

International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2023; SP-8(5): 1127-1131
© 2023 Stats & Maths
<https://www.mathsjournal.com>
Received: 08-06-2023
Accepted: 10-07-2023

Roshan Pancholi
Department of Agronomy,
Institute of Agricultural Science,
BHU, Varanasi, Uttar Pradesh,
India

Shishpal Choudhary
Department of Agroforestry,
Collage of Forestry, VCSG,
Uttarakhand, India

Ajay Prajapati
Department of Agroforestry,
Collage of Forestry, VCSG,
Uttarakhand, India

Arti Sharma
Department of Entomology,
(RARI) Durgapura Jaipur,
Rajasthan, India

Jyoti Sharma
Department of Entomology,
Sardarkrushinagar, Gujarat,
India

Corresponding Author:
Roshan Pancholi
Department of Agronomy,
Institute of Agricultural Science,
BHU, Varanasi, Uttar Pradesh,
India

Agroforestry's contribution to environmental sustainability

Roshan Pancholi, Shishpal Choudhary, Ajay Prajapati, Arti Sharma and Jyoti Sharma

Abstract

Environmental instability and unsustainable resource use are the results of rising demand on the world's natural resources brought on by economic and population growth. Environmental issues like land erosion, flooding, frequent and severe storms, depletion of soil fertility, natural disasters, and seasonal changes in the global climate have been brought on by the unstable nature of the world climate, which is attributed to human activities. These negative effects on the global ecosystem have necessitated urgent attention. This essay examines the value of agroforestry and explores numerous agroforestry techniques that can improve environmental sustainability. By using agroforestry, the nation can break the cycle of deforestation, soil erosion, and other environmental issues. Agroforestry is the term used to describe the integration of farming and forestry techniques. As a system of land use, it meets the many needs of since the individual farmer's use of local natural resources cannot be made to make sense with the conventional agricultural practices. Increasing the therapeutic properties of crops and trees is involved. Land's economic, environmental, and food security and profit potential. Agroforestry follows. Systems like the taungya system, improved fallow, alley farming, living fence, home garden, shelterbelt, Agrosilvopastoral systems are strongly advised as a remedy for environmental issues.

Keywords: Natural resources, agroforestry, role, and sustainability

Introduction

According to Owunubi and Otegbeye (2002) [22], agroforestry is a dual land-use system in which woody perennials and agricultural crops are both produced on the same piece of property. Agroforestry approaches cover a wide range of land use systems in which farmed crops are purposefully integrated with woody perennials or creatures arranged in a certain time or space (Lundgren and Raintree, 1982) [14]. Supporters have claimed that one of its main advantages is soil conservation. Woody perennials' inclusion in agroforestry several bio-physical and bio-chemical processes that determine the soil's health may be impacted by systems. (Nair, 1993) [16] Substance. The less controversial effects of trees on soil include: reducing erosion, primarily through surface litter cover and understory vegetation; maintaining or increasing organic matter and biodiversity; fixing nitrogen; and improving soil biodiversity. physical characteristics such soil structure, porosity, moisture retention through the vast root system, and higher efficiency of nutrient usage due to the tree-root system's ability to intercept, absorb, and use Leaching would otherwise result in the loss of soil nutrients, which can then be recycled (Sanchez, 1987) [26]. Nigeria is blessed with a considerable amount of land and plants, yet this valuable resource has been misused and not managed or exploited responsibly. Ladipo (2010) [13] noted that many rural residents formerly treated the forest as though it were an endless resource. Recently, everyone has realized that the forest is about to disappear. If nothing is done to stop the unsustainable use, the species will go extinct. Evans (1992) [10] believes that the diminishment of Nigeria's forest reserves result from a lack of available agricultural area for food production. Changing agriculture and urbanization. It is common knowledge that the three main uses of land are agriculture, forestry, and urban development. According to Unanaonwi and Bada (2004) [27], these varied uses of land are a result of environmental stress and deterioration, which always result in a reduction in the amount of

land that can be used for agricultural. Consequently, farmers have been limited to long-term, continuous farming on the same piece of land has frequently led to a drop in crop output as well as harm to the environment.

