

Magazine on Low External Input Sustainable Agriculture



LEIS INDIA



Trees and farming



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Successful agroforestry model in central himalayan region.

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The editors have taken every care to ensure that the contents of this magazine are as accurate as possible. The authors have ultimate responsibility, however, for the content of individual articles.

The editors encourage readers to photocopy and circulate magazine articles.

Dear Readers

Trees are integral to our traditional farming systems, for the innumerable benefits that they provide. However, over time, with shrinking land holdings, annual crops replaced trees for various reasons. Trees complement farming in terms of manure, fodder and fuel needs of the farmer. They form the backbone for practicing integrated farming systems which is necessary for self reliant and sustainable agriculture. Including trees in farming becomes more crucial than ever before. Also, trees considered as carbon sinks, are one of the well known ways of reducing the global warming effects. In this issue we present experiences where farmers have integrated and practiced tree based farming, reaping rich benefits, individually and for the community as well.

We are happy with the feedback we are receiving through web on the utility of the magazine. Also, we would be grateful to readers sharing how a particular experience they read has inspired them to practice something better.

We once again are grateful to all those who are voluntarily supporting the magazine and the movement. We would like to inform you that owing to funding constraints, we may not be able to share the print copy of LEISA India free of cost, beyond the September 2011 issue. For details on this aspect, see the insert enclosed in this issue. We would like to inform you that the contributions made to LEISA India are exempted under 80CC of Income Tax regulations. Kindly avail this opportunity and donate generously.

The Editors

LEISA is about Low-External-Input and Sustainable Agriculture. It is about the technical and social options open to farmers who seek to improve productivity and income in an ecologically sound way. LEISA is about the optimal use of local resources and natural processes and, if necessary, the safe and efficient use of external inputs. It is about the empowerment of male and female farmers and the communities who seek to build their future on the bases of their own knowledge, skills, values, culture and institutions. LEISA is also about participatory methodologies to strengthen the capacity of farmers and other actors, to improve agriculture and adapt it to changing needs and conditions. LEISA seeks to combine indigenous and scientific knowledge and to influence policy formulation to create a conducive environment for its further development. LEISA is a concept, an approach and a political message.

AME Foundation promotes sustainable livelihoods through combining indigenous knowledge and innovative technologies for Low-External-Input natural resource management. Towards this objective, AME Foundation works with small and marginal farmers in the Deccan Plateau region by generating farming alternatives, enriching the knowledge base, training, linking development agencies and sharing experience.

AMEF is working closely with interested groups of farmers in clusters of villages, to enable them to generate and adopt alternative farming practices. These locations with enhanced visibility are utilised as learning situations for practitioners and promoters of eco-farming systems, which includes NGOs and NGO networks.

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ILEIA - the Centre for Learning on sustainable agriculture and the secretariat of the global AgriCultures network promotes exchange of information for small-scale farmers in the South through identifying promising technologies involving no or only marginal external inputs, but building on local knowledge and traditional technologies and the involvement of the farmers themselves in development. Information about these technologies is exchanged mainly through Farming Matters magazine (<http://www.theagriculturesnetwork.org>).

Kerala Home Gardens Nurturing biodiversity

**Allan Thomas, S Bhaskaran, Sajan Kurien and
Usha C Thomas**

Home gardens in Kerala which started as a means of subsistence have today transformed into a means of additional income generation. These systems developed over years have optimized their production activities that satisfies the biophysical needs, socioeconomic security and environmental requirements in which they live.

Fodder banks Relieving women from drudgery

Shalini Misra, R K Maikhuri and Deepak Dhyani

Raising fast growing and high yielding nutritious fodder species on farm lands can reduce the drudgery of women in collecting fodder from distant forests and also protect the degrading forests. G.B.Pant Institute of Himalayan Environment and Development achieved this intent through promotion of Fodder bank model.



Payments or rewards? Farmers benefit by providing environmental services

Godfrey Mwaloma

More and more land in Africa is being cultivated, reducing the area covered by forests, the existing biodiversity, and affecting the water supplies of nearby cities. Could farmers produce the same services as forests do – at least partly? The World Agroforestry Centre is working to develop arrangements between farmers and private parties in a bid to have farmland supply clean water and carbon sinks. But what should farmers get in return? Money is not the only reward they are looking for.

Wadi, the tree based farming model

B V Sherkar and R C Kote

Tree based farming has proved successful in providing sustained incomes for the farmers in the rainfed areas. The model has helped in converting the unproductive waste lands of tribal families in parts of Maharashtra into productive mango and cashew growing lands.



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Trees and farming

Trees have been historically an important component of the farming systems in several parts of India. They have been as part of peasants' subsistence strategies. They are grown in homesteads, farm boundaries or the field itself. Trees are either planted in conjunction with other crops, or grown as a monocrop. The purpose of tree growing have been many - ecological, to meet consumption of family or cattle, means for building soil fertility, as barriers for wind flows, or to generate cash through sale in the market. Patterns of tree growing vary with farming system, soil capabilities, demand for tree outputs, and farmers' perception of market conditions.

There are several situations in which farmers protect, maintain and plant trees on farm lands and bunds. Trees which have multiple uses are preferred, especially yielding fruit, fodder and mulch and being suitable as supporting structures for the cultivation of pepper, betels and various climbers. This diversity also reduces risks from pests and adverse weather as they tend to affect different crops differently.

Trees complement agriculture

With depletion of agricultural lands and lack of irrigation facilities, agriculture in arid and semiarid regions is becoming uneconomical. Integrating trees on farms provides a viable solution for such problems. Under this system, trees serve as wind breaks, source of organic matter, shade and soil binder to prevent soil erosion while generating additional income. Establishing shelterbelts by planting tall growing trees on field bunds is very popular in India (Hegde, p.6).

In semi-arid regions, trees increase soil productivity and land sustainability through nutrient recycling, provide mulch and shade for crops, and hence complement agricultural production. Trees are planted on farm boundaries, or inter-cropped with field crops without much loss of the main crops. Trees are raised primarily to benefit farms by its soil enriching effect and prevent soil erosion, also providing subsistence products like fodder and fuel wood. In Uttoor in Andhra Pradesh, around 373 farmers planted *sunhemp*, *diancha*, *glyricidia* and *cassia siamea* for producing biomass which was later composted as organic manure (Ashok Kumar, p.14). Farmers took up several other measures to improve their soil fertility, for instance, application of enriched farm yard manure; pre-season in-situ green manuring; composting weeds; composting other farm residues; composting of cotton stalks; in-situ incorporation of inter crops.

Traditional systems

Homesteads is a very old tradition that has evolved over a long time and widely prevalent in States like Kerala. The forest-like structure has been the result of deliberate planning of home garden to mimic the forest, which has its own techno-socio-economic



implications. Trees on homesteads in regions of high rainfall and good soil increase overall output from land. The major advantage is family involvement in farming and providing nutritional security to individual households. In the course of evolution, however, there has been a shift in the purpose for which home gardens are being raised – from food, nutritional and cultural needs to economic needs. It is believed that population boom and pressure on land where the land itself has become a constraint coupled with the development of a market economy made an effect on the complexity of the home gardens. Its resemblance to a forest no longer continues. Tree crops have become a casualty in the process of incorporating home gardens with annual crops for subsistence and for the market.

Tree fodders play an important role in traditional farming systems common across the foothills of the Himalayas. A number of multipurpose tree species are conserved as scattered trees in settled farms on terraced slopes by the traditional farmers in Central Himalaya. They are especially valuable during the dry winter season, when fodder from other sources becomes limited in quantity and quality (Maikhuri and Negi, p.10).

Tree based farming for improved livelihoods

Farming in semi arid regions has become more and more unsustainable. Large tracts of land are left degraded which cannot support agriculture. A majority of small farmers depend on such unproductive lands for their livelihoods. To help such farmers to make a living, efforts have been made by development agencies to promote and integrate trees as a component in the farming systems.

Maharashtra Institute of Technology Transfer for Rural Areas (MITTRA) an organization promoted by BAIF Development Research Foundation, Pune promoted tree-based farming through agri-hortiforestry model called as *wadi*. The model has helped in converting the unproductive waste lands of tribal families in parts of Maharashtra into productive mango and cashew growing lands (Sherkar and Kote, p. 35). Similarly, Chetna, an NGO in Andhra Pradesh has been working with the tribal communities of Adilabad district in improving their farming livelihoods. Local farmers are identified and trained in sustainable agriculture practices. The programme is integrated and coordinated with all departments and

agencies like Integrated Tribal Development Authority (ITDA) for convergence (Ashok Kumar, p. 14).

Women, especially in the hill regions, spend a lot of time and energy in procuring fodder for their livestock. To reduce their drudgery, G.B.Pant Institute of Himalayan Environment and Development promoted fodder banks. Women in Maikhanda village were motivated to grow fast growing high yielding nutritious fodder species on farm lands. Complemented by fodder banks, this initiative relieved women from drudgery in collecting fodder from distant forests, also protecting the degraded forests (Shalini Misra, Maikhuri and Deepak Dhyani, p.19).

Choice of species is one of the key factors for the success of any afforestation programme. While promoting tree planting on private lands, the preference of farmers should be considered. Tree species to be selected, should be based on the quality of land, availability of moisture, suitability of climate, growth rate, gestation period, profitability and for fulfilling certain objectives. Profitability is the main factor for tree plantation on private lands, followed by other minor factors such as gestation period, demand for produce, level of investment, access to market, availability of planting material and specific local uses, which influence the farmers to select tree species for planting on their lands.(Hegde, p.6)

Social structures and institutional building are also important in having sustainable positive impacts of the initiatives on the communities. For instance, the Mahila Mangal Dals in Garhwal region were strengthened to help women make decisions in forest use. The members ensured that forest product collection did not conflict with periods of heavy agricultural work like finger millet harvesting season. With the women's group in place, the forest

resources are used sustainably without leading to their over exploitation (Shalini Misra, Maikhuri and Deepak Dhyani, p.19).

Benefits beyond the farm

Agroforestry is seen as an important means of 'climate- smart' development. Maximizing the productivity of trees and crops in agricultural landscapes becomes important as they serve as the much needed 'carbon sinks'. A significant improvement in soil physico-chemical characteristics and the ability of the soil to sequester carbon increases tremendously after five years of plating trees on degraded lands (Maikhuri and Negi, p.10).

Agroforestry is uniquely suited to improving food and fuel security, while they continue to provide essential ecosystem services. In such situations, can farmers be rewarded for providing environmental services (such as habitats for wildlife, carbon sequestration, climate regulation or the regulation of water flows and quality) in addition to producing food? Rewards can come in different forms. The best known system is that of "Payments for Environmental Services" or PES, which make *direct payments* to farmers. So far, farmers have rarely been rewarded for their environmental services. However, one could learn useful lessons from a pilot programme in Malawi where farmers get cash payments for growing trees (Mwaloma, p.26).

Rewarding communities for environmental services can provide powerful incentives and efficient mechanisms for conservation, while also offering new sources of income to support rural livelihoods. By doing so, the rural communities who have been blamed for most of the degradation will become wardens of the environment.



Trees for improving farm productivity

Narayan G Hegde

With depletion of agricultural lands and lack of irrigation facilities, agriculture in arid and semiarid regions is becoming uneconomical. Agroforestry provides a viable solution for such problems. Promotion of afforestation should be based on well tested technical and economic data to guide the farmers and general public in the right direction.



We need trees for our survival. Trees purify the atmosphere by converting carbon dioxide into oxygen, provide food, fodder, medicines, organic manure, fuel, timber and also improve the soil productivity, ground water table and the ecosystem. Thus, trees play a significant role in improving our quality of life. Among trees, there is a large number of species and a wide variation exists among them. These variations may be due to their size, growth rate, and adaptability to various agro-climatic conditions, their ability to tolerate harsh weather conditions or their utility. By and large, every tree created by nature is good, although some are more useful than others. Some trees may not survive under certain soil and climatic conditions while some others may grow aggressively, suppressing other species. Hence, the success of tree planting depends on the choice of species.

