



Transforming Nigeria Food System: The Role of Agroforestry

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ABSTRACT: It has been generally established that the global food system needs to be transformed urgently, in order to meet the growing demand for food, feed and fodder. Agroforestry is a type of farming system that combines trees/shrubs with crops with the objective of enjoying a mutual benefit that enhances productivity, profitability and biodiversity, which at the moment is unpopular in Nigeria. Therefore the objective of this paper is to provide relevant information on the role of agroforestry in transforming the Nigerian food system. Some of the agroforestry technologies which can be used to achieve its mutual benefit include taungya system, home garden, alley cropping, improved fallow, woodlots, live fences, fodder banks, orchards or tree gardens, windbreaks, shelterbelts, trees on pasture and apiculture with trees. Planting trees as a component of crop farming is a smart way to achieve multiple purposes with a single enterprise. Planting multipurpose trees in a world affected by climate change can decelerate the negative impact of anthropogenic cause of climate change, while providing food for humanity. Hence, the paper also review the roles of agroforestry in the global fight against climate change, while also ensuring food security through food system transformation.

DOI: <https://dx.doi.org/10.4314/jasem.v27i2.18>

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Cite this paper as: OTIWA, G. I; ADAAJA, B. O; ZAMAN, E. Y; HARUNA. A. Z; OLOYEDE, E. O; AKEMIEN, N. N. (2023). Transforming Nigeria Food System: The Role of Agroforestry. *J. Appl. Sci. Environ. Manage.* 27 (2) 311-316

Dates: Received: 26 January 2023; Revised: 11 February 2023; Accepted: 14 February 2023
Published: 28st February 2023

Keywords: Food system; agroforestry; climate-change; food-security; farming-system

The negative impact of the current global food system on human health and the environment has been well documented. This system generates more than a third of global anthropogenic greenhouse gas emissions (Crippa *et al.*, 2021). Unsustainable farming practices and agricultural expansion into natural habitats drive biodiversity loss, nutrient depletion, and soil erosion. Yet, the global food system does not produce the diversity of foods needed for healthy diets. Only 15 crops provide 90% of humanity's energy intake (Antonelli *et al.*, 2020) with rice, maize and wheat alone accounting for 48% of global average daily calories (FAO, 2018). In the wake of geometric

increase in population growth in Africa, the traditional farming system is unlikely to produce enough food for the people if appropriate steps are not taken. Two ways out of this scenario include; bringing more land under cultivation; and making existing lands more productive using sound management practices (Adeola, 2015a). Agroforestry is a type of farming system that combines trees/shrubs with crops with the objective of enjoying a mutual benefit that enhances productivity, profitability and biodiversity. Different scientists have defined agroforestry depending on the components involved. According to Umeh (1987), agroforestry is a land management system combining

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forest trees and food crops production with or without livestock in such a way that they are technically and financially feasible, and will enable the small holder farmer to obtain high income and living standards, while ensuring improvement of soil and the environment. Nair (1989) described agroforestry as a collective name for land use systems and technologies where woody perennials (trees, shrubs, palms, bamboos etc) are deliberately planted on the same land management unit as agricultural crops and animals in some form of spatial arrangement or temporal sequence with implied ecological and economic interactions between the different components including social benefits to farmers. Adeola (2015a) refers to it as an effort at combining trees and shrubs with crops, with emphasis on their mutual benefits, to enhance diversity, productivity and sustainability of the land use system and hence the farmers.

Other Definitions of Agroforestry: *Agroforestry as an age long practice:* According to Adeola (2015a), any farmer who has a defined role for the tree crop s/he tolerates on the farm land is practicing agroforestry. This definition describes the practice of agroforestry by emphasizing that all other crops and/animals must be mixed with a compulsory tree crop component for the practitioner to be seen as practicing agroforestry. By this definition, our forefathers who practiced the shifting cultivation system were agroforesters. Such age long farmers left useful trees for which they had defined roles on their farmlands e.g. *Irvingia spp* (Oro in Yoruba) was left on farmlands because of its use as food and as condiments, while *Chrysophyllum albidum* (Agbalumo in Yoruba) and *Dacryodes edulis* (Ube in Igbo) were also left on farmlands for their food value. The *Parkia spp* (dawadawa in Hausa) in Northern Nigeria was preserved and is still preserved by farmers for its value as condiment.

