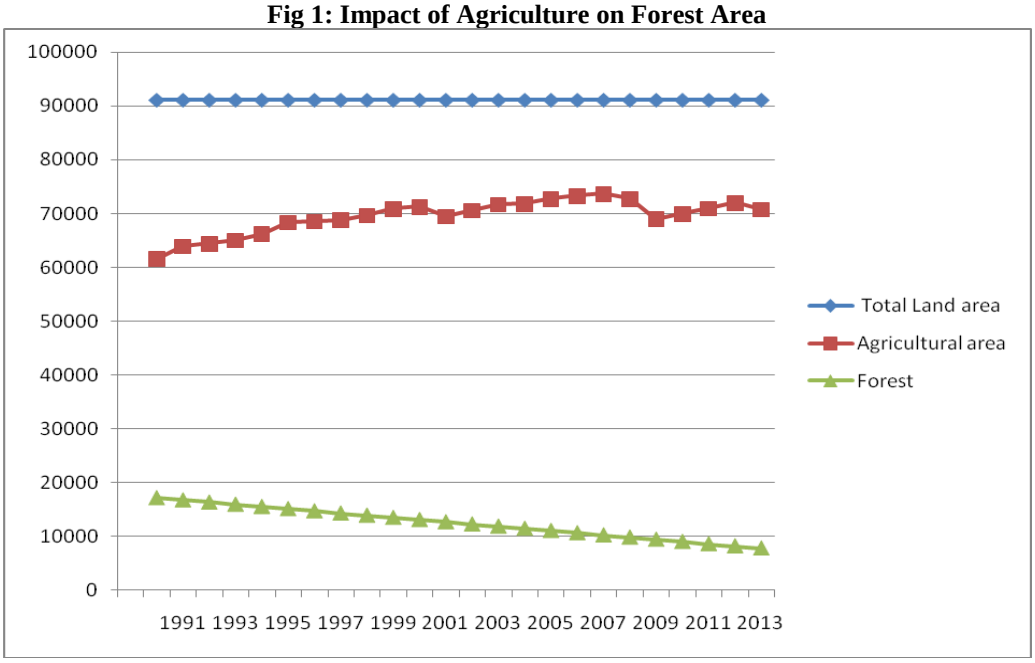
Solving the problem of food and nutritional security therefore requires among other interventions a range of interconnected agricultural approaches, including improvements in stable food productivity, the bio-fortification of staples and the cultivation of a wider range of edible plants that provide fruits, nuts, vegetables etc, for more diverse diets [2].

Food production and Land use evolution

Food production plays a major role in the deforestation process in the developing countries especially where increase in food production is achieved through land expansion rather than through agricultural intensification. Food production in Nigeria and in many parts of the world generally is land dependent whereby large area of forest is usually cleared and cultivated (slash and burn). The consequence of this is forest degradation and high rate of deforestation leading to the reduction of forest area as being experienced in Nigeria and other parts of Africa today.

[3] reported Nigeria's forest area is estimated to be about 11,089 million hectares, representing only 12.2% of the total land area. The area of forest per 1000 people is given as 77 ha while the annual change was -2.7% and -3.3% for 1990 to 2000 and 2000 to 2005 respectively. The most recent Forest Resources Assessment(FRA) carried out in 2010 showed that Nigeria's forest estate is now less that 10 percent of the country's land area which is a far cry from the minimum requirement of 25 percent recommended by FAO [4]. Of the total forested area in Nigeria, natural forests account for 95.8% while the total plantation area is 382,000ha out of which Gmelina and Teak account for 44% [7] cited in [4]. These statistics show continuous annual negative changes as a result of degradation and deforestation. Fig.1 below shows the expansion and increase of agricultural land area as against a decrease in forest area in Nigeria from 1990 to 2015. The implication is that food production increase can only be achieved through clearing of more forest areas thus exacerbating deforestation.

Fig 1: Impact of Agriculture on Forest Area



Source: FAOSTAT(2016)

Importance of forest to Man

The importance of forest to mankind cannot be overemphasized. According to FAO, over 1.3billion people all over the world depend on the forest for their livelihood. Forests as well as trees on farms are a direct source of food and cash income for more than a billion of the world's poorest people, providing both staple foods and supplemental foods such as fruits, edible leaves and nuts. More than 50 million people in India alone depend directly on forests for subsistence, while in the Lao People's Democratic Republic, wild foods are consumed by 80 percent of the population daily. Trees are an integral part of the agricultural systems of many small-scale farmers, providing both cash and subsistence benefits. These benefits come from trees that are planted or managed on farms as well as from forest resources in communally managed, open-access or state-managed areas.