Trees have a significant role in keeping the environment clean, while supporting livelihoods. Over 43% of the cooking energy in the world is met from biomass. In rural areas where 65% of the population lives, biomass is the only accessible and affordable source of energy. In the developing countries, the average per capita consumption of biomass in rural areas is equivalent to a ton of wood per annum and 50% of the wood cut in the world is used for fuel (Hall and de Groot, 1985). More than 2 billion people in the Third World are dependent on biomass to meet their energy needs which is equivalent to 22 million barrels of oil every day. In 1979, about 68.5% of the total rural energy was met from wood in India. In 2000, the annual demand for wood in the Indian rural sector was 192.6 million tons while it was difficult to meet even 50% of it from the available sources. This indicates the extent of damage caused to the natural forests and the need for growing trees to meet the fuelwood needs.

Presently, only about 12% of the geographical area in the country is under close forests as against the stipulated forest cover of 33% required for maintaining ecological balance. It is estimated that India has about 80-100 million hectares of denuded forests and wastelands, which have been accelerating soil erosion, run off of rainwater, loss of bio-diversity and contributing to global warming. Therefore, to conserve the ecosystem while solving the energy crisis, the strategy should be to encourage people's participation to revive and regenerate the natural forests while planting tree species of their choice on private and public non-forest lands.

Social Forestry – A drive for people's participation

With the aim of developing private and non-forest public wastelands under afforestation while protecting the natural forests, the Government of India introduced several people-oriented afforestation schemes from the early 1950s. Significant among them were decentralised plant nurseries for distributing among small farmers, cultivation of fodder, fuelwood and round timber species through Forest Development Corporations, fuelwood plantation on urban wastelands, production of industrial raw materials on Government-owned wastelands and leasing revenue wastelands to the poor for growing trees, etc. To enhance people's participation in tree planting programme, the schemes were modified to integrate livestock with forage production and shift from fuelwood production to income generation by introducing short rotation species with long rotation trees and timber species with fuelwood. However, most of these schemes could not attract small farmers as they had very little scope to plant species of their preference. On the contrary, farm forestry schemes to cultivate eucalyptus and other commercial species exceeded the target area as the participants were motivated by the prospect of economic

gains. Fast growth, high value for the produce, sustained demand from industries and existence of an easily accessible market contributed to the popularity of eucalyptus plantation. Higher profitability due to higher rate of survival, short gestation period, higher yield, ready market, high value products like round wood, remunerative price, negligible impact on seasonal crops, easy management of labour and ease in protection were the other reasons for acceptance of eucalyptus by farmers.

Choice of tree species for farmers

Based on various social forestry projects implemented over the last 2-3 decades, it is clear that choice of species is the key to the success of any afforestation programme. Profitability is the main factor for tree plantation on private lands, followed by other minor factors such as gestation period, demand for produce, level of investment, access to market, availability of planting material and specific local uses, which influence the farmers to select tree species for planting on their lands. Farmers generally plant tree species on their land either because they are convinced or because they are motivated by some of the agencies engaged in promoting afforestation. Most of the small farmers are influenced by publicity, incentives and perceived benefits, while selecting tree species for planting. The popularity of the species also varies from region to region, based on the value and demand for produce, marketing infrastructure, agro-climatic conditions, available inputs and publicity by the extension agencies.

Tree species for income generation

A study in Maharashtra revealed that when different agencies were promoting tree planting, a majority of the farmers preferred to grow fruit, timber and round wood species on their marginal lands. This preference was based on the profitability, demand for the produce and field publicity. For instance, eucalyptus was the most popular species not because of higher returns, but because of easy marketability, short gestation, fast growth, non-browsing foliage, and wider publicity. Similar popularity has been observed for poplar (*Populus deltoides*) in North India and for *Casuarina* in South India. In interior areas, where marketing facilities for wood were inadequate, farmers preferred to grow fruit crops and used existing market outlets for selling their produce. Selection of fruit species was dependent on the soil productivity, irrigation facility, availability of good quality planting material and profitability. Oil seed trees such as neem (*Azadirachta indica*), mahua (*Madhuca indica* and *Madhuca longifolia*), pongamia (*Derris indica*), undi (*Calophyllum inophyllum*) and jatropha (*Jatropha curcus*) are also gaining importance due to their use for bio-diesel production. Among these, jatropha and pongamia have received wider publicity, but farmers are yet to realise the advantages of these species. There are many other non-wood tree species having economic importance.

Farmers did plant some fuelwood species such as Subabul (*Leucaena leucocephala*), Gum acacia (*Acacia nilotica* var. *telia*) and Australian acacia (*Acacia auriculiformis*) on their field boundary, mainly to protect their fields, while meeting the fodder and fuelwood needs.

Trees for Agroforestry

With depletion of agricultural lands and lack of irrigation facilities, agriculture in arid and semiarid regions is becoming uneconomical. Agroforestry provides a viable solution for such problems. Under this system, trees serve as wind breaks, source of organic matter, shade and soil binder to prevent soil erosion while generating additional income. Establishing shelterbelts by planting tall growing trees on field bunds is very popular in India. Popular species used under shelterbelt plantation are eucalyptus, poplars, casuarina, bamboo (*Dendrocalamus strictus* and *Bambusa arundinaceae*), acacia, dalbergia, leucaena, Silver oak (*Grevillea robusta*), sesbania, gliricidia, melia, etc. To prevent adverse effects of these trees on agricultural crops, regular pruning of side branches and lateral roots will be helpful. These trees will be ready for harvest as poles, while contributing foliage and twigs for fodder, fuel and green manure.

Depending on the fertility and depth of soil and moisture availability, different tree species can be introduced. In areas receiving more than 800 mm annual rainfall, it is possible to introduce various fruit crops while planting multipurpose tree species on field bunds and borders. Agri-horti-forestry promoted by BAIF Development Research Foundation on degraded private lands particularly in hilly terrains for rehabilitation of tribals, is based on this concept. Under this programme, various agricultural crops are grown as intercrops between the fruit trees, to generate income from the first year itself, while fruit trees start bearing fruits after 4-6 years. These orchards established on 0.4 ha by each family provide gainful employment all round the year, while improving the ecosystem.

Planting trees for social cause

People also want to plant certain tree species with religious sentiments or for beautification, but in small number. Many species of Ficus, Bael / Stone apple (*Aegle marmelos*) and Acacia are also considered holy trees and people generally do not cut them. However, they do not want to plant these plants in large number, without any tangible benefits. Many flowering trees are planted for beautification around residential or public places. Tall growing trees with wide branches to provide shade, such as mahogany (*Swientenia macrophylla*), raintree (*Samania saman*) and ficus trees can be planted to bring the open area under tree groves. Plants like bamboo, bottle brush (*Callistemon viminalis*) and weeping willow (*Salix babylonica*) can be planted along lakes and canals.

Profitability of tree species

A benefit-cost analysis of important fruit and round timber species based revealed that pole timber such as eucalyptus, bamboo, casuarina, melia and leucaena start generating income from the third year. As most of them coppice well, plantations can be maintained to harvest 3-4 crops. Drumstick (*Moringa oleifera*) and papaya (*Carica papaya*) start fruiting in the first year while other fruit trees like jujube (*Zizyphus mauritiana*), custard apple, pomegranate, guava, Indian gooseberry (*Emblica officinalis*), mango, citrus, sapota (*Manilkara zapota*) and cashew start fruiting from the third year. Trees like tamarind (*Tamarindus indica*),

jackfruit (*Artocarpus heterophyllus*) and jamun (*Syzygium cumini*), start fruiting after 7-8 years. Oil seed trees like neem, pongamia and mahua start fruiting after 7-8 years. As these species have different gestation period and various uses, it is extremely difficult for common farmers to take a quick decision about planting them. Nevertheless, farmers are ready to plant many of these species on field bunds without affecting arable crops, if good quality plants are locally available. However, if they have to establish a sole plantation on good lands using their own resources, then they will certainly explore more about resources required, investment and profitability before taking a final decision. It was observed that the net income from round timber and fruit trees was high but varied from place to place, mostly depending on the market linkage. In such a situation, small holders preferred fruit trees while large holders opted for round wood species. Farmers do not mind planting tree species of long gestation like teak (*Tectona grandis*), sandalwood (*Santalum album*), siris (*Albizia lebbek*), shishum (*Dalbergia sissoo*) and many non-wood product species useful for food, oil, gum, resin, wax, pesticides, tan, dyes, fibre, soap and medicines, in small number on the field boundary or backyard. There are many tree species which are good for fuelwood and fodder, but most farmers are not very keen to grow them.

As compared to fruit and timber species, income from fuelwood is very low. If a ton of wood is sold for fuel, it would fetch only Rs.1000/-. The same wood when sold as pulpwood would fetch 50% more and as round timber, 200% more. When the wood is used as timber either for construction or furniture, it would fetch 400-500% higher price. Thus, farmers would prefer to plant tree species which provide higher returns. Under Social Forestry Programme, the poor farmers were persuaded to plant fuelwood and fodder, while large farmers had the option to grow wood for round timber, paper and pulp. Thus, unknowingly, there was discrimination and the poor were left out of an excellent opportunity to earn more from the programme. This was the major reason for lack of people's participation and failure of many projects, which were intended for the benefit of the poor.

Preference for different tree species

While calculating the profitability of different tree species, it is necessary to take their entire life cycle and convert into annual returns. Most of the fruit trees start generating income from an early age and contribute to profit every year. In case of round wood and timber species, income is generated only when trees are cut, after a long gestation. Thus, fruit and non-wood tree species can be widely accepted by farmers if serious efforts are made to promote them.

Even for expansion of various fruit crops, there are limitations of labour, resources and market beyond certain scales of operation. Unless efforts are made to process the fruits for value addition and preservation, farmers are not likely to cultivate most of the species on a large scale. For crops like mango, in the absence of cold storage and processing, glut during a particular period in the year may affect the price realisation. In such a situation, farmers are likely to select the next best crops for cultivation. Looking to the present trend of tree planting on private lands, it can be



Farm forestry - teak with melia

concluded that farmers opt for different types of tree species in the following order of priority:

1. Fruits and nuts
2. Round wood species and plywood
3. Non-timber forest products and oil seeds
4. Paper and pulpwood
5. Fuelwood and forage

This preference is based on current profitability and is subject to availability of good soil, assured soil moisture and easy availability of inputs. The priority may change for different sites, based on adaptability of the species to local agro-climatic conditions, infrastructure for backward and forward integration, investment capabilities, etc. Many conservationists argue that preference should be given to native tree species and not to exotic. However, if farmers have to make a choice, they will select on the basis of adaptability, utility and profitability and not by their origin. Nevertheless, it is the responsibility of the facilitating organisations to evaluate their suitability under local conditions before promoting new exotic species (Hegde, 2010).

To ensure selection of suitable species, it is better to prepare a land use plan, based on the soil productivity of the site earmarked for tree planting. Fertile soil with assured soil moisture is highly productive, where fruit trees grow well and give high returns. Hence, such lands can be reserved for establishing fruit orchards, if farmers are not intending to grow arable crops of high value. Medium quality soils with moisture stress, not suitable for fruit crops, can be used for growing round wood, soft wood or plywood species. Soils of slightly inferior quality can be used for pulp and paper wood. Soils of low fertility with moisture stress, not suitable for above types of species can be used for establishing fuelwood plantation. There are shallow soils with moisture stress, where it is extremely difficult for tree species to survive. Such soils can be used for growing fodder shrubs and grasses.

Strategy for solving fuelwood crisis

Based on various studies, it is clear that establishment of tree plantations for fuelwood and fodder is neither economically viable nor attractive to farmers for cultivation. However, in the absence of easy supply of fuelwood, pressure on community woodlots and

forests will further increase, to accelerate further denudation. To reduce this problem, the following alternatives need to be considered.

