



Fruit tree based alternate land use system for degraded rainfed lands

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The North West Himalayan Region (NWHR) plays key role in providing ecosystem services, food and livelihood security to the inhabitants. Majority of the farmers are small and marginal (around 92%), and hold 63% of the total cultivated area of the region. Ecosystem diversity, fragility, inaccessibility, marginality and high-risk-low-pay-off agriculture are common features of the region. Agriculture is largely rainfed, subsistence or there is not much surplus for the market. Average productivity of major crops like cereals (1164 kg/ha), pulses (717 kg/ha) and oilseeds (712 kg/ha) in the region is very low in comparison to national productivity of these crops. Furthermore, the cropping intensity of NWHR is low (around 162%) and it is apparent that about 70–90% of the area remain vacant during the post rainy (Kharif) season due to severe water scarcity, as most of the rainwater flows as run-off through sloppy land. All these interconnected problems are considered to be the major cause of poor economic status and large scale migration of the hill people. Altogether, to solve these problems sustainably, serious efforts are required to manage the natural resource base by employing appropriate location specific soil and water conservation measures and adoption of alternate land use system, viz. fruit crop based system, to rehabilitate degraded land and provide economical, livelihood and nutritional security to farmers.

Keywords: Capacity building, Fruit crop based system, North West Himalayan Region

FRUIT trees by virtue of their perennial nature of woody framework, extended physiological stages of growth, differential root distribution pattern (root volume distribution) and deep rooting have greater resilience towards drought and can be adopted under degraded landscape. Fruit crop based system has capability to provide guaranteed returns under increased land degradation and climate change scenario. It can be practiced both under rainfed and irrigated conditions for enhanced productivity, profitability and sustainability. The advantages of the system are given here.

- Fruit trees fit well in crop diversification programmes in various scales, ranging from organised orchards to a few tree in the wasteland or backyard or homestead garden and has tremendous potential to enhance economic profitability per unit area, environmental sustainability and nutritional security.
- It provides effective strategy for improvement of land productivity as there are ample opportunities for raising annual, biennial and perennial crops during juvenile phase of fruit tree and can also meet diversified need of farmer throughout year.

- The system is helpful in generating added employment as it provides scope for ancillary industries like fruit processing, canning, preservation, dehydration, package transport and refrigeration.
- Fruits are considered as protective foods, considering their richness in vitamins, minerals, antioxidants and other nutraceutical traits, thereby, fruit based cropping system has potential to provide nutritional security.

Farmer FIRST project

Considering the situation of resource degradation and associated livelihood challenges, the study was initiated in 2016 under ICAR sponsored Farmer FIRST Project and three group of hamlets namely Kotigaon, Sindhwalgaoon and Badasi grant of Raipur block of Dehradun District, Uttarakhand, comprising 23 hamlets were selected for the purpose. Rehabilitation of degraded/marginal/waste land by adoption of fruit tree based alternate land use systems in conjunction with soil and water conservation measures was one of the key component of the project. Overall, idea was to improve local livelihoods and

strengthen ecosystem services in a sustainable manner.

Major challenges in the project area

Initially, detailed survey of existing situation of project area was performed through field group discussion, meetings and interaction with farmers and stakeholders etc. Multiple factors were considered for survey such as eco-physiological and environmental situation, agriculture and socio-economic status, farmers' perception and problems etc. Following broad constraints affecting natural resource base, agricultural production and livelihood security of inhabitants were recorded in the selected villages.

- Land degradation was a major constraint. Largely majority of land has steep slopes, undulating topography, fragile geology which favours intense soil erosion in the region. Thereby, leading to barren or underutilized land with features like shallow soil depth with high percentage of gravels/pebbles/stones, poor soil organic carbon/soil fertility and low water holding capacity etc.
- Small and scattered land holdings with less crop diversification were predominant in the area. Farmers were traditionally relying on monocropping of cereals and minor millets. Hence, most of the cropping systems were far from their productive potential.
- Few farmers were also engaged in traditional mango plantation and vegetable cultivation (in backyard). Predominantly existing mango orchards of region were of seedling origin providing low yield of poor quality fruit with less profitability. These traditional old cultivars have inherent constraints like alternate bearing, low productivity, poor fruit quality, susceptibility to disease and pest e.g. mango malformation, anthracnose etc.

Furthermore, non-availability of quality planting material, dominance of rainfed situations, uneconomical use of available barren lands, poor access to modern technologies, lack of technical knowledge and poor productivity level leading to abysmally and low marketable surplus were recorded in the area. Notably, wild animal menace also emerged as the key challenge in recent past.

