E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(4): 131-137
Received: 09-02-2024
Accepted: 12-03-2024

Supratim Mandal
School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India

Debasma
School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India

Sasmal
School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India

Shreya Modak
School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India

Priya Ghosh
School of Agriculture, Swami Vivekananda University, Barrackpore, 700121, West Bengal, India

Suprabuddha Kundu
School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India

Sudip Sengupta
School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India

Sahely Kanthal
School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India

Tanmoy Sarkar
School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India

Corresponding Author:
School of Agriculture, Swami Vivekananda University, Barrackpore, West Bengal, India

Agroforestry: socio-economic impact and future aspect

Supratim Mandal, Debasma, Sasmal, Shreya Modak, Priya Ghosh, Suprabuddha Kundu, Sudip Sengupta, Sahely Kanthal and Tanmoy Sarkar

DOI: https://doi.org/10.33545/2618060X.2024.v7.i4Sb.565

Abstract
Agroforestry has been used historically in India as a sort of subsistence farming, but it is now also being acknowledged for its benefits to the recently developed wood-based manufacturing sector from an economic perspective. A complete imbalance among demand and supply has been brought about by insufficient forest cover, inadequate productivity, and legal constraints, together with rising demand for wood and wood products due to growing populations, industries, and related policy changes. Through technological, organizational, and commercial initiatives, some organisations have led research by developing a value chain in industrialized agroforestry. Agroforestry has the ability to deliver food security, aid in the reduction of poverty, and contribute to ecosystem conservation through carbon absorption and conservation of soil. Despite its numerous benefits, agroforestry is still not widely used in rural areas, especially by smallholder farmers in developing nations. The lack of agroforestry in public policy makes it difficult to recognize this system's potential to address the climate problem and enhance rural livelihoods. The availability of a market support system for several types of plywood, pulp wood, lumber, and match wood had a big impact on farmers who grew trees. Similar to all other economic sectors, agroforestry is transitioning to a market economy and facing major modifications to its social, legal, fundamental, effective, and supply setups. To build effective and fruitful agroforestry systems and to maximize private and public investments in agroforestry, however, comprehensive economic research and analysis are required. This review gives a special emphasis on the current evidence depicting the characteristics of agroforestry adoption, its benefits and potential drawbacks, as well as challenges for the adoption in India.

Keywords: Agro-forestry, India, socio-economy, innovation, value chain

1. Introduction
Agroforestry is a multiple-use system in which agricultural crops and perennial woody plants are grown on the same plot of land. In the Asian region, India is one of the major producers and users of wood and wood products. Numerous types of wood and wood products are in high demand due to factors including population growth, industrialization, and related scientific and technical advancements. As a result, there have been large imports of these materials (Upadhyay, 2021) [57]. Agroforestry aims to increase the efficiency of the use of rural resources by reducing or eliminating ecologically harmful land-use practices and by introducing new or improved agroforestry enterprises to produce sustainable increases in incomes and living standards, as well as to provide for social equity (Mercer, 1993) [36]. Forest and fuel wood species were planted with closer spacing than fruit trees, which were planted with wider spacing. Because they have increased access to food, fodder, and fuel wood, which is reflected in higher access to livelihood capitals, farmers' lives have significantly improved as a result of the practice of agroforestry. However, pests and diseases that affect trees and annual crops are becoming more common, according to farmers. Species variety is increased, financial return is guaranteed, and farmer livelihoods are sustained by agroforestry practices. One of the key factors affecting a nation's wellbeing and general progress is the security of its livelihoods. India is dangerously near to reaching a point when most of its natural resources can no longer be replenished due to their extreme overexploitation (Chakraborty *et al*., 2009) [10]. Agroforestry techniques are being promoted as potential solutions more and more.

As a land use system, it has the ability to increase the utilization of agricultural land while bringing about long-term advantages and reducing unfavorable environmental effects on both a local and global scale. It has the potential to lower emissions caused by deforestation and forest degradation; it also supports sustainable forest management and the preservation and sustainability of the ecosystem. Use of agroforestry, a strategy of land use that promotes increased productivity and environmental stability, is consequently essential. This review describes the numerous advancements made in the development of industrial agroforestry as well as the improvements made in the production to consumption system (PCS) in agroforestry.