- Promotion of commercial plantation, where only 40-50% wood is used for timber or industrial raw material and the rest is sold as fuelwood at a subsidised price.
- Planting fuelwood species of short gestation in fruit orchards or timber plantations is feasible. Selection of nitrogen-fixing tree species like *leucaena*, *gliricidia*, *sesbania*, *acacia* and *albizia* which are known for high calorific value can further benefit farmers by nursing the main tree species through soil enrichment.

Summary

While promoting tree planting on private lands, the preference of farmers should be considered. Tree species to be selected, should be based on the quality of land, availability of moisture, suitability of climate, growth rate, gestation period, profitability and for fulfilling certain objectives. While most of the farmers consider profitability as the primary consideration, beautification, conservation and improving micro-climatic are the other considerations. For the success of any afforestation programme on private lands, income being the primary consideration,

arrangements should be made for backward and forward linkages. The extension programme to promote afforestation, should be based on well tested technical and economic data to guide the farmers and general public in the right direction.

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Indian gooseberry trees bordering cotton crop



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, *Albizia 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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Kerala Home Gardens

Nurturing biodiversity

Allan Thomas, S Bhaskaran, Sajan Kurien
and Usha C Thomas

Home gardens in Kerala which started as a means of subsistence have today transformed into a means of additional income generation. These systems developed over years have optimized their production activities that satisfies the biophysical needs, socioeconomic security and environmental requirements in which they live.



Home gardens of Kerala are traditional agro forestry systems in which perennial and annual crops are grown, often without any definite arrangement. Tree crops are essentially an important component in Kerala home gardens. Also other components like animal husbandry, aquaculture, sericulture, apiculture etc., are included for the purpose of meeting the home needs and also to generate additional income.

Of late, these home garden systems are facing many challenges owing to shrinking per capita land availability and growing market economy. This has a direct bearing more on tree crops than on annuals impinging upon the biodiversity of home gardens. To understand the status on challenges faced by these traditional home garden systems, around 208 home gardens were studied in Thiruvananthapuram, Kollam, Alapuzha and Pathanamthitta districts in South Kerala.

Home gardens, its biodiversity

Home gardening is a very old tradition that has evolved over a long time from the practices of the hunters/gatherers and continued till now. It started as a system for the production of subsistence crops for the household with or without the involvement of cash crops. For example, a prominent structural characteristic of earlier home gardens were the great diversity in life forms - varying from those creeping on the ground, such as sweet potato to tall trees of 10 m like coconut palm, bamboo poles or other multi purpose tree species along with some livestock components, birds or domestic animals. In such a system, the structure and function is very significant and of conspicuous nature. The forest-like structure has been the result of deliberate planning of home garden to mimic the forest, which has its own techno-socio-economic implications.

Different indigenous and exotic varieties mango, jack and guava were found in every 7 out of 10 home gardens. April to July was the regular bearing period of mango and jack that invariably formed a major part of diet requirement of home garden members in different (raw and cooked) forms. Guava was found bearing in home gardens during different periods. All these fruit crops mentioned are rich in nutrition and some fruits like jack, even though seasonal, can act as a source of food security. An earlier attempt to study the bio diversity of Kerala home gardens using Shannon-weiner diversity index quantified species diversity. It was found that the diversity of home gardens was more as a result of tree crops. Both commodity and non commodity tree crops together constituted maximum biodiversity of home gardens.

Changing structures, changing biodiversity

In the course of evolution, there has been a shift in the purpose for which home gardens are being raised – from food, nutritional and cultural needs to economic needs. It is believed that population boom and pressure on land where the land itself has become a constraint coupled with the development of a market economy made an effect on the complexity of the home gardens. Its resemblance to a forest no longer continues. Tree crops have become a casualty in the process of incorporating home gardens with annual crops for subsistence use and surplus for marketing.

In Kerala, home garden primary structures are constituted by one or more tree crop with suitable intercrop mix. They are mainly coconut, arecanut, banana, vegetable, rubber and spices in general. Many other added included contributed significantly in terms of economics or specialization in homegardens. The economic preference and various aspects related to home garden was clearly visible through the inclusion of specialized components like



Sacred groves are a repository of tree biodiversity.

sericulture, apiculture, aquaculture, floriculture, nursery units etc making way for the home gardens to be categorized as subsistence with subsidiary commercial interest. Such type of specialization aided the home garden with continuous production throughout the year helping in better income generation and also family labour involvement.

Poultry rearing was noticed in at least 28 homegardens and that too majority (18 homegardens) in Alappuzha and Kollam districts. One to two mini poultry sheds made out of wooden reaps with a capacity to hold 4-6 chicken per shed for egg purpose was installed 6 ft above in the branches of trees/crops. Farmers followed this method owing to various reasons availing shade and a cooler climate. This provided conducive physical environment for the chicken; it provided safety during night especially from the attack of dogs; it was an efficient means of utilizing waste as castings fall at the base of the trees; the larva of crop pests served as chicken feed and it was optimal space utilization through vertical farming. Such farming system integrating tree crops, is also a system that promotes sustainability through effective recycling of waste.

Every farm plan needs to be custom made to the existing cropping situation without eliminating non commodity tree crops. For this non commodity crops need to be transformed to commodity crops through the principle of synergism. i.e. Trailing a shade tolerant variety of pepper (say for example Panniyur 5) in *Thespesia populnea* (found vastly in the coastal region of Southern districts) for years can make the non commodity crop transform itself to a commodity crop helping the farmer reap the benefit of economic dominance and generating more profit from the same space. In one way this could be a crude method of vertical farming for overcoming the barrier of space. Also the base crop in which pepper was trailed, owing to its timber value, will fetch the farmer a very high price in the long run. There are several indirect benefits as well. Planning each home garden in similar way will not only benefit farm family in terms of economic returns but will improve the biodiversity. Also, such a system with tree crops would enable an increase in bird population, which will act as a predator to many pests in this type of home garden farming system incorporated with food and cash crops.

The socio-religious importance of home garden cannot be under estimated as even today structures like *Kudumbakshethrem* and *Kavu* exist in Kerala home gardens as evident from the results of study. Worship of trees and plants has been a documented part of religious factors in India since the hunting-gathering stage. The presence of rudraksham, *Santalum album*, *Ficus religiosa*, acacia, bamboo, *Saraca indica*, *Aegle marmelos* which were commonly recognized by devoted people in Kerala as strictly religious trees associated with the *Kudumbakshethram* and *Kavu* (*Sacred groves*).

Conclusion

Kerala home gardens vary in diversity adding significantly to the biodiversity and functional dynamics. The structural composition and the functional diversity of home garden are very much related and support the dynamic nature of this ever-evolving system. Kerala home gardens are not only mere food suppliers but also generate income and employment. The major advantage is family involvement in farming as well as providing nutritional security to individual households.

This system that has developed over years and dynamic has optimized production activities that satisfies the biophysical needs, socioeconomic security and environmental requirements in which they live. This system needs to be protected, sustained and augmented for generations to come and supportive policy framework need to be in place.

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Integrating multi-purpose trees for improving soil health

M Ashok Kumar

Planting trees on bunds and wastelands generates additional biomass, serving as a source for enriching soil-health. Chetna brought about a positive impact on the livelihoods of tribal farmers in Uttoor by promoting small shifts in the cropping systems integrating trees. Such interventions being low-external-input have proved to be environmentally safe and economically viable.

Gonds is a major tribal community in Uttoor region in Adilabad district in Andhra Pradesh. They are primarily dependant on rainfed agriculture for their livelihoods. They have been growing rainfed crops like cotton, redgram, jowar and soyabean.

The soils in this area have low fertility, and low water retention capacities. Infiltration and percolation ratio of the soil is also very poor. Weeds are rich in nutrients as they draw nutrition from different depths. But, farmers just throw them away on bunds or burn them. Thus nutrients are thrown out of the field in real sense. Though there isn't enough organic manure to apply, farmers have no knowledge about ways of composting the biological resources available. Poor living standards of farmers with low population of livestock and fodder shortage adds to the challenges.

Chetna, an NGO has been working with the tribal communities of Adilabad district in improving their farming livelihoods. Given the situation, a holistic approach at increasing productivity through socio-technical interventions which optimally utilize the locally available resources was planned. Integration of leguminous, agro-forestry trees and multi-purpose trees was one such alternative.

Plantation of biomass on field bunds and wastelands becomes significant in enriching soil-health and optimum crop production. Such interventions being low-external-input are also environmentally safe and economically viable. Trees around a small farm serve a variety of purposes. In fact a single species of tree has manifold benefits ranging from food security to better soil health. Farmers were motivated to plant different types of trees serving various purposes. For instance, *Glyricidia/Cassia siamea*, *Sesbania grandiflora* for fixing nitrogen in the soil; *Cassia siamea*, Neem, *Pongamia pinnata* for generating additional plant biomass; fruit trees like mango, clustered apple, Jack fruit for edible



purposes; *Sesbania grandiflora*, Subabul, Teak, Muvva and Pongamia for fodder and timber purposes.

Around 373 farmers planted trees for producing additional biomass, later composted as organic manure. The farmers diversified their cropping system from mono cropping to mixed cropping and inter cropping with legumes like black gram, green gram, cowpea etc. The seeds of various crops were made available in time helping farmers to go in for the plantation. Farmers were encouraged to prepare organic manure on their own. One compost pit was planned for every farmer.

Farmers took up different measures to improve soil fertility, for instance, application of enriched farm yard manure; pre-season in-situ green manuring; composting weeds; composting other farm residues; composting of cotton stalks; in-situ incorporation of inter crops; biomass (*sunhemp* and *diancha*) generation on bunds and bund plantation with *glyricidia* and *cassia siamea*.

Results

Production of biomass from an acre yielding 8 tons contains approximately 60-72 kg of nitrogen that can be sufficient per acre crop for boosting the yield (See Table). *Glyricidia/Cassia siamea* (200 per acre) planted on bunds yielded biomass of 30 kgs /plant /year from fifth year after planting. Neem trees on wastelands gave 300 kgs per tree per year. Pongamea trees on farm yielded biomass of 300 kgs per tree per year.

Table: Production of biomass on farm

Sl.no	Biomass source	Qty of biomass produced (kgs/yr)	Remarks
1	biomass produced at farm level		
a	glyricidia / cassia siamea(200 per acre) plante on bunds and around compost pits	6000	30 kgs / plant /year-from 5 th year after planting(three loppings)
b	sunhemp sown on bunds	728	1.3 kgs/sqm.total area of bunds per acre is 280sqm(100m x 40m) and 2m wide bunds.
c	neem trees on wastelands on farm(min -3)	900	300 kgs per tree per year(2 loppings)
d	pongamea trees on wastelands on farm(min-3)	900	300 kgs per tree per year(2 loppings)
e	weeds	800	
f	crop residues	1000	
1	Totalfresh biomass produced at farm level (kgs)	10328	
2	Total manure recovered after composting at farm level (60%)	6196.8	
3	FYM (at household/village level)	4000	
4	Vermicompost	2000	



Trees on farms for yielding additional biomass



Farm in the flowering stage

Soil fertility improvement with available resources, productivity enhancement in rain-fed areas and promoting food security with low external inputs for sustainable rain-fed agriculture were the major objectives of the programme which has been achieved to a large extent. There have been pitfalls and challenges which were addressed and improvements were made to make the program a success. Presently, 96% of tribal farmers are directly involved in the programme. Local farmers are identified and trained for monitoring and providing further guidance. The programme is integrated and coordinated with all departments and agencies like Integrated Tribal Development Authority (ITDA) for convergence. Social structures and institutional building is inbuilt into programme for sustainability.

Though there were apprehensions from farmers and some of the staff initially about the strategy, a considerable impact was made not only on the field but also in the minds of farmers and the staff. The staff and farmers witnessed how a small change in cropping system can have a positive impact on livelihood improvement. Farmers in Utnoor no doubt are expected to continue adopting these sustainable practices even during coming years.

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“We know what to do”

Hans Herren is president of the Millennium Institute, an international NGO providing tools and methods worldwide that facilitate decision making for sustainable development. The driving force in all his activities and professional choices is the concern for a more sustainable world where there is a future for everybody.

