

Sequestering carbon through indigenous agriculture practices

Mountain communities have been adapting to changing environment for a long time. Traditional farming methods depending on recycling of available natural resources is the key to sustainable production systems. Local marketing systems have also played a vital role in reducing the emissions and food miles.

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About 10% of the world's population depends directly on the use of mountain resources for their livelihoods and well being, an estimated 40% depends indirectly on them for water, hydroelectricity, timber, mineral resources, recreation and flood control. The resilience and adaptation of people in mountain regions have acquired important dimension in the light of changing climatic conditions. Ironically, agriculture is not only affected by climate change but also contributes to it.

Farming communities in Garhwal region cultivate many species and varieties of legumes. To maintain and conserve this diversity, the farming communities of this region practice low-input agriculture with a significant concern for agricultural sustainability. Here are some of the indigenous and traditional practices related to the climatic problems that are still practiced in Niti, Mana, Kedarnath, Pinder and other far flung valleys of Garhwal.

Diverse cropping systems

One of the main practices that has been practiced in low as well as high altitude of Garhwal is that of mixed cropping system. Farmers in the central Himalayan region have developed a rainfed mixed cropping system, over a period of time. A wide range of variation in edaphic, topographic and climatic conditions and selection procedures over centuries of cultivation has resulted in the preservation of an immense crop genetic diversity. The advantage of mixed cropping is that it will ensure some income even if one of the crops fails due to pests, diseases, drought or any other natural calamity. Trees planted on the bunds of terraced crop fields as part and parcel of mixed cropping and can provide some additional income.

Higher plant diversity in the form of trees and the crops would mean more efficient conversion of carbon dioxide to organic form during photosynthesis, thus reducing the chances of global warming and climate change. A few vegetables, fruit-producing trees, legumes, climbers, etc. could all be grown in a unit area with trees providing a boundary. Based on the choice of species, the fence (element) also serves several other functions - as windbreak, a habitat for birds, reptiles and small animals, a forage area for bees and birds, a zone for fuel wood, timber, fruit production, and nitrogen fixation. Through leaf fall, it also acts as a stable and steady production zone for a fair amount of organic matter. Some of these crops, although low yielding, are preferred by the local people due to their stress tolerance, resistance to disease and good nutritional value. Crop combinations such as of *Solanum tuberosum* and *Phaseolus vulgaris*; *Pisum arvense* and *Hordeum vulgare*; *Solanum*



A view of mountain agriculture

tuberosum, *Phaseolus vulgaris* and *Amaranthus frumentaceus* are grown as mixed cropping during April - Oct followed by monocropping of *Panicum miliaceum*, *Fagopyrum* spp., *Hordeum himalayense* and *Triticum aestivum*.

The *Baranaaja* a traditional mixed cropping practice is being practiced in the region. The *Baranaaja* system can be described as a 'simultaneous system' in which components are grown in mixtures and the interactions are both spatial and temporal. It has been described as a cropping pattern involving 12 or more food crops grown in 'synergetic' combinations. Described as a traditional mixed farming system, farmers of Central Himalaya grow about 100 varieties of paddy, 170 varieties of kidney beans, eight varieties of wheat, four varieties of barley and about a dozen varieties of pulses and oil seeds each year.

Back to indigenous crop varieties

Among the main crops grown in Garhwal for consumption are millets, pseudo-millets and cereals, which have very high nutritional and ecological value. However, owing to preference to cash income and changing food habits, farmers have been cultivating high yielding varieties of cash crops. Unfortunately, increasing atmospheric temperature coupled with the unreliable monsoon conditions do not suit these introduced varieties. They tend to fail at the slightest alteration of the weather. Farmers are therefore shifting back to traditional varieties which withstand climatic fluctuations better and provide subsistence yields.

Indigenous soil management practices

Soil is also affected by climatic changes and increased temperature in the atmosphere. Changing temperature alters the microbial activity in the soil that causes the breakdown of organic matter at faster rates and results in greater release of CO₂. Soil can remove CO₂ from atmosphere by minimum or no-tillage agriculture, which should increase SOC (Soil Organic Carbon). Legume crops fix atmospheric nitrogen and have enormous potential to fulfil the nitrogen requirements of soil. Legume crops are a viable source of nitrogen in Central Himalayan region, where landholding is small and traditional agriculture is entirely practiced on rainfed terraces under low-input system.

