ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2021; 7(10): 408-411
www.allresearchjournal.com
Received: 23-08-2021
Accepted: 29-09-2021

Rajput PK
Department of Soil Conservation, Janta College, Chhatrapati Shahu Ji Maharaj University, Kanpur, Uttar Pradesh, India

Corresponding Author:
Rajput PK
Department of Soil Conservation, Janta College, Chhatrapati Shahu Ji Maharaj University, Kanpur, Uttar Pradesh, India

Agroforestry as a tool for climate change and livelihood security

Rajput PK

Abstract
The present study is an attempt to review the global agroforestry system. Agroforestry has enormous potential to prevent climate change, safeguard people and livelihoods, and lay the groundwork for more sustainable economic and social growth. Agroforestry continues to play an important role in illuminating the agricultural sector's competitive position. The primary problem for improving output in agroforestry systems is rational resource utilization by maximizing positive interactions and reducing negative ones. Climate change, which is produced by global warming, is a phenomena induced in part by an excess of carbon dioxide in the atmosphere. Adaptation strategies that encourage sustainable management and community-based practices have the potential not only to protect land and people from some of the negative effects of rising global temperatures, but also to provide opportunities for greater, more sustainable rural development and poverty reduction. The dominance of many traditional agroforestry systems in India provides an opportunity worth examining for carbon sequestration, improved livelihoods, biodiversity protection, soil fertility improvements, and rural employment.

Keywords: Agroforestry, climate change, livelihoods, sustainable management

Introduction
Agroforestry refers to land-use systems and methods that intentionally mix woody perennials with crops and/or animals on the same land management unit. The trees may be planted alone or in groups within parcels (silvoarable agroforestry, silvopastoralism, grazed or intercropped orchards) or on parcel boundaries (hedges, tree lines) (EURAF 2012). Climate change is a shift in the long-term weather patterns that define different parts of the planet. The globe is warming, according to scientists. This pattern cannot be explained only by natural climate fluctuation. Human activities, particularly the combustion of coal and oil, have warmed the planet by significantly increasing the quantities of heat-trapping gases in the atmosphere. There is growing acceptance that even very ambitious greenhouse gas mitigation measures that go beyond current international climate agreements will not be effective enough to halt the increase in atmospheric greenhouse gas concentrations in the medium term, and that adaptation measures are just as important as mitigation measures. Climate change will have a greater impact on developing countries than on industrialized countries, not least because of their relatively low adaptive capacities (IPCC, 2003). The agricultural sector will be among the most vulnerable in these countries, putting rural populations at risk. The global climate change has heightened interest and concern in the green economy. According to the Planning Commission's "Greening India" study, agroforestry is the only way to achieve 33% forest cover. Land management operations play an important role in the context of global change and sustainable development through mitigating climate change. Forests, on the other hand, are affected by climate change, and their contribution to mitigation efforts may be influenced by stressors caused by it. Agroforestry has the potential to make a large contribution to a low-cost global mitigation strategy that also includes adaptation and sustainable development. However, only a small percentage of this potential is currently being utilized. Carbon mitigation potentials through minimizing deforestation, forest management, afforestation, and agro-forestry vary substantially depending on activity, region, and system. Globally, millions of households depend on goods and services provided by forests. This underlines the importance of assessing forest sector activities aimed at mitigating climate change in the broader context of sustainable development and community impact.

Forestry mitigation activities can be designed to be compatible with adapting to climate change, maintaining biodiversity, and promoting sustainable development. There is robust evidence that agroforestry systems have the potential for improving water use efficiency by reducing the unproductive components of the water balance. A new land-use options that increase livelihood security and reduce vulnerability to climate and environmental change are necessary. Traditional resource management adaptations such as agroforestry systems may potentially provide options for improvement in livelihoods.

Agroforestry as a tool for climate change and livelihoods

Agroforestry has enormous potential to prevent climate change, safeguard people and livelihoods, and lay the groundwork for more sustainable economic and social growth. Sustainable forest management provides a framework for international and national planning on how to best deal with this ever-changing environment. Adaptation strategies that promote sustainable management and community-based practices have the potential to not only protect land and people from some of the negative effects of rising global temperatures, but also to provide opportunities for greater, more sustainable rural development and poverty alleviation through income generation and job creation. Farmers can use these systems to diversify their produce, minimize farm risk, contribute to food security, and create much-needed money. They also address commercial timber needs while improving environmental circumstances. In rural places, biomass from trees and plants provides 70-80% of the energy. A substantial amount of wood is currently being generated outside of normal forest lands as a result of agroforestry activities. Indigenous tree species (*Acacia nilotica*, *Azadirachta indica*, *Melia azadirachta*, *Leucaena luecocephala*, *Casuarina equisetifolia* etc.) have high fuel wood potential. Species such as *C. equisetifolia*, *Prosopis juliflora*, *Leucaena luecocephala* and *Calliandra calothyrsus* have become prominent due to their potential for providing wood energy at the highest efficiency, shorter rotation and also their high adaptability to diverse habitats and climates. In India the energy demand is expected to grow at 4.8%. Further, increasing gap between demand and domestically produced petroleum the dependence on import of oil will increase in the near future (Anitha, S. & R SathyaPriya 2012) [2].

