International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(1): 2359-2361
© 2019 IJCS
Received: 14-11-2018
Accepted: 18-12-2018

Pratap Toppo
Department of Forestry, College of Agriculture, I.G.K.V., Raipur Chhattisgarh, India

Shalini Toppo
Department of Forestry, College of Agriculture, I.G.K.V., Raipur Chhattisgarh, India

Correspondence
Pratap Toppo
Department of Forestry, College of Agriculture, I.G.K.V., Raipur Chhattisgarh, India

Tree crop interaction in agroforestry system: A review

Pratap Toppo and Shalini Toppo

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. Agroforestry-the deliberate combination of woody perennials on the same piece of land with agricultural crops and/or animals, plays a crucial role in climate change mitigation especially due to its tree component. Micro-climate amelioration and maintenance or improvement in soil productivity is the major positive interactions while competition for light, water and nutrients, and allelopathy are the major negative interactions in agroforestry systems. The balance between negative and positive interactions determines the overall effect of interactions in a given agroforestry system. The presence of trees on the farms ensures income diversification through the provision of additional resources like fruits, nuts, timber, vegetables, fodder, etc. 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, climate change, GHGs and phytoremediation etc.

Introduction
Agroforestry system as an ecologically sustainable land use option alternative to the prevalent subsistence farming patterns for conservation and development. Science of agroforestry system centers around four factors- competition, complexity, sustainability, and profitability and there should be a balance among all these factors to get fruitful results. However there are several limitations linked with agroforestry system. This includes competition of trees with crops for resources, allelophathic effects, rapid growth of trees occupy space of crops, etc. To gain maximum benefits from agroforestry system, it is essential to minimize the negative concerns linked to it. Ecological sustainability and success of any agroforestry system depends on the inter-play and complementarily between negative & positive interactions. It can yield positive results only if positive interactions outweigh the negative interactions.

Whenever tree-crop combination is tried as an agroforestry intervention, there can be strong above-ground and below-ground interaction for critical and limited resources. A scientific frame work for a quantitative analysis of tree-crop interactions explaining the productivity potential and resource use between the components of an agroforestry system is thus necessary as the magnitude of these interactions and their affects are not quantified and well researched with respect to local edaphic and agroecological conditions. This will help in comprehending the nature and extent of these interactions at the tree-crop interface (TCI) the way agroforestry systems function. It will not only provide a reliable method to determine which benefits are likely to be realized for a given agroforestry technology in a defined situation and enable researchers to evaluate the relative importance to each interaction in order to guide them more precisely in the choice of research priorities, but also offer the scientific basis for designing yet more productive and sustainable land use system. Agroforestry system is the complex of tree and crop and/or animal components that interact with each other and have discrete boundaries, separating the system from others on a farm. In agroforestry systems, understanding interaction between its components is the most challenging task because of the competition or

sharing the common resource by different species of widely different nature (Sanchez, 1995) [1].

Agroforestry areas

According to Dhyani *et al*. (2013) [2] 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). Moreover, agroforestry is also providing livelihood opportunities through lac, apiculture and sericulture cultivation and suitable trees for gum and resin have been identified for development under agroforestry (Dhyani, 2012) [3]

Scope of agroforestry in India

Agroforestry has tremendous scope and 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 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 it fertility that results in more output this adds in national economy. Thus, bright future of Agroforestry in India is inevitable.

Traditional AFs for climate change mitigation

Traditional agroforestry systems (TAFS) may be described as a set of age-old agroforestry systems which are generally devoid of intentional intensified cultivation of agricultural or forage crops and which have been practiced across the world with varying structure, function, socio economic attributes and ecological services. In India, TAFS are present across different regions, having different practices. Agroforestry systems are most predominant in the arid and semiarid regions of the country. Trees accumulate CO_2 (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). For instance, the trees in agro forests provide shade for both companion crops and the farmer against the rising temperatures, and also shelter the crops against the harmful effect of raging storms.

Tree-crop interactions

Interaction is defined as the effect of one component of a system on the performance of another component and/or the overall system (Nair, 1993) [4]. Regarding this, ICRAF researchers have developed an equation for quantifying tree-crop interaction (I), considering positive effects of tree and crop yield through soil fertility enrichment (F) and negative effects through crop competition(C) for growth resources between tree and crop I=F-C. If F> C, interaction is positive, if F< C interaction is negative and if F=C interaction is neutral. Interaction occurs both above and below ground and includes a complex set of interaction relating to radiation exchange, the water balance, nutrient budget and cycling, shelter and other microclimatic modifications.

