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Livelihood security and employment opportunities through agroforestry based smart agriculture

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Abstract

Agroforestry as a land use system provides a tremendous potential to contribute towards livelihood security and rural development through employment generation. The selection of suitable agroforestry model for a specific agro-ecological region is very important particularly in reference to small and marginal farmers. Screening and evaluation of selected multipurpose trees for higher returns and better compatibility with intercrops is essential to increase the productivity and economic returns. Standardization, refinement and dissemination of agroforestry based amelioration technologies for problem soils, development, standardization and adoption of agroforestry models linked with market for enhancing productivity and profitability of small holding farmers is one of the important solutions to meet the future challenges. In a country where, more than 85 % are small holders and 67 % are having only 0.38 ha to feed their family and generate sufficient income for the decent livelihood, desirable diversification in farming system perspective is essential. Holistic and innovative approaches are found to be better for improving the profitability of highly location specific systems. Complementing the farming systems with bio-intensive cropping systems which can take care of food, fodder, fibre, fuel and fertility requirement of the system is also essential for long term sustainability of small holder systems. Appropriate marketing interventions and capacity-building programmes provide better economic returns and will be instrumental to check the migration of rural youth towards urban areas.

Keywords: Agroforestry, agro-ecological regions, Livelihood security, Agroforestry Policy

Introduction, scope and main objectives

Adoption of a viable agroforestry system by the farmers is one of the key solutions to face the current challenges of increasing farm income, providing livelihood security and mitigating climate change. The agroforestry has evolved as an assured and important land use system against crop failure as it plays a role in reducing vulnerability, increasing resilience of farming systems and buffering households against climate related risks. In addition to productivity role, it also contributes towards ecosystem services – water, soil health and biodiversity. There are number of options which can be integrated with agroforestry to ensure livelihood security in rural areas, such as apiculture, sericulture, lac cultivation, gum and resin, medicinal and aromatic plants.

Organized agroforestry research in India began in the eighth decade of last century when the Indian Council of Agricultural Research (ICAR), New Delhi launched the All India Coordinated Research Project (AICRP) on Agroforestry in 1983. Further, National Research Centre for Agroforestry was established in 1988 to accelerate basic, strategic and applied research in agroforestry, which was later on upgraded as Central Agroforestry Research Institute. In addition to ICAR, Indian Council of Forestry Research and Education (ICFRE) and its regional centres, private institutions and NGOs Wood based

industries, National Tree Growers Cooperatives are also engaged in research and promotion of agroforestry in the country.

In spite of an estimate that currently agroforestry meets almost half of the demand of fuel wood, two thirds of the small timber, 70-80% wood for plywood, 60% raw material for paper pulp and 9-11% of the green fodder requirement of livestock, we are still importing wood and wood products in huge amount annually to meet the requirements of wood based industries. This import can be reduced through selection of proper agroforestry practices as it has been demonstrated that higher productivity from agroforestry can be achieved by proper selection of tree-crop combinations. Trees have been an integral part of our traditional farming systems, however over time, with shrinking land holdings, annual crops replaced trees for various reasons. Trees complement farming in terms of maintaining soil fertility and are backbone for practicing integrated farming systems for self-reliant and sustainable agriculture. Agroforestry systems due to diverse options and products provide opportunities for employment generation in rural areas. Increased supply of wood in the market has triggered a substantial increase in the number of small-scale industries dealing with wood and wood based products in the near past (Dhyani and Handa, 2013).

Approach

Diversity of agroforestry systems

Survey of the existing agroforestry system to identify suitable species and traditional agroforestry practices shows that diverse agroforestry systems are being adopted by the farmers. These are improved agroforestry practices and systems such as home gardens, block plantation, energy plantation, shelterbelts and improvement or alternative to shifting cultivation. The All India Co-ordinated research Programme on Agroforestry (AICRP-AF) and ICAR-Central Agroforestry Research Institute Jhansi recommended *Morus* and *Grewia-based* system for the western Himalayas, alder-based for the North Eastern Hill (NEH) region, poplar and eucalyptus -based for the Indo-Gangetic region, aonla, Ailanthus, Hardwickia and Prosopis based for the semi-arid and arid regions, teak-based for the tropical region and *Gmelina, bamboo* and *Acacia*-based system for Humid and Sub humid regions. Home-gardens in Kerala and other coastal states promote food security and diversity and provide basic needs of food, fuel-wood, fodder, plant-derived medicines, and cash income from their small holdings (Handa et al, 2019; Handa et al, 2020). In addition, agroforestry practices have been intertwined with the various programmes/ schemes like watershed development, rehabilitation of problem soils, treatments of degraded and other wastelands etc. (Dhyani and Handa, 2014). Deliberate growing of trees on field bunds (risers) and in agricultural fields as scattered trees, and the practice to utilise the open interspaces in the newly-planted orchards and forests for cultivating field crops are also widespread in the sub-continent. It is estimated that currently agroforestry (outside the forest) has a greater number of trees than the “State” forests.

