Обзор / Review

https://doi.org/10.18619/2072-9146-2024-4-111-119
УДК: 630*2:630*182

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Funding. I am ensured that this study didn't get any financial support from any funding agencies Conflicts of interest. The author declare that there is no potential conflict of interest.

Authors' Contribution: Alemitu Worku planned this review, and prepared the first manuscript, Finally author read and agreed on the final manuscript.

Acknowledgements. First, I would like to thank Almighty of God for allowing me to complete this review in peace patience and with great honor. Next I would like to acknowledge Ethiopian forestry development Jimma center.

Ethical considerations. I declared that this manuscript is not submitted for possible publication to other journal publishers. In addition to this, I confirmed that this result is free of research misconduct.

Research limitations. There is a limitation on the role of Agroforestry in ecosystem and especially on mitigation of climate change.

For citation: Worku A. The Role of Agroforestry in Ecosystem Services and Mitigation of Climate Change. *Vegetable crops of Russia.* 2024;(4):111-119. https://doi.org/10.18619/2072-9146-2024-4-111-119

Received: 25.03.2024
Accepted for publication: 16.06.2024
Published: 08.07.2024

The Role of Agroforestry in Ecosystem Services and Mitigation of Climate Change

ABSTRACT

Relevance. **Agroforestry systems are believed to provide a multitude of ecological services. It is thought that agroforestry enhances resilience to the impacts of climate change and aids in adaptation by supporting diverse land use practices, sustainable lifestyles, and income streams, as well as increasing productivity in both forests and agriculture, and reducing weather-related losses in production.**

Results and Discussion. **The aim of this review was to present genuine evidence on the role of agroforestry in ecosystem conservation and mitigation of climate change impacts. Compared to monocropping and open cereal-based agriculture, agroforestry has made a more significant contribution to ecosystem conservation and in reducing carbon dioxide emissions. However, it has been found that agroforestry contributes less to carbon sequestration than natural forests. Carbon sequestration through above-ground and underground biomass, carbon emission reduction from deforestation, and microclimate adjustment are key measures for mitigating climate change. Agroforestry systems provide essential ecosystem services, such as food, fuel wood, fodder, income, and improved soil production, which enable communities to cope better with the impacts of climate change. Therefore, agroforestry must be given significant attention if it is to play a crucial role in ecosystem management.**

KEYWORD:

Agriculture, Biodiversity, Carbon dioxide, Homegarden, Species diversity

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Вклад авторов: Алемиту Ворку спланировал эту рукопись и подготовил первую рукопись, Наконец автор прочитал и согласовал окончательную рукопись.

Конфликт интересов. Автор заявляет об отсутствии конфликта интересов.

Для цитирования: Worku A. The Role of Agroforestry in Ecosystem Services and Mitigation of Climate Change. *Vegetable crops of Russia.* 2024;(4):111-119. https://doi.org/10.18619/2072-9146-2024-4-111-119

Поступила в редакцию: 25.03.2024
Принята к печати: 16.06.2024
Опубликована: 08.07.2024

Роль агролесоводства в экосистемных услугах и смягчении последствий изменения климата

РЕЗЮМЕ

Актуальность. **Считается, что агролесомелиорационные системы предоставляют множество экологических услуг. Считается, что агролесоводство повышает устойчивость к последствиям изменения климата и помогает в адаптации, поддерживая разнообразные методы землепользования, устойчивый образ жизни и потоки доходов, а также повышая продуктивность как в лесах, так и в сельском хозяйстве, а также сокращая потери производства, связанные с погодой.**