Interview: Mireille Vermeulen

Next to his work at the Millennium Institute, Mr Herren is co-chair of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD). The publication of “Agriculture at a Crossroads” in 2008 sought to bring about real change in policies for agriculture and development. Fifty-nine countries have endorsed the report and many other states and organisations have noted the importance of the assessment. The report pictures possible scenarios, looks clearly at policy and institutional issues, and provides decision makers with a range of options for action. It has a great potential – but things have been quiet in the past two years.

What happened with the IAASTD report?

My big disappointment was that after the report was finished and the plenary in Johannesburg in 2008 was over, there was no money left for a good PR and media launch, not even to promote it among international bodies, governments, research institutes and donor organisations. I am trying to promote IAASTD through my own activities and those of my foundation (www.biovision.ch). Fortunately, some of the report's authors and supporters have also taken up promoting the report and see the need for a next step. Yet at the same time the International Panel on Biodiversity and Ecosystem Services is being seen as an alternative to IAASTD, something with which I don't agree. It has taken us a long time to get agriculture recognised as the key issue in international development. With the IAASTD we managed to put it back on the agenda; now we need to do even more.

What is the status of agriculture on the international agenda at this moment?

Agriculture is still at a crossroads, very little has happened at any government level. Even countries which have endorsed the agreement are doing nothing. In England, for instance, Parliament endorsed the report, but it has done little to implement its findings. Instead it commissioned a new report, which came out with basically similar conclusions, but suggesting that GMOs may be needed to cope with food security issues in the future. In the IAASTD report we specifically wrote that genetic engineering has not yet solved any problem in agriculture and food security, that research is needed on its health and ecological impacts, and that this should not be at the expense of research, extension and the implementation of sustainable and organic farming.

Why is it so difficult to change anything here?

Governments are under pressure from the U.S., Canada and Australia, who did not endorse the agreement because of their views on trade and GM crops. These three countries are major donors and they have a large influence on the development agenda. Another reason is the pressure from the private sector and some large private foundations. Companies like Monsanto, Syngenta and Bayer raise the spectre of unemployment and hunger to get support for their GM technologies. But there is also a general problem that people do not understand: the potential of sustainable agriculture to solve food security problems. Many policy makers have been led to believe that sustainable or ecological agriculture will not be productive enough to nourish the world. But experiences from the field, published in peerreviewed journals, show increases in production by a factor of two and more after a transition to sustainable, ecological or organic agriculture.

Should politics not play a more important role then?

I have become more and more convinced that we cannot count on politicians or politics to make the decisions that will bring about the needed changes in consumption patterns and the way we do agriculture. There are too many lobbies out there, and politicians always put the need to be re-elected ahead of the common good. They don't dare to take unpopular decisions today that would make

the world a better place tomorrow. Against my earlier thinking, some private sector companies and people may be the best option for leading change. We need to find out who these people are and what companies they lead, and then work with them. It is a big job to inform them about the findings of the IAASTD report, so this is why it is important that the IAASTD process continues. We also need to include a much broader range of stakeholders and work with groups of people who can see the broad range of problems and help to solve them. The way forward with IAASTD may be to set up a permanent panel like the IPCC, to inform the public, politicians and the private sector about policies for food security and sovereignty.

Where should we start?

We keep on measuring CO2 levels and these are going up, no matter what we do. Even if we would stop driving cars today, this will continue, and the consequences will be quite dramatic. But we keep on talking, referring to new reports, organising new meetings, and the CO2 levels keep on rising. Sustainable agricultural practices could absorb a third or more of the CO2, instead of being a source of emissions. One way to change that is to reward sustainable farmers for the positive externalities they create, rather than charging them with extra labelling costs. Globally, some 800 million dollars every day is spent on direct and indirect subsidies for farmers in developed countries. These subsidies promote cheap food and enormous waste (up 60 % from production to consumption) along the value chain. It is time to sell food at the true cost that includes the externalities and, where necessary, assist the poorer segments of the population with something like food stamps. This would make industrial food more expensive and sustainably produced food cheaper.





report is based on information collected in 2006-2008 and was published in 2008. It is already getting old. So we want to publish new material and we need a new assessment in a couple of years. This time we need to try to involve the next generation of policy makers. We could have a competition at universities to find the best solutions and to choose the best reports. You have to be a bit more creative to attract young people, but they are interested as we are talking about their future. In the last assessment procedure, I also tried to convince the IAASTD Director to involve film schools on every continent by asking them to produce a short film about crucial sustainability issues at a local level. That would have provided wonderful PR material, but it didn't work out for lack of funds. In the next phase of the IAASTD we really have to make better use of the media, in particular the new social media such as Facebook and Twitter. As we prepare to take the IAASTD process to the Rio+20 meeting and assure that sustainable agriculture will be high on the agenda, the importance of youth participation cannot be over-emphasised.

Don't we just need more food for a growing world population?

The fact is that we have to change our lifestyles, and that's tough news. We keep driving on in our SUVs, we keep on over-consuming cheap meat, and every year we listen to the experts say that economy and technology will fix these problems. This is the general mindset. But will it? I don't think so, and many others agree. We have reached the ecological limits and need now to reconsider the way we produce and consume food and other products. When it comes to food production we know exactly what to do: transform 1.5 billion hectares into agroecological farming and increase the rate of change with factor 37, and then it can all be sustainable by 2050. Today we produce 4,600 calories per person per day. That's already enough to feed the highest estimates of 12 billion people predicted to be on this planet then.

But is that really possible?

The potential is enormous. We can produce more rice with less water, using the System of Rice Intensification (SRI). We can use methods like push-and-pull, intercropping maize with repellent plants which "pull" the insects. We need to put life into the soil again, and have at least five or six different crops in rotation. It's also about having animals back on the farm and using the manure well. These agronomic options are in line with our requirements and needs for food security. It's not a bleak picture. We all want a better, healthier and more rewarding life. But the Gates Foundation, for example, is still pushing for a Green Revolution with more fertilizers, more hybrid seeds and more dependency, while ignoring local solutions that have shown great impact.

What's the role of youth in this?

We need to take them on board in our search for a better future, for they are the producers and consumers of tomorrow. It's their world that is at stake and they are concerned. Youth have to be involved and empowered so they can really do something. The IAASTD

Fodder banks

Relieving women from drudgery

**Shalini Misra, R K Maikhuri and
Deepak Dhyani**

Raising fast growing and high yielding nutritious fodder species on farm lands can reduce the drudgery of women in collecting fodder from distant forests and also protect the degrading forests. G.B.Pant Institute of Himalayan Environment and Development achieved this intent through promotion of Fodder bank model.



Maikhanda village is located in Kedarnath Wildlife Division in Uttarakhand State, situated in Chamoli-Rudraprayag district. The village is inhabited by a large number of local Garhwalese community. Agriculture and animal husbandry along with tourism related jobs are main sources of income in the valley.

Like other high altitude communities, animal husbandry is practiced. Rearing animals is an inevitable part of their social system. Each family maintains 5-8 cattle of indigenous breed i.e. a cow, a pair of bullocks, a buffalo and a horse or mule that are reared on traditional lines. A few families also rear sheep and goats but over the last few decades the number of such families has reduced from 20 to 4-5 because of ban imposed on free grazing in most of the alpine areas and pastures of Garhwal.

Fodder obtained from arable land is not sufficient to maintain the livestock in sound health. Therefore, the inhabitants largely depend upon the forest based fodder resource of the upper Kedar valley. The area under Potato and Kidney bean has increased tremendously abandoning traditional crops and cropping practices. This has added more pressure on forests biomass (leaf-litter) for preparing farm yard manure (FYM) and tree branches to support legume crops. The major part (62.2%) of the fodder is extracted from forests (tree, shrub, leaves and herbaceous ground flora). The remaining fodder (37.8%) is derived from agroforestry systems, low altitude grasslands, degraded lands, high altitude grasslands and crop residues. A large variety of tree species, forest floor phyto-mass and agricultural by-products are used as animal fodder.

In earlier times, livestock was left to graze in the forests of community lands. The animals sought out their own food and were assembled only for milking and to protect them from wild animals. In the present setting, cattle are generally stall fed but buffaloes,

sheep and goats are left for grazing in nearby forests, alpine and *kharaks* or pastures. With the introduction of stall feeding, the demand for fodder has increased greatly with subsequently increased workload on women.

Unavailability of green forage during winters in higher Himalayan region has always been a serious issue that has added to the drudgery of women. Women in hills are mostly involved with the collection of fodder so, they spend more of manual energy for collection of fodder. In the villages of upper Kedar valley, fodder collection is quite a frequent household activity. Almost one woman from each household visits the forests twice a day to collect fodder and other forest produce. Women walk at least 1-2.5 km for harvesting fodder and during winters walk more than 3-4 km. During winters, local women leave their houses before sunrise and climb the rocks and mountains to collect dry grass and come back to their dwellings by afternoon. They carry a backload of more than 50-65 kgs.

The model

Developing fodder bank models among a few village clusters was tried by G.B.Pant Institute of Himalayan Environment and Development. The objective of the initiative was to relieve the pressure on women by reducing their fodder collection time as well as the distance they travel. It was also meant to create awareness among them on better methods of livestock feeding, and better health improved milk and meat yield by improved quality of fodder. Fodder bank initiative was taken up in March, 2009 by the financial support from Department of Science and Technology, Government of India under its Science and Society Scheme.

Maikhanda village cluster with a majority of poor people and with limited resources was chosen for trying out this model. The willingness of local communities to provide huge village

community land for fodder bank and a small piece of agriculture land for nursery helped in setting up the model.

Fodder bank

This project was designed to develop a pilot fodder bank model using fast growing and high biomass yielding nutritious species (both indigenous as well as introduced). The indigenous species were selected by people based on their need, their indigenous knowledge about species, with regard to enhanced lactation, better nutrition etc. Also, our last six years of research on forests of Kedarnath area helped in identifying and prioritizing indigenous species for plantation. Introduced species were selected based on discussions with fodder experts and our research work on suitable species in the context.

Women were trained in growing high biomass yielding fodder species in their cropland bunds and kitchen gardens. Livestock owners and farmers were also trained to construct their animal houses and sheds on scientific lines provided with cost-effective feeding and watering systems and proper ventilation using locally available materials.

Plantation was carried out twice a year - once during monsoon and other during spring so that plant gets increasing temperature conditions that are better suited for adaptation and growth. Fodder bank was developed by using both indigenous and introduced fodder species (trees, shrubs and grasses). Indigenous grass species included Ringal Bamboo (*Chimnobambusa falcata*, *Thamnocalamus spathiflorus*, *Arundinaria spp.*) while, indigenous tree species are *Alnus nepalensis*, *Quercus glauca*, *Quercus leucotricophora*, *Ficus nemoralis*, *Ficus auriculata*, *Debregeasia salicifolia*, *Ficus subincisa*. Introduced tree species were *Celtis australis*, *Morus alba*, *Bauhinia variegata* and introduced grass species were *Pennisetum purpureum*, Joint star, Makuni, Cox food etc. The basic idea behind this was to ensure conservation of biodiversity while, providing nutritious fodder to livestock.

The results illustrated that there was more than 80% survival of *Quercus glauca* and *Q. leucotricophora* seedlings. On the other hand the decline in survival percentage of *Dendrocalamus*, *Celtis australis* and *Bauhinia variegata* was found to be maximum. During last one year introduction of fast growing, high biomass yielding fodder trees *Morus alba* and *Pennisetum purpureum* Hybrid Napier 2 varieties were also included with onsite training of planting, harvesting fodder and multiplication. The results are very good and at the end of the year, 65 women initially reported 8 times harvesting and stall feeding of Napier grass to their milching animals. So, during the first phase of this programme these 65 women have not visited forests for 6-8 days of each month to harvest fodder. They have also reported better milk yields.