Action Framework

Selection of suitable fruit species: Considering perennial nature and high initial establishment cost, careful approach was followed while selecting and promoting fruit species. Seven ecologically adapted and hardy fruit species, viz. mango cv. Mallika, jackfruit cv. Gumless, guava cv. L-49, kagzi lime (local), litchi cv. Rose scented, pomegranate cv. Bhagwa, and bael (local) were selected and promoted in the project area (Table 1). These fruit species were selected taking into account multiple criteria/factors such as agro-climatic and edaphic suitability, irrigation facility, market demand, economic profitability, wild animal menace, biophysical and economic resources available with farmers and traditional knowledge, experience and perception

Table 1. Fruit species plantation in project area

Fruit	Variety	No. of plants	Area covered (ha)
Jackfruit (grafted)	Gumless	1700	10.89
Mango	Mallika	950	6.00
Kagzi lime	Seedlings	1500	3.75
Pomegranate	Bhagwa	430	1.59
Guava	Lalit and L-49	300	1.00
Litchi	Rose scented	611	3.91
Bael	NB-5, NB-7	500	1.25

of farmers'. Afterwards, site selection was carried out and degraded/marginal, fallow land was preferred for rehabilitation through plantation. The quality planting material procured from accredited fruit nursery were provided free of cost to selected farmers.

Site specific intervention for soil and water conservation: Site specific different soil and water conservation measures, viz. trenching, micro-site improvement through pit fortification, organic and polythene mulching, application of Pusa hydrogel, spring water harvesting and provision of gravity based drip irrigation system were adopted according to orchard site suitability and demand (Table 2). These interventions ensured better survival and growth of fruit plants at respective sites.

Spring water harvesting and poly-lined dug out tanks: Low discharge water streams or springs are a common feature of the hilly region. The source of these springs are either from the continuous seepage from the farmer's field during rainy season or seepage of wastewater of community residing uphill. Such low discharge streams can be tapped for the purpose of water harvesting for providing irrigation to crops and allow the utilization of degraded, gravelly lands to enhance the income of the farm families. Four newly planted orchard sites were selected based on the initial soil characteristics and the feasibility of construction (availability of space and discharge rates of streams) during the first year. Afterwards, in second year, four poly-lined dug out tanks (Table 3) were constructed at the respective sites. The capacity of the tanks ranges from 1000 to 6000 litres depending on the discharge available. The average discharge rates of the streams tapped for water harvesting varied from 0.7 to 1.5 litre/

Table 2. Different soil and water conservation measures implemented at orchard sites

Site/hamlets	Fruit species	SWC measures
Sindhwal Gaon-I, Talai and Kuknawa	Jackfruit, Mango, Lemon and Bael	Silpaulin lined water harvesting tank with drip irrigation system, Pusa hydrogel application, and mulching
Sindhwal Gaon-II	Jackfruit, Mango, Lemon, Bael, Guava and Banana	Silpaulin lined water harvesting tank with drip irrigation system, Pusa hydrogel application, and mulching



Polylined tank at village Sindwalgaoon



Kisan Gosthi and Training programme on budding and layering

min. Silpaulin sheet of 120 gsm geo-membrane was used for lining of the tank. The tanks were further connected with micro-irrigation system (gravity based drip mechanism) for irrigating the fruit plants and increase their survival, as moisture scarcity is the main cause for poor survival of the plants in the area.

During the third year of the project the performance of the drip irrigation system associated with the water harvesting ponds was evaluated. The survival percentage after the intervention for all the fruit crops i.e. jackfruit, bael, kagzi lime and mango at different sites increased from as low as 38% to as high as 100% (Table 3). This was a noteworthy success indicator as without the intervention the establishment of alternate land use system would be a major challenge. Considering the long juvenile phase (4–5 years) of fruit trees no yield was obtained, so gain in terms of yield was not calculated. Additionally, due to introduction of this intervention, there was a remarkable saving in terms of man days required for watering the plants manually which was calculated to be 30 mandays per 300 plants in a year. The conveyance loss of water which varied from 80–90% before the introduction of the drip irrigation system was now negligible which resulted in huge water saving.