Acacia senegal was preserved for gum Arabic and for soil fertility. *Militia excelsa* (Iroko in Yoruba) was left for its wood and cultural values. All these trees mentioned and some other trees were always allowed to grow with various food crops (maize, cassava, melon, pepper, sorghum, cocoyam, banana, plantain etc) on farmer's farmlands. Animals were supported in the system by free range, while Fulanis were known to graze their animals in such systems during which the animals browse on the fields.

In agroforestry, the three main components - animals, crops and trees - can be combined in numerous spatial and temporal arrangements and for different functions, creating thus many different kinds of systems. The definitions for the systems are described in figure 1.

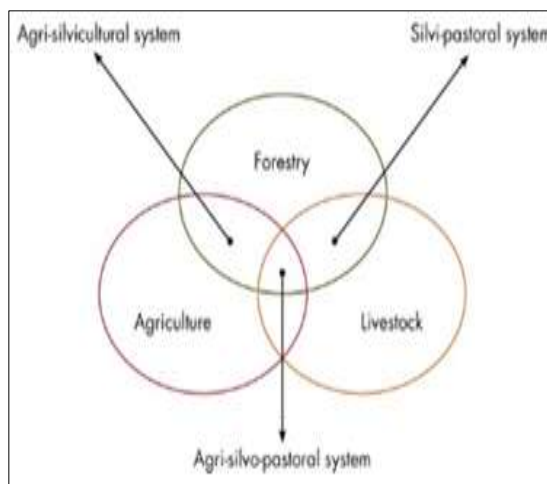


Fig. 1: Graphical illustration of agroforestry systems

Agrosilvicultural System (Trees combined with crops): The agrosilvicultural system is a system that combines tree planting with crop production. This could either be in the form of home garden, alley cropping, taungya, improved fallow, multilayer tree garden, multipurpose trees on cropland, plantation crop combination, trees in soil conservation and reclamation, shelterbelts, windbreaks and live hedges, and fuelwood production (Adeyemi *et al.*, 2020).

Silvopastoral System (Trees and pastures or animals): The silvopastoral system of agroforestry is a system that integrates tree planting with pasture or livestock. This could either be in the form of trees on rangeland or pasture, plantation crops with pastures and animals, and protein banks.

Agrosilvopastoral Systems (Animals, trees and crops): This type of agroforestry practice involves the complex combination of trees, crops and livestock. This could take the form of home garden involving animals, multipurpose woody hedgerows, apiculture with trees, and aquaforestry. The major aim of Agroforestry is to enhance positive interactions between trees, shrubs, food crops and livestock while maintaining soil fertility and adequate water balance. The overall concept is to improve net production from a given area of land without depending on costly farm inputs, which are usually unavailable to the rural farmers. Survey by FAO (2011), showed that tree crops and food crops combinations dominate agriculture in the humid tropics and provide a stable food crop yield and income for subsistence farmers in the region. This appears to satisfy the needs of the rural farmer as food and wood can be produced at the same time in a sustainable manner thus making trees a productive part of the farming system as in the traditional system of shifting cultivation.

According to Thanh *et al.*, (2005), agroforestry has long been recognized in sustainable development models throughout the world due to the benefits they bring not only to the economy and society but also to the ecosystem. Several factors are responsible for the rising increase in agroforestry practice, some of which include; increased deforestation and scarcity of land because of population pressures, farming systems, climate change mitigation, and food system transformation.

