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## Role of agroforestry in climate change mitigation

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**Abstract**

Agroforestry is an ecologically sustainable land use system that maintains increase total yield by combining food crops (annuals) with tree crops (perennials) and/or livestock on the same unit of land. A large hectare is available in the form of boundaries, bunds, wastelands where this system can be adopted. Farmers retain tree of *acacia nilotica*, *acacia catechu*, *Dalbergia sissoo*, *Mangifera indica*, *Zizyphus mauritiana* and *Gmelina arborea* etc in farm land. It plays a crucial role in climate change mitigation especially due to its tree component. Trees accumulate CO<sub>2</sub> (which is the most predominant GHG) in their biomass. Agroforestry not only helps in climate change mitigation but also climate change adaptation. It is an established fact that despite our present effort at climate changes mitigation (GHG reduction), there is a more pressing need to cope with the impact of climate change (adaptation). People should be aware about the scope and benefits of Agroforestry and they should participate in implementation and development of Agroforestry in India. Therefore, agroforestry system is economically and ecologically sound practices with enhancement of overall farm productivity, soil enrichment through litter fall, maintaining environmental services such as climate change mitigation (carbon sequestration), phytoremediation, watershed protection and biodiversity conservation.

**Keywords:** Agroforestry, biodiversity, bund, climate change and phytoremediation.

**Introduction**

Agroforestry” is the new name for an ancient land use practices and just a compromise between agriculture and forestry (Raj A. *et al.*; 2014 and Raj A. *et al.*; 2016)<sup>[18, 19]</sup>. Similarly, Indian forest plays major role in mitigation of climate change and symbolize diversified flora and fauna (Toppo P. *et al.*; 2014, Toppo P. *et al.*; 2016)<sup>[28, 29]</sup> conserve plant diversity and source of timber and non-timber products like commercially important gums (Raj A. *et al.*; 2015, Das I. *et al.*; 2014, Raj A. *et al.*; 2015a, Raj A. *et al.*; 2015b)<sup>[17, 6, 21, 22]</sup>. It has a lot of importance and work as a social forestry, agroforestry, reforestation and rehabilitating the waste lands and degraded industrial lands (Jhariya M.K. *et al.*; 2013, Raj and Jhariya, 2016)<sup>[10, 20]</sup>. Therefore, agroforestry may be defined as an efficient and integrated land use management system by raising of certain agricultural crops, forest tree species and or animals simultaneously or sequentially on the same unit of land with appropriate management practices which result in overall increase in the production under a particular set of climatic and edaphic conditions and socio-economic status of local people (King, 1969)<sup>[12]</sup>. It involves interaction of woody perennial ecologically and economically with the crop and or livestock. Agricultural crops (herbaceous plants), woody perennials (tree crops/ forest plants) and animals are the component of Agroforestry. In the present scenario of climate change, agroforestry practices, emerging as a viable option for combating negative impacts of climate change (Singh N.R. *et al.*; 2013)<sup>[26]</sup>.

**Worlds and Indian scenarios**

Nair P.K.R. *et al.* (2009)<sup>[15]</sup> has reported that area currently under agroforestry worldwide is 1,023 million ha. According to Dhyani S.K. *et al.* (2013)<sup>[7]</sup> in India the current area under agroforestry is estimated at 25.32 Mha, or 8.2% of total geographical area of the country. This includes 20.0 Mha in cultivated lands (7.0 Mha in irrigated and 13.0 Mha in rainfed areas) and 5.32 Mha in other areas such as shifting cultivation (2.28 Mha), home gardens and rehabilitation of problem soils (2.93 Mha). Kumar (2006)<sup>[14]</sup> estimated the area of homegarden in South and Southeast Asian homegarden as 8.0 Mha.

**Scope**

There is tremendous scope of Agroforestry in India. A large hectare is available in the form of boundaries, bunds, wastelands where this system can be adopted. This system permits the growing of suitable tree species in the field where most annual crops are growing well. Agroforestry assures permanent sources of higher income even in extreme adverse conditions. Realizing such scope, an All India Coordinated Research Project on Agroforestry was initiated

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In 1983 to initially operate at eight Research Institute of the Indian Council of Agricultural Research (ICAR) and twelve Agricultural Universities, and now it is being extended to large number of universities and institutes. Since Agroforestry involves intensive use of land under proper management without deterioration of its fertility that results in more output this adds in national economy. Thus, bright future of Agroforestry in India is inevitable.

### Potential

Agroforestry- the incorporation of trees into farming systems- has enormous potential to mitigate the effects of drought, prevent desertification and restore degraded soils. It can also help to boost food production (for humans as well as animals) and provide alternative sources of nutrition or income when crop yields are low. With climate change expected to lead to unpredictable seasons in the future, placing even greater pressure on agricultural systems, food production and food prices, agroforestry is a viable option to help buffer farmers against the impacts” (WAC, 2012) [31]. Therefore, agroforestry has many potential, such as enhance the overall

(biomass) productivity, soil fertility improvement, soil conservation, nutrient cycling, micro-climate improvement, carbon sequestration, bio drainage, bio energy and bio fuel etc (Bargali S.S. *et al*; 2004, 2009, Fanish and Priya, 2013) [2,1,8].