Agroforestry techniques are increasingly promoted as potential treatments. Due to the fact that it is a land use system that has the ability to enhance agricultural land usage while delivering long-term advantages and reducing negative environmental effects on a local and global scale. It is reported to have the capacity to decrease emissions from forest deterioration and deforestation; it also encourages sustainable forest management. Environmental preservation and sustainability. Therefore, it is crucial to adopt agroforestry as a type of land use. Mechanism that promotes both environmental stability and increased output.

The Value of Agroforestry

It is impossible to overstate the significance of agroforestry because it benefits a large portion of the rural population by providing food and other basic needs (Such as fuel wood, staking materials, fibers, timber, medicinal concentrates, oils, fruits, and animal fodder) as well as playing a crucial role in soil fertility. Along with reducing environmental degradation, restoration and weed control are also important. Agro-forestry techniques have been asserted to having the potential of being promoted more frequently as potential cures for enhancing agricultural land use practices, delivering advantages that last, and reducing negative environmental effects both locally and globally Agroforestry, according to Adedire (2004) ^[1], Adekunle (2005) ^[3], and Oke (2008) ^[18], can offer novel and practical solutions to many of the negative effects of human land use, such as greater agricultural production system diversification, increased yield of crops and livestock, and decreased non-point source pollution. Through supporting an ecosystem-based management approach, source pollution and increasing rural development that ensures environmental quality and sustainability. Therefore, agroforestry should be viewed as a system that increases the variety of solutions available to remedy the deteriorating state of the ecosystem, especially the soil from the farmer's harvest. In addition to raising the farmers' income, this will contribute to the security and balance of the food supply. In the semi-arid region of Adamawa state, it has been proven that keeping trees in farming systems increases crop productivity (Amadi *et al.*, 2013) ^[4]. Ajake (2012) ^[5] acknowledged the significance of forest plants in the long-term of generating cash, quality healthcare, creating jobs, supplying raw resources, and providing food, among others. Others. Agroforestry is being advocated more and more for recovering forests, improving the environment, and lowering greenhouse gas emissions while receiving additional benefits, (Richard *et al.* 2009) ^[25] Richard *et al.* (2009) ^[25] also highlighted some of the major advantages that agroforestry brings to sustainable development initiatives, such as biodiversity preservation, environmental (watershed) protection, and the reduction and adaptation to climate change. Therefore, it was considered helpful in promoting afforestation. "Reduction of Emissions from Deforestation and Forestry Development" is the mechanism for forestry development. It has also been acknowledged that Deforestation and Forest Degradation (REDD)" meets (Inter) national goals for combating climate change. Agroforestry is well noted for its contribution to the creation of traditional jobs, consequently, it has the potential to provide a number of benefits (Such as income generation

for underprivileged farmers, environmental and ecological preservation (Including stopping desertification and logging).

Agroforestry's Impact to Environmental Sustainability

Through its environmental, economic, and social roles, agroforestry significantly contributes to the sustainability of the environment. While increasing the soil's capacity for production, no harm is done to the environment. It is renowned for its capacity to preserve natural resources, particularly at the while continuing to support human activity. The traditional African farming technique is no longer viable due to the world's ever-growing population unsustainable. Food demand is increasing, putting more pressure on forests and forest products has made significant contributions to the unsustainable exploitation of the country's natural resources. These factors make agroforestry as a method is regarded as a sustainable land management system that boosts production, environmental development that is sustainable and promotes ecological stability (Wilson, 1990) ^[28]. In addition to producing wood, food, and/or animal products, the inclusion of trees in farming systems has the potential to significantly reduce environmental problems, particularly by fostering microclimates that are favorable for crop growth improving mineral recycling to create a more comprehensive ground cover that could help safeguard the soil from erosive forces and mild temperature extremes (Adedire, 2004) ^[1]. Additionally, Evans (1992) ^[10] noted that the economic, social, and environmental benefits of agroforestry provide a substantial contribution to sustainable development social and environmental functions. They added that it has been demonstrated that agroforestry meets the environmental neutrality is a necessary component of sustainable development.