2. Importance of agroforestry

Agroforestry practices encompass an entire spectrum of land use systems in which woody perennials are deliberately combined with agricultural crops and/or animals in some spatial or temporal arrangement (Lundgren and Raintree, 1982) [33]. Through its environmental, economic, and social roles, agroforestry significantly contributes to the sustainability of the environment. 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 (Fig. 1). Agro-forestry techniques are being promoted more and more as viable treatments because they have the ability to enhance agricultural land use systems, offer long-term advantages, and lessen negative environmental consequences on a local and global scale. According to Adedire (2004), Adekunle (2005), and Oke (2008), agroforestry can contribute to an ecosystem-based management system that ensures sustainability and environmental quality, as well as new and practical solutions to many of the negative effects of human land use, including increased agricultural production system diversification, increased yield of crops and livestock, decreased non-point source pollution, and increased rural development. Therefore, agroforestry should be viewed as a method that improves the farmer's yield while simultaneously addressing the deteriorating condition of the environment, particularly the soil. In addition to raising the farmers' income, this will contribute to the security and balance of the food supply. (Richard *et al*., 2009) 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. Ajake (2012) acknowledged the role of forest trees in terms of generating revenue, excellent healthcare, employment, raw materials, and food provision among other things. Agroforestry is being advocated more and more for its potential to restore damaged environments and forests, cut greenhouse gas emissions, and provide other advantages (Richard *et al*., 2009). As a result, it was considered helpful in encouraging afforestation and replanting and in the mechanism for forestry development: Additionally to achieving (inter)national standards, "Reduction of Emissions from Deforestation and Forest Degradation (REDD)" has been acknowledged goals for combating climate change. Agroforestry is also renowned for its contribution to the creation of traditional jobs; as a result, it has the potential to provide a number of advantages, such as the creation of income for underprivileged farmers and the stability of the environment and ecosystems, including the prevention of desertification and deforestation.