Результаты. **Целью этого обзора было представить достоверные данные о роли агролесомелиорации в сохранении экосистем и смягчении последствий изменения климата. По сравнению с монокультурным и открытым сельским хозяйством, основанным на выращивании зерновых, агролесоводство внесло более значительный вклад в сохранение экосистем и сокращение выбросов углекислого газа. Однако было обнаружено, что агролесоводство в меньшей степени способствует связыванию углерода, чем естественные леса. Связывание углерода за счет надземной и подземной биомассы, сокращение выбросов углерода в результате вырубки лесов и корректировка микроклимата являются ключевыми мерами по смягчению последствий изменения климата. Системы агролесомелиорации обеспечивают важные экосистемные услуги, такие как продукты питания, дрова, фураж, доход и улучшенное плодородие почвы, что позволяет общинам лучше справляться с последствиями изменения климата. Поэтому агролесоводству необходимо уделять значительное внимание, если оно должно играть решающую роль в управлении экосистемами.**

КЛЮЧЕВЫЕ СЛОВА:

сельское хозяйство, биоразнообразие, углекислый газ, приусадебный участок, видовое разнообразие

1. Introduction

Crop productivity may be conserved while offering an alternative solution to ecological problems by applying agroforestry [1-3]. Depending on the spatial layout or temporal sequence, this system combines animal production, crop cultivation, and/or tree culture on the piece of land [4]. Agroforestry may help in the conservation of natural ecosystems through efficient resource management and sustainable land management (including reforestation) [5]. Agroforestry also has a significant role to condense greenhouse gas (GHG) emissions since it incorporates a number of activities that have been found to promote carbon absorption [6]. Additionally, the system can support biodiversity by incorporating a variety of plant and agricultural species that can serve as habitats for a variety of wildlife [7, 8]. Agroforestry has been demonstrated to provide socioeconomic benefits for rural residents in addition to its favorable effects on the environment [9]. The community's economic resilience might be improved by implementing a large-scale agro-ecosystem including animals, plants and other agricultural crops [10]. The method may potentially improve family food security through a range of food sources [11]. Therefore, agroforestry may be able to assist with present socioeconomic issues.

According to Ripple, Wolf [12], in order to keep the increase in global temperature to 1.5 degrees Celsius, which is now occurring due to climate change, immediate action is needed [13]. Extreme droughts, flooding, and diseases are just a few of the climate change hazards that can seriously harm agricultural systems and cause soil erosion, crop failure, biodiversity loss, reduced soil moisture, insect damage, and economic losses. Due to increased severe occurrences and frequent drier and wetter weather that endangers present production methods and food supply, farmers are now finding it challenging to plan planting and harvesting [14]. Agriculture, forests, and trees are crucial for reducing carbon emissions and achieving the targets set forth in the Paris Agreement, by replanting the appropriate plant species in the appropriate location (site), farmers may make adjustments to the effects of climate change [15]. Literature has shown that due to its economic, social and environmental benefits [16], agroforestry is the common experience that has been promoted throughout in the world [17]. It's also an instrument for diversifying production from a single land unit [18].

Ethiopia's population is growing rapidly, leading to increasing demands for food, energy, and other resources. This is driving the expansion of cropland into the remaining forests and woodlands in the country. Agricultural investment and small-holder farming continue to be major contributors to Ethiopia's greenhouse gas emission levels [19]. In response to these challenges, the Ethiopian government has identified agroforestry as a critical component of its Forestry Strategic Plan, Climate Resilient Green Economy strategy, and Sustainable Land Management program. Agroforestry, which integrates trees with crops and/or animals, has gained significant attention and focuses from the government as a practice that can help address the countries environmental and food security concerns. Agroforestry system is the basic extension package in Ethiopia [20]. Because it is highly practice in all parts of the country in different configuration like tree-enset-coffee, tree-enset, and woodlot, scattered trees on farmland and pasture land, and boundary planting [21]. Agriculture is the mainstay of Ethiopian economy, which accounts 42-45% of the total gross domestic product (GDP) of the country [22]. However, it is adversely affected by soil erosion and land degradation [23], climate change [24], shortage of land and lack of proper land use [25]. Literature shows, tree-based agroforestry systems significantly contribute in alleviating poverty [26]. Although it is still debatable and much investigated, agroforestry systems may help maintain ecosystems [27]. Furthermore, there is a lack of empirical data about the relationships between household livelihood resilience and agroforestry, especially with regard to climate change mitigation [28]. Therefore, the purpose of this paper is to present empirical evidence on the particular role that agroforestry plays in both mitigating climate change impact and providing ecosystem services.