Agroforestry's Part in Preventing Climate Change

Global difficulties in terms of economy, society, and the environment are brought about by climate change. According to research, human actions that cause CO₂ emissions by removing forest cover are to blame for climate change (Owolabi, 2010) ^[21]. Deforestation brought on by humans typically, conversion of forests to non-forest activities results in significant initial losses in forest by destroying land, carbon stock. Ineffective forest management practices and unauthorized forest invasion reserves, city growth, road building, burning of fossil fuels, and excessive collection of fuel wood, contribute to the ozone layer's thinning. United Nations Food and Agriculture Organization FAO (2010) noted that about 18% of the world's carbon emissions come from deforestation Furthermore, according to FAO (2001), 12 to 15% of the world's carbon emissions from fossil fuels are sequestered through reduced deforestation, forest regeneration, increased plantation development, and agroforestry.

Agroforestry has a significant potential to lower atmospheric carbon dioxide (CO₂) levels and ameliorate global warming. It is well known that adding more trees, expanding the quantity of land covered by forests, or increasing the forest's density in Nigeria would assist the nation lessen the effects of climate change and on a worldwide scale. Additionally supporting the notion that the amount of carbon dioxide in the atmosphere is rising is Morgan *et al.* and the accompanying global warming issue can only be resolved by implementing CO₂ reduction measures. Agroforestry, a system that mixes agronomic crops (Annual or perennial) with trees and/or shrubs (Perennials), has considerable potential for the

sequestration of carbon both above and below ground. Agroforestry systems, albeit not their main focus they offer a special chance to increase the carbon stock in the environment because they are developed for carbon storage. (Jacob *et al.*, 2013) ^[12] The terrestrial biosphere.

Agroforestry's Contribution to Economic Sustainability

According to Nuga and Iheanacho (2011) ^[17], soil erosion is another long-standing, major environmental issue that negatively affects Nigeria's economy. This has a number of environmental and economic effects, particularly in West Africa where soil resilience is low. Therefore, an agroforestry strategy that includes woody perennials has the potential to reduce the effects of soil erosion by including both the above- and below-tree biomass. According to Bamigbade *et al.* (2011) ^[17], the system of agroforestry will aid in addressing various concerns of economic instability in the nation when it is adequately improved and placed in the right perspectives by all environmental stakeholders. In an agroforestry system, trees are known to offer a variety of benefits, including improved soil fertility, income, raw materials, and the provision of drugs, food, shelter, and fuel wood. In addition to offering a wide spectrum of environmental protection, forest goods and services are crucial to many facets of existence. In a study on the economics of a few forest fruit trees, Asinwa *et al.* (2012) ^[7] discovered that the harvesting, processing, and marketing of goods from economically valuable forest trees is crucial for ensuring food security, creating jobs, and generating money.

Agroforestry Systems of Different Types for Environmental Sustainability



Taungya Farming This technology has been employed to create forestry plantations. During the initial years of establishing the forestry plantation, this entails producing annual agriculture crops alongside the forestry species. Typically, the forestry department or their large-scale leases own the property on which the subsistence farmers grow their crops. The farmers receive some or all of the agricultural output in exchange for caring for the forestry seedlings. According to Adekunle and Bakare (2004) ^[2], the agreement will run for two to three years, during which time the forestry species will develop and widen its canopy. It was explained as

a strategy for fully utilizing forest soil to boost agricultural output in underdeveloped countries. Farmers now have a way to take part in the government's afforestation effort and actively plant trees. According to Otegbeye & Famuyide (2005) ^[23], taungya farming was a popular reforestation technique in Nigeria's semi-arid and desert regions.

