



Diversification of Agroforestry Systems in Navsari District of South Gujarat

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ABSTRACT

Agroforestry have the potential to meet the ever increasing demand for diversified products such as food, fiber, fodder, fruit, fuel and timber. Challenges in diversification of existing farming systems warrants development of suitable agroforestry models for popularization and further adoption by the farmer. A survey taken in five talukas of Navsari district (Navsari, Gandevi, Jalalpore, Chikhli and Vandsa) during 2015-16 to document the prevailing agroforestry systems revealed that the farmers prominently adopted five types of agroforestry systems viz., Agri-silvi-horticulture (ASH) Agri-silviculture (AS) Agri-horticulture (AH), Homegardens (HG) and Horti-pasture (HP) according to household requirements and livelihood security. The common systems recorded in these villages were mango+rice, sugarcane+teak (boundary plantation), vegetables crop+mango+teak (on boundary), sapota+grass. Homegardens were restricted to Gandevi and Chikhli taluka only. The hilly tract of Vandsa taluka had *Eleusina coracana*+teak (boundary plantation), rice+*Terminalia tomentosa*, *Eleusina coracana*+*Terminalia tomentosa* (boundary plantation) systems. This clearly showed that the selection of intercrops depends mainly on edapho-climatic conditions of the area, farmer's preferences, resource availability and their utilization pattern in a sequence in order to enhance diversification and achieve resilience in the existing farmland.

1. Introduction

Agroforestry is a land use system to compliment food production while also enabling carbon sequestration, and is majorly a low-input system. Realising the full potential, the "National Agroforestry Policy 2014" has been put in place in India to help promote this land use option for harnessing multifunctional benefits (Johl *et al.*, 1986; Garrity, 2004) that it has proven to provide especially in terms of livelihood improvement and climate change adaptation. The ever increasing demand for diversified products such as food, fuel, fiber, fodder, fruit and timber, therefore calls for diversification of existing farming systems by developing suitable agroforestry models.

Changing priorities in context to present climate justice and green energy avenues like bio-fuels, employment generation, carbon sequestration and value addition are now being discussed and debated for agroforestry. Nonetheless, it has been realized that agroforestry is the only alternative to meet the target of increasing forest cover to 33 per cent. Meanwhile, it is also necessary to development mechanism to reward the rural poor for the ecosystem services of agroforestry such as biodiversity conservation, watershed protection and carbon sequestration. Over all, it requires appropriate research interventions, investment, suitable extension strategies, incentives and marketing linkages to enable diversification agroforestry practice and system to harness both tangible and intangible benefits.

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2. Agroforestry Systems in Gujarat

Agriculture occupies a prominent position in Gujarat. Cultivation of crops in each agro-climatic sub-division is conditioned majorly by water availability amongst others. Nearly 20 % of the area in Gujarat is drought-prone, with high rainfall variability, but still manages to harbour varied cropping pattern enabling production vis-à-vis food security. The net cultivated area comprises 52 per cent of the reported area (Mehta, 2012). -According to the State of Forest Report 2013, the total forest cover in Gujarat is 14563 km² or 7.48% of the total geographical area. The trees outside forest (TOF) have been estimated to cover 8358 km² area which constitutes about 4.26% of the total geographical area of the state. Likewise the area of tree cover under agroforestry is about 11591 km² constituting 5.91 % of total geographical area. The State being the pioneer in social forestry sector in the country contributes immensely to the TOF. Total number of trees in the non-forest areas in 2003 was 251.0 million that increased to 268.7 million in 2009. Thus, tree population has increased at an annual rate of 2.9 million trees. At present, nine species - Neem (*Azadirachta indica*), Deshi babool (*Acacia nilotica*), Nilgiri (*Eucalyptus sp.*), Sharu (*Casuarina sp.*), Ardusa (*Ailanthus sp.*), Teak (*Tectona grandis*), Subabool (*Leucanea leucocephala*), Bengali babool (*Acacia auriculiformis*) and Bamboo are dominant economic species in agroforestry plantations. Besides these, eight exotic species – *Prosopis chilensis*, *Eucalyptus sp.*, *A. tortalis*, *Casuarina equisetifolia*, *Leucanea leucocephala*, *Pithocolobium dulce*, *Ailanthus excels* and *Acacia auriculiformis*, which were absent or rarely seen five decades ago have now become the dominant species, constituting over one-third of total TOF in the State. At the same time, these exotic species have changed the botanical landscape of the state, while also improving the wood production and economy of the state (Gujarat State Forest Department). Region-wise, in areas of North Gujarat tree species like neem, deshi babool and ardusa constitutes dominant agroforestry plantations as preferred by farmers. In central Gujarat, *Eucalyptus sp.* along with Deshi babool and neem is the main species in commercial plantations of agroforestry. Plantation of sharu and Bengali babool is ever increasing in the high rainfall areas of south Gujarat, although teak, *khair* and bamboo are also preferred by the farmers. Saurashtra and Kachchh have relatively less agroforestry plantations due to adverse climate and poor soil conditions. Sharu, neem, sitafal are however preferred by the farmers in this region. Amongst fruit species, mango (*Mangifera indica*), drum-stick or Sargavo (*Moringa oleifera*), Sitafal or Custard apple (*Annona squamosa*), aonla or Indian goose berry (*Embilca officinalis*), Bordi (*Zizyphus sp.*), Jamun (*Syzygium cumini*), Nariyali

(*Cocos nucifera*), Chikoo (*Acrus sapota*), and Guava or Jamfal (*Psidium guajava*) are important tree species raised by the farmers. This showed the selection of intercrops depends mainly on edapho-climatic conditions of the area, farmer's need/traditions and resource availability (Saroj and Dadhwal, 1997).