Agroforestry for food and nutritional security

The country’s food production has increased many fold since independence but recent improvements in food supply have been insufficient to fulfil the nutritional needs of the average person owing to the increasing population. Increasing the production and consumption of protein-dense foods, pulses in particular, will be necessary if the country is to meet its protein needs. Agroforestry with appropriate tree-crop/ legume combination is one option. The different agroforestry systems provide the desired diversification to increase the food security of the country and act as a shield against poor production during drought and other stress conditions. Agroforestry also provides nutritional security because of diverse production systems which include fruit,

vegetables, oilseed crops, medicinal and aromatic plants in addition to normal food crops grown by the farmers. Vegetable crops yield a higher return on an average than the common field crops. Crops like peas and cowpeas can be grown successfully during winter and summer months respectively under trees and these crops can also fix the atmospheric nitrogen and improve the fertility status of the soil along with providing additional income from the production of vegetable crops. Agroforestry has the immense potential to increase and sustain the food production per unit area in systems like the *Prosopis cineraia* (Khejri) based agroforestry system of the arid region of India. The tree is also called the King Tree of the Great Indian Desert due its multiple benefits in conserving the fragile desert ecosystem. Since time immemorial, Khejri has been the friend of arid dwellers and providing all types of ecosystem services (food, fodder, shade, shelter, fuel, aesthetic value, improving soil fertility etc.). Khejri is a nitrogen-fixing leguminous tree having characteristics of phreatophyte root system which enables it to obtain water from the zone of saturation or capillary fringe and makes moisture available to the agricultural crops in the upper strata of soil. Thus there is no competition between trees and crops/grasses for soil moisture. It is also reported that the vegetative growth is high under trees; it is known to increase the fertility status of the soil. Though the tree is present in scattered form in arid environments, it is beneficial to maintain a tree density of 100-200 trees per hectare that can increase crop yield by 15 to 20% compared to sole crops. The tree is lopped for fodder and fuelwood. Lopping practices in winter helps for winter crops. Prosopis cineraria trees are lopped annually to gain maximum fodder yield, however, trees of more than 75 cms diameter can be lopped for maximum returns. This agroforestry is considered as the most sustainable basis and is helping to increase food production in arid regions of India (Chaturvedi et al 2016 and Chaturvedi et al 2017).

Agroforestry for livelihood options

The role of agroforestry products and environmental services to meet the subsistence needs of low income households and providing a platform for greater and sustained livelihood of the society have been well recognized. The Increased supply of wood due to agroforestry adoption triggered a substantial increase in the number of small-scale industries dealing with wood and wood based products. Such industries promote agroforestry and contribute to increasing area of farm forestry. Recognizing agroforestry as a viable venture, many business corporations, wood based industries and financial institutes have entered into the business and initiated agroforestry activities in collaboration with farmers on a large scale. The linkage of agroforestry with wood based industries significantly impacted the economy in terms of income and employment generation.