Improved Fallow As in conventional shifting agriculture, this rotating technique alternates between cultivating crops and favored tree species as the fallow species. Such trees are planted for the purpose of producing an economic good, accelerating soil development, or both. The World Agroforestry Center examined the efficacy of improved fallow systems for reducing soil erosion utilizing fast-growing shrubs like *Crotalaria* spp. and *Tephrosia* spp. Additionally, an enhanced fallow system has been seen to significantly improve soil moisture content (Jacob *et al.*, 2013) ^[12]. A fallow species that grows quickly and effectively would be the best candidate since it would speed up the process of re-establishing fertility by absorbing and recycling available nutrients. *Gliricidia sepium*, *Leucaena leucocephala*, and *Fardherbia albida* are a few examples of these species.



Fig 1: *Gliricidia sepium* is used as a living fence to mark boundaries.

Live fence in this agroforestry method, fences made of living plants are used to demarcate boundaries or keep animals out of farmlands. The land is shielded from stray animals and other biotic impacts in this system by a variety of fodder trees and hedges that are planted as living fence. The species that are employed for live fencing must typically be those that provide little to no shade on farmlands, are tolerant of animal browsing, or are not browsed at all. These include *Acacia* sp., *Gliricidia sepium* (Plate 1), *Sesbania grandiflora*, and *Erythrina* sp. Farmers frequently use this approach because woody species not only serve as boundary markers but also help families have more fuel wood available (Adedire, 1992) ^[30].

Home Garden these are examples of land use systems that intentionally manage multifunctional trees and shrubs in close proximity to annual and perennial agricultural crops and livestock within the grounds of individual homes. Family labor is used to handle the entire tree-crop-animal groups in an intense manner. Multitier cropping or multitier systems are other names for home gardens. Home gardens are exceedingly feasible, very sustainable, and productive (Plate 2). Most household gardens are primarily used for food production. Numerous tree, bushes, vegetable, and other herbaceous plant species are cultivated in crowded, haphazard, and irregular configurations. Numerous animals can be found in the majority of home gardens. Legumes and fodder grass are also planted to fulfill the needs of animals. Edmund (2005) revealed that multi-story home gardening and border planting are two of the agroforestry strategies used in the south-eastern state of Abia. The security it offers in food production, the variety of crops harvested, the ability to increase soil fertility,

and the much-needed revenue were some of the factors he noted as to why the method is utilized more frequently.



Fig 2: Home garden

Alley farming Agronomic, horticultural, or forage crops are grown in the alleys between the rows of woody plants when trees or shrubs are planted in two or more sets of single or multiple rows. (Plate 3) Typically, trees and shrubs are arranged in a single row or a series of rows. Alley cropping allows for the cultivation of all conventional crops. The canopy density and sunshine need for the agronomic, horticultural, or pasture crop are the main determinants of which crops can be grown. According to reports, contour hedgerows, an effective innovation for decreasing soil erosion on sloping areas, boost vegetative cover through agroforestry. In a study conducted by Oke and Kadeba (2001) [18], they found that *Cajanus cajan* fallow and alley cropping had positive effects on soil nitrate. Hulugalle and Kang (1990) [31] reported improvements in soil physical and chemical properties with long-term effects of alley cropping with various hedgerow species continued by stating that the tree litters used in alley cropping facilitate nitrogen cycling, aid in weed suppression, and regulate soil erosion.



Fig 3: Hedgerow intercropping/Alley farming

Shelterbelts: These windbreaks are made to shield agricultural buildings and cattle from the wind. In this strategy, trees and bushes are planted in one or more rows against the wind to lessen wind speed that could harm crops and manage wind erosion. Otegbeye and Famuyide (2005) [23] described this technique as a significant land use strategy that farmers in Nigeria's arid and semiarid regions frequently use. When compared to crops produced outside of it, it was found to enhance farmers' gross crop yields. This supports an earlier study by Adegbeyin (1986) that some areas of Jigawa State experienced increases in maize and millet of 183–363%, compared to 114–189% in unsheltered areas. For this system,

tree species including *Azadirachta indica*, *Eucalyptus camaldulensis*, and *Acacia nilotica* are suited.