Capacity building: Capacity building, awareness creation and skill improvement programmes for local people through organizing village-level meetings and trainings were an integral part of the approach. Initially in 2016, two *kisan gosthis* and several field group discussion (FGD) and individual farmer meetings were arranged to sensitise farmers' regarding significance of fruit tree based cropping systems for degraded/marginal land. Farmers were specifically sensitised for market potential, economic profit, climate resilience and nutritional significance of fruit trees. Adoption of any

technology by farmers largely depends on demonstration and training, transfer of knowledge, awareness generated and level of strengthening of capacity. The farmers from project villages were regularly exposed to several capacity building training programmes on different horticultural aspects. Additionally, hands-on training for fruit propagation techniques like budding, grafting, air layering was imparted to farmers.

Farmers' Participation: Farmers participation was ensured right from initial phase; while selecting the fruit species, farmers' experience, perception and interest were taken into account. Subsequently, the Memorandum of Understanding (MoU) was signed with interested farmers to build confidence, sense of ownership and delegating them responsibility of orchard plantation and management. Afterwards, quality planting material procured from accredited fruit nursery were provided free of cost to these farmers. However, pit digging of recommended size, fruit sapling plantation and management was entrusted with farmers. Similarly, for site specific soil and water conservation work beneficiary farmers' contributed their share by doing manual work for construction of tanks/ponds, trenching etc. and thus throughout project farmers' participation was ensured which in turn lead to increased survival of fruit plantation and better management of soil and water conservation structures in sustainable manner. Accordingly about 65 ha area has been covered under alternate land use system in all 23 hamlets.

SUMMARY

Adoption of fruit tree based cropping system in conjunction with site specific soil and water conservation measures can keep the production system sustainable

Table 3. Performance of Fruit crops before and after intervention

Sindhwalgaon I			Talai			Sindhwalgaon II		
Fruit	Survival BF (%)	Survival AF (%)	Fruit	Survival BF (%)	Survival AF (%)	Fruit	Survival BF (%)	Survival AF (%)
Jackfruit	42	89	Jackfruit	73	97	Jackfruit	38	100
Kagzi lime	85	100	Lemon	32	100	Lemon	38	100
Bael	46	100	Bael	40	100	Bael	75	100
Mango	45	75	Mango	25	68	Mango	80	100

BF, Before intervention; AF, After intervention all are per cent.



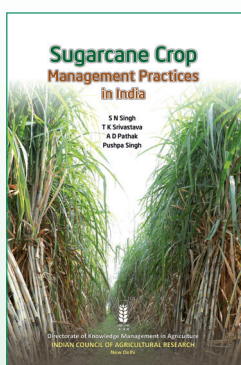
Fruiting in Lemon and Mango crops in farmers' field

and successfully ameliorate land facing degraded challenges in North West Himalayan Region (NWHR). Fruit tree species such as mango, guava, jackfruit, pomegranate, kagzi lime, bael and pomegranate has remarkable potential to augment farmers' income and supports optimum utilization of land and natural resources. In addition, it can ensure short and long-term ecological, economical, livelihood and nutritional security of the farmers in terms of fruit, fuel, fodder and other ecosystem services. However, considering the stretched juvenile phase of fruit trees, long-term

monitoring is required for concrete recommendation. The capacity building and active participation were the most crucial aspects of the project. The outcomes would be helpful for developing appropriate strategies and action plans for the management of natural resources and rehabilitation of wastelands through sustainable manner in lower NWHR.

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Sugarcane Crop Management Practices in India



A single publication collating sugar-cultivation practices in different states of India is still unavailable. The present textbook is penned by the eminent scientists of ICAR-Indian Institute of Sugarcane Research, an umbrella institute under ICAR, dedicated to research on fundamental and applied aspects of sugarcane. The Book attempts to address sugarcane cultivation practices in Indian states. The book comprehensively presents the recent cultivation practices of 17 states with detailed description on climatic conditions, soil, sugarcane-based cropping systems, preparatory tillage/field preparation, planting methods and geometry, fertilizer and manures, their time and method of application, irrigation/water management, intercultural operations, weed management, plant-protection strategies, harvesting, jaggery making, ratoon management, cultivation economics and constraints in sugarcane cultivation in a simple and lucid way. Each chapter caters to a single state. Since the information pertaining to sugarcane manage-

ment practices being followed in different states of the country is not available at one place, this textbook will be a knowledge resource for the vast network of sugarcane research, training, extension and development activities. This book will serve the purpose of different stakeholders and interested readers and go a long way in nurturing the interest of sugarcane farmers across the states for sustained sugarcane productivity.

TECHNICAL SPECIFICATIONS

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