Some of these benefits derived from the forest include fruits which are good sources of minerals and vitamins; seeds and nuts which add calories, oil and protein to diets; wild leaves for cooking which add flavours and nutritional values to diets. Other benefits include roots and tubers; fodder and browse for enhanced livestock production; mushroom and honey as well as wild animals which the rural people depend as their major source of animal protein and income. In many rural communities, forest is the only dependable source of fuel wood and affordable energy for cooking and food processing. It suffices to say that most small scale enterprises in the rural and urban areas of most developing countries are based on non-wood forest products (NWFPs) e.g. wood

and rattan for furniture. Forests also provide important food safety net for the rural people especially during critical periods of the year when there is scarcity of food.

Deforestation in Nigeria

Deforestation is a growing global problem with serious environmental consequences. Today, deforestation has become a practical problem of the whole world. The demand for forest products and the conversions of forest to agriculture continually increase in all parts of the world including Nigeria [6]. The involvement of human beings in various activities in order to sustain a living has given rise to high rate of deforestation across the globe. [6] outline the causes of deforestation to include direct and indirect causes. Direct causes include agricultural activities, firewood collection, commercial logging, bush burning, overgrazing, and industrial development. On the other hand, population explosion and poverty; and government or economic policy failures are considered as indirect causes of deforestation. The major human causes of deforestation today include livestock grazing, agricultural uses and the expansion of urban areas. Table 2 shows changes in forests area between 1990 and 2013 indicating yearly decrease in the total forest area within the given period.

Table 2: Changes in forests area between 1990 and 2013

Forest Type	**Forest Area(1000 ha)**					**Annual Change rate [a]**			
	1990	2000	2005	2010	2013	1990 -2000	2000 - 2005	2005 - 2010	2010 - 2013
						1000ha %	1000ha %	1000ha %	1000ha %[b]
Total Forest Area	17234	13137	11089	9041	7812.2	-410 -2.69	-410 -3.33	-410 -4.00	-410 -5.20
Primary forest	1556	736	326	54	36	-82 -7.21	-82 -15.03	-65 -42.01	-48 -5.34
Forest Plantation	251	316	349	328	383.2	7 2.33	7 2.01	7 1.82	7 3.34

a: negative number represents deforestation

b: rate of gain or loss in percent of the remaining forest area each year within the given period

Source: [7]

II. Deforestation and its Environmental Implications

Deforestation is the large scale removal of forests. It occurs when forests are converted to non-forest areas such as urbanization, agriculture, and other reasons without sufficient reforestation. Deforestation is the permanent destruction of forests and woodlands in particular areas. Deforestation has many significant climatic consequences. [8] outlined the effects of deforestation in Nigeria which include loss of biodiversity, soil erosion and flooding, desert encroachment and change in climate.

The removal of vegetation results in increased temperatures in various places due to the destruction of its carbon sequestration potentials. It also contributes to climate change in a region thereby altering the climate of the place. Variation in weather and climate has led to serious consequences and effects in various parts of the country [9]. These include flooding, deforestation/ desertification, erosion, drought, sea level rise, low agricultural yield; drying up of water bodies, pests and diseases, erratic rainfall patterns, and land degradation. All these are evident in Nigeria. For example, [10] stated that the felling of trees and bush burning along the coastline in Nigeria has increased the threats associated with climate change in the coastal marine environment resulting in occasional sea surges, tidal waves, pollution and land degradation.

The long term impact of deforestation on the soil resource can be severe. Clearing the vegetative cover for slash and burn farming exposes the soil to the intensity of the tropical sun and torrential rains. This can negatively affect the soil by increasing its compaction, reducing its organic material, leeching out its few nutrients available, increasing its aluminum toxicity of soils, making it marginal for farming. Subsequent cropping, frequent tillage, and overgrazing by livestock accelerate the degradation of the soil. In the dry forest zones in Nigeria, land degradation has become an increasingly serious problem, resulting in extreme cases of desertification.