Agrosilvopastoral: The term "Agrosilvopastoral system" refers to the cultivation of woody perennials alongside annual crops and pastures (Plate 4). This system comes in two varieties: (a) home gardens (b) wooded hedgerows for browsing, mulch, green manure, and soil conservation. The reason this system is employed more frequently is due to the security it offers in terms of food supply, the variety of crops it can produce, and its ability to increase soil fertility.



Fig 4: Agrosilvopastoral system

Conclusion

The issue of environmental instability, which is brought on by increasing strain on the land resources as a result of population growth that won't stop, has caused significant disruption to the natural ecosystems that are already in place. These human interferences and irresponsible usage of the natural ecosystem posed a significant threat to Local biodiversity needs to be addressed because it contributes to environmental degradation. Consequently, it is necessary to accept agroforestry, a promising method of land use that combines the use of a range of tree types with herbaceous plants and/or animals arranged spatially or chronologically. These programs possess the capacity to boost household output generally and biodiversity in particular.

References

1. Adedire MO. Environment protection. The Agroforestry option. Nig. J Forestry. 2004;34(1):16.
2. Adekunle VAJ, Bakare Y. Rural Livelihood Benefits from Participation in Taungya Agroforestry System in Ondo State Nigeria. Journal of Small-Scale Forest Economic, Management and Policy. 2004;3(1):131-138.
3. Adekunle VAJ. Trends in Forest Reservation and Biodiversity Conservation in Nigeria. In: Environmental Sustainability and Conservation in Nigeria, Okoko, E., Adekunle, V.A.J. & Adeduntan, S.A. (Eds), Environmental conservation and Research Team, Federal University of Technology, Akure Nigeria; c2005. p. 82-9.
4. Amadi DC, IIdiege DA, Sobola OO. Agroforestry Technique and Its Influence on Maize Crop Yield in Gombi Local Government, Adamawa State, Nigeria. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS). 2013;4(3):52-55.
5. Ajake AO. The role of forest trees in indigenous farming systems as a catalyst for forest resources management in the rural villages of Cross Rivers state Nigeria. Global Journal of Human social science. 2012;12(1):1-24.
6. <https://www.ceew.in/publications/sustainable-agriculture-india/agroforestry>