2. Socioeconomic benefits of Agroforestry

Agroforestry is distinct from other land-use systems because it incorporates a variety of plant species. This kind of tree-based farming can, from an economic standpoint, boost economic resilience by diversifying the goods produced [2]. Since they may meet a range of needs, such as offering rural residents alternative income sources, using multifunctional trees in particular may increase the profitability of agroforestry by providing food (such as wild edible fruits) or fodder during challenging times [29]. Furthermore, in addition to the income generated by their yearly crops, certain plant species with higher economic value can be able to provide income for the residents of the area. Due to the plant's delayed growth phase, teak-agroforestry (*Tectona grandis*) systems in Indonesia, shown to produce up to 12% of the total household income while having less of a recycling period [30]. Agroforestry is yet another technique to improve the benefit-to-cost ratio. Planting woody species that require less input (chemical fertilizers, pesticides) is one strategy that can enhance farmer income while lowering production costs [31].

The farmers' awareness of the procedure, especially in regards to choosing appropriate plants for their system, may have significant effects on the outcome. Growing certain trees next to complimentary crops might be beneficial. Contrarily, nutrient competition can be caused by the inappropriate selection of tree or crop components [32], which affects production and, subsequently, the farmers' profit.

According to Iskandar, Iskandar [33], the introduction of agroforestry in rural areas may open up new job options for off-farm work. Since they may participate directly in production operations, women may also got profit from greater work options, which might improve gender inequality in rural areas. Additionally, retaining jobs in rural areas can reduce the exodus of people from those places, improving the rural economy [34]. Agroforestry contribute the food and nutritional security of people who live close to forests while also producing income. In Indonesia, children between the ages of one and five were found to be taking micronutrients at a greater rate than was previously believed, according to Ickowitz, Rowland [35] examination of geographical data. Low-income farmers who had received agroforestry training upon it was introduced also shown better food yield and plant diversity this indicating improved food availability [36]. Implementation of agroforestry system has been positively correlated with family food security, according to findings from other research conducted in South Asia, Latin America, and Sub-Saharan Africa [37, 38].

3. Agroforestry for Ecosystem services

Agroforestry uses a number of ecological techniques that might enhance ecosystem provision in pastoral areas, these techniques include raising biodiversity, improving water quality, decreasing erosion, improving soil fertility, improving aesthetics, and sequestering carbon [37]. It is commonly known that agroforestry techniques provide services and advantages throughout a wide geographic and temporal scales. It is becoming more widely recognized as a part of a multipurpose working environment that provides economic commodities, environmental benefits, and ecological services.

Agroforestry systems give different biological system administrations, extending from the arrangement of nourishment, and fiber to non-commodity yields, such as climate, water and soil control and recreational, stylish and social legacy values [39]. Evaluation of these environment administrations makes information to get it the supply and request of environment administrations, to raise mindfulness, and to realize priority on the political motivation within the European Union [40]. Evaluations of biological system capacities and their potential arrangement of environment administrations to individuals have been overwhelmed by common sciences and financial matters [41]. The common approaches to assessment have been recognized as biophysical, socio-cultural and financial [42]. Montagnini [43] focused on the potential of agroforestry systems for sequestering carbon by looking at a number of case studies from across the world.

3.1. Agroforestry for Biodiversity conservation

Agroforestry is a new approach helps us in conservation of ecosystem through improving soil and microclimate properties, reduced erosion, and improved water quality, carbon sequestration and biodiversity conservation [44]. The five main functions of agroforestry system in biodiversity conservation are as follows [45]: (1) Agroforestry provides habitat for species that can withstand some degree of disturbance; (2) Agroforestry helps preserve sensitive species' germplasm; (3) Agroforestry minimize the rates at which natural habitat is converted by offering a more productive to traditional agricultural systems that may involve clearing natural habitats; (4) Agroforestry creates connectivity by creating corridors between habitat remnants, which may support the integrity of these remnants and the conservation of area-sensitive floral and faunal species; and (5) Agroforestry contributes to biological diversity conservation by offering other ecosystem services like erosion control and water recharge.