Apart from participating in fodder bank model site development women also started growing high biomass yielding fodder grasses and shrubs on their small cropland bunds and kitchen garden bunds. In 2010, 60 women harvested Napier fodder thrice from their cropland.

Fodder nursery

A small fodder nursery has also been established near the fodder bank site. Fodder nursery includes a polyhouse, nethouse and a rain water harvesting area. Trials as well as mass propagation of trees and grasses is being carried out in fodder nursery. At the model site trenches are also prepared for storing the rain water. Most of the seedlings and seeds of fast growing fodder species are available for locals at a nominal price and free of cost for the poor families of the valley. From 2012 onwards, we plan to sell the seedlings at a nominal cost so that women can earn alternative income from selling fodder seedlings and selling harvested fodder in nearby Gaurikund market which has a great demand for fodder for pack animals.

Vegetative propagation and mass multiplication of some lesser known but prominent fodder tree species of higher Himalayas such as *Ficus nemoralis*, *F. auriculata* and *Debregeasia salicifolia* was carried out in Fodder nursery. *Ficus auriculata* and *Debregeasia salicifolia* have shown better results and about 200 saplings of each are planted in the Fodder bank site.

Mahila Mangal Dals

Hill women are the backbone of economy and most often are engaged in forest resource extraction as well as conservation activities. *Mahila Mangal Dals* (MMD) are women groups actively engaged in the resource management of forests. They have established effective control over management of the village forest as collection of fuel wood, fodder and water as it is almost exclusively women's work in the hills. *Mahila Mangal Dals* are active in almost all villages of Garhwal. All households of the village are members of *Mahila Mangal Dals*. Usually an elderly woman is the head of *Mahila Mangal Dals*.

Members regularly attend meetings. They guard the forests and put penalty on illegal approaches. Penalties collected are used as forest fund of the village. Decisions about when to open the forest for grass, leaf and firewood collection, the rules for collection, the fines for violation, etc. are taken by the *Mahila Mangal Dal* and communicated to the *Van Panchayat Sarpanch* (president). The women's control over forest use enables them to ensure that forest product collection does not conflict with periods of heavy agricultural work. Soon after harvesting the monsoon *finger millet* crop in October, they open the forest closest to the village for grass collection. This practice of harvesting with an agreed calendar is to promote sustainable use of forest resources, help regeneration as well as prevent leaching of nutrients from the forest floor. One or two patches of forest in a year/ season is opened for resource extraction. Thus, it does not cross the carrying capacity of the forests while, closing the remaining patches or stands for next three to four years for giving them a proper time period for their regeneration.

Presently, the fodder bank is governed by the organisation with an active collaboration and support of *Mahila Mangal Dals*. MMDs with their women members and heads take part in fodder bank meetings and initiatives. All decisions about the fodder bank are taken in consultation with MMDs. In three years time, the entire management of fodder bank model will be with the MMDs.



Women come together to discuss fodder problem and explore solutions

Future steps

The village women and men have immensely supported the programme by their active participation in plantation, trainings and capacity building programmes. Women folk from nearby villages have also been participating in the meetings and training programmes. The project has helped in enhancing awareness regarding management of available fodder, preservation and storage of surplus fodder and more importantly the need for conserving forests resources. Moreover, it has reduced the drudgery in collecting fodder from forests. There is a plan to extend the fodder bank activities and involve atleast 250 more women of neighbouring villages. This model is ready for replication and adoption. Initial levels of replication are already being noticed in the high altitude village of Triyuginarayan.

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Seabuckthorn – ideally suited for Himalayan highlands

Hippophae salicifolia commonly known as Seabuckthorn is one of the few potential lesser-known multipurpose plant species, native of higher Himalaya. The people in high mountainous areas have been growing seabuckthorn without being aware of its overall benefits. Major traditional uses of Seabuckthorn in high mountainous cold and dry zone of Uttarakhand and Himachal Pradesh are fuelwood, fodder for goats and cattle (nutritious forage), fencing to protect fruit trees/nurseries/orchards, maintenance of traditional irrigation channel besides soil conservation, improving fertility/quality timber, useful for newly opened areas etc.

The plant is also very well known for outstanding ability to fix nitrogen directly from the air through root nodules. It was estimated that about 180 kg of nitrogen per hectare per annum can be fixed in the soil around Seabuckthorn forests. Generally, these plants grow wild and get rotten in mountain areas. As the plant increases the fertility of the soil, farmers destroy these plants and normally cultivate potatoes and other food crops. All organic and mineral materials derived from *Hippophae* plant can improve the soil's physico-chemical properties. Its root system makes it suitable to be planted even in the fragile slopes. An observation made in most of the cultivated areas showed that a 5 years old plant has a tap root of about 5 meters deep.

Small agriculture fields near to the natural pockets of Seabuckthorn in Yamunotri Valley of Uttarakhand

Its genetic characters such as wide ecological adaptation, fast growth, strong coppicing and suckering habit coupled with efficient nitrogen fixation makes this plant well suited in soil and water conservation, soil improvement and marginal lands reclamation. Studies have shown that this plant promotes the growth of poplars, pines and other tree species in mixed stands.

Though, seabuckthorn is a multipurpose and vital species for mountain-rural poor, it is one of the least known and unexplored and underutilized plant species in Himalayan states. There is an urgent need to promote Seabuckthorn as an agro forestry crop particularly in higher altitude areas. The collective efforts of research and development organizations, in true partnership with local communities will raise awareness and stimulate communities to plant this tree species. This can result in improved food security, nutrition, health and income for the rural poor.

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Save arid zone agroforestry Trees from biotic stresses

Dry land areas of Western India experiences frequent droughts and famines besides harsh climatic conditions. To reduce the impact of adverse abiotic conditions, the desert dwellers have evolved age-old practices to boost the crop production and their other needs such as fodder, fuel, fruits and timber though mixing woody perennials in their farming system. Their ingenuity, according to climatic and edaphic features has selected various drought hardy and multipurpose species of trees or shrubs for sustainable production and conservation of environment. In normal years of rainfall this system provides sustainable crop for their food and fodder production for livestock while under adverse conditions they are able to harvest top feed, fuel, fruits and other economically important products from perennial plants.

Arid zone vegetation comprises a wide range of trees including edible fruit bearing, food producing and woodcarving tree species. Khejri (*Prosopis cineraria*) tree is called Kalptaru. It increases the soil fertility, availability of fuel, timber, vegetables to human being, green fodder to animals, and shade to all creatures during scorching heat in summer. Its cultural, economic and socio-religious values have been



Prosopis tree

noticed in performing many of the rituals and rites in various sections of arid zone society. Similarly, utility of timber products of 'Rohira-a Marwar Teak Wood Tree' of desert in improving their economic conditions is well known. Now, woodcarving industry has emerged as an important source of income to local artisans. These woody perennials are an integral component of integrated farming system and 'Gohar/Oran' lands. Trees have provided food and shelter to man since ages. About 20% of the xerophytes have direct utility to mankind.

The trees and shrubs in the arid zone have adopted various strategies to endure abiotic stresses such as intense heat, high evapotranspiration rate and long dry spells. Besides abiotic stresses, pest and diseases are the other major biotic constraints. Recent outbreak of diseases, alarm the situation even in arid zone climatic conditions warrant timely planning. For instance, sudden death of *P. cineraria* in large proportion is a matter of serious concern and needs attention. Under these situations non-chemical methods such as cultural and biocontrol measures need to be used. Trees like *Khejri*, *Rohira*, *Kumat*, *Israeli babul*, *Babul*, *Khara Jhal*, *Mitha Jhal* and *Neem* are vulnerable to pest and diseases from seedlings stage to the stage of complete maturation of the tree. However, the biodiversity inherent in multiple cropping and multiple cultivar traditional farming systems enhances resistance or tolerance to

various pest and diseases.

Our ultimate vision is to protect the trees from abiotic to biotic stresses to support the life of this part of planet for our children. Trees must be planted, cared and conserved as they represent historical significance to people as well as events. Such programmes will help to offset the impact of deforestation. In recent years, the public movement such as 'Chipko Movement' not only inspired numerous people to work on practical programmes of water management, energy conservation, afforestation, and recycling, but also encouraged scholars to start studying issues of environmental degradation and methods of conservation in the arid parts of India. Thus protecting trees from manmade and natural hazards will boost the greenery and conservation of valuable biodiversity present in arid zone.

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Cinamomum tamala - A multipurpose potential agroforestry tree Species in Uttarakhand

Farmers grow multipurpose trees all along the farm boundary as living fences as well as wind breaks species. Tree is planted as hedgerows between rows of agricultural crops to improve soil fertility, to slow down run off and reduce soil erosion.

Farmers in Bhugiaghat, Dogra, Robraand Chopra villages in Uttarakhand mostly grow Wheat, Paddy, Maize and other vegetables. With their average land holdings being small *Cinamomum* trees are grown on the farm bunds of agricultural fields. *Cinamomum tamala* (locally known as Tejpat) also known as Indian cassia or Indian Bay leaf, is a food flavoring spice, also having medicinal properties. Around 700 farmers are growing around 500 Tejpat trees per hectare of land.

Tejpat is a potential tree in enhancing the economy of small and marginal farmers in Uttarakhand. Systematic and scientific steps are needed to restore it to its past glory and make it popular worldwide. A change in the methods of cultivation, harvesting, post harvest techniques and oil extraction of Tejpat is needed. Work has to be carried out in co-ordination with farmers and scientists at large in the country. It is important to emphasize that a proper interaction between villagers, agriculture department, NGOs, institutions, and government agencies need to be facilitated. A people centered approach should be implemented based on farmers needs.

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Women harvesting Pipla roots

PIPLA – Enhanced livelihood opportunities for tribal communities of Eastern Ghat region

Pipla (Long Pepper or *Piper longum*) is a medicinal plant cultivated in the hills of Eastern Ghats of Odisha state in Koraput dist. It is mostly cultivated in the area bordering to Andhra Pradesh. About 6 decades back, tribals were cultivating the plants in patches in the hills and also collecting from the forest. Traders from Andhra Pradesh started buying the Pipla roots from the tribal farmers in the villages. This led to a gradual increase in the cultivation of the crop across the area. In the mean time, the Department of Forests notified Pipla as a forest produce and prohibited its cultivation. But over time, Pipla was deleted from the list of forest produce, paving way for its large-scale cultivation.

Usually planting is undertaken during the rainy season in the months of July-Aug when there is enough moisture present in the soil. Pipla is grown under organic conditions. Pipla farmers in the region usually apply 10-20 truckloads of compost per acre. Compost is either made available from the cattle owned by the farmers or purchased from nearby villages. Since the quantity required is high and cannot be met from an individual's cattle population, it is sourced from different farmers. Intercropping is also done in the fields of Pipla during its three years of gestation period. Crops like brinjal, tomato, cucumber, chilli, papaya, turmeric, ginger, beans etc. are cultivated. On an average, yield of 6 quintals of roots is harvested from an acre of plantation.

In 1960s the farmers used to sell the Pipla carrying head loads to Madugula, a village in Vishakhapatnam district of Andhra Pradesh, where the transportation facility in those days was very limited. Gradually the market shifted to Vantalamamidi to Padalu to Paderu to Gutuluput in 1980 and finally Pedabayulu in 1985 and till date continuing. Pedabayalu weekly market is the most potential place for Pipla marketing not only for the producer but also for the trader.

Processing of Pipla also provides a lot of employment to local labour. For instance, Mr. Venkata Rao engages 30 skilled labours on a regular basis to work at the processing unit. Also nearly 150 to 170 labour are engaged in their respective houses processing pipla, on weekly payment basis. Ahmedabad, Mumbai, Delhi, Kanpur, Chennai are the main centers for marketing of processed Pipla. Gujarat state consumes the most quantity of processed pipla.

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Kurl Bader with the author on the farm

Small-scale organic farming

Mr. Kurt Bader, born in Switzerland is a passionate organic farmer settled in Bijaynagar village of Chitwan district, Nepal. With no formal education, he gained a lot of knowledge by practicing organic farming and sharing knowledge on sustainable agriculture across countries like Australia, India and Nepal.