7. Asinwa IO, Jegede OC, Ebiniro DS, Akerele JO, Akanmu OO. Assesment of the contribution of *Parkia biglobosa* (JACQ) BENTH to Rural livelihood in Oyo state Nigeria. *Continental journals*. 2012;6(2):9-17.
8. <https://www.fao.org/agrovoc/concepts-of-the-month/agrosilvopastoral-systems>
9. Edmund Merem. The agroforestry systems of West Africa: The case of Nigeria. AFTA Conference proceedings; c2005. p. 1-11.
10. Evans HJ. *Plantation Forestry*. In: *The Tropics*. 2nd Edn. Clarendon Press. Oxford; c1992. p. 300.
11. Food and Agricultural Organisation of the United Nation. *Global Forest Resources Assesment. Country report*; c2010.
12. Jacob DE, Ufot IN, Sotande AO. Climate change adaptation and Mitigation through Agroforestry principles in the Sahal region of Nigeria. *Proceedings of the 35th Annual Conference of the Forestry Association of Nigeria held in Sokoto State from 11th 16th February, 2013*; c2013. p. 300-308. <https://doi.org/10.1079/pwkb.species.25380>
13. Ladipo D. The state of Nigeria's forests; c2010. <http://adreview.org/2010/04/thestate-of-Nigeria's-forest> (accessed 17 Nov 2013).
14. Lundgren BO, Raintree JB. Sustained Agroforestry. In B. Nestel (ed.) *Agricultural Research for Development: Potential and Challenges in Asia*. ISNAR, The Hague, Netherlands; c1982. p. 37-49.
15. Morgan JA, Follett RF, Allen LH, Grosso SD, Derner JD, Dijkstra F, *et al*. Carbon sequestration in agricultural land of the United States. *J Soil Water Conserv*. 2010;65:6A-13A.
16. Nair PKR. *An introduction to Agroforestry*. Kluwer Academic publishers Netherlands; c1993. p. 499.
17. Nuga BO, Iheanacho CO. Application of Agroforestry Practice in soil conservation and Erosion Control: In book reading in forestry, wildlife management and fisheries. 2011;2:316-337.
18. Oke DO. The Changing Cocoa Agro-forests of Ondo State, Nigeria: Implications for Environmental Stability, Food Security and Biodiversity Conservation. In: *Research for development in forestry, forest products and natural resources management*, Onyekwelu, J.C., Adekunle, V.A.J. and Oke, D.O. (Eds.), *Proceedings of the 1st National Conference of the Forest and Forest Products Society held at the Federal University of Technology, Akure, Nigeria*; c2008. p. 60-63.
19. Oke DO, Kadeba O. Effects of some land use systems on soil nitrate and maize growth on a humid tropical Alfisol. *Journal of sustainable Agriculture and the environment*. 2001;2(1):104-107.
20. Oke DO, Kadeba O. Effects of some land use systems on soil nitrate and maize growth on a humid tropical Alfisol. *Journal of sustainable Agriculture and the environment*. 2001;2(1):104-107.
21. Owolabi OO. Climate and Biodiversity conservation in Nigeria; The perceived Adaptations. *Proceedings of the 2nd Biennial Conference of the Forest products society 26th - 29th April, 2010*; c2010. p. 20-24.
22. Owonubi JJ, Otegbeye GO. Disappearing forest: A review of the Challenges for Conservation of genetic resources and environmental management. *J Forestry. Res. Manage*. 2002;1(1/2):1-11.
23. Otegbeye GO, Famuyide OO. Agroforestry systems in the Arid and Semi-Arid lands of Nigeria: Management and Socio-Economic Importance of the Agroforestry woody species. *Journal of Forestry research and Management*. 2005;(2):1-13.
24. Olujobi OJ. Assessment of Existing Agroforestry practices in Ondo state, Nigeria. *Proceeding of the 30th Annual conference of the Forestry Association of Nigeria*; c2005. p. 11-18.
25. Ingwe R, Ushiel M, Ojong FE, Okeme I. Pursuing sustainable Development through Agroforestry in Nigeria: Geodemographic and spatial Analysis of Agroforestry Implementation in 36 states and capital Territory. *Journal of sustainable Development in Africa*. 2009;3:101-133.
26. Sanchez PA. Soil productivity and sustainability in agroforestry systems. In H. A.; c1987.
27. Unanaonwi OE, Bada SO. Adoption of agroforestry system in Ayepe and Ayibode Communities of Osun and Oyo states, Nigeria *J For*. 2004;34(1 and 2):118-124.
28. Wilson JR. The eleventh hypothesis shade. *Agroforestry today*. 1990;2:14-15.
29. Young A. *Agroforestry for soil conservation*. International council for Research and agroforestry and CAB International, Wallingford, UK; c1989.
30. Adedire CO, Balogun RA. Amylase activity in the gut homogenate of the kola weevil, *Sophrorhinus insperatus* Faust and its response to inhibitors from kola nuts. *International Journal of Tropical Insect Science*. 1992 Apr;13:223-30.
31. Hulugalle NR, Kang BT. Effect of hedgerow species in alley cropping systems on surface soil physical properties of an Oxic paleustalf in south-western Nigeria. *The Journal of Agricultural Science*. 1990 Jun;114(3):301-7.