It has been shown that agroforestry is a viable alternative for less biologically diverse agriculture in striking a balance between productivity and biodiversity conservation. Nevertheless, other research has also shown that the benefit of agroforestry systems for conserving biodiversity varies according to management choices. The availability of resources and the vegetative composition of animal species can be impacted by various management choices, which could have an impact on the species' overall conservation value. The development of biodiversity-friendly management strategies depends on the identification and evaluation of these tradeoffs because they represent the best options for preserving ecosystem functioning and the services required to ensure sustainable output. Agroforestry systems for biodiversity conservation and the varying implications that management approaches might have on the value of particular agroforestry systems [46].

3.2. Agroforestry for Soil Improvement

Depending on the crop type, temperature, and geography, agroforestry can have different impacts on soil quality through changes in ecosystem functions and services brought about by the direct and indirect effects of trees. By bringing back nutrients that have been leached through their deep roots, trees contribute significantly to the cycling of nutrients by acting as a "safety net" against nutrient losses from the cycle. In tree-based agroforestry systems, trees also aid in dry deposition and absorb atmospheric nutrients. According to Chatterjee, Nair [47], agroforestry offers a viable way to store and recover carbon from the soil that is lost as a result of intensive farming practices, heavy tillage, and fertilizer use. Because of the structural and functional diversity of the components obtained in a mixed cropping canopy, agroforestry encourages more efficient use of resources than monocropping [48]. A farm's field capacity (FC), organic matter (OM), available potassium, phosphorus, soil carbon stocks, and bulk density (BD) are all improved by the integration of trees. These factors increase the water holding capacity (WHC) of the soil and release water to plants gradually, much like a sponge [47]. In order to decrease bulk soil density and promote soil aggregation, organic matter (OM) must

be added. The rhizosphere's water dispersion, air circulation, groundwater recharging, and nutrient quality are all enhanced by the soil's decreased bulk density (BD).

With agroforestry systems, the accumulation of litter from twig and leaf shedding serves as the primary source of both organic carbon (OC) and nutrients. The soil organic carbon (SOC) has an impact on the efficiency with which nutrients are used in agriculture, both directly and indirectly. An active deep root system and abundant organic matter (OM) in the soil will increase absorption and availability, which will increase the efficiency of nutrient consumption. Additionally, the inclusion of organic matter (OM) has increased microbial diversity, which attracts mycorrhizae and releases phosphorus (P) for crop uptake [49]. It is widely known how important agroforestry is for ensuring and maintaining long-term soil sustainability and productivity. The integration of plants and trees with the ability to fix nitrogen naturally is a common practice in tropical agroforestry systems. Non-N-fixing trees also contribute to the physical, chemical, and biological aspects of soil by releasing and recycling nutrients in agroforestry systems, as well as by adding significant amounts of organic matter both below and above ground.

3.3. Agroforestry for Enhancing Air and Water Quality

Building levees and farmlands are protected from floods and sand deposition by broader riparian buffers when agroforestry is incorporated, which enhances flood control. The ability of trees to store and utilize water, as well as soil change processes, all help to reduce floods. According to Tyndall and Colletti [50], to improve the quality of the air, green vegetation filters out odor, gasses, mist, volatile organic compounds, minerals, and spores. Techniques used in agroforestry, such as windbreaks and shelterbelts, are praised for their several benefits, among these advantages are the ability to effectively protect structures and roads from drifting snow, cost savings in livestock production from lower wind chills, protection of crops, making of habitat for wildlife, production of oxygen from atmospheric carbon dioxide removal, reduction of noise pollution, and mitigation of odor from concentrated livestock processes. Riparian buffers, for example, have been suggested as an approach to reduce non-point source pollution from agricultural areas. Deep-rooted trees in agroforestry can enhance ground-water quality by functioning as a "safety net," capturing extra nutrients that leak from agronomic crops below their rooting zones. These nutrients are then recycled back into the system through root turnover and litter fall, increasing the system's efficiency in using them [43].