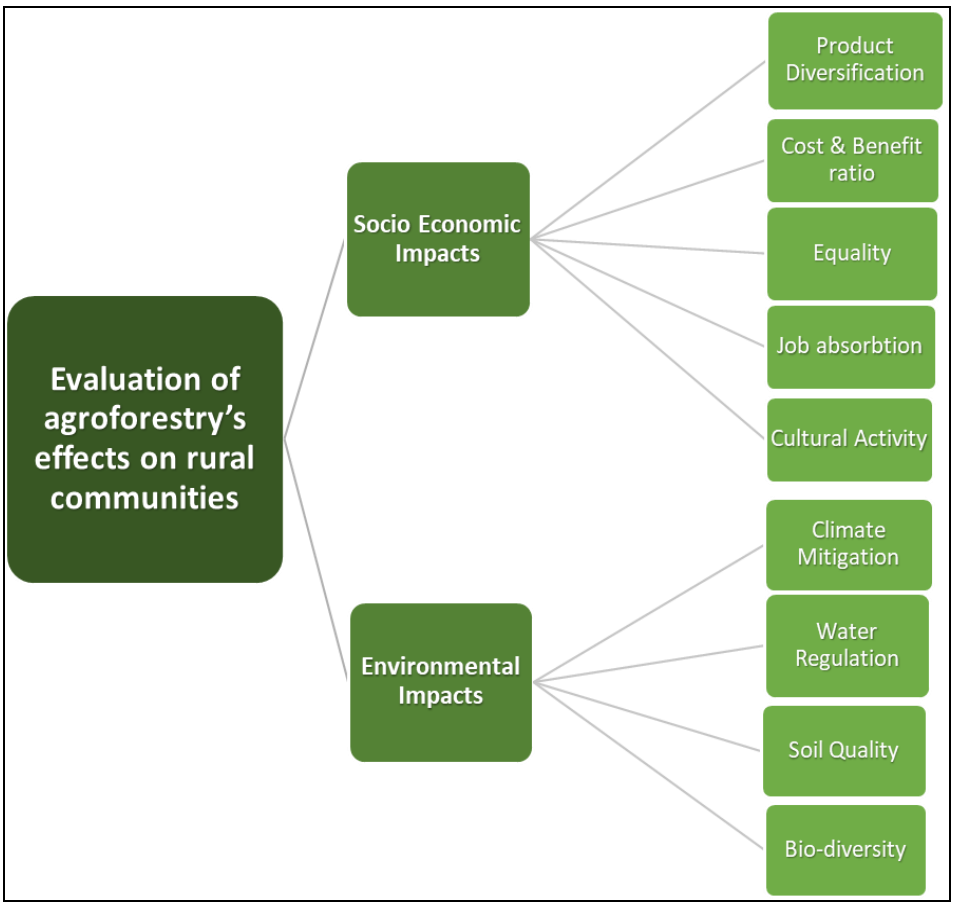

Fig 1: Effects of agroforestry and its importance

3. Lacunae in agroforestry

Since India's independence, several agencies, institutions, and organizations have worked to promote forestry and agroforestry, both in natural forests and in agricultural land use systems. This may be seen in the way that agroforestry and Indian forests helped to meet the need for wood for domestic and industrial purposes (Handa and Dhyani, 2015) [20]. In 1952, the Indian government adopted the countrys' first National Forest Policy, which mandated that trees and forests must cover one-third of the country's total land area. At the exact same time, increased focus was placed on the emergence of new wood-based businesses, which mostly sourced their raw materials from unmanaged forests. One of the main obstacles to conducting effective agroforestry impact evaluations is the length of the research. For instance, it may take decades to witness the effects of a specific agroforestry system since trees take time to develop than annual crops. However, project financing may only be available for a short time, which might result in the research coming to an end before its real influence is felt in the field. This issue can be solved by a research study employing a model for prediction to calculate the effects of various agroforestry systems in relation to other potential land uses, such as a widely used traditional system (monoculture). The effects of agroforestry systems on society and the environment may be estimated using model parameters such as above-ground biomass, tree growth rates, the amount of vegetation, the ability to store carbon, and changes in input and product costs (Jalón *et al*., 2018; Kraft *et al*., 2021) [16, 29]. Limitations of collaboration amongst studies, particularly those addressing socio-economic and ecological effects concurrently, is another weakness in agroforestry research. However, the bulk of agroforestry research conduct impact evaluations based on each individual factor, such as social, economic, and environmental characteristics independently. For instance, research on the financial and environmental benefits of agroforestry is quite well-established. To assess the combined socio-economic and environmental effects of agroforestry on rural communities, many methodologies have been used. For example, the Public Goods Tool (PG tool) was used as a tool for multi-criteria analysis to look at the sustainability of agroforestry (Mukhlis *et al*., 2022; Paraskevopoulou *et al*., 2020) [39, 42] in rural regions of Northern, Southern, and Eastern Europe (Smith *et al*., 2022) [54]. Analysing the socioeconomic and ecological effects of agroforestry on the indigenous Kichwas community in Ecuador (Heredia *et al*., 2020) [22] using the Response-Inducing Sustainability Evaluation (RISE) technique, was similar (Loss *et al*., 2021; Grenz *et al*., 2022) [32, 19]. To evaluate the impact of agroforestry both quantitatively and qualitatively, PG tool and RISE collect data from respondents by questionnaire and/or interview. Each question is developed based on certain standards. For instance, the PG Tool uses SAFA (Sustainability Assessment of Food and Agriculture System) indicators (Smith *et al*., 2022) [54], which cover the areas of ethical leadership, environmental stewardship, economic toughness, and social wellbeing. The sustainability index is then scored using the data gathered from the PG Tool and RISE methodology before being converted into a particular diagram (i.e., radar chart). Therefore, a diagram like this may be used to more clearly illustrate the trade-offs between agroforestry systems and other potential land uses. As a result, it enables academics and policymakers to better understand how agroforestry affects both people and the environment.

4. Agroforestry value chain approach

Commodity value chains are the full set of activities required to produce an item or service from inception through different manufacturing stages, transformation, and distribution to final consumers, and finally disposal after use. Marketing to farmers has received little attention in the past and has received inadequate understanding (Kaplinsky and Morris, 2002) [26]. A chain can go from the smallest size to the largest. Or, 'actors'-people or organizations who engage in a variety of activities-may do so, including gatherers, processors, traders, merchants, and service providers. The relationships between actors and chain control are referred to as chain governance (Gereffi and *et al*., 2005; Helmsing and Vellema, 2011) [18, 21]. To analyse both firm- and industry-level competitive strengths and weaknesses, the value chain must be dissected into its strategic components to better comprehend each component's effect on cost and value (Stabell and Fjeldstad, 1998) [56]. Further imply that value chain analysis, "an approach to the analysis of firm-level competitive advantage based on the theory of three value creation technologies and logics," must evolve into value configuration analysis. In accordance with Stabell and Fjeldstad, the primary activity and support activity categories change for each of the value configurations (Baig and Akhtar, 2011) [1]. The value chain-based industrial agroforestry promotion has attracted significant interest from the wood-based industries, farmers who grow trees, and other value chain participants. As a result, the area has expanded, productivity has improved, more industries are participating, socioeconomic growth has occurred, and the carbon sequestration process has been accelerated. Due to their intrinsic complexity, agroforestry market system connections are less developed or obvious than those in value chains for single staple crops. A flexible market systems strategy may be used to connect, provide value-added services, and promote market access among smallholder producers and agribusinesses while eliminating direct actions that run the risk of further upsetting the market system (Singh *et al*., 2023) [51]. The market systems approach strives to boost the efficiency, efficacy, and profitability of value chains for all stakeholders in the short to medium term with an emphasis on vulnerable and disadvantaged groups, particularly women (Eastwood *et al*., 2010) [14]. The use of a market systems approach is preferred to support sustainable, equitable, and inclusive change since agroforestry is a diverse market system (Kinyili and Ndunda, 2021) [27]. India stands out as one of the few tropical nations that have had a constant rise in forest cover over the past 20 years. Agroforestry has drawn a lot of attention as a feasible land-use system because to its critical role in supplying home and industrial wood demands. However, there is now a large gap between the supply and demand of wood and wood products because of the growing need for wood and the legal difficulties associated with collecting wood from government-owned forests. The adoption of a "value chain model" has become crucial in order to solve this problem and guarantee sustainability in the production and supply of industrial wood. In order to promote collaboration and coordination across the wood supply chain for long-term viability and ecological balance, this approach engages a wide range of stakeholders.