Agroforestry: nexus between food production and forest development

Some vital elements that have aggravated food and poverty situations in Nigeria are deforestation, growing scarcity of tree products and environmental degradation that have also created serious problems for rural land use. The quest for survival and food production has led to adoption of farming purposes that are inimical to soil conservation, slash and bush systems etc. These have not only destroyed the ecosystem but have equally reduced soil fertility and food production. To mitigate these threats to the rural economy, agroforestry which is a land use system that incorporates the planting of trees, shrubs, palms and bamboos on the same land as agricultural crops or livestock/ wildlife becomes a viable option. Agroforestry has been defined as a land use system in which woody perennials are grown with food crops and/or livestock leading to many beneficial,

ecological and economic interactions between trees and non trees components. The International Council for Research in Agroforestry (ICRAF) now World Agroforestry Centre defined agroforestry as a `dynamic ecologically based natural resources management system that through interactions of trees on farm and in the agricultural landscape diversifies and sustains production, enhancing social, economic and environmental benefits for land users at all levels'' [11] observed that more than 1.3 billion people worldwide practice the system which ranges from open packed assemblages to dense imitation of tropical rainforests such as home gardens to planted mixture of only few species to trees planted in hedges or on boundaries of field and farms with differing levels of human involvement of the various management. They observed that agroforestry supports food and nutrition through the direct provision of food, by raising farmers' income and providing fuel for cooking and through various ecosystem services. [12] noted that agroforestry is one of mankind best hopes to create a climate-smart agriculture, increase food security, alleviate rural poverty and achieve a truly sustainable development. [13] stated that a wider application of agroforestry system will reduce the necessity to cut down additional forest and encourage a fuller use of natural forest ecosystems for the products and services which they only can provide. This, he said, is an addition to its potential to increase organic matters of the soil leading to a more efficient nutrient cycling and improvement of the soil physical conditions among others, necessary for food production.

Agroforestry is not only practiced for economic reasons but also for environmental ones, to replenish wood stocks while upgrading land through diminishing erosion, water loss and other natural phenomenon [14] The system includes managing natural regrowth, seedling, planting and maintaining trees as border plantings; inter-planting in agricultural crops, wood lots and home gardens. The objectives of agroforestry is to create sustainable land management strategies which increase overall yields of the land and which are also compatible with the environment as well as the local cultural practices [15]. Agroforesry as a system, therefore, has potentials not only to increase food, fuel and incomes for farmers or holders of marginal lands but also to help stop destruction of world's forestland and is so productive and environmentally sound.

Types of Agroforestry Systems

The list of agroforestry is inexhaustible. [16] noted that there are hundreds possibly thousands of Agroforestry systems but only 20 distinct practices are in vogue in various ecological zones and regions. [17] identified the following agroforestry systems:

1. Agri-silvicultural system: the management of land for crops and forest products (fodder, fruits, wood etc). This includes improved fallow, taungya, alley cropping, multi layer tree gardens, home gardens, shelterbelt and wind breaks, live hedge and fuel wood production;
2. Silvo-pastorium: this involves the establishment of forest for wood and the raising of livestock.
3. Agri-silvopastorium : the establishment of land for arable crops, forest products and live stock. This includes the following subsystems; home gardens involving animals; multipurpose woody hedge rows; apiculture with trees and aquaforestry
4. Other evolving system of agroforestry is farm wildlife management: a special form of agroforestry that incorporates crop cultivation and wildlife management on the same land.

Properly implemented, agroforesty has the prospects of providing new and useful solutions to many of the adverse consequences of human land use as well as increase diversification of agricultural production system and also enhance rural development by contributing to ecosystem- based management system that guarantees sustainability and environmental quality [18].

