

Land use Intensification and its Ecological Impacts, in Himalayas of India – Lessons for scenario development in mountainous regions

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Abstract - The traditional agriculture land use system in Indian Himalayan region is an integral part of the society and local environment as in that the crop husbandry, animal husbandry and forests constitute interlinked systems. But due to variety of factors the land use under traditional crops is changing very fast in a part of Indian Himalayan region. This kind of land intensification is a severe threat to the environment of the region. In the present paper it is described that efforts are needed towards conservation and management of traditional agroecosystems of the Himalayan region which closely interlinked with the fragile Himalayan environment.

Key words: Himalaya, Traditional land use, Environment, Conservation and management

1. Introduction

The traditional agriculture in Central region of Indian Himalaya is closely dependent on the surrounding forests for resources. The existing farming system is an outcome of the process of the trial and error which people of the region have been trying to standardized since generations. Similar to other parts of the Indian Himalaya, in the Central region, due to variations in climatic conditions, unavailability of reliable market accompanied by large family size on small fragmented farms on small terraces covered on steep slopes have led the farmers to adopt the subsistence farming systems which are characterized by substantial diversity and also high degree of self-reliance (Maikhuri *et al.*, 1996; Semwal and Maikhuri, 1996; Palni *et al.*, 1998; Rao and Saxena, 1994; Ramakrishnan *et al.*, 1994; Nautiyal *et al.*, 1998; Nautiyal *et al.*, 2002-2003). The agriculture is mainstay of the people which interlinked with other subsidiary activities such as animal husbandry, horticulture, NTFPs collection and entirely depend on the availability and accessibility of the natural resources (forest ecosystems) of the region for sustainability. However, during recent past, the traditional agricultural systems are being increasingly perturbed a variety of factors e.g. socio-economic and cultural changes, imposition of conservation policies consequences scarcity in availability of resources required to sustain hill agriculture, low market facility and off-farm economic avenues. The change from traditional agriculture to modern agriculture (HYVs cultivation)/ cash crop based agriculture) has been advancing since last few decades in the region. The present study is an attempt to understand the causes and consequences of land use change. We have studied and analysed the economical and ecological potential of the traditional land use and altered land use (where traditional land use is replaced by some introduced crops such as tomato and bell pepper) to understand the efficiency ratio

(economical and ecological) of traditional land use Vs altered land use in the region. Besides, productivity of the traditional landraces and high yielding varieties of paddy (HYVs replacing the traditional land races of the crops and paddy is an important staple food crops in the region) is also analysed in view to understand the potential of traditional farming to support the demand of the people in the region.

2. Methodology

Study was carried out in 12 villages located in Central Himalayan region during October 1999 to October 2002. These villages represent the difference agroecological zones of the Central Himalaya in which they fall. The total number of households are 410 with a population of 2132. They harvest three crops in two years period from rainfed agriculture land and two crops in a year from irrigated land. The rainfed and irrigated land ration is 70:30 and per capita average land holding is 0.22ha. All the households were surveyed to determine average land holding size, area under different crops, crop compositions, cropping patterns and crop rotations. The information was collected through informal discussions with knowledgeable members of the households. To gather the above information, each household was visited at least 5-6 times during the study period. However, it is very difficult to measure diversity of agricultural crops and ranking them in order of rarity, endangered or extinct. For measuring crop diversity more accurately, total land under agriculture was surveyed to assess the actual area under cultivation of different crops during Rabi (Oct./Nov. to April/May) and Kharif (May/June to Sept./Oct.) seasons. Meanwhile villagers were asked to know the status of existing traditional landuse system and reason for land use change in the region. A door to door survey was conducted in each village to enumerate the total land area under cultivation of traditional crops and introduced crops. The area under each crop cultivar/ landrace grown presently and the situation in the recent past (during 1970 to 1980) was worked out by interviewing the people of the region. The information was subsequently cross-checked by taking observations in the field. The analysis for economic and ecological efficiency of traditional land use and altered land use (traditional land use pattern replaced by introduced crops) was determined in different plots of the crops based on the 20 quadrates (1x1 m²) per plot. The economic yield was determined in a plot as an average of 15 plants for a given crop variety. The economic yield per hectare in all cases was calculated on the basis of yield from the entire plot.

3. Agriculture of the Central Himalaya

In Central Himalayan region, the rainfed agriculture on steep terraces is the predominant form of land use, while only about 15-20% of the total cultivated land is irrigated. Irrigation is practiced only in the valley areas situated >1500m amsl and two crops are taken in one calendar year. Majority of the population is involved in agriculture. Average per capita land holding is ranged from 0.15-0.19ha. The rainfed agriculture in the village (<2200m asl) is practiced on two almost equal, halves of agricultural land locally with different crop compositions from where three crops are taken in two calendar years to manage the soil fertility.