Some of the important activities which can be integrated with agroforestry for livelihood security include lac cultivation. Conventional tree hosts of lac like ber (*Zizyphus mauritiana*) and Palas (*Butea monosperma*) can easily be integrated in bunds of cropped fields. Other quick-growing hosts like Flemingia semialata hold potential for integration in farming system models for lac production. Another option is to integrate sericulture as of the four hosts of the silk worm viz., Mulberry (*Bombyx mori*), Tasar (*Antheraea myllitte*), Eri (*Phelosamia ricini*) and Muga (*Antheraea assamensis*) are cultivated in India. These silk work insect can feed on leaves of different agroforestry tree species such as *Terminalia tomentosa* (asan), *T. arjuna* (arjun) and *Shorea robusta* (sal) for the Tasar insect; the commonly used *Morus alba, M. indica, M. serrata* and *M. latifolia* for the mulberry insect; can be included in the agroforestry models (Handa et al, 2016). An apiculture-based agroforestry system is another option which will not only provide additional income to the farmers, but will also result in other benefits to the agricultural production due to the role of honeybees as pollinators. A number of agroforestry tree species have been identified which can act as host species for honey bees and there is ample scope for including such trees in different agroforestry models to sustain round-the-year honey production. Gums and resins form another important group of non-wood forest products. India is traditionally the largest producer of guar gum and karaya gum. Gum-yielding trees species such as

Acacia senegal (gum Arabic), *Acacia nilotica, Butea monosperma* (Bengal kino gum) and *Boswellia serrata* (yielding salai guggul) are potential species for agroforestry models and need to be promoted on a large scale to provide sustained income and livelihood security to resource poor rural masses (Chavan et al, 2016).

There are a number of studies from different parts of the country suggesting that agroforestry is more profitable to farmers than agriculture or forestry for a particular area of land. Poplar- based agroforestry has been very successful in Northern States. Similarly Eucalyptus and Casuarina based system have been adopted on a large scale by the farmers in the southern tropical region. The success of these systems is due to the fact of credit support provided by banking institutions and buy back support from industry. Hence, there is tremendous scope for promoting viable agroforestry models for different agro-ecological regions of the country through quadripartite arrangement among industries, banks, research institutes and farmers. Research institutes have developed a number of agroforestry models but these are mostly restricted to research farms. These models need to be taken to cultivator's field for improvement of farmer's livelihood.

In the Western Himalayas, 60 to 70% requirement of the firewood is met from the arboreal components and several MPTs along the bunds of agricultural lands or scattered trees on the pasture lands were developed depending upon the needs, economics and environmental status of the land. Green fodder is too scanty to support a large cattle population. The foliage of trees forms the alternative source of green fodder. The silvipastoral system form the most predominant land use system. Agroforestry systems in the western Himalayas may be classified in to three broad categories based on needs, economics and environmental compulsions of land (Kumar et al, 2018).

Need-based systems include growing of scattered trees on farm bunds or on fallow lands to meet the need of fuel wood, fodder, fruit, small timber, fiber, etc. Fifty to hundred trees are generally planted in a hectare of land for fulfilling part of the fodder and fuel wood requirements. The harvested products of these trees are utilized either during rainy season or when manpower is not available to collect fuel wood and fodder from far off areas. Economy based system are horticultural systems. These systems are available in areas where the fuel wood and fodder resources are available. In these areas, landholdings are comparatively large. The fruit trees provides cash returns to the growers. In stone-fruit and apple zone, the dominance is of horticultural trees, whereas, in citrus zone, the agricultural crops form the predominant component in agroforestry systems. In the interspaces of horticultural trees, cash crops like pea, cabbage, tomato, cauliflower, chilli, beans and ginger are also grown besides wheat and maize.

Homestead agroforestry forms a dominant land use system in many parts of humid tropics. A fundamental attribute of the homegarden is the great diversity of species with several life forms varying from creepers such as sweet potato, to tall trees, e.g. coconut and vines climbers on poles and trees e.g. pepper vine. In Kerala, the dominant homegarden species are coconut, areacanut, mahaneem, mango, Jack, Teak, Cashew, Wild jack, Tamarind, Erythrina, Macaranga, Gliricidia, etc. Species diversity of these homegardens are very high. Homegardens are known for their stable yield, varied products and continuous or repeated harvest during the year and low inputs. Besides meeting the calorific requirements of the gardens they are also important source of nutrients. Other homegarden products include fuelwood, fodder and timber.

Agroforestry has gained its importance with emphasis of Hon'ble Prime Minister on planting trees in farm boundaries for providing livelihood support and economic benefits to the farmers. His

emphasis on devoting one third farm land under tree plantation alongwith agriculture and animal husbandry will help in providing environmental and economic securities to the farmers.