5. Innovations and its Approaches

a. Technological Development Innovations

Numerous authorities, institutions, and organizations have worked to promote forestry and agroforestry since India gained its freedom, both in naturally occurring forests and in agricultural land use systems. The importance that Indian forests and agroforestry plantations have played in supplying home and industrial wood needs is evidence of this (Handa and Dhyani,

2015) [20]. Despite being a long-standing tradition, agroforestry has evolved in response to comparable challenges in numerous, frequently isolated societies and is still being improved upon by the local communities who employ it (Fujisaka and Wollenburg, 1991) [15]. The creation of novel technologies has been essential in filling in research gaps, resolving issues, and expanding the field of agroforestry. This development included developments in the fields of organization, technology, and marketing. Traditional methods of forestry and agroforestry depended on genetic resources that were not upgraded, which resulted in low yield and lengthy harvesting times. Practices were also founded on traditional wisdom, which led to a disjointed and multipartite supply chain (Buck, 1995) [9]. The creation and use of High Yielding Short Rotation (HYSR) clones, which have greatly increased output, is the only noteworthy development. These high yielding clones produce more than 25 m3 / ha/year as opposed to less than 10 m3 / ha/year earlier thanks to the adoption of stronger genetic stocks. These clones are designed to meet particular technical specifications, allowing for harvesting over a period of 48 months for plywood utility and between 16 and 18 months for pulp and paper utility. Mini clonal Technology adoption has also had a transformational impact. Agroforestry plantations have historically relied on seed-based descendants with variable and uneven productivity. Genetic uniformity and large-scale multiplication have been made possible thanks to the development of Mini clonal technology, giving it a significant edge over traditional mass multiplication techniques. The design and development of machinery is a key component of technological advancement in agroforestry. Machines have increased the efficiency of tasks like pitting and debarking, solving the labour shortage and easing human suffering (Pollini, 2009) [46]. These modern innovations have helped agroforestry become a more achievable and attractive land-use system by enhancing its sustainability, productivity, and income creation.

b. Organizational innovations

Contract tree farming was created and implemented as a result of the restructuring of the agroforestry industry's unorganized supply chain, ensuring improved cooperation between farmers and industries. An organized value chain model has taken the place of the prior multiparty supply chain. Three contract tree farming models were created and put into practice in collaboration with the pulp and paper, energy, matchwood, plywood, and timber businesses. The formation of the consortium was coordinated with technology-based agroforestry development under India's National Agroforestry Policy (Bhan and Behera, 2014) [4] to meet policy goals in the forestry and agroforestry sectors (Kumar *et al*., 2021) [31]. The Consortium of Industrial Agroforestry is a self-sufficient business that makes money through a variety of ventures (Minz *et al*., 2021) [37]. The consortium's wood-based companies contribute money to research and development. The current research team has pioneered in conceptualizing and establishing an exclusive institution called Consortium of Industrial Agroforestry (CIAF) to sustain the organizational structure and resolve the issues from the entire production to consumption system in agroforestry in order to further strengthen the organizational linkages and to create institutional mechanisms (Parthiban *et al*., 2019) [45]. In order to promote and facilitate coordinated agroforestry promotion and growth, the consortium was created using a self-sustainability model and includes all supply and value chain participants of different wood-based sectors. Overall, structured agroforestry, collaboration, and the development of sustainable wood-based enterprises have all benefited greatly from the design and implementation of contract tree farming as well as the founding of the Consortium.

c. Marketing innovations

Forestry and agroforestry land use systems, in contrast to agriculture and other land use systems, require a sustainable approach that takes into account the nature and type of growth and development. The Consortium of Industrial Agroforestry institutionalized the advancements made through organizational, technological, and commercial techniques. To maintain the income and continue the employment creation efforts, it was necessary to create company development prospects. Lack of guaranteed buyback and price support is one of the biggest issues facing farmers who plant trees. By creating a market support structure and assuring a buyback by the Consortium industries, this problem has been handled. The price support scheme was initially only extended to species of pulpwood, but it is now also extended to species of plywood, matchwood, energy, and timber. The price support system was developed through ongoing price and market analysis and mutual interaction with all parties involved in the production to consuming system. Markets and marketing for agroforestry in India cover the flow of goods and services from producers to consumers. The interchange of forest, agricultural, and livestock goods in particular places is at the heart of the agroforestry market. The lack of well-established marketing organizations, market data, and uniform quality grades are just a few of the clear contrasts between agroforestry marketing and agriculture marketing, despite the latter's similarities (Parthiban *et al*., 2020) [44]. Despite these difficulties, agroforestry has several advantages, such as effective resource management, optimal output, higher agricultural revenue, market expansion, and the development of companies dependent on forests (Parthiban and Fernandaz, 2017) [43].