Carbon stock in different agroforestry system

Climate change, caused by global warming, is a phenomenon partly resulting from abundance of carbon dioxide in the atmosphere. It is the most pressing environmental problem of the world. It persists and cannot be stopped, although it can be reduced. Agroforestry systems as a land use can help to lower carbon dioxide levels in the atmosphere. According to recent forecasts, the global area under agroforestry will grow significantly in the near future. This will undoubtedly have a significant impact on the flux and long-term storage of C in the terrestrial biosphere (Dixon, 1995). Smith *et al*., 1993; Dixon *et al*., 1994) [8, 27, 10] estimate that agro-ecosystems contain around 12% of the world's terrestrial Carbon. However, negative changes in the global climate (rising temperatures, higher frequency of droughts and floods) are often the cost consequential processes associated. Land-use management such as agroforestry systems or the combination of production of trees with agricultural crops plays a very important role in climate change mitigation by absorbing excess carbon dioxide which is used in the process of photosynthesis by the trees. Carbon is stored in tree biomass and in soil that helps protect natural carbon sinks through the improvement of land productivity and the provision of forest products on agricultural lands (Albrecht & Kandji 2003) [1]. Because of secondary environmental benefits such as food security, secured land tenure, increasing farm income, restoring and maintaining above-ground and below-ground biodiversity, maintaining watershed hydrology, and soil conservation, agroforestry systems are a better climate change mitigation option than oceanic and other terrestrial options (Pandey D.N, 2002) [20].

Soil fertility improvement through agroforestry

Carbon sequestration in degraded agricultural soils in underdeveloped countries is increasingly being touted as a potential technique to reduce atmospheric greenhouse gas concentrations (Petra Tschakert, 2004) [28]. According to the research, agroforestry systems that promote the use of legumes as fertilizer or shade trees may increase N2O emissions when compared to unfertilized systems. Mondini *et al*. investigated the impact of various variables on GHG production and soil C sink capacity by monitoring CO2 and N2O fluxes from amended soils under laboratory conditions and reported that the C conservation efficiency of organic residues, calculated by the combined loss during composting and after land application, was higher for less transformed organic materials. Lal R. (2005) [16]. Ram Newaj *et al*. (2008) [24] discovered that when Albizia procera was grown in agri- silviculture with different pruning regimes, the organic carbon of the soil increased by 13-16% from their initial values, which was 5 to 6 times higher than growing a single tree or crop. Soil fertility can also be restored by relocating cultivated areas and planting suitable species. For example, a field experiment to evaluate N2 fixation efficiency found that planting stem-cuttings and flooding resulted in increased biological N2 fixation by Sesbania rostrata and S. cannabina, 307 and 209 kg N ha-1, respectively. S. rostrata can thus be utilized as a green manure by planting stem-cuttings in flooded conditions (Patel *et al*., 1996) [21].

Livelihood security by adoption of agroforestry

Agroforestry provides other benefits in addition to those connected to climate change. Forests provide economic, social, cultural, and environmental services, accounting for around 30% of the world's land mass. Adoption of a diverse agricultural production system with complementary economic and/or ecological components involving crops, trees, livestock, and post-harvest processing improves the economy. Over one billion people rely on agroforestry and consume its resources. 70 million indigenous peoples live in distant places and rely heavily on agricultural resources for a living. Increasing market prospects for smallholders, especially in niche markets and high-value goods, is important to the success of agroforestry technologies (Russell and Franzel, 2004) [29]. Agroforestry is not only a means of increasing one's own income, but it also provides a unique opportunity for people to collect or grow non-timber forest products as part of their cultural and family traditions. Many high-value crops can be planted or developed within the protection of the present agricultural system. It is a

method of generating short-term income from tree resources while high-quality trees are developed for wood products. Traditional agroforestry has gradually given way to more simple production approaches. Over the last few decades, agroforestry has been modernized and helping people a lot.

Agroforestry and microclimate development

In general, open area receives more sunshine than covered land, and temperature follows similar trends. Many studies have shown that agroforestry systems outperform solitary cropping systems in locations where there is a lack of ground water or where rain fall is low. Agroforestry is a tool that benefits both shade-loving and low-temperature crops. The role of agroforestry in the creation of microclimates has been investigated using energy and water balance analyses. Brenner, 1996) [30]. Analysis by Ong *et al*. (1991) [19] suggested that atmospheric interactions in hedgerow cropping in the semiarid tropics were positive but were of minor importance compared with below-ground, often competitive, interactions. Rao *et al.* (1997) [25] concluded that the net positive effects of trees on crops were more likely in sequential rather than simultaneous agroforestry systems, as below-ground competition dominated tree–crop interactions for major food crops. Compared to open-field agriculture, all land-use systems with trees have reduced daily amplitude of air temperature, with a gradual decrease of the amplitude within the top layers of the soil. The temperature is restricted to a few multiples of tree height, depending on the solar elevation (Kohli and Saini, 2003) [31]. Similarly Hairiah *et al.* (2006) [14] compared the effects of shading on the litter layer soil temperature and its spatial variability in open- and closed-canopy.

Conclusion

Agroforestry systems are a land management method that, among other things, may improve the resilience of agro-ecosystems to the effects of climate change. This review provided an overview of a few agroforestry systems and their carbon sequestration potential. Agroforestry has the potential to create synergies between efforts to mitigate climate change and initiatives to assist vulnerable populations in adapting to its negative repercussions. Agroforestry has the potential to improve the resilience of tropical farming systems. Agroforestry continues to play an important role in strengthening the agriculture sector's competitiveness. The dominance of many traditional agroforestry systems in India provides an opportunity worth examining for carbon sequestration, improved livelihoods, biodiversity protection, soil fertility improvements, and rural employment. As a result, a systematic agroforestry system with adequate management techniques will be more beneficial to climate change mitigation and will provide more opportunities for sustainable livelihood. Agroforestry continues to play an important role in strengthening the agriculture sector's competitiveness.

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