Benefits of Agroforestry

Agroforestry is a promising approach to support agricultural intensification in the developing countries. Growing agricultural production exacerbates environmental problems such as the depletion of water and nutrients, loss of biodiversity and emission of green house gases, hence the need to invest in sustainable intensification. Establishing trees on farmland can provide a wide range of social and economic benefits which include the following:

(i) Protection of land from soil erosion generated by water and wind, thereby protecting future productive potentials and preserving important watershed that feed hydro-electric projects and supply water for population centers;
(ii) Trees in agricultural fields provide an important source of nutrients for the farm. They also regulate soil, water and microclimates which help to sustain long term productivity while decreasing dependence on external inputs;
(iii) Trees also provide wood products from the farms thus relieving the pressure on rural forest areas; they provide raw materials for rural industries that generate employment for rural communities and also they provide environmental and social benefits such as wildlife habitats, water retention capacity or shade for dwellings;

(iv) Including trees in farms also provides farmers with a great variety of products e.g. fruits and fuelwood that they can sell or use for subsistence purposes;
(v) Because daily needs of fodder, fuelwood, leaf litter etc are met from the land, pressure on the forest is reduced and so is conserved.
(vi) Through the practice of agroforestry, timber production can be enhanced;
Agroforestry, therefore, is a win-win approach both for food production as well as forest development.

III. Status of Agroforestry Technology Adoption in Nigeria

Agroforestry is not entirely a new concept within the Nigerian farming landscape. Farmers have always allowed the growth of trees within the farm areas to either serve as shade for resting during the hot period or to provide leaves for mulching as well as fodders for livestock. However its adoption on a large scale had been mixed depending on the farming system, area and location. In the northern part of the country, farmers have embraced shelterbelt system and woodlots because of the peculiar environmental challenges like desert encroachment. Home gardens have been a common feature in the South East and South-South ecological zones while in the Southwest, farmers allow trees within the cocoa farm, for example, to provide the initial shade for the young cocoa seedlings.

Factors militating against the development of agroforestry in Nigeria

There are some bottlenecks and limitations that must be resolved if agroforestry is to achieve the desired goal of ensuring sustainable forestry development in Nigeria. These include the following:

i. Land tenure and ownership: Trees planted on farm land take many years to mature before harvesting unlike food crops. Agroforestry farmers who farm on rented land or on land without security may not be given the opportunity to hold on to the land for a long period of time. This situation may discourage farmers to go into agroforestry.
ii. Finance: One of the major challenges facing an average farmer in Nigeria is capital in terms of money and materials. Access to credit is generally low and in some cases nonexistent thereby limiting many farmers going into agroforestry enterprise.
iii. Lack of expertise/ knowledge about agroforestry resulting in the low adoption of the technology is another problem militating against the adoption of agroforestry in Nigeria. Many farmers especially in the southern part of the country are not fully aware of the socio-economic and environmental benefits derivable from agroforestry. This makes them not to embrace agroforestry technology. In fact, many farmers see trees in the farm land as having negative effects on their crops and thus often resist the planting of trees alongside their arable crops.
iv. Lack of education: closely related to the above is the problem of low level of education among the farmers which makes it somehow difficult for the farmers to grasp the intricacies involved in the application of agroforestry technologies.

IV. The way forward

The prospects of AF in Nigeria depend on a number of factors which include the following:

i. Creating awareness about the importance and benefits of agroforestry. As mentioned above the level of awareness of agroforestry in some parts of the country is very low. There is the need to educate the farmers through seminars and workshops about the importance and socioeconomic and environmental benefits of AF and the need to embrace it as a veritable tool to combat climate change and other environmental challenges.
ii. The adoption of AF technologies in Nigeria is low. This is because research results are not usually disseminated to the farmers. This calls for a closer collaboration between research institutes, universities and the farmers. Researchers must develop strategies of working with the farmers who are usually the end users of their research results.
iii. A strong extension service is urgently required to disseminate AF technologies to the farmers;
iv. Setting up of agencies both at the federal and state levels that will be responsible for the formulation and implementation of AF policies in Nigeria becomes imperative.
v. Easy access to capital by the farmers will go a long way to help the farmers to procure the necessary materials (e.g. seedlings) needed to adopt AF technologies.

V. Conclusion

This paper examined and advocates agroforestry as a panacea to check the rate of deforestation and at the same time enhance food production in Nigeria. Undoubtedly, the rate of deforestation is high as a result of the need to produce food to feed the teeming and rising population often through extensive land clearing and forest destruction. Producing food while ensuring that our forests are preserved and properly managed on

sustainable basis must form the thrust of policies that promote the development of AF technologies and ensuring their effective implementation. Therefore, government at all levels must, among other things, promote AF by organizing training through seminars and workshops for farmers on the socio-economic and environmental benefits of AF supported by a strong extension service to disseminate AF technologies to the farmers.

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