6. Characteristics of agroforestry adoption in developing countries

Agroforestry has drawn a lot of interest in India because of its function in the production of raw materials and its contribution to ecosystem services. In developing nations, agriculture is essential since it becomes the primary means of support for the majority of people, especially those who reside in rural regions (Diao *et al*., 2010) [12]. Rural populations have traditionally used traditional agroforestry to increase their standard of living. Communities that are close to forests, for example, frequently use forest goods, such as selling lumber or enjoying the fruits or edible plants that grow naturally there (Kalaba *et al*., 2010) [25]. Additionally, in order to make a livelihood, subsistence farmers in remote regions frequently plant crops in addition to cultivating some perennial trees or raising livestock (Duffy *et al*., 2021; Soler *et al*., 2018) [13, 55]. Around the world, there are generally a number of agroforestry techniques used, including silvoarable systems (combinations of trees/shrubs with crops), silvopastoral (combinations of trees and livestock), Agro-silvopastoral (combinations of shrubs/trees with both crop and livestock), multipurpose trees, riparian buffer, and improved fallow (Mosquera Losada *et al*., 2008) [38] (Table 1). Despite the claimed advantages, developing nations still embrace agroforestry at a very low rate (Mbow *et al*., 2014; McGinty *et al*., 2008; Iskandar *et al*. 2016) [34, 35, 24]. Farmers' lack of awareness of agroforestry methods, a lack of legislative support, and restricted access to funds are among the obstacles to the establishment (Beyene, 2019) [3].

There is little acknowledgement of such tree-based systems to address the climate issue and enhance rural livelihoods since agroforestry is not included in public policy (Bishaw *et al*., 2013; Beddington *et al*., 2012) [6, 2].

Table 1: Several practices of agroforestry that are commonly adopted in several developing countries and their brief description

Types of Practices	Descriptions
Silvoarable	Forests are grown with seasonal or perennial crops. It includes lined belts, dispersed trees, and alley cropping.
Silvopastoral	Integrating the use of trees with animal production and fodder. It includes open forest trees and forested or forest grazing.
Agro-silvopastoral	Combining annual crops and animal production with trees, albeit the agricultural and livestock parts are often separated in time and space.
Multipurpose trees	On order to provide fruit, fuelwood, fodder, and timber, among other things, fruit and other trees are planted on cropland or pasture.
Riparian buffer	Between cropland/pastures and water sources such streams, lakes, marshes, and ponds, there should be strips of perennial vegetation (tree/shrub/grass), either natural or cultivated, to safeguard the water quality.
Improve fallow	In shifting land use, rapidly developing generally leguminous woody plants are planted. Additionally, this species can increase soil fertility and provide useful goods.

7. Socio-economic impact of agroforestry

Due to the land's limitations and the agroforestry system's ability to boost output on the same plot of land, marginal and small landholdings of farmers see a large societal benefit. Growing the area covered by agroforestry and the value chain development activities linked with it, such as developing nurseries, plantations, creating institutions for falling trees, and organizing marketing groups, have produced sustainable job and revenue production activities. In Rajasthan, Uttar Pradesh, and Gujarat in India, where agroforestry was introduced, it was discovered that more benefits to women's conditions were found when women and children were enrolled in the agroforestry system (Bose, 2015) [7]. This is because the head of the family takes more care of the cultivation there. When comparing the socioeconomic circumstances of agroforestry and non-agroforestry farmers in Bangladesh, it was found that agroforestry farmers fared better than non-agroforestry farmers both socially and economically (Chakraborty *et al*., 2015) [10]; this finding was also found in eastern Uttar Pradesh (Singh, 2019) [52]. Similar to this, a research conducted in the Nilgiris Biosphere Reserve in Kerala discovered that farmers who used any type of agroforestry system in their farming methods had considerable benefits, including increased food production, improved livelihood security, additional revenue, and decreased climate pollution (Kumar, 2006) [30]. Due to the system's significant direct and indirect benefits, agroforestry aids in the study of ecosystem conservation, biodiversity preservation, product production, carbon sequestration, soil fertility in degraded areas, income generation, and socioeconomic profitability (Singh and Pandey, 2011) [53]. An agroforestry system focuses on enhancing or strengthening the sustainability of socioeconomic return as well as a sustainable method of enhancing the landscape through the planting of native tree species (Kittur and Bargali, 2013) [28]. Agroforestry skills were supplied to small people that depend on this system for their livelihoods, such as subsistence farmers, allowing them to swiftly create revenue while also aiding in the storage of carbon and limiting adaptable environmental change (Buchman *et al*., 2008) [8]. The importance of agroforestry increased due to the fact that trees provide a significant natural resource for cleaning the environment, and the mix of agricultural products improves soil fertility, which benefits local plants and microorganisms. Farmers have now decided that agroforestry is a viable alternative to traditional 'modern' agricultural approaches, and the socio-economic advantages it provides are crucial (Saha *et al*., 2010) [50]. According to reports, agroforestry is a supporting and sustainable activity in this region and is essential to the numerous aspects of a household's subsistence (Bijalwan *et al*., 2011) [5].

When small landholders adopt agroforestry practices and grow crops like medicinal plants, fruit trees, nuts, and fodder in place of grass, fuel wood, and timber, they benefit more and improve their standard of living (Raj *et al*., 2019) [48]. The most common traditional agroforestry systems that supported socioeconomic status and livelihoods were Agri-silviculture, Agri-horticulture, and Agri-Horticulture in the Indian Garhwal Himalaya. According to reports from the examined region, agroforestry systems boost farmers' income, the ease with which they may get firewood and lumber on their property, the preservation of natural forest, and the socioeconomic well-being of rural residents (Raj and Chandrawanshi, 2016) [47]. Because of the yearly revenue created by the agricultural solitary crop system as opposed to the installation of an agroforestry system, agriculture often provides advantages more rapidly.