4. Potential of Agroforestry for mitigation of climate change impacts

The global climate change caused by rising carbon dioxide (CO_2) and other greenhouse gas (GHG) levels is recognized as one of the major environmental issues of the twenty-first (21st) century [51]. Climate change may result from both internal and external influences, including variations in the volcanic eruptions, and enduring manmade changes to the atmosphere's composition or the way land is used. Agroforestry practice is the deliberate planting of trees species and agricultural crops in interacting combinations began to gain popularity in the late 1970s [52]. Throughout the 1990s, industrialized nations came to understand the significance of agroforestry in solving problems such as the decline of family farms, increased soil erosion, contamination of surface and ground waters, and decreased biodiversity, as a result, agroforestry is presently receiving more attention as a sustainable land-management option in a worldwide because of its advantages on an ecological, economic, and social levels. As a result, the knowledge on agroforestry is growing quickly, as seen by the rise in the quantity and caliber of scientific publications on a variety of agroforestry-related topics. Thus, adaptation and mitigation of climate change will reduce the intensity of its impacts.

However out of all the options for mitigating climate change, agroforestry is the most effective and, with correct management, it is sustainable in worldwide. According to Charles, Nzunda [53], agroforestry is a climate-smart agricultural method that is thought to be more adaptable to climate change than monoculture. Agroforestry, an environmentally and ecologically sound land use, offers great potential for lowering the rising levels of atmospheric carbon dioxide (CO_2) through carbon sequestration [54]. As Brakas and Aune [55], stated that perennial tree absorbed carbon at an advancing rate than those are exclusively included annual crops or grasslands. Since perennial tree will acquire carbon through roots, litter, and aboveground biomass, whereas annual crops will only do so through roots and the preservation of crop waste [56]. Agroforestry focuses on using trees on farms and other landscapes for the benefit of rural inhabitants and other land users. Because agroforestry provides products and services including fruit, fodder, firewood, timber, medicine plants, soil fertility, shade, erosion control, and carbon sequestration, the agroforestry is at the center of innovation and adoption [57]. In the context of climate change, agroforestry is recognized as an essential component of climate-smart agriculture, which is characterized as agriculture that brings people closer to safe operating environments for food systems across temporal and spatial scales [58]. However, agroforestry's significance as a carbon dioxide (CO_2) link, a means of reducing climate change, and a means of adaptation has just lately come to light [59].

As to Mohan Kumar and Nair [52] study, agroforestry received particular attention as a carbon sequestration technology after being designated as such under the Kyoto Protocol's afforestation and reforestation operations. The goal of the post-Kyoto Protocol climate change discussions

Table. Estimates of above- and below ground biomass carbon (Mg C ha−1) and soil organic carbon (0–60 cm depth, Mg C ha−1) in major agroforestry practices in Ethiopia. The values are mean ± standard error

Agroforestry practice	Aboveground carbon	Belowground carbon	Soil organic carbon	Country	Reference
Boundary planting	26.7±14.1		112.7	Ethiopia, Kenya	[60-63]
Fodder bank	9.2±4.2		14.5±1.4	Ethiopia, Uganda	[64, 65]
Homegarden agroforestry	28.2±6.0	9.6±2.8	115.7±15.1	Ethiopia, Kenya	[66,67, 68, 69, 70, 71, 72, 62, 60, 73]
Parkland systems	4.9±2.5	1.9±0.8	41.6±11.3	Ethiopia	[74, 75, 76, 77, 60]
Perennial tree crop systems	23.7±10.0	8.2±4.8	110.9±30.3	Ethiopia, Uganda	[78, 79, 80, 70]
Scattered trees on farm	8.2±1.4	2.9±1.0	52.5±23.4	Ethiopia, Kenya, Tanzania	[81, 82, 83, 62, 84, 85]
Silvopasture	2.1±0.01		73.0±35.6	Ethiopia, Kenya, Tanzania	[74, 75, 86, 62]
Woodlot	25.0±5.6	4.559	58.6±8.5	Ethiopia, Kenya, Tanzania	[86, 72, 60]