In 2004, Kurt Bader presently aged 75 years, started agroforestry system in 0.3 ha of lands on organic basis with two assistants, Prakash and Durga. He grows vegetables like potato, chilly, onion, cabbage, cauliflower, radish, carrot, colocassia, leafy vegetables following organic principles. He has planted trees on bunds and farm boundaries and grown shrubs in between the vegetable crops. He has planted perennials trees like *Tectona grandis*, *Atrocarpus lokoocha*, *Leucaena leucocephala*, *Melia azadirach*, *Azadirachta indica*, *Ficus variegata*, *Ricinus communis*, bamboo, etc. on farm boundaries. Also he has raised diverse fruit trees like papaya, mango, jackfruit, passion fruit, drumstick, citrus, guava and banana.

Trees provide fodder to animals and fruits for household consumption. Multipurpose trees like Clover bush is a source of food for birds and animals. While the birds feed on the seeds, the animals feed on the leaf matter. The stem of Clover bush is a very good source of high quality firewood and charcoal. Trees are also being used for their medicinal properties. For instance, a mixture prepared from the leaves of *Casuarina equisetefolia* and *Cassia ellata* have shown good response to leaf blight in potato. Most of

the diseases are managed by using biological methods, and there is no incidence of any large scale pest/disease infestation.

The entire farm operates on recycling resources. The livestock component on his farm includes 4 goats, 20 poultry (both locals and hybrids), 8 rabbits and fishes which feed on most of the farm wastes. On the other hand the animal wastes like urine and dung and biomass generated on bunds and trees are recycled to form organic manure. Charcoal made from tree wood is applied to the soil along with silt, a source rich in minerals. Waste water from fish pond is utilized to irrigate the crops using underground pipelines. Thus, every farm component complements each other.

Water management is taken care of. Rain water is harvested in two concrete tanks with the capacity of 20,000 litres each, which is sufficient over the year. Sprinkler irrigation is provided over the year except rainy season assuring the proper utilization of rain water. It helps to maintain surface layer moist for growth and development of crops.

A lot of farmers from the neighbourhood visit Bader's farm and have been practicing tree integration in their farms. He is a role model in organic agriculture for many farmers in the region.

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This is based on the interactions with the farmer by Dinesh Panday, Institute of Agriculture and Animal Science, TU, Nepal.

Payments or rewards? Farmers benefit by providing environmental services

Godfrey Mwaloma



More and more land in Africa is being cultivated, reducing the area covered by forests, the existing biodiversity, and affecting the water supplies of nearby cities. Could farmers produce the same services as forests do – at least partly? The World Agroforestry Centre is working to develop arrangements between farmers and private parties in a bid to have farmland supply clean water and carbon sinks. But what should farmers get in return? Money is not the only reward they are looking for.

For several decades, forests and grazing lands in Africa have continued to deteriorate, and rural communities have taken the blame for cutting down trees and overusing common land. But since the 1950s, governments and the global conservation movements have deliberately excluded farmers from this resource, taking over control of forests and establishing parks or government-managed forest reserves. Farmers thus lost their feeling of ownership, while their numbers grew and the forests and communal lands were not fully protected. The result is that, today, large areas of previously forested land have been lost. Forested watersheds where biodiversity thrived which provided clean water, fuel and timber in abundance, have now dwindled.

Can farmers provide environmental services (such as habitats for wildlife, carbon sequestration, climate regulation or the regulation of water flows and quality) in addition to producing food? Around big cities in Africa the situation is particularly precarious. But the rural communities who have been blamed for most of the degradation are best placed to become wardens of the environment. So far, farmers in Africa have rarely been rewarded for their environmental services. Some live next to hydroelectric power plants that utilise water from their land and yet they are not provided with electricity. These farmers continue to use wood for their fuel, and hence continue to degrade forest ecosystems.

Agroforestry is uniquely suited to improving food and fuel security. While sustainably managing agricultural landscapes, they continue to provide essential ecosystem services. How do we get more farmers adopt agroforestry and other suitable land use practices

that secure the continued provision of these environmental services?

Experimenting with rewards

The World Agroforestry Centre (ICRAF) is conducting research on the ways to promote more productive, diversified, integrated and intensified agroforestry systems that provide livelihood and environmental benefits. ICRAF is working with the International Fund for Agricultural Development (IFAD) in a research programme aimed at building knowledge about the necessary rewards for environmental services. This programme is called “Pro-poor Rewards for Environmental Services in Africa” (PRESA), and is linked with local research and farmers’ groups to identify and establish those arrangements that bring multiple benefits. The programme is working in seven sites (three core and four associate sites) in the highlands of East and West Africa, where there is immense pressure from growing human populations and demand for increased food production. PRESA does not consider rewards for environmental services solely in terms of monetary compensation, but has adopted a broader perspective (see box).

A first condition is that those who need the environmental service recognise the importance of rewarding the one who provides it. As a market-based mechanism, with buyers and sellers, rewards for environmental services must involve establishing a correct price. Price setting is difficult because the market for environmental services is neither open, nor transparent. With little data from related markets it is often difficult to determine a market price. Moreover, buyers cannot choose their suppliers. For example, a

What kind of rewards?

Rewarding communities for environmental services can provide powerful incentives and efficient mechanisms for conservation, while also offering new sources of income to support rural livelihoods. Rewards can come in different forms. The best known system is that of “Payments for Environmental Services” or PES, which make direct payments to farmers. Examples are direct deals between water and hydropower utilities and communities living in catchment areas, and payments for carbon sequestration. The latter involves global systems of trade in terms of carbon credits. Other rewards create opportunities for economic benefits for farmers. They include the use of certificates and labels in order to access a better market, community-based eco-tourism, conditional tenure rights in areas where land and resource ownership is community based, or specific rights to harvest and sell tree products from public land. Other types of rewards are the support to livelihood conditions for farmers. The service “buyer” provides infrastructure – schools, roads or water holes – in exchange for more environment-friendly farming. Building the capacity of farmers is another possible reward: better management of degraded ecosystems can restore the productivity of land and provide local communities with food and fuel.

In all cases a major issue is the monitoring of the services as well as the level of the reward provided. Who measures the services, how is the reward level set, how are rewards delivered, and how can you make sure that farmers actually get the reward they earned?

water scheme has to make a deal with a particular group of farmers – it cannot look for another (cheaper) group outside the catchment area of their water source. So buyers and suppliers need to strike a deal – which can easily result in dissatisfaction or conflict.

Auctioning services

A pilot programme in Malawi where farmers get cash payments for growing trees could provide useful lessons in price setting. A study by ICRAF researchers in 2008 examined two different approaches to setting prices and allocating environmental service contracts: an auction and a fixed price offer.

An initial survey identified 27 villages with 538 households. A total of 467 people were registered as eligible for the contracts and divided into two equally-sized groups. The first group was exposed to the “auction” method. Individuals made bids on how much money they would require to allocate half an acre of their farms to trees. The bid cards were collected and the data analysed. Naturally, there were both high and low bids, varying from 100 Malawi kwacha (• 0.46) to almost 1 million kwacha!

The second group was exposed to a “fixed price” method. The data from the “auction” was used to set a realistic price, considering everyone’s opinion and the available budget. This was offered to the second group as a fixed price: 12,000 kwacha (circa • 55) per half an acre. Over 90 percent of those in the second group agreed to this price. This exercise is expected to avoid any potential conflicts, as it has transparently set a clearing price mechanism that was offered to anyone interested in a contract.

Pricing water quality

In Kenya, the Sasumua watershed supplies Nairobi with almost 20 percent of its water needs. Most of the rivers feeding the Sasumua Dam flow through intensively cultivated areas, where land use decisions have a great impact on downstream water flows and quality. Over the last few years, the area has seen a clash of interests between water authorities and local communities. A fair reward system might help to create a win-win situation.

In such a situation, what level of rewards would be fair to both parties? The project first sought to understand how agricultural best practices, such as contour grass strips, contour farming and agroforestry, affect the quality and regime of water flowing into the reservoir and treatment plant. The project also determined sediment levels and the cost of purifying water under different land management scenarios. A cost-benefit analysis of conservation practices and savings allowed land owners and the Nairobi Water Company to make a decision on how to set a reward scheme, and on whether to participate in it or not.

The Sasumua Water Resources User Association, a local group for the equitable allocation of water rights, says that its members are more interested in obtaining assistance to implement land conservation measures than in cash payments. They want the Nairobi Water Company to help them to establish rain water harvesting technologies.

Mixed rewards

The role of agriculture and forestry in carbon sequestration to mitigate global climate change is well documented, but it is difficult to price carbon or find ways so that communities benefit from this exercise. Ecotrust Uganda, an organisation that is developing environment conservation financing, is working in a carbon sequestration scheme with small scale farmers. The scheme prepares a contract with individual farmers with targets for establishing trees.

Farmers who achieve the targets are issued carbon payments of 632 euros for establishing and maintaining one hectare of woodlot. The payments come from local and multinational corporations interested in carbon credits, such as Tetra Pak, Camco, Nedbank and African Safaris. The majority of farmers participating have between one-half and two hectares, resulting in payments ranging from • 316 to • 1,264. This total is paid in five instalments over a ten-year period, provided that producers continue meeting certain “milestones”. Apart from providing additional income, the trees protect soils from erosion while providing shade, medicine, fruit, wood fuel and construction materials.

When carbon payments are distributed to each individual farmer, the amount often doesn’t justify the effort. So most carbon projects (and other PES projects) in the region tend to focus on collective benefits to a community, for example, roads, schools, access to markets, access to farm inputs, etc. One way to optimise the benefits for individual farmers is to initiate nature-based enterprises through “eco-labelling” schemes. Such a label provides products such as honey, baskets and fruits with better access to global markets and



relatively higher prices. Eco-labelling can become an important extra source of income for farmers and contributes to sustainable carbon binding.

Policy solutions

Policy makers have grappled with the dilemmas of livelihoods and conservation for decades, and they welcome the arrival of schemes that offer practical solutions. Farmers can be convinced of the merits of sustainable land use management if such schemes consider the costs in terms of lost income opportunities, or the costs of implementing land management technologies. Rewards for environmental services offer an obvious compromise between livelihoods and conservation. There is no denying that there is

much to learn on how to establish efficient and sustainable mechanisms to reward communities for sustainable land use and to ensure that buyers of environmental services can be sure that they get value for their money. But in the long-term it is the only solution to overcome further degradation of the rural environment in Africa.

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Themes for LEISA India

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Regional Food Systems

If there is one thing that the world food crisis has shown us it is that heavily relying on global food markets can be dangerous – especially for the urban areas and where households rely on imported food. This is a strong argument in favour of strengthening local and regional food systems. These are characterized by fewer intermediaries, lower transportation costs and more personal forms of exchange, resulting in less risky transactions. Producers and consumers can exert a greater degree of control, allowing for quantities and prices to be negotiated locally, and for more value to remain within the region. Moreover, proponents of regional food systems argue that this contributes to increased food security, benefits the environment and increased the autonomy of farmers.

Regional food systems, however, run against the dominant paradigm that sees global markets and modern technologies as the way forward in agriculture. And they also run against

another paradigm, one that considers global food security mainly in terms of quantity of food available. But addressing hunger and malnutrition is not must about calories. It is about the quality of the diet, which inherently means nutrition diversity. In many parts of the world, regional food systems used to provide a large variety of local grains, tubers, pulses, green leaves, wild fruits and berries, meat and fish. Today, much of that diversity has gone.

We invite you to share your experiences in strengthening local and regional food systems. How to create the conditions that can support their development? What role can farmers, consumers, farmer organizations, the private sector, field technicians, government programmes and the media play to (re)create regional food systems? How do they contribute to improved food and nutrition security? We will examine initiatives taking place and ask what farmers and consumers think about them and what lessons we can draw from them.

We welcome your contributions as articles, photographs, contacts of people you think have expertise in this area.