3. Agroforestry in Navsari District

Navsari district is (20° 45' to 21° 00' N latitude and 72° 45' to 73° 15' E longitude) is in the south eastern part of Gujarat state in the coastal lowland along Purna river. The district has 5 talukas namely Navsari, Jalalpore, Gandevi, Chikhali and Vandsa all covering geographical area of 2196 km². Agro-climatically, Navsari district is categorized into three regions such as forest and hilly tracts of the Eastern parts comprising Vandsa block, saline soils due to inundation by sea of Western parts comprising parts in Gandevi and Jalalpore blocks and black fertile soils of the central parts comprising Navsari, Gandevi and Chikhli blocks. With respect to land holding, about 78 per cent farmers have less than 2 ha land and the remaining 22 per cent hold between 2-4 ha of land district.

Over all, the agricultural land utilization pattern showed that the total area is about 220077 ha where non-agriculture area is about 34971 ha and total cultivable barren land is about 6970 ha. To document prevailing agroforestry systems in Navsari district, a survey was conducted in five talukas of Navsari, Gandevi, Jalalpore, Chikhli and Vandsa during 2015-16. In the study, more than 25 tree species have been recorded in the agroforestry system. Prominent species were *Tectona grandis*, *Eucalyptus spp*, *Casuarina equisetifolia*, *Terminalia spp*, *Azadirachta indica*, *Cocos nucifera*, *Artocarpus spp*, *Acacia catechu*, *Annona squamosa*, *Annona reticulata*, *Dalbergia sissoo*, *Embilca officinalis*, *Moringa oleifera*, etc. have been recorded. Moreover, farmers of this region are also growing intercrop under Mango and Sapota orchards. Crops such as rice, okra, brinjal, chilly, spiderlilly, *Eleusina coracana* (Nagli) and chickpea have generally been cultivated with tree crops. Based on preliminary studies on cropping pattern and allied economics in Navsari district, only four major agroforestry systems have been adopted by the farmers (Panchal, 2013). The dominant agroforestry practices adopted in this region are summarized presented in Table 1. Farmers generally grow various types of crops according to their needs and utilization and for cash crops especially according to market demand. During *kharif*, they generally cultivated crops such as paddy, pulses like pigeon pea and black gram, sorghum and vegetables. During *rabi*, they cultivated sugarcane, summer paddy, Indian bean and sun hemp/dhaincha. Other/cash crops such as mango, sapota, cucurbits, okra, brinjal, flower crops, etc. were also grown on their farm land, thus maintaining the diversification of the farm crops.

Apart from these, aqua-based integrated farming system is also practiced where in rice is a major agricultural crop, particularly along the coast lines. Horticulture based agroforestry system/agri-horticultural system has been widely adopted in different parts of Navsari. This kind of system is preferred by farmers over other agroforestry systems due to its higher economic returns even under stressed condition prevailing under the upland situations than any other annual crops. Mango and sapota are the major horticultural fruit crops that are widely grown in this area. Agricultural crops like okra, pigeon pea, green gram, brinjal, tomato, cabbage and chilly are commonly used as intercrops. It is envisaged that such an integration of horticultural species with silvicultural species will help ensure income/productivity to the farmers much earlier. Agricultural crops are generally planted in the interspaces of fruit trees at the spacing of 5-7 m apart. Since, fruit trees have long gestation period of 4-5 years to get income, the interspaces can be conveniently used for cultivation of agricultural crops profitably till they develop a canopy. Moreover, the local farmers preferred crop rotation. For instance, initially they practice teak+ sugarcane and then after three-four years, sugarcane is replaced by rice *i.e.*, teak+ rice. Likewise, perennial crop on the hedge or boundary is also grown.

Interestingly, many non-resident Indians having enormous land utilize their lands for growing short-rotation tree species like *Eucalyptus* and *Casuarina*.

Conclusion

Our observations revealed that the farmers of Navsari prominently adopted five types of agroforestry systems *viz.*, Agri-silvi-horticulture, Agri-silviculture, Agri-horticulture, Homegardens and Horti-pasture according to their needs to achieve livelihood security. The multiple-crop interaction has been methodically practiced by the farmers of Navsari's district in Gujarat, raising opportunities of diversification and climate resilience. Further, it also provides a scope of appreciating and bio-prospecting agro-biodiversity considering the varieties of local genotypes available for further utilization.

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Table 1. Prevalent agroforestry systems in Navsari District of South Gujarat

Sl. No	Agroforestry System	Tree-Crop Mixtures
1	Agri-silvi-horticulture (ASH)	Brinjal + Mango + Teak (on boundary) Okra + Mango + Teak (on boundary)
2	Agri-horticulture (AH)	Mango + Rice Sapota + Rice Mango + Vegetables
3	Agri-silviculture (AS)	Spider lily + Eucalyptus Sugarcane + Teak (boundary plantation) Rice + Teak (boundary plantation) <i>Eleusina coracana</i> + Teak (boundary plantation) Rice + <i>Terminalia tomentosa</i> <i>Eleusina coracana</i> + <i>Terminalia tomentosa</i> (boundary plantation)
4	Homegardens (HG)	Homegarden
5	Horti-pasture (HP)	Sapota + Grass

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