is to reduce the atmospheric carbon dioxide (CO2) concentrations by storing carbon in terrestrial plant systems. As a result, several nations include agroforestry principles and systems into their policies. Agroforestry systems have the potential to significantly reduce greenhouse gas emissions by increasing carbon storage in biomass, both above and below ground, as well as in soil organic carbon [13]. Carbon sequestered in agroforestry in East Africa is less than forested areas but greater than what would be found in low biomass systems such as natural grasslands, pastures and or annual crops without trees. Much of the aboveground carbon is held in homegardens (34.3±7.9 Mg C ha^{-1}), perennial tree-crop systems (29.9±12.7 Mg C ha^{-1}) and trees on boundaries (26.7±14.1 Mg C ha^{-1}) (Table).

For the enset-tree (73.2 Mg/ha), enset-coffee (105.7 Mg/ha), and tree-coffee system (116.2 Mg/ha) systems, the aboveground biomass estimated by the CO2FIX model estimated to biomass carbon of 96.6, 139.5, and 153.4 Mg/ha, respectively [87]. These estimates were higher than those reported in the region and were therefore excluded from the computation of mean carbon storage. Comparable system estimates for enset (34.9 mg/ha), enset-coffee (59.2 mg/ha), and fruit-coffee (58.3 mg/ha) yield half that amount [67].

Aboveground carbon storage in woodlots is decently comparable over studies in Kenya and Tanzania, but for one study in Siaya District in Kenya where the combined biomass carbon of trees, s hedges and permanent crops within woodlots was 122.6 ± 59.2 Mg C ha^{-1} [66]. Rotational woodlots in Tanzania stock an average of 29.2±5.5 Mg C ha^{-1} [88]. Eucalyptus-based small-scale woodlots in Ethiopia would have higher aboveground carbon but this was not measure d [72, 89, 90]. Whereas rotational woodlots are harvested routinely, the average carbon stocks in that is higher than carbon stocks in degraded land, cropland and pastures. Their commitment to soil carbon, particularly restoration of degraded landscapes is also critical [88].

4.1. Agroforestry as Tool for Climate Change Adaptation in Response to Changing Climate Conditions

According to Verchot, Van Noordwijk [91], climate change poses a threat to tropical agriculture, particularly subsistence farming. Due to declining soil productivity, decreased water availability, and biodiversity loss, Africa's agricultural production faces sustainability issues; yields of significant cereal crops have plateaued at one ton per hectare (ha-1) [92].Thus, inadequate food production for household use poses a major threat to smallholder farmers' livelihoods, particularly in areas with more unstable weather patterns. Due to their lack of resources, smallholder farmers might benefit from agroforestry in order to adapt to changing climates [93]. Agroforestry may increase smallholders' resistance to present and upcoming climate issues, such as future climate change, at the farm and landscape levels [94]. They are essential for preserving homes even in areas where soil, water, and biodiversity are compromised. The role of trees in agriculture has considerably increased land productivity and livelihoods by supplying several ecosystem products and services, both direct and indirect [95].

Franzel, Carsan [96] state that because of fodder trees in agroforestry systems are mostly utilized to feed dairy cows and make up for production problems during periods of harsh climatic conditions, such as droughts, they are particularly significant in the highlands of Eastern Africa. These quickly growing trees or plants produce a variety of byproducts and may usually be used for food a year after

planting. They also need less money, manpower, and land. Parklands and other agroforestry practices are essential because they cover the soil with trees and bushes, preventing removal of soil and reducing consequences of climate change impact. In risky areas like the Sahelian zone of West Africa, they assist farmers generate revenue by giving them green fodder to supplement agricultural wastes for animal feeds, fruits, and leaves for human use. The interactions between different components of the agroforestry system have an impact on the ecosystem service functions of parkland trees in a number of ways, according to Bayala, Sanou [97] (such as providing, regulating, and sustaining services). Through the supply of fuels wood, agroforestry has contributed a substantial contribution to the provision of sustainable alternative energy (SSA), and it is predicted that in the next decades, it will continue to dominate the energy portfolio of the region's population [98]. In Ghana's agroforestry, for example, 83% of the 20 species were used as medicines, while 100% of the species were used as fuel wood, according to Asase and Tetteh [99].