Please send your articles to leisaindia@yahoo.co.in before July 31, 2011.

Tree service should not be free service

K V S Krishna

India has the second largest net work of roads in the world with 3.5 million kilometers. Of the 3.5 million kilometers of roads, just 2% i.e. 50, 000 kilometers are national highways. The rest of the roads are either unpaved roads or mostly badly managed ones. To improve the road infrastructure, it is suggested to grow avenue trees on a war footing as it also helps to mitigate climate change and in the process earn an income for doing the work on the principle that “tree service should not be a free service” to achieve its goals.

Let us assume that there are already some avenue trees at the rate of 100 per kilometer of road. To make it to 200, trees need to be planted every 10 meters apart on both sides of the roads. This not only gives protection to the roads and gives valuable shade for road users, they also serve as an excellent carbon dioxide absorbers. These trees can grow without any competition, provided they are not tampered with by goats, sheep, livestock and human beings. Trees to be selected need to have food or commercial value like tamarind, neem, fruit trees or even timber trees. The choice depends on the region.

At 200 trees per kilometer, the total number of trees that needs to be maintained would come to 700 million. But the canopy of the full grown trees which joins at the centre of the road also spreads out on either side of the road and therefore the canopy area would, for a kilometer, be $1000 \times 20 = 2$ hectares. For 3.5 million kilometers it is 7 million hectare equivalent. As said earlier, these trees will have no competition from other vegetation and therefore, it is estimated that it would absorb 280 million tons of CO₂ annually at the rate of 40 tons per hectare per year. If Certified Emission Reduction units (CER) as per Clean Development Mechanism (CDM) at \$15 per ton is given, an amount of \$4200 million could be made available for maintenance of trees i.e. Rs 20,160 crores.

Forests alone cannot succeed in absorbing the huge emissions the world is now making nor can agriculture alone absorb the surplus carbon dioxide. Is it not time to think out of the Box?

Communities in New Zealand deal with planting trees on the bunds in a field so that they can prevent wind damage. If this could be replicated in Indian conditions, we can prevent increase in temperature and increase in humidity in some 60 million hectares of dry farming region.

K V S Krishna

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Trees on field bunds in New Zealand

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Trees, the living assets to farmers

Trees are very important for economical crop production. Bio-mass production is very easy from trees than from surface crops, as trees grow pyramidally and utilize 60% more sunlight and more photosynthesis happens and more starch is produced. Again with their huge volume of rhyzosphere, trees encourage water percolation and help in recharging ground water, in the absence of which there would have been more soil and water erosion, resulting in heavy crop losses. Trees are capable of utilizing uncontested or unutilized water and plant nutrients from deep soil strata. Trees provide fodder, fibre, food and biomass at very cheaper cost. They also act as wind barriers and check fast winds damaging crops and desiccating soils. They also create micro-climate by their continuous evapo-transpiration helping better crop production. Trees contribute much in increasing humus by dropping their dry leaves which act as mulch and later on they are converted into humus and reduce soil carbon being, mineralized due to tropical temperatures. Humus is very important in improving the soils capacity to hold water and improving the biological activity in the soils, thus helping in yield improvement. Trees play an important role in providing fodder for animals of the farmer even during the drought situations.

In spite of all the advantages that trees offer to farmers, many farmers do not like to plant trees on their cultivated lands, fearing the shade of trees will affect crop yields. However, if trees are planted in wider rows and in east-west direction and raised to a height of 5 meters, the crops get enough sunlight except between 10 A M and 2 P M. i.e. 4 hours. There may be crop loss to an extent of 20% when integrated with trees, but the benefits they get owing to trees will offset these losses. Hence, planting trees and bushes on the edges and bunds helps in more crop yields.

Trees provide shelter and host many beneficial insects (predators) and birds, which are very useful in controlling insect damage in



the crops. Since droughts and untimely rains are very common, it is much safer for farmers, particularly small and rainfed farming communities, to adapt agro-forestry system to be safe and risk free. Since they have trees and regular supply of fodder from trees they can go for backyard dairy or sheep/goat farming to get some additional income. If they have green manure or fodder species among their crop lands, they can cut the branches during the critical period when the crop needs more sunlight. For example, most of the annual crops need more sunlight during vegetative growth period for about only 70 – 80 days. If farmers prune the tree branches during such critical periods there will not be much crop loss. Again, if they have fruit trees, they can thin 1/3 of the smaller branches so that the crops get more sunlight. At times of distress, trees are the living assets which the farmers can bank upon.

Shri Narayana Reddy is a legendary organic farmer and is one of the most sought after resource persons on ecological agriculture.

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LEISA India in regional languages



With an increasing demand from our readers for local language editions, LEISA India is now being brought out in five language editions – Hindi, Tamil, Kannada, Telugu and Oriya. These regional editions include translations of selected articles and are published twice a year – June and December.

State of the World 2011 Innovations that Nourish the Planet by Worldwatch Institute. £14.99; January 2011; 272 Pages: 234 x 176mm. ISBN 9781849713528.

Over the last two years, Worldwatch's Nourishing the Planet team has travelled to 25 sub-Saharan African nations - the places where hunger is greatest - and uncovered a treasure trove of innovations from farmers' groups, private voluntary organizations, universities, and even agribusiness companies. These innovations offer global benefits - from the continent's role in preventing disastrous climate change to the way urban farmers are feeding people in cities and why even determined locavores are sustained by the crop diversity preserved by farmers thousands of miles away.

This book assesses the state of agricultural innovations from cropping methods to irrigation technology to agricultural policy with an emphasis on sustainability, diversity, and ecosystem health in the hope of guiding governments, foundations, and concerned citizens in their efforts to eradicate hunger and poverty.

Published annually in 28 languages, State of the World is long established as the most authoritative and accessible annual guide to our progress towards a sustainable future. It is relied upon by national governments, UN agencies, development workers and law-makers for its up-to-the-minute analysis and information.

Encircling the Seamless : India, Climate Change, and the Global Commons by A. Damodaran, 2010, ISBN: 9781098066750; Price: Rs. 850; US\$ 19.32.

This book explores global environmental negotiations against the backdrop of complex political relations, the climate change conventions and multilateral environmental assessments and their effect on special interest groups. It weaves in the story of India's emergent economy, its sustainable development, and the multifaceted nationhood, the diversity of its rural scene, and the challenges of seamlessness brought in by the power of its information technology.



Agriculture, Food Security and Rural Development Asian Development Bank - Indian Resident Mission, New Delhi, 2010; ISBN #: 9780198064664; \$42.00; 384 pages; Oxford University Press.

After a decade of neglect of agricultural research, the importance of agriculture in fulfilling the basic objectives of development is increasingly being recognized. This volume provides a comprehensive review of India's experience in agricultural development and the role played by the state and the public sector. It draws lessons from the agricultural policies undertaken since Independence, both in terms of their relevance for the country's future course of action and their wider significance for the developing world.

The essays in the volume focus on key policy issues in agriculture, food security, and rural development, including land reforms, institutional constraints in water management, agricultural diversification, disaster management, and public-private participation in agricultural investment. Arguing that policies need to be rooted in the history, geography, and polity of the country, the essays carefully diagnose the challenges in the current scenario, and offer reasoned suggestions to achieve the twin objectives of agricultural development and poverty reduction. In recent times, the importance of agriculture in fulfilling the basic objectives of development has been increasingly

reinforced. Why does the Indian economy continue to be vulnerable to weather-induced agricultural fluctuations? Why does India have widespread poverty and malnutrition despite being self-sufficient in food production? What are the responsibilities of the state, the public sector, and civil society in redressing the agrarian crises? This volume provides answers to such questions through a comprehensive review of India's experience in agricultural development. The focus is on key policy issues related to land reforms, sustainable water use, crop diversification, disaster management, and public-private participation in agricultural investment. The volume draws lessons from agricultural policies since Independence, both in terms of their relevance for the country's future course of action and their wider significance for the developing world. Arguing that policies need to be rooted in the history, geography, and polity of the country, the essays carefully diagnose the challenges in the current scenario and offer reasoned suggestions to achieve the twin objectives of agricultural development and poverty reduction. Readership This volume will interest students and researchers of development economics, agricultural economics, and Indian economy. It will also help policymakers identify the key issues and initiate the right policies.

Water Conservation, Management and Analysis by Madireddi V. Subba Rao, 2011, ISBN #: 9789350180198, \$29.50, 128 pages, Readworthy Publications.

Water is an essential commodity for survival of mankind and other living organisms on the earth. Availability of fresh and clean water on earth is very limited in quantity. Therefore the management and conservation of water is very vital for sustainability. This book deals with the important aspects of conservation and management of water with various analytical procedures and techniques of water quality assessment.



Liberalizing Foodgrains Markets : Experiences, Impact, and Lessons from South Asia. Ashok Gulati, A. Ganesh-Kumar & Devesh Roy (Ed.). Year: 2010; ISBN: 9781098066958; Price: Rs. 750.00, US\$ 17.05.

The essays place contemporary food security policies in historical perspective, examining the divergent approaches to food security adopted in the past by Bangladesh, India, Nepal, Pakistan, and Sri Lanka. They analyse policies on the production, stocks, trade, and consumption of various foodgrains - rice in Bangladesh, Nepal, and Sri Lanka, and rice and wheat in India and Pakistan -and draw lessons for South Asia as a region.

Environmental Concerns. D.D. Gupta, Agrobios, 2011, 688 p, ISBN : 9788177544282 , Rs. 2,250.

Environment has become the central point of global concern. The quality of environment is affected by production and consumption activities of people. Society's welfare with its economic activities is also governed by environment. Here, the convergence between ecology, ethics economics and other allied sciences obviously encompassing issues of environment has become the centre of our concerns. In such context this book on "ENVIRONMENTAL CONCERNS" concentrates. This volume contains the issues like global warming and climate , degradation of natural resource base, biodiversity phenomena, food security, watershed management, mining action, energy use efficiency, environmental audit, environmental laws and overall ethics in environmental.

Agrofuels: Big Profits, Ruined Lives and Ecological Destruction

Francois Houtart, 2009, ISBN: 9780745330129; Price: Rs1,366.20; 196 pages.

This book shows that the use of agrofuels has led to an absurd situation where a sustainable energy source actually increases human & ecological damage simply due to the profit-maximising decisions of the Capitalists rather than a flaw in the concept of agro fuels.

Farm Forestry in India - An Economics and Environmental Analysis Dr. S.Puttaswamaiah, 2009; ISBN: 9788189640873; Rs. 795.

This book deals with issues of efficient utilization of natural resources, land and trees particularly in dry land areas. Government of India implemented the farm Forestry Programme, a component of social Forestry Programme since 1980, to involve farms in tree plantation activities. Farm Forestry Programme was defined as the practice of forestry in all its aspects on farm or village land, generally integrated with other farm operation. It is a programme of planting of trees on bunds and boundaries of the fields of farmers and to be taken up by the farmers themselves. The Programme persuaded farmers to grow trees on farmlands, farm bunds and particularly in environmentally fragile areas, by distributing various trees species, which attracted large numbers of farmers in several states.

Development and Agroforestry: Scaling Up the Impacts of Research Edited by Franzel, Steven Cooper, Peter, Denning, Glenn L.Eade, Deborah. © Oxfam GB 2002, in association with ICRAF. ISBN 0 85598 464 3

Agriculturalists have been benefiting from the range of products and services that trees can supply for thousands of years. Through the integration of trees into agricultural landscapes, farmers and land users at all levels can enjoy diversified production, and a range of social, economic, and environmental benefits. Agroforestry is the scientific application of this widespread body of knowledge. This stimulating collection explores the experiences of researchers and small-scale farmers undertaking agroforestry development projects around the globe, and addresses the question of how local, small-scale development successes can be 'scaled up' to create wider, long-term benefits. Each of the contributions offers insights into important wider debates. The relationship between theory and practice, the proper role of research in development, constraints on 'scaling up' local successes, the nature of human motivation for risk-taking and learning, and the ways in which individuals and communities respond to technical innovation, are all critically explored here. Contributors stress the importance of experimenting with a range of possible agroforestry techniques and approaches, in conjunction with the farming communities that will adopt or reject these methods over time. Readers from all backgrounds and disciplines will find in this volume a highly accessible collection of papers, informed by extensive experience, and relevant to development policy and practice in the broadest sense.

