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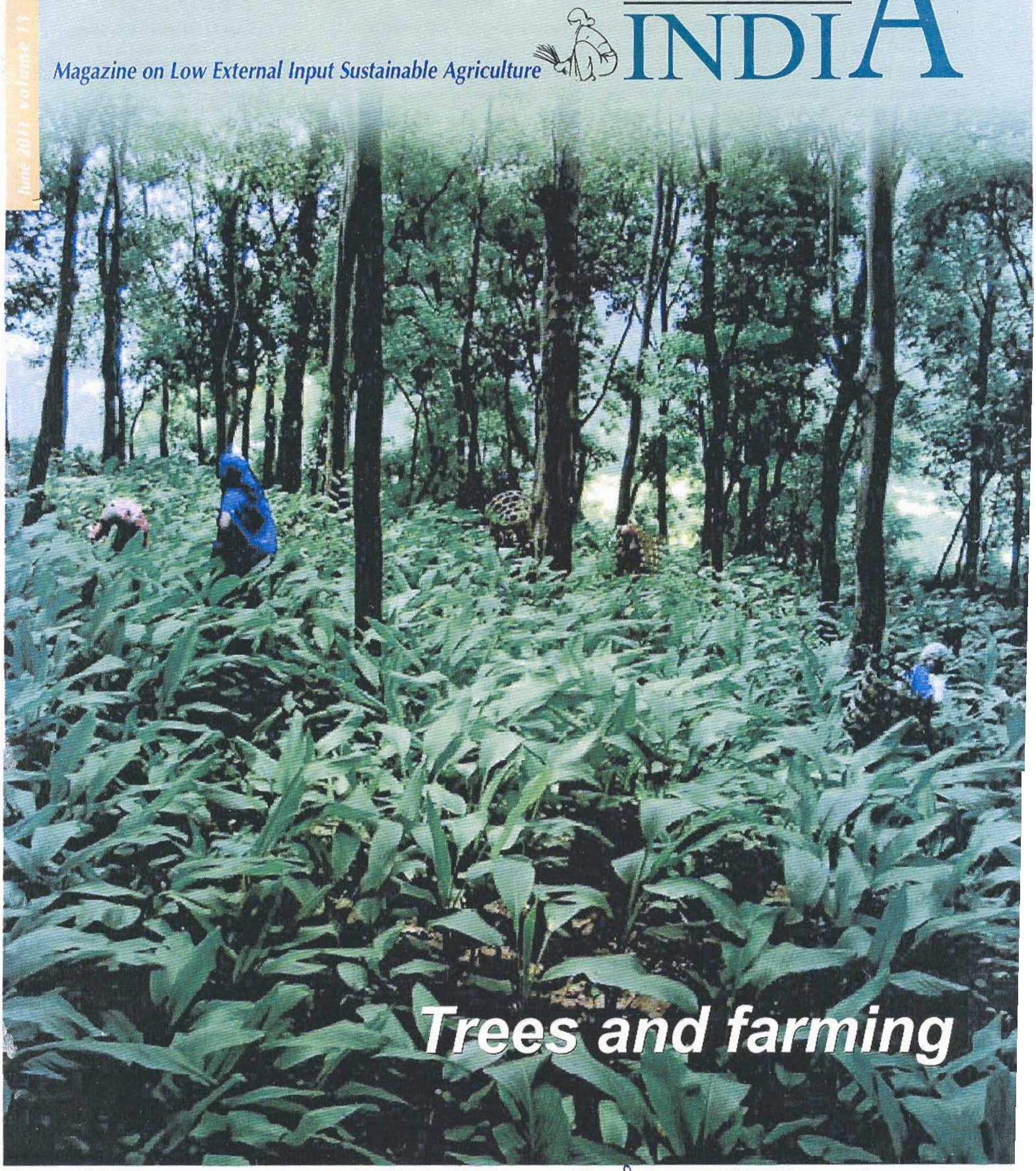

## Trees and farming

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Ram & Vijay.

# Agroforestry for ecological and economic benefits

**R K Maikhuri** and **Vikram S Negi**

***Tree cultivation in agroforestry system has the potential to take pressure off extractive harvesting from natural forests, contributing to in-situ conservation, limiting deforestation and fixing carbon in farmland. Agroforestry is therefore seen as an important means of 'climate- smart' development.***

Agriculture is the major economic activity of the people inhabited in the central Himalayan region and practiced on steep terraced slope and is very complex in that of crop husbandry; animal husbandry and forest constitute interlinked production systems. A number of multipurpose tree species are conserved as scattered trees in settled farms on terraced slopes by the traditional farmers in Central Himalaya. However, in recent years, environmental degradation, poor resource management, and increased migration of men to plains have led to abandonment of agricultural land in the form of degraded land.

Fodder and litter plays a major role in crop-livestock-manure-soil nutrient cycle of farms in middle mountains of the Himalaya. In Garhwal part of Indian Himalayan Region fodder is mainly collected by lopping the vegetative biomass of trees, shrubs, herbs and grasses. Tree fodders play an important role in traditional farming systems common across the foothills of the Himalayas and are especially valuable during the dry winter season, when fodder from other sources becomes limited in quantity and quality. Development of a agroforestry model integrating trees in the cropping system not only supplements economic benefit to the people but also ecological benefit indirectly. Plantation of trees in degraded lands could accompany significant tangible (viz., improved production of food, fuelwood, fodder, timber and other products) and intangible (viz., carbon sequestration, hydrological balance, soil fertility recovery and slope stability) benefits serving the interests of both local and global community.