Agroforestry Models (Technologies) in Nigeria: Homegarden: This is the planting of trees along with vegetables and food crops in free spaces around the homes. They could be arranged to include many multipurpose trees in multistory association with animal, crops and small livestock. Home gardens are very well developed in the southern part of Nigeria especially in the East. The food crops are integrated with trees behind homesteads. The smaller trees occur near the house while the bigger trees are at the border of the home farm. A lot of fruits, nuts, and grains have been known to be produced from this technology, generating a lot of income for the farmer. In the Northern part of Nigeria where participation by farmers is low for this technology, their major reason for planting home gardens is for food and fruits production (Adeola *et al.*, 2000a). According to Adeola (2015b), of the few farmers practicing homestead in the semi-arid zone, the emphasis is on fodder for animals and shade around homestead. The major tree species used are fruit trees like *Mangifera indica*, *Psidium guajava*, *Anacardium occidentale*, *Moringa oleifera* and *Terminaria indica* (Adeola *et al.*, 1995).

Taungya System: According to Adeola (2015a), taungya system involves the cultivation of food crops in forest reserves. Lands under forests are known to be fertile and in communities with limited land where there are government forest reserves; forest lands are distributed to land hungry farmers to grow their food crops after forest exploitation. Such farmers will however plant seedlings of government preferred tree crops on such land along with their food crops. The growth of food crops is temporary as the trees soon close canopy in one or two years and take over the entire land. Meanwhile, the farmer would have harvested his crops (usually maize, cassava, pepper, okra etc) at the end of the first year. He could now be allocated another portion of forest land for clearing, packing, burning and planting for the next planting season. In this way, the farmer has fertile land to use, while the government obtains farmers' free labor to plant trees. Most plantations of teak and gmelina along roadsides in the former western region of Nigeria were grown through this method.

Improved Fallow: This agroforestry technology involves the planting of leguminous and other soil improving trees species on fallow land. It was developed especially to replenish soil nitrogen on farm lands. It is increasingly adopted by farmers in southern, (eastern and western) Nigeria as well as in parts of West Africa (Adeola, 2015a). In the traditional farming system, trees/shrubs are preserved on fallows to allow the soil to recover some of its fertility. Under low population pressure and long fallows, soil fertility could usually be restored to an acceptable level before the farmer returns to the land again. Increased population has forced the farmers to reduce the fallow periods such that farmers now return to previously cultivated lands before soil fertility could be restored. This has often led to poor yield (Adeola, 2015a). The traditional farming system can no longer accommodate long fallows in many zones of the region. The improved fallow technology therefore involves the planting of short rotation, nitrogen-fixing trees on fallows for a period of time (usually between two and five years) followed by arable crops for some years. Trees like *Gliricidia sepium*, *Leucaena leucocephala* and *Enterolobium cyclocarpum* have been used successfully in the humid region. Other species used include *Sesbania sesban* and *Tephrosia vogelii* in Eastern and Southern Africa (Adeola, 2015a).

Alley farming: Just like improved fallow, alley farming is an agroforestry based technology that can be used by small holder farmers in the humid tropics to control erosion. According to Adeola (2015a), this system combines both mulching and hedgerow barriers in reducing run-off and creating soil stability. The hedgerow crops are pruned and scattered on the alleys. This is usually done to provide nutrients to the soil but it helps to reduce water run-off and sand drift, minimizes rain drop impact, and reduces erosion/run-off. The hedgerow barriers are usually planted along the contours on sloppy lands. If planted at 3m/25cm apart, the hedges close gaps in time and are therefore able to prevent sand drift while the mulch reduces run-off.

Woodlots and Orchards: These are plots on farmer's lands where fuel-wood or fruit trees are planted by the farmers. These plots are usually about 0.5ha or less in area (Adeola, 2015b). This is mostly practiced in the northern/semi-arid zone of Nigeria.

Fodder Tree Banks: Also referred to as protein bank, they are blocks of forage plants that are planted by farmers to serve as browse for their animals during off-season when there is fodder shortage e.g. during rainless months. Usually, the forage plants used are

legumes like *Leucaena leucociphalla*. Most farmers have been taught to mix *Leucaena leucociphalla* with *Gliricidia sepium* in order to minimize the intake of mimosine from leucaena. The trees may be grown with grasses or with herbaceous legumes to make the bank richer. The pruning from the fodder trees could be fed to restricted animals in a cut and carry method (Adeola, 2015b).