8. Conclusion and future scope

Agroforestry is a system or contemporary, scientifically advanced technology that enables farmers to better our security of socioeconomic situations and environment cleanliness by cultivating all crop components on a fixed-size plot of land. Because of the woods' abundant biodiversity, they continue to play a significant part in enhancing rural populations' quality of life. Natural forests can therefore supply for your needs in terms of energy, food, nutrition, and health. More and more people throughout the world are realizing the value of agroforestry systems in producing environmental services including carbon sequestration, improved water quality, and biodiversity. Agroforestry has been used as a system of land use from the beginning of time, but it has only been used for industrial and commercial purposes for the past two to three decades, and this has led to a number of difficulties and limitations due to the lack of appropriate interventions at various levels. Understanding agroforestry techniques gives commendable chances to develop answers to the global issues of self-sufficiency and the provision of essential necessities. It is suggested that farmers constantly promote awareness campaigns, correct management practices, and the use of appropriate planting materials. Despite several studies highlighting the advantages of agroforestry, few emerging nations have quickly shifted to this type of tree-based farming. One of the reasons might be that the core narrative - "a monoculture system with high output" - goes against agroforestry (Ollinaho and Kröger, 2021) [40]. Agroforestry uses a more intricate system with a variety of components (tree species, crops, and/or animals), and it depends on the interaction of each component to get the best results in terms of both economic performance and environmental sustainability. There have been several attempts to popularize the idea of agroforestry

by working with the business sector and emphasizing the growth of vast plantations. The practice of "industrial" agroforestry is specifically cited as a cause for worry, despite the fact that the technique is generally seen as a positive attempt to increase adoption rates. Such a method may eventually transition from having more diverse components to a small-scale intercropping system where one type of tree serves as the main source of output. Instead, agroforestry may be used to restore soil quality and increase biodiversity in degraded regions outside of main forests. Many rural areas, especially those with smallholder farmers, lack the necessary land, seedlings, and germplasm to establish an agroforestry system. These resources are often controlled by businesses or governments (Gebru *et al*., 2019) [17]. In order to make such degraded lands available to anyone who are interested in implementing agroforestry systems, government or NGOs may do so. In order to increase communities' economic resilience, the government can also provide temporary aid such as market access, post-harvest equipment, or price stability.

Conflict of Interest: The authors should declare that they do not have any conflict of interest.

Author contributions: Conceptualization the review work (S. Kundu, S. Sengupta, S. Kanthal, T. Sarkar); Preparation of manuscript (S. Mondal, D. Sasmal, P. Ghosh, S. Modak, S. Kundu); Edition and checking of the manuscript (S. Kundu, S. Sengupta, S. Kanthal, T. Sarkar). All the authors approved the final version of the manuscript prior to submission.

Acknowledgement
Authors acknowledge the library assistance from the Swami Vivekananda University, Barrackpore, West Bengal, India.