Farmyard manure, which is derived mainly from forest and livestock component, contributes more than 50% of energy input to hill agro-ecosystems. But, owing to depletion of forest area, it has become difficult to collect required amount of organic material (leaf litter) from the forests, leading to nutrient loss and soil degradation. Composting is a way through which local inhabitants effectively help in mitigating the effects of climate change. So, under such circumstances, incorporating pulses in agriculture can help to some extent in maintaining soil fertility and would also minimize pressure on existing forest resources.

Crop rotation is also an established practice in Garhwal, which helps alleviate the poor soil condition. The crop fields of the higher region, both under the rain-fed and irrigated conditions, are highly efficient. This is because the crops are cultivated only during the "Kharif" season and are left fallow in the "Rabi" season.

Organic agriculture is claimed to be the most sustainable approach in food production. It emphasizes recycling techniques and low external input and high output strategies. It is based on enhancing soil fertility and diversity at all levels and makes soils less susceptible to erosion even during severe drought and floods.

Local marketing systems

Barter system still exists in hill societies. Grains or other food articles are exchanged with daily need articles. They exchange daily use commodities and salt for local products like Marsha (*Amaranthus* sp.) and Rajma. They procure salt once a year, in bulk quantity, to fulfil local demands. Villagers obtain 6-8 kg of salt in return for 1 kg of *Amaranthus*. All families in the villages obtain 25-80 kg of salt through barter, enough to last the whole year. Usually, this yearly transaction takes place during October and November. By this system, villagers save their money and shop keepers more than double their profit.

Barter is a way of trading in Bhotiya tribal community (an indomongoloid sub-community) of Trans Garhwal. People grow ramdana (amaranth) potatoes; they would have cattle and sheep and thus have ghee (clarified butter), they would make baskets out of ringal (mountain cane) and then take all their produce to the plains. The people in the plains would buy this in return to grains like rice, dal (lentils) etc. This way, self-sufficiency was developed. Bhotiya tribes are also used to exchange medicinal and aromatic plants like *Allium strachei* (a medicinal and aromatic herb) and woollen handicraft with the inhabitants of the adjacent region of the Garhwal at the equivalent price of articles for exchanging with local crops cultivated in the lower regions. When they have no oxen to plough the fields, they work with a person for two days and get the oxen for their job. Same is the case with spraying FYM in their far off croplands. They take care of the farming jobs together. Thus, they don't have to spend anything on labour and they receive enough of agricultural produce for the year.

In remote rural settlements, where market supplies are not organized, local inhabitants still depend on indigenous vegetables, both cultivated in kitchen gardens and in the wild, for enriching the diversity of food. Hence, inhabitants of Garhwal lessen the possibilities of adding more carbon to the atmosphere.

Strengthening against degradation of resources and ecosystem services

Natural resources and accompanying environmental and ecosystem services are increasingly getting degraded. This has exacerbated environmental hazards such as landslides, floods and glacial lake outburst floods among others. Climate change has put an increased

stress on mountain communities. The growing population in the Himalayas, which depends on the limited area of the farmland, will increase the need to depend on traditional under-utilized crops and wild edibles. Most of them have tolerance to the biotic and abiotic stress. The livelihood systems are adapted through the promotion of high value mountain niche products such as value added wild edible products (viz. Seabuckthorn berries, Rhododendron flowers, Bamboo culms, Berberis fruits, etc.), handicraft articles and services rendered by the vulnerable. Thus it is a visible contribution to the reduction of poverty among mountain communities as well as reducing the impact of climate change to the vulnerable environment of Himalayas.

An indigenous mitigation perspective

After Organic agriculture movement took the entire Uttarakhand state, local people have started moving back to their traditional and indigenous cropping practices and crops to generate more income from their small land holdings. Many governmental and non-governmental agencies are also training local people regarding science and technology aspects of organic agriculture. Govind Ballabh Pant Institute of Himalayan Environment and Development, an autonomous institute of Ministry of Environment and Forests with its units in all major Indian Himalayan states is also demonstrating and disseminating the cost effective hill technologies to mitigate or lessen the impact of climate change at many valleys in Garhwal and other Himalayan states.

Participatory approaches and teamwork are fundamental in implementing sustainable changes at any place. Community organization and strong linkages among individuals and institutions working together as equal partners can help to bring out innovation and progress. Local knowledge needs to be integrated with modern science. Agriculture has the potential to be a considerable carbon sink, if good farming practices like organic farming are employed.

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