Live Fences: These are lines of trees/shrubs planted as boundary crops to delineate farm lands or pasture lands. It is made up of very dense hedges or thicket of trees (usually thorny) planted around a garden or farm to protect it from free ranging livestock. In most circumstances, they are planted around gardens within family compounds and buildings (Adeola, 2015b). The trees are of limited height and are usually heavily pruned to form a continuous shield that is difficult for animals to break through thorns or prickles. Live fences keep off animals from destroying farmer's crops or confine them to a location. Species that are mainly used in the semi-arid region include *Acacia nilotica*, *Acacia senegal*, *Prosopis juliflora* and *Zyziphus spp.* If the live fences are used to keep animals within, the trees may be left to grow so that they can serve as shade, protection and privacy for the animals (Adedire, 2014).

Borderline Planting: In this practice, trees, shrubs and grasses are established to delineate individual farmlands. They are property markers even though they provide wood and other forest products for various purposes. Species used for this technology include *Moringa oleifera* and *Termarindus indica*. These species are useful as vegetables and in water treatment in the Northern parts of Nigeria. The leaves of *Moringa* are highly valued as vegetables and more recently for its medicinal and other uses. A lot of *Moringa* are found as borderline crops on farmlands. This technology is also used in the south to demarcate farmlands. *Newbouldia leavis* has been frequently used for this role in many farms of the southern Nigeria (Adeola, 2015b).

Scattered Trees on Cropland: This is also referred to as parkland agroforestry. In this practice, trees are retained or planted on farmer's cropland in a much dispersed sequence while the crops are grown in the understorey unhindered (Adeola, 2015b). They could also be scattered at random based on farmer's desire. Typical examples of this form of arrangement can be found in many parts of the semi-arid areas of Nigeria where trees, dispersed naturally on farm lands form an integral part of the cropping system. Different species are found in such dispersed, park-like stands, depending on the site conditions. Examples are

Vitellaria paradoxa, *Parkia biglobosa*, *Adansonia digitata*, *Parkia biglobosa*, *Adansonia digitata*, *Vitellaria paradoxa*, *Tamarindus indica* (Adedire, 2014), *Irvingia gabonensis*, *Cryosophyllum albidum* and *Meletia excelsa* (Adeola, 2015b). Traditionally, the trees are homogeneously distributed across farms in random patterns due to their ability to regenerate naturally. They do not take up as much space, thus a large part of the productive land is left for the crop production. They provide wood, fodder and other forest products to the farmers. Some of the trees like parkia provide a lot of income for the farmer through fruits. It is the main component of the shifting cultivation system in which farmers allow some preferred trees to stay on the farmland with their food crops during the farming season. Such trees however have specified roles. They may be for soil fertility, fruits, nuts food, timber, fuel or a host of other reasons.

Windbreaks: These are strips of trees/shrubs planted to protect fields, homes, canals or other areas from wind and blowing soil or sand. It is planted to reduce soil erosion, improve microclimate for growing crops as well as shelter people and livestock. It can also improve and sustain crop yield (Adeyemi *et al.*, 2020). Usually, one or two rows of trees are established across the path of the prevailing wind. The length is usually across a farmer's plot or property. Windbreaks are used both in sahel and sudan savanna. Major species used are *Azadiracta indica*, *Eucalyptus camadulensis* and *Prosopis juliflora* (Adeola *et al.*, 1995). Some of these species are also used for erosion control (Adeola, 2015b).

Roadside planting: This is amenity planting 1 - 3 rows of trees along roadsides and in public spaces. Apart from beautification, the trees have an effect on the microclimate of the area. They provide shade and protect the houses in the cities from storms which could otherwise be destructive (Adedire, 2014).