Références

1. Baig VA, Akhtar J. Retracted: Supply Chain Management: Value Configuration Analysis Approach: A Case Study; c2011.
2. Beddington JR, Asaduzzaman M, Clark ME, Fernández Bremauntz A, Guillou MD, Howlett DJB, *et al*. What next for agriculture after Durban? Science. 2012;335(6066):289-90.
3. Beyene AD, Mekonnen A, Randall B, Deribe R. Household level determinants of agroforestry practices adoption in rural Ethiopia. Forests, Trees and Livelihoods. 2019;28(3):194-213.
4. Bhan S, Behera UK. Conservation agriculture in India–Problems, prospects and policy issues. International Soil and Water Conservation Research. 2014;2(4):1-12.
5. Bijalwan A, Mohan Sharma C, Kediyal VK. Socioeconomic status and livelihood support through traditional agroforestry systems in hill and mountain agro-ecosystems of Garhwal Himalaya, India. Indian Forester. 2011;137(12):1423.
6. Bishaw B, Neufeldt H, Mowo J, Abdelkadir A, Muriuki J, Dalle G, *et al*. Farmers' strategies for adapting to and mitigating climate variability and change through agroforestry in Ethiopia and Kenya; c2013.
7. Bose P. India's drylands agroforestry: A ten-year analysis of gender and social diversity, tenure and climate variability. International Forestry Review. 2015;17(4):85-98.
8. Buchmann N, Dorn S, Mody K, Plath M, Eugster W, Wolf S. Agroforestry for carbon sequestration to improve small farmer's livelihoods. ETH Zurich; c2008. p. 26-26.
9. Buck LE. Agroforestry policy issues and research directions in the US and less developed countries: insights and challenges from recent experience. In: Agroforestry: Science, Policy and Practice: Selected papers from the agroforestry sessions of the IUFRO 20th World Congress, Tampere, Finland, 6–12 August 1995. Springer Netherlands; c1995. p. 57-73.
10. Chakraborty M, Haider MZ, Rahaman MM. Socio-economic impact of cropland agroforestry: Evidence from Jessore district of Bangladesh. International Journal of Research in Agriculture and Forestry. 2015;2(1):11-20.
11. Dhinnan RC. Status and impact of commercial agroforestry in India. Indian J. of Agroforestry Vol. 2013;15(2):55-67.
12. Diao X, Hazell P, Thurlow J. The role of agriculture in African development. World development. 2010;38(10):1375-83.
13. Duffy C, Toth GG, Hagan RP, McKeown PC, Rahman SA, Widyaningsih Y, *et al*. Agroforestry contributions to smallholder farmer food security in Indonesia. Agroforestry Systems. 2021;95(6):1109-24.
14. Eastwood R, Lipton M, Newell A, Pingali PL, Evenson RE. Handbook of agricultural economics. In: Handbook of Agricultural Economics. Elsevier North-Holland; c2010. p. 3323-97.
15. Fujisaka S, Wollenberg E. From forest to agroforest and logger to agroforester: a case study. Agroforestry systems. 1991;14:113-29.
16. García de Jalón S, Graves A, Palma JH, Williams A, Upson M, Burgess PJ. Modelling and valuing the environmental impacts of arable, forestry and agroforestry systems: A case study. Agroforestry systems. 2018;92:1059-73.
17. Gebru BM, Wang SW, Kim SJ, Lee WK. Socio-ecological niche and factors affecting agroforestry practice adoption in different agroecologies of southern Tigray, Ethiopia. Sustainability. 2019;11(13):3729.
18. Gereffi G, Humphrey J, Sturgeon T. The governance of global value chains. Review of international political economy. 2005;12(1):78-104.
19. Grenz J, Thalmann C, Stämpfli A, Studer C, Häni F. RISE–a method for assessing the sustainability of agricultural production at farm level. Rural Development News. 2009;1(2009):5-9.
20. Handa AK, Dhyani SK. Three decades of agroforestry research in India: Retrospection for way forward. Agricultural Research Journal. 2015;52(3):1-10.
21. Helmsing AHJ, Vellema S. Value chains, inclusion and endogenous development contrasting theories and realities. Abingdon: Routledge; c2011.
22. Heredia-R M, Torres B, Cayambe J, Ramos N, Luna M, Diaz-Ambrona CG. Sustainability Assessment of Smallholder Agroforestry Indigenous Farming in the Amazon: A Case Study of Ecuadorian Kichwas. Agronomy. 2020;10(12):1973.
23. Ingwe R, Ushie M, Ojong FE, Okeme I. Pursuing Sustainable Development through agroforestry in Nigeria: Geodemographic and Spatial Analyses of agroforestry implementation in 36 States and capital territory. Journal of Sustainable Development in Africa. 2009;11(4):101-33.
24. Iskandar J, Iskandar BS, Partasasmita R. Responses to environmental and socio-economic changes in the Karangwangi traditional agroforestry system, South Cianjur, West Java. Biodiversitas Journal of Biological Diversity, 2016, 17(1).
25. Kalaba KF, Chirwa P, Syampungani S, Ajayi CO. Contribution of agroforestry to biodiversity and livelihoods