A research carried out in western Kenya found that having trees on farms makes fuel wood more easily accessible, safe, and reliable for energy and income, especially for women [100]. According to Syampungani, Chirwa [101],agroforestry with proper planning and management can have a positive impact on yield, revenue, and future production potential. For example, species found in homegardens are necessary for small-scale home production of honey for financial gain [102]. Similarly, [103] found that around 24.4% and 10% of respondents, respectively, used woody plants for revenue, and that beekeeping assisted respondents in purchasing food at market prices for subsistence. Numerous research show that countries that have adopted agroforestry have increased their cash revenue and food security [104]. Coffee Based agroforestry produced 46% of the honey sold in southwest Ethiopia in 2010, according to Eshete [105]. According to Mekonen, Giday [106], over 25% of plant were used in Ethiopia as food, 13% as medicinal, and 10% as household equipment. Fertilized tree species (FTS) have been shown to significantly increase maize yields when compared to non-fertilized maize agriculture in Zambia [107]. The amount of shade directly affects how stable the soil moisture is and how much the microclimate varies. By protecting the crop of interest from severe climatic occurrence, this reduce the livelihood of crop failure in agricultural produc ts [108].

According to Lin [109], soil evaporation and plant transpiration cause crops grown in open settings to lose between 31 and 41% of their moisture. Additionally, it was discovered that coffee beans have developed under agroforestry (under trees) than they did in direct sunshine, even though full daylight produced more fruiting and beans per cluster. The implementation of agroforestry systems, which might potentially help with some ecosystem services regulation and support, may also help to balance coffee production with conserving biodiversity under the effect of climate change [110, 111]. Kebebew and Urgessa [112] claim that tree-based agricultural systems are risk-free and more profitable than other agricultural options because they provide a wider range of commodities and are less likely to be infected by pests, allowing farmers to avoid hazards. Furthermore, agroforestry techniques often encourage crop diversity within the systems, expanding the variety of food, fuel, and fodder produced for smallholder farmers and reducing wind damage by up to double the windbreak's height [109]. As a result, different agroforestry schemes allow for a wide range of adaptations to occur under various climatic circumstances. More diversity within the agroforestry system will result in higher co-benefits, but the amount of variety introduced into the system will determine the degree of co-benefits [113]. As a result of this, the ecosystem services that agroforestry provides assist in making humans and other ecosystems more resilient to changes in the climate.

5. Conclusion

Agroforestry system is a type of land use that improves livelihood resilience to climatic fluctuation, change and contributes to environmental conservation by lowering CO_2 emissions. It reduces soil erosion and also lowering pressure on natural forests since CO2 is stored in living biomass and soil. A significant body of research has recently supported the claims made regarding the ecosystem services and environmental benefits of agroforestry systems and practices in both tropical and temperate regions. In this era of ecological sustainability and awareness, agroforestry's position as an environmentally sound and sustainable substitute for traditional farming that also offers a range of ecosystem services has to be carefully studied. Agroforestry system provides tested solutions for carbon sequestration, soil enrichment, biodiversity conservation, water and air improvement, and poverty reduction not only for farmers but for society as a whole. There are different environmental and socioeconomic barriers that hinder agroforestry from reaching its full potential for conservation, and CO2 reduction must be understood and effectively managed. Decision-makers and the general public must also be made aware of the potentials of agroforestry system, and farmers must get training by technical expertise and choice of suitable planting species, and management. Future research should focus on determining the most effective ways of integrating different agroforestry components, diversifying agroforestry components and management strategies, assessing the various ecosystem services that different agroforestry systems provide, and examining the roles that urban agroforestry plays in managing climate change and ecosystem conservation.

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