G.B. Pant Institute of Himalayan Environment and Development initiated agro forestry model programme in mid-altitude village in Garhwal Himalaya to understand role of trees in farming as they complement agriculture production by improving soil fertility and sustaining land productivity. One and half hectares of degraded agricultural land and two hectares of degraded community forest land was selected at Banswara village in Rudarparyag District in Garhwal in July 1991.

Three land use-land cover types were identified: settled farming on privately owned terraced slopes with scattered multipurpose trees, degraded community forest land and degraded abandoned agricultural land. Annual crops are grown in two seasons - the warm rainy season and the cold winter season. Finger millet, barnyard millet and paddy are grown in the rainy season, while wheat, lentil and rape seed crops are grown in the winter season. The fields are fallowed during the winter season once in two years.

Tree planting as a component of land rehabilitation strategy was built on people's knowledge and their local needs. People's participation was the central focus. The species selected for plantation were chosen by the village community from a wider list of traditionally valued and naturally regenerating tree species identified in a survey of a cluster of villages. Local uses, management and ecological features of plantation species were kept in mind while selecting the species for plantation. Among selected plant species *Boehmeria rugulosa*, *Grewia optiva* and *Ficus glomerata* were considered to be the best in providing good quality fodder, *Albizzia lebbek*, *Celtis australis* and *Dalbergia sissoo* as the best quality timber trees and *Pyrus pashia* and *Sapium sebiferum* as the best quality fuelwood species. *Alnus nepalensis* and *Dalbergia sissoo* do not have any fodder value but are nitrogen fixing, capable of sequestering larger quantities of carbon and are not as much affected by soil moisture and nutrient stress as the fodder species. Local communities preferred plantations dominated by high quality fodder species *Grewia optiva*, *Boehmeria rugulosa* and *Ficus glomerata*.

Ten-to-twelve-month-old seedlings were planted at regular intervals of 3 m in 45 x 45 x 45 cm size pits, providing 2 kg of farm yard manure in each pit, as random mixture of above mentioned tree species at both sites. In the case of degraded agricultural land site, the terraces were repaired and agricultural crops were grown providing supplemental irrigation and organic manure, along with the planted trees, following traditional farming practices. During the first two years after plantation, vegetables including spinach, radish, *Brassica juncea* (locally called Rai) were grown during the winter season. Lady's finger, brinjal, french bean, cucurbits, bitter gourd, sweet gourd and sponge gourd (*Luffa cylindrica*) were grown during the summer and the rainy seasons. From the third year onwards when considerable shade was created by the canopy of planted trees, mustard, wheat and lentil were grown during the winter season and adjuki bean (*Vigna angularis*), cow pea and pigeon pea during the rainy season. Both sites were protected from grazing and other human disturbances.

## Learnings

- While local communities preferred plantations dominated by high quality fodder species, these species lacked nitrogen fixing capability and made limited contribution to carbon sequestration and were not highly suitable for degraded land conditions. In such situations, mixed multipurpose tree plantations could be established in the areas where tree-crop combined agroforestry is impractical for socio-economic and ecological reasons.
- The studies showed that a substantial amount of rehabilitation cost could be borne by the local communities if tree-crop combined agroforestry along with soil and water management technologies are promoted on degraded lands.
- The economic benefits from exclusive multipurpose tree plantations or tree-crop combined agroforestry under rainfed conditions proved too low to induce active local participation in rehabilitation programmes.

## Gains from the model

After five-year intervals regular monitoring and research activities were conducted by different scientists. taking into consideration survival, height, stem circumference, crown depth and width, number of branches, above ground biomass, carbon sequestration and soil physico-chemical characteristics. A high level of crop diversity in traditional agroforestry system is maintained through rotation of crops in coexistence with mono and mixed cropping practices. Above-ground tree biomass accumulation at the degraded agricultural land site was higher as compared with the degraded forest land site. A significant improvement in soil physico-chemical characteristics was observed after five years at both of the sites. Carbon sequestration in soil was higher than that in bole biomass. In all species above-ground biomass accumulation, crown depth, crown circumference and number of branches per tree was higher at the degraded agricultural land site as compared to degraded forest land.

Better performance of multipurpose tree species at the degraded agricultural land compared to the degraded forest land site could be attributed to irrigation and additional organic manure applied primarily for growing annual food crops in the former site. The magnitude of difference in growth between the degraded agricultural land site and degraded forest land site could be viewed as an indicator of species response to soil moisture and nutrient conditions.

Studies indicated that the mean annual carbon sequestration at the degraded agricultural land site was substantially higher than that at the degraded forest land site. In the mixed plantations, a significant improvement in soil carbon and nutrients was observed in both the sites, though the magnitude of change varied between sites.

With the success of this model at Banswara, people in the surrounding villages of Kedarghati have adopted this kind of agroforestry model, managing agriculture and forestry together for their survival. The models are also serving as demonstration sites for institutions and government departments besides serving as a site for conducting research by many research institutions.

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