Interactions help to know

- How the components of agroforestry utilize and share the resources of the environment, and
- How the growth and development of any of the component will influence the others.

Factors affecting tree crop interaction

- Effect of species: Proper choosing of compatible tree-crop combinations.
- Effect of sun light: Light crown tree, either selection of shade tolerant crops or management of tree crop for reducing shade on agricultural crops.
- Effect of density: Numbers of trees/ha, planting of tree at optimum numbers of tree in a given area for reducing competition among crop and tree.
- Effect of age: At early stage of tree crop, competition is minimal.
- Effect of site factors: Relates about the carrying capacity of the site, site quality.
- Effect of management: Level of management for tree crop for benefits of agricultural crops or improving the total productivity of the system.

Advantages of tree-crop studies

- Choice of Species: Proper selection of both tree as well agricultural crops.
- Design of agroforestry system: Either parallel rows of trees and crops or concentric rows of crops around the tree.
- Management of agroforestry System: Degree of management, at what time, etc.

Negatives Effects

1. Competition

When plants grow in proximity to each other they interact either in positive ways (complementary) or in negative ways (competition). The biophysical bottom line of agroforestry is how to manage the interaction for light, water and nutrients between the tree component and the crop and/or livestock components for the benefit of the farmer. Competition may be above and below ground competition for resources uptake. However, the extent of below-ground competition is often not apparent.

Above ground competition

Competition for solar radiation is the most prominent above ground competition between trees and companion crops. Low light intensity is one of the important constraints for higher yield. Dhillion *et al*. (2005) [5] concluded that the causes of reduction in growth and yield losses due to *Eucalpytus* tree plantation was due to direct competition for moisture, light and nutrients from the nearby rows of pear trees.

Below -ground competition

Tree roots can compete with annual crop roots for available water and nutrients in the top soil. Below ground root competition for moisture, nutrients and space is relatively more important in agroforestry systems than above ground crown competition as concerned in Indian situation. Since light is more relatively more abundantly available than moisture and nutrients. It is necessary to have information on the nature of root development in two types of crop plants.

Dadhwal and Tomar (2005) [6] found tree root pruning was very helpful in enhancing crop yields in marginal and degraded lands of north-western Himalaya of Uttaranchal thus indicating reducing in the root competition.

2. Allelopathy

The phenomenon of one plant having detrimental effect on another through the production and exertion of toxic chemical compounds is called 'allelopathy'**.** Allelopathy substance was first detected by Davis in black walnut (*Juglans regia*) whose foliar leachate containing Juglone was found to damage germination and seedling growth of crops beneath the tree. Allelopathy is one of the widely considered limitations for promotions and adoption of agroforestry at the field scale.

Complementary effect (Positive Effect)

There are a several complementary effects of tree crop interaction such as increased productivity, improved soil fertility, efficient and balanced nutrient cycling, improved Soil conservation management and improvement of Microclimate which are very important in the way of overall agroforestry health and its productivity.

Conclusion

Studying tree-crop interaction in agroforestry would help to devise appropriate ways to increase overall productivity of land. Increased productivity, improved soil fertility, nutrient cycling, soil conservation are the major positive effects of interactions and competition is the main negative effect of interaction, which substantially reduces the crop yield. It may be for space, light, nutrients and moisture. There are many research reports indicating significantly higher yield of crops in different agroforestry systems compared to sole crop yields. In the present scenario of climate change, agroforestry practices, emerging as a viable option for combating negative impacts of climate change.

References

1. Sanchez EA. Science in Agroforestry. Agroforestry Systems. 1995; 30:5-55.
2. Dhyani SK, Handa AK, Uma. Area under agroforestry in India: An assessment for present status and future perspective. Indian Journal of Agroforestry. 2013; 15(1):1-11.
3. Dhyani SK. Agroforestry interventions in India: Focus on environmental serices and livelihood security. Indian Journal of Agroforestry. 2012; 13(2):1-9.
4. Nair PKR. An introduction to Agroforestry, ICRAF, Nairobi, Kenya, Kluwer Academic Publishers, 1993, 243.
5. Dhillon WS, Singh H, Chauhan SK, Bal SS. Effect of *Eucalyptus* boundary plantation on the growth, yield and fruit quality of the adjoining pear and guava trees. Agoforestry in 21st Century, Agrotech Publishing Academy, Udaipur. 2005, 149.
6. Dadhwal KS, Tomar VPS. Managing tree roots for enhancing biomass production in an agroforestry land use from Uttaranchal Himalaya. Agroforestry in 21st Century, Agrotech Publishing Academy, Udaipur. 2005, 241.