improvement in rural communities of Southern African regions. In: Tropical rainforests and agro-forests under global change: ecological and socio-economic valuations; c2010. p. 461-476.
26. Kaplinsky R, Morris M, Readman J. The globalization of product markets and immiserizing growth: lessons from the South African furniture industry. World development. 2002;30(7):1159-77.
27. Kinyili BM, Ndunda E. Chapter-6 Potential of Agroforestry to Improve Rural Income and Livelihoods in Sub-Saharan Africa. In: Chief Editor Dr. Jai Kumar, ed.; c2021. p. 105.
28. Kittur BH, Bargali SS. Perspectives of agroforestry: Present and future facets. Journal of Progressive Agriculture. 2013;4(2):91-94.
29. Kraft P, Rezaei EE, Breuer L, Ewert F, Große-Stoltenberg A, Kleinebecker T, *et al*. Modelling Agroforestry's contributions to people: A review of available models. Agronomy. 2021;11(11):2106.
30. Kumar BM. Carbon sequestration potential of tropical homegardens. In: Tropical homegardens: A time-tested example of sustainable agroforestry. Springer, Dordrecht; c2006. p. 185-204.
31. Kumar R, Singh JK, Singh AK, Minz SD, Kumar NM. Boron management in green gram (Vigna radiata L. Wilczek) under Custard Apple (*Annona squamosa* L.) based agri-horti system in semiarid region. Annals of Arid Zone. 2021;60(3&4):01-05.
32. Loss SR, Noden BH, Fuhlendorf SD. Woody plant encroachment and the ecology of vector-borne diseases. J Appl. Ecol. 2022;59(2):420-430.
33. Lungren BO, Raintree JB. Sustained agroforestry. In: Agricultural Research for Development: Potentials and Challenges in Asia; c1982. p. 37-49.
34. Mbow C, Van Noordwijk M, Luedeling E, Neufeldt H, Minang PA, Kowero G. Agroforestry solutions to address food security and climate change challenges in Africa. Curr Opin Environ Sustain. 2014;6:61-67.
35. McGinty MM, Swisher ME, Alavalapati J. Agroforestry adoption and maintenance: self-efficacy, attitudes and socio-economic factors. Agrofor Syst. 2008;73:99-108.
36. Mercer DE. A framework for analyzing the socio-economic impacts of agroforestry projects; c1993.
37. Minz SD, Singh AK, Kumar NM, Singh BK. Effect of crop geometry and nitrogen management on growth attributes of pearl millet (*Pennisetum glaucum* L.) under guava based Agri-Horti system. Pharma Innov J. 2021;10(9):2191-2195.
38. Mosquera-Losada MR, McAdam JH, Romero-Franco R, Santiago-Freijanes JJ, Rigueiro-Rodróguez A. Definitions and components of agroforestry practices in Europe. In: Agroforestry in Europe: Current status and future prospects; c2009. p. 3-19.
39. Mukhlis I, Rizaludin MS, Hidayah I. Understanding socio-economic and environmental impacts of agroforestry on rural communities. Forests. 2022;13(4):556.
40. Ollinaho OI, Kröger M. Agroforestry transitions: The good, the bad and the ugly. J Rural Stud. 2021;82:210-221.
41. Papiya C, Tewari HR, Jha MK. Sustainable rural livelihoods through participatory Natural Resources Management: A case study. J Rural Dev (Hyderabad), 2009, 28(1).
42. Paraskevopoulou C, Theodoridis A, Johnson M, Ragkos A, Arguile L, Smith L, *et al*. Sustainability assessment of goat and sheep farms: A comparison between European countries. Sustainability. 2020;12(8):3099.
43. Parthiban KT, Fernandaz CC. Industrial agroforestry-Status and developments in Tamil Nadu. Indian J Agrofor. 2017;19(1):1-11.
44. Parthiban KT, Kumar NK, Fernandez CC. Forest business incubator-an innovative institution for business development in forestry and agroforestry sector in India. Indian For. 2020;146(7):584-591.
45. Parthiban KT, Sudhagar RJ, Fernandaz CC, Krishnakumar N. Consortium of Industrial Agroforestry. Curr. Sci. 2019;117(1):30-36.
46. Pollini J. Agroforestry and the search for alternatives to slash-and-burn cultivation: From technological optimism to a political economy of deforestation. Agric. Ecosyst. Environ. 2009;133(1-2):48-60.
47. Raj A, Chandrawanshi S. Role of agroforestry in poverty alleviation and livelihood support in Chhattisgarh. South Indian J Biol Sci. 2016;2(3):326-330.
48. Raj A, Jhariya MK, Yadav DK, Banerjee A, Meena RS. Agroforestry: a holistic approach for agricultural sustainability. In: Sustainable agriculture, forest and environmental management; c2019. p. 101-131.
49. Rigueiro-Rodríguez A, Fernández-Núñez E, González-Hernández P, McAdam JH, Mosquera-Losada MR. Agroforestry systems in Europe: productive, ecological and social perspectives. In: Agroforestry in Europe: current status and future prospects; c2009. p. 43-65.
50. Saha SK, Ramachandran Nair PK, Nair VD, Mohan Kumar B. Carbon storage in relation to soil size fractions under tropical tree-based land-use systems. Plant Soil. 2010;328:433-446.
51. Singh AK, Kumar NM, Singh BK, Agnihotri D, Karada MS. Incorporating agroforestry approaches into commodity value chains: A review; c2023.
52. Singh V. Study on socio-economic status and characteristics of farmers adopting agroforestry system in Kaushambi district of eastern Uttar Pradesh, India. Int. J Farm Sci. 2019;9(4):83-88.
53. Singh VS, Pandey DN. Multifunctional agroforestry systems in India: science-based policy options. Jaipur, India: Climate Change and CDM Cell, Rajasthan State Pollution Control Board; c2011.
54. Smith LG, Westaway S, Mullender S, Ghaley BB, Xu Y, Lehmann LM, *et al*. Assessing the multidimensional elements of sustainability in European agroforestry systems. Agric. Syst. 2022;197:103357.
55. Soler R, Peri PL, Bahamonde H, Gargaglione V, Ormaechea S, Herrera AH, *et al*. Assessing knowledge production for agrosilvopastoral systems in South America. Rangeland Ecol. Manag. 2018;71(5):637-645.
56. Stabell CB, Fjeldstad ØD. Configuring value for competitive advantage: on chains, shops, and networks. Strategic Management J. 1998;19(5):413-437.
57. Upadhyay VK, Singh MP, Nandawar A, Kushwaha PK, Murthy N, Kumar M. Statistics, trend and scenario of wood log import in India. Indian For. 2021;147:01-11.