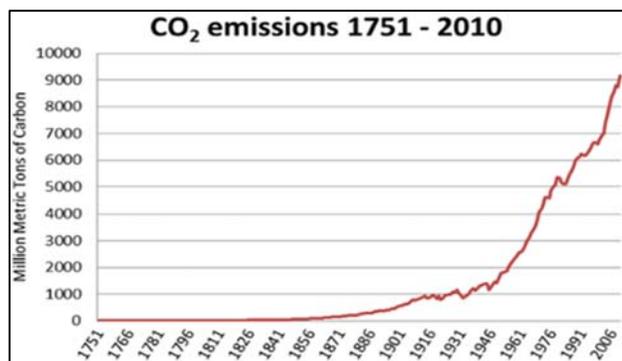


Fig 1: Global projection of CO<sub>2</sub> emission (1751-2010) (CDIAC, 2013) [4]

Table 1: The carbon absorption capacity of different agroforestry models

Agroforestry model	Carbon storage capacity	Region	Author
Agrisilviculture system (aged 11 years)	26.0 tC/ha	Semiarid region	NRCAF (2005) [16]
Block plantation (aged 6 years)	24.1–31.1 tC/ha	Central India	Swamy S.L. <i>et al</i> ; (2003) [27]
<i>Populus deltoides</i> 'G-48' + wheat	18.53 tC/ha		
Silvopasture	31.71 tC/ha		
Agrisilviculture	13.37 tC/ha	Himachal Pradesh	Verma K.S. <i>et al</i> ; (2008) [30]
Agri-horticulture	12.28 tC/ha		
Silvopastoralism (aged 5 years)	6.55 Mg ha <sup>-1</sup> y <sup>-1</sup>	Kerala, India	Kumar B.M. <i>et al</i> ; (1998a) [13]
Indonesian homegardens (aged 13.4 years)	8.00 Mg ha <sup>-1</sup> y <sup>-1</sup>	Sumatra	Roshetko M. <i>et al</i> ; (2002) [23]

### Climate Change: An overview

Climate change is a burning issue of the world. Increasing of CO<sub>2</sub> by industrialization, fossil fuel burning, etc can cause a subtle change in global climate. Greenhouse gases include CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>, and CFC etc are foremost region behind global warming leads to changing climate. Carbon dioxide (CO<sub>2</sub>) is the main heat trapping gas largely responsible for most of the average warming over the past several decades (Forster P. *et al*; 2007) [9]. The atmospheric concentration of CO<sub>2</sub> has increased from a preindustrial era (AD 1000 – 1750) concentration of approximately 280 parts per million (ppm) to around 383 ppm, as measured at Mauna Loa, Hawaii in 2007 (Forster P. *et al*; 2007, Keeling R.F. *et al*; 2008) [9, 11]. A graphical representation (figure 1) is shown below for global projection of CO<sub>2</sub> emission (1751-2010) that leads to rise in temperature (CDIAC, 2013) [4]. Earth biodiversity is greatly affected by unusual climate leads to loss and degradation of natural resources and environment. Change in weather regime such as rainfall pattern causes flood and drought not only effects on agricultural production but also influence emergence of several cause emergence of infectious disease.

### Mitigation strategies

As we know, climate change is the most important global environmental challenge which is facing by all living organism including humans and disturb natural ecosystems, agriculture and health. This change in climate and weather patterns results agricultural production in unsustainable. In this situation, agroforestry plays a viable option to mitigate climate change and reduce global warming by absorbing greenhouse gases (CO<sub>2</sub>) through the process of carbon-sequestration. Various literatures (Table 1) are available on

carbon storage potentials of different agroforestry models. Therefore, agroforestry, a form of Climate Smart Agriculture, is a promising adaptation option for smallholder farmers throughout the developing world. The diverse adaptive benefits of agroforestry have been captured in case examples and scientific studies in developing countries in Asia, Africa, and Central and South America (Colin, 2013) [5]. Moreover, introduction of the resistance plant variety, mixed cropping, reforestation and agroforestry practices are major remedial measure to mitigate climate change which helps to uplift socioeconomic status of people. Therefore, sustainable agroforestry can upsurge resilience against environmental change, to enhance carbon sequestration and also to generate income, which will result in improved livelihood of small and subsistence farmers (Buchman, 2008) [3].

### Conclusion

Indeed, climate change is the most important global environmental challenge which is facing by all living organism including humans and disturb natural ecosystems, agriculture and health. In this situation agroforestry emerge as a robust farming practice addressing food security problem by making feeds to people, mitigate adverse effects of climate change by enhancing environmental quality, sustain economic viability and enhance quality of life. Therefore, agroforestry systems comprises different models in different region worldwide, which plays an enviable role to combat negative impact of climate change by increasing tree-crop diversification that's leads to more carbon storage (carbon-sequestration) capacity than alone cultivation of sole agricultural crops.

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