Agroforestry and Food System: Tree cover has been linked to greater dietary diversity (Ickowitz *et al.*, 2014), as all nuts and more than half of human-consumed cultivated fruits grow on trees (Powell *et al.*, 2013)) most of which are rich in nutrients. Combining trees with crops, apart from providing important environmental services, help adapt and mitigate climate change, restore degraded lands, enrich biodiversity, while providing nutrient-dense crops. Agroforestry is one the few land use strategies that promises such synergies between food security and climate change mitigation (Mbow *et al.*, 2014). It is also less likely than other strategies to negatively affect the provision of non-carbon ecosystem services, such as water cycle regulation (Smith and Olsen,

2010) or biodiversity conservation (Ravindranath, 2007), all of which are integral aspects of 'climate-smart agriculture. According to Amonum *et al.*, (2012), agroforestry programme as a practice is very useful in sequestering carbon and could be used on

sustainable landscape management principle to address the needs of the stakeholders for food, fibre, fodder and energy as well as other services while still serving as carbon sink.

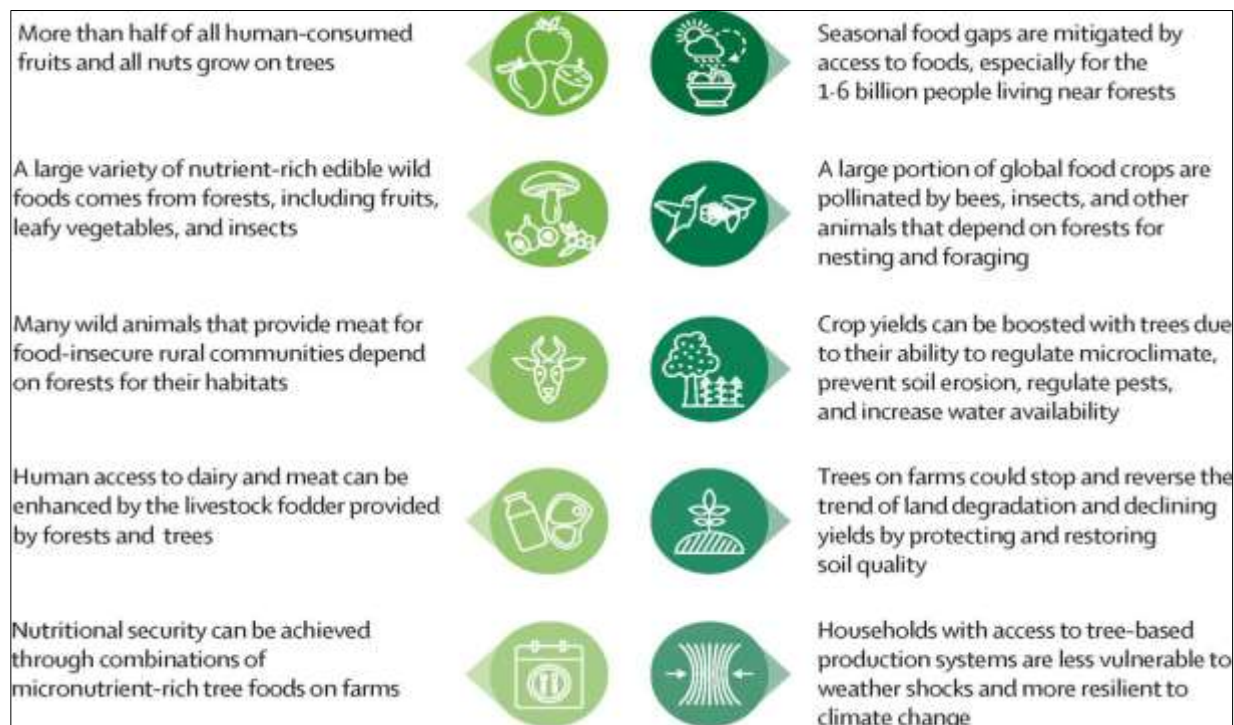


Fig. 2. Reasons why trees and forests are crucial for food system transformation.
Source: Ickowitz *et al.* (2022)

Conclusion: It is obvious the world needs a paradigm shift from the conventional to a more sustainable way of food production. With the increasing price of fertilizer and other agricultural production inputs, coupled with scarcity of land associated with land degradation and rapid urbanization, Nigeria needs to transform its food system urgently to ensure sustainable production of quality diets, of which agroforestry can play a crucial role in this transformation.

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