Multipurpose Tree Species Research Retrospect and Prospect

K. R. Solanki, A. K. Bisaria & A. K. Handa. ISBN: 9788177540451 Year: 2008; Pages: 349; Size: 14.5 x 22 x 2 cm; Binding: Hard; Language: English; Rs. 990.

Farmers have nurtured trees on their farms, pasture land and around homes for millennia to satisfy their livelihood needs. These trees were later on defined as multipurpose trees which provide fodder, firewood and also replenish nutrients in soil. Many strides have been made to

define characterize, evaluate multipurpose tree species for various agroforestry system under different agro-ecological zones of the world. Since the initiation of agroforestry research in India, efforts are going on for identifying promising multipurpose trees and shrubs through diagnosis and design exercise and evaluating them for their suitability pertaining to growth, development, biomass production and natural resource conservation. Now, voluminous data is available about multipurpose tree species for all the twenty one agro-ecological zones of the Indian Union.

In view of continuous reduction in forest cover, demographic pressure for livelihood needs and importance of trees, National Research Centre for Agroforestry, Jhansi organized a National Symposium on "Multipurpose Tree Species for Agroforestry System" during 11-13 June, 1998 to collect information on MPTS in relation to agroforestry systems and to provide a platform to discuss various aspects of MPTS and exchange of scientific knowledge among scientific community, foresters, planner and NGOs.

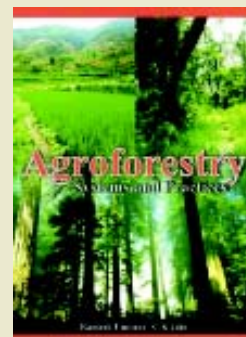
This volume brings together a vast and useful collection of papers by experts in agroforestry. Emphasis has been given to many problems and challenges facing their sustainable development such as evaluation, management and ecology.

Overall the papers reflects both progress and degree of comprehension achieved in understanding, management, utilization and conservation of MPTS.

It is fervently hoped that this volume will facilitate research on multipurpose tree species more vigorously and will serve the researchers, development agencies and policy makers as a ready reference.

Agroforestry Systems and Practices by Ramesh Umrani & C. K. Jain. ISBN: 978938017917; Year: 2010; Pages: 298; Size: 19 x 25 x 2 cm; Binding: Hard; Language: English; Rs. 1,800.

Agroforestry is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and/or livestock. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy and sustainable land-use systems. In agroforestry systems, trees or shrubs are intentionally used within agricultural systems, or non-timber forest resources are cultured in forest settings.



The present book describes the state of current knowledge in the rapidly expanding field of agroforestry. Organised into 16 chapters, it reviews the developments in agroforestry and describes the accomplishments in the application of biophysical and socioeconomic sciences to agroforestry. Although the major focus of the book is on the tropics, where the practice and potential of agroforestry are particularly promising, the developments in temperate zone agroforestry are also discussed. The book is designed for students, teachers, and researchers in agroforestry and farming systems.

Wadi, the tree based farming model

B V Sherkar and R C Kote

Tree based farming has proved successful in providing sustained incomes for the farmers in the rainfed areas. The model has helped in converting the unproductive waste lands of tribal families in parts of Maharashtra into productive mango and cashew growing lands.



Bhendipada is a small village with 80 households. Around 80% of total population is 'Warli' tribals and 15 % is Katkari community. Average land holding is 2.50 acres. Majority of the farmers cultivate paddy during the monsoon and also grow millets like Nagli and Varai. But during the other seasons, people depend on the forest produce or migrate to nearby places in search of livelihood.

To help small farmers to get sustainable income, Maharashtra Institute of Technology Transfer for Rural Areas (MITTRA), an organization promoted by BAIF Development Research Foundation, Pune promoted tree-based farming through agri-horti-forestry model called as *wadi*. *Wadi* model consists of plantation of 50 to 60 plants (2 to 3 species of grafts) on one acre land with forestry along the borders. The one acre land is also provided with live hedge and dry fencing. Small farmers with less than 5 acres lands are eligible for participation in programme. They are provided with technical support in pit digging, graft selection, plantation, after care activities along with improved agriculture and vegetable cultivation.

The *wadi* model was first shared and discussed in village meetings. Initially, people of Bhendipada were reluctant to go for *wadi*. Most of the farmers were apprehensive of survival of grafts owing to rainfed conditions prevailing in the area. Some also feared that their lands may be grabbed by these outsiders. To convince them a few selected farmers were taken to Gujarat where BAIF had successfully established wadies.

Mr. Ganesh was the first person to go for *wadi*. Though people laughed at him, he ignored them. He had stiff opposition from the elders in the family as Ganesh's grandfather had earlier failed in such tree farming. Ganesh's grand father had taken a loan of

Rs. 1000 for plantation of 50 Alphonso grafts 20 years back. But he couldn't raise horticulture plants as they did not survive under rainfed condition. His loan mounted to Rs.5000 which he could not repay.

But Ganesh was keen on trying the *wadi* model. He felt it would help him stay back in his village instead of migrating to Mumbai or Nashik after Kharif season. In the year 2000-01, Mr. Ganesh decided to participate in BAIFs *wadi* programme and planted mango and cashew grafts on a piece of one acre land. He not only cared for plants but also treated plot for conservation of soil and water by trenching. He actively involved in *wadi* holders group meetings for knowing the scientific techniques of pit digging, fertilizer application, taking care of plants and watering plants as and when needed. Now he has 60 plants grown successfully along with forestry, floriculture and also started vegetable cultivation.

Later on he also participated in floriculture by planting Galardia and Marigold on 200 square meter area as an intercropped crop in the same plot. He not only stopped at this but also planted eucalyptus as block plantation on 0.5 acre land and could manage to get diesel engine from tribal department for watering plants. Ganesh earned Rs. 30680/- in year 2010 from one acre land. The year wise income from wadi plot of Mr. Ganesh is given in the Table.

Wadi management

Participant farmers are grouped called as *wadi* tukadi with 10 members. Monthly meetings are held where various issues related to activities, marketing and processing of tree based produce are discussed. Through self help groups, women also participate in these meetings and interact on issues like growth of *wadi* plants, savings, health, marketing of products etc. Now the representatives



Mango trees on marginal lands - Farmers enjoying the benefits under Wadi Programme

from such wadi tukadi and SHGs have formed a 'Vibhag' for future planning of marketing and processing of produce like cashew, mango and vegetable. The processing of cashew is now being taken care of by the participants only. Vibhags are linked further with Vasundhara Agri-horti Producers' Company (VAPCOL) a producer organization that brings together farmers to help them market their produce.

Mr. Ganesh is the member of Sahyadri Vibhag, which is the lead Vibhag for collecting and processing of produce like cashew and mango. He looks after cashew collection activity of Vibhag. He has also donated his one acre land to Vibhag for construction of cashew processing unit.

Scaling up

Looking at the success of Ganesh, 69 tribal farmers participated in raising wadies in village Bhendipada. MITTRA has successfully up scaled *wadi* model on on 1405.50 acres of 1658 families in

Mokhada taluka and on 12293.50 acres land involving 13848 families in the tribal areas of Mokhada, Surgana, Peint and Trimbak blocks of Nasik district in Maharashtra through Adivasi Development Programme. Today, the unproductive waste lands of tribal families of Peint, Surgana, Trimbak and Mokhada talukas of Nashik and Thane district, are converted into mango and cashew growing lands.

B V Sherkar

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Year	Mango		Cashew		Vegetable Cultivation Earnings (Rs)	Floriculture Earnings (Rs)	Total Earnings (Rs)
	Yield (kg)	Earnings (Rs)	Yield (kg)	Earnings (Rs)			
2004	-	-	50	1750	-	-	1750
2005	-	-	60	2100	-	1200	3300
2006	30	1500	105	3675	800	9600	15575
2007	60	2400	125	4375	2600	7600	16975
2008	90	3600	200	7000	3500	8000	22100
2009	45	1800	237	9480	3000	8500	22780
2010	400	10000	174	7830	3600	9250	30680



Trees as rich farm resources

S Rama

Narendra's farm in Beluru, a small village in Karnataka is a farm rich in crop diversity. He grows more than 27 crops on his farm which is little more than an acre. Among these, trees occupy a major portion of his land.

Narendra has been practicing tree based farming since three decades. One can find varieties of trees on his farm. In the upper portion of the farm, he has planted mango trees. On the remaining land, there are around 980 arecanut trees. As intercrops, he has raised 100 nutmeg trees, 350 banana plants, 15 clove and cardamom plants. He has used arecanut trees to trail creepers. Around 350 creepers of pepper and beetle vines grow with the support of trees. In between these creepers and spices, tubers like ginger, turmeric and elephant yam, locally called as *suvarna gedde* are grown.

Narendra adopts low external input methods on his farm using the natural resources on his farm to the extent possible in a sustainable way. For instance, he has followed a unique pattern in planting the

trees so that all the trees benefit from good sunlight and freeflow of air. He has planted trees in a 'zig zag' pattern leaving a distance of 9 feet in between plants. The interspaces are used for raising plants like nutmeg, clove, cardamom, coffee, and banana. 'By experience I adopted this technique. It gives the required shade and light to the crops'

Narendra also uses organic liquid manure from the bio-digester for the entire farm. He dilutes the liquid manure with water and applies it to the farm through drip irrigation and sprinkler. He learnt this technique by practice. He feels these methods help in reducing labour, time and wastage of compost. '*This is an indirect benefit*' says Narendra.

Trees have many benefits

Narendra never expects income from each tree. He says 'Trees are not only the source of fruits but can also supplement manurial needs.

The leaves fallen from the trees will be converted in to compost thereby improving soil fertility. Besides, Narendra procures dry leaves (biomass) from *Soppina Betta* and near by forest in summer. He mulches the dry leaves six inches thick on the entire farm. This also adds to the cooling effect in the farm. The leaves gradually get converted to compost. '*When I use these dry leaves in my farm, it controls wilt disease (called soragu roga locally) in pepper.*



Narendra on his farm full of trees

Due to mulching the ants, earthworms and microbes increase, says Narendra.

He harvests the tubers only for his kitchen requirement. Rest of the tubers are left in the field. *‘These tubers increase soil micro nutrients and nitrogen improving soil fertility. As the tubers grow the soil also becomes porous enabling better water percolation into the soil. This helps in keeping the root zone of surrounding trees and plants moist’* says Narendra.

Till this day Narendra doesn’t evaluate the yield specifically. While he is also happy with the increase in yield, quality, taste and weight of the fruits and nuts, he feels he has gained much more by practicing intercropping and recycling of resources.

He sells spices, banana and arecanut in the local markets for spices and arecanut. He sells Nutmeg and Pepper to Bangalore, Mangalore and Sirsi markets. Beetle leaves are bought by the laborers He doesn’t sell vegetables, tubers, greens and grains. These are grown only for home purposes – says Narendra’s wife.

Farm as a learning center

Narendra has a passion for documenting details about his farm, the trees, their characteristics and the quantity and quality of outputs. He observes every arecanut plant and collects the characteristics of the plant and enters the data’s in the note book. He has numbered each tree. Every year he records the number of

bunches and the grade/quality of each bunch in his register. By this record keeping he sees many uses. Firstly he can estimate the exact yield from his farm, even before it is harvested. The harvest in terms of grade and type (variety) is also known before hand to help him in better marketing. Most importantly, Narendra uses his documentation task as a tool for his learning. Through his record he knows which tree is yielding and which is not. This helps him in identifying the trees which have some problem, so that he attends to those trees.

Documenting both success and failures equally, Narendra says *‘I use recording as a tool for decision making and as a means for learning’*.

S Rama

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