However, with so much contribution and potential, the agroforestry on account of its dependency on multi-institutions and multi-disciplinary approach, has failed to take off in a significant way. In 2014 India became the first country to have an independent National Agroforestry Policy, which is supposed to go a long way in large scale adoption of the agroforestry by the farmers and to provide the required raw material to wood based industries on one hand and play its role in energy and environmental security on other hand. In addition to NAF Policy, number of other initiatives have been taken at national level to promote successful agroforestry models such as initiation of Sub Mission on Agroforestry and National Bamboo Mission.

National Agroforestry Policy

In India, agroforestry has been receiving increasing attention of researchers, policy-makers and others for its perceived ability to contribute significantly to economic growth, poverty alleviation and environmental quality. Agroforestry is now recognized as an important part of the 'evergreen revolution' movement in the country. This all helped the country to launch the National Agroforestry Policy (NAP 2014) in 2014 and became the first country in the world to have a National Agroforestry Policy. The policy is not only seen as crucial to India's ambitious goal of achieving 33% tree cover but also to mitigate greenhouse gas emissions from agriculture sector. Since the launch of the policy in 2014, considerable progress has been made in terms of putting it into practice. To implement the recommendations, an inter-ministerial committee has been set up. The Department of Agriculture Cooperation & Farmers Welfare (DAC&FW) under the Ministry of Agriculture and Farmers Welfare (MOA&FW) is now the nodal Ministry for implementing agroforestry policies and initiatives. In another significant move, the Corporate Social Responsibility (CSR) laws of India were modified in 2014, and agroforestry was included as a legitimate CSR activity. As of now, 27 states have ratified the recommendations of the NAP.

Sub-Mission on Agroforestry (SMAF) & National Bamboo Mission

Based on the recommendations of the National Agroforestry Policy (NAP), a dedicated Sub-Mission on Agroforestry (SMAF) was established by Government of India under the framework of National Mission for Sustainable Agriculture (NMSA) The SMAF is focused to achieve increased tree cover to enhance carbon sequestration, enrichment of soil organic matter, availability of quality planting material, improved livelihood and productivity. Relaxation of transit regulations is a pre-requisite for assistance under Sub-Mission on Agroforestry (SMAF). Keeping in view the vast untapped potential of the bamboo sector, to boost the domestic production for supply to the industry, recently (2018) a National Bamboo Mission (NBM) has been launched. This is expected to give a big boost to bamboo-based agroforestry systems.

Conclusions

During last more than three decades many agroforestry models / technologies have been developed and demonstrated by various research organizations. So far suitable tree-crop combinations have been identified in different agro-climatic zones of the country and their package of cultivation practices standardized but the same has not reached to farmer's field for want of awareness, inadequate infrastructure and lack of extension support. Therefore, the desired impact has not been observed in terms of adoption of agroforestry models. The agroforestry models have been successful

in the areas where farmer's got incentive in terms of quality planting material and assured market for example in poplar and eucalyptus. Since woody perennials are the major component of any agroforestry programmes, the availability of quality planting material of the woody perennials, un-regulated nurseries, lack of credit and insurance are some of the major concerns and need to be addressed urgently. Dissemination of proven agroforestry technologies to the farmer's field is not at desired level and a strong linkage is required to be established between research organizations and line departments like KVK. Human resource development in agroforestry is another area which needs immediate concern. Also, knowledge gained in agroforestry has to be translated on farmer's field for averting degradation and enhancing productivity of not only herbaceous vegetation but woody perennials as well. To bring farmers into tree cultivation is a difficult task and hence necessary care should be given to analyse the site specific conditions, objectives of the farmer, selection of suitable tree species and the market potential for the species. High yielding, short rotation tree species with genetically superior planting material, market intelligence, price supportive mechanism and a viable supply chain can play a very important role in enhancing the livelihood of farmers adopting agroforestry. To tap the true potential of agroforestry, the following policy and development initiatives are needed to be taken up:

- Promotion of production and supply of quality planting material of agroforestry species through incentives and by promoting adequate infrastructure.
- Formulation and implementation of special line of scheme for credit to agroforestry.
- Rationalizing the tree felling and transit norms/rules
- Replicating the success of linkage models between farm and industry, by emphasizing public private partnerships.
- Relaxation in land leasing rules by the state governments for agroforestry.
- To devise mechanism for Payment for environmental services to the stakeholders

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