4. Results

The magnitude of land use change in the Central Himalayan region of India is two types: a) where traditional land use is totally changed and farmers have introduced modern crops such as tomato and bell pepper cultivation to fetch more economic benefit; b) where traditional land race based cultivation is being replaced by the high yielding varieties of paddy and wheat. To understand the trend of land use change here we have setup time period 1970 onwards at the interval of 15 years.

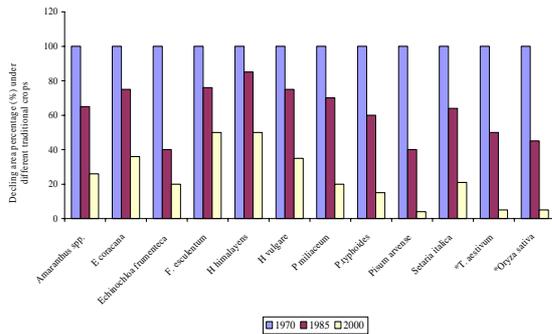


Fig. 1. Land under different crops in a part of Central Himalaya

*The land under cultivation of traditional land races of Wheat and Rice has been replaced by high yielding varieties

But it is very difficult to analyze the land use change pattern before 1970 due to some flaw in the methodology and more particularly only using the conventional methods. Therefore, we assumed that during 1970 the land use was optimum under each crops of the area and that has started changing thereafter. Based on the study we found that the traditional land use system is changing very fast in the region and intensifying by introduced crops/ high yielding crop varieties to fetch more economic benefit. After 15 years (1985) it is noticed that the land use under many traditional crops has reduced between 15 and 60 percent. However, this trend is continued and in the year 2000 the decline in land use under traditional crops is increased between 50 and 96% (Figure 1). The traditional land use and altered land use systems in the region are analyzed in ecological and economical currencies. Our analysis showed that the traditional land use system is more efficient in term of ecological currency. However, the altered land use system is showing more economic benefit than the traditional land use (Figure 2).

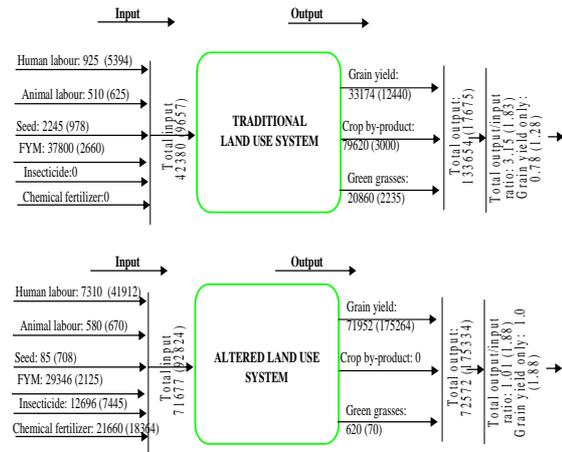


Fig. 2. Ecological and economic efficiency of traditional Vs altered land use system

In the another kind of land use change in the region where traditional landraces have been replacing by the high yielding varieties is analyzed in term of productivity. For this purpose the experiment was designed for different crop fields but here we only have given the production (grain yield q/ha) of HYVs vs traditional landraces of paddy (Fig 3). The grain yield of six landraces of the paddy was compared with its six HYVs. The productivity of HYVs was collected from secondary sources (Naseem and Abdullah, 1998; Singh, et.al., 2001) whereas for traditional landraces the data were collected from field studies/observations. The HYVs viz., Parag and Sugandha give 40-42 q/ha grain yield under improved agronomic management. Among the landraces, Bhabri and Shyudwal were relatively more productive and produce 32.5 and 34.3 q/ha grain yields, respectively, even under farmers' marginal conditions. The productivity of other HYVs (Terna, Ambika, VL 221 and PD-6) is reported between 19.9 and 25 q/ha whereas the productivity of some of the traditional landraces (Khullu, Ukhari, Kalon and Lalsati) ranges between 20 and 24 q/ha.

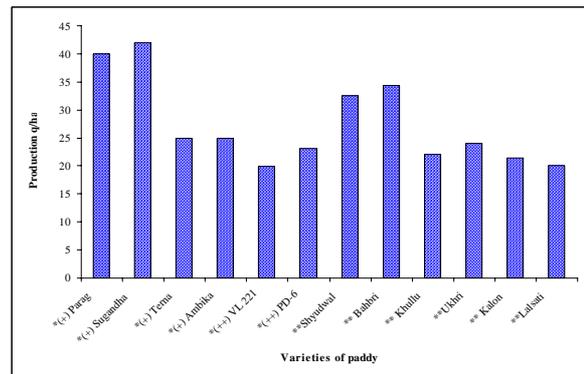


Figure 3. Production (q/ha) of the high yielding Vs traditional landraces of paddy

5. Discussion

The land use change from traditional subsistence agriculture to modern agriculture is advancing in a part of Indian Himalaya. Traditional land use in the Central Himalaya, India is the reservoir of a large variety of crops and their cultivars, which normally lesser known to mainstream societies. There are many factors responsible to decline the traditional land race based cultivation and lead to popularize modern agriculture/ high yielding varieties. Based on the present study it is observed that the land under variety of crops has been declined between 50-96%. Similar information is reported in the studies done by Maikhuri, et. al., 1996; 1997; Palni et al., 1998. Under the changing socioeconomic and environmental conditions the attitude of the local people has been changing and they want to enhance their earnings therefore they are adopting introduced crops to fetch more money which requires more input in terms of biomass. However, in due course of time the productivity of the lands started declining as decline in resource availability (Nautiyal et al., 2000). The agricultural intensification with use of high yielding/ modern varieties and purchased inputs has many negative implications particularly for the unique landscapes of the Himalayas where farmers are dependent on local resources and locally developed technologies (Sen, et al., 2002).

In Himalayan region the agriculture production is directly linked to surrounding ecosystems therefore, equilibrium should be maintained between agricultural production systems and surrounding natural ecosystems for evaluation of sustainability (Lefroy et al., 2000; von Wiren-Lehr, 2001). Extension of agriculture land use into forestland coupled with variety of factors such as fragile land use policies, lack of awareness among the people, ecosystem degradation arising from traditional practices of litter collection for maintaining agricultural soil fertility and unsustainable harvesting and overexploitation of the resources could be threat to forest biodiversity and ecosystem services on one hand and sustainability of traditional farming on the other (Singh et., 1984; Pilbeam et. al., 2000). In general the altered land use system showing high monetary benefit if only grain/economic yield is considered for output/input analysis. However, if all the auxiliary output from the system (such as by-product, green grasses etc.) are given value and considered for economic analysis then the traditional land use system is more efficient in terms of ecological point of view (Semwal and Maikhuri 1996) and by and large similar to altered land use system for economic point of view.

To maintain the equilibrium between land use change and requirement of the local people in the fragile region of the Himalaya, the traditional landrace-based indigenous knowledge system would play a significant role in making value addition to the traditional crops so that local farmers could be encouraged to grow more traditional crops which, besides staple food, have medicinal values and can play a great role in food and nutritional security (Maikhuri et al., 1996; Palni et al., 1998; Kazmi, 2003). Policy makers should not only promote planning to increase consumption of traditional crops as human and animal food but should also support research that will enhance their utilization. The comparison between grain yield of traditional landraces of paddy in Himalayan region and its high yielding varieties

suggests that the hill agroecosystems with traditional crops are ecologically and economically viable and still have the potential to support the food requirements in the Himalayan region. There are substantial evidences that introduction of modern HYVs in agroecosystems have resulted in extinction of traditional landraces in the in the Himalayan region. A recent study conducted by Nautiyal et al. (2000) in the Uttaranchal Himalaya showed that a prominent scented paddy landrace, "Mukhmar" has become extinct because of the introduction of HYVs by government policy interventions in certain areas where traditional agriculture was once an integral component. During 1980s a programme was launched by the government through watershed management project in the region and seeds of HYVs along with fertilizers at subsidized rate were provided to the local farmers. Farmers started cultivating a scented HYV of rice in place of the local scented rice landrace. At initial stages the HYV showed high output in terms of grain yield under high agronomic management but later on its production declined when the government agencies stopped giving subsidy on fertilizers. The traditional landrace Mukhmar has completely disappeared from the area now. Such state sponsored policies/programmes have therefore negative implications on traditional land use. The policies which general prepared for the low land areas/ plain areas are just implemented in the hilly region while ignoring the negative consequences of such kind of implementation on the fragile Himalayan ecosystems (Nautiyal et al., 2000).

The existing land use in the Central Himalayan region having potential to produce good output and support the depend population along with manifold uses needs policy support for conservation. The local communities need proper awareness and encouragement. Lack of economic incentives for promotion of conservation traditional land use is an important land use change detection factor. A participatory approach through institutional and policy support is required for developing new strategies and approaches for land utilization, adding new dimensions to its enhancement and better productivity such as promotion of elite landraces selected and enhanced on the basis of growing urban consumption needs on one hand and maintaining ecosystem services on the other. Urban demand for value based crops of the Himalaya would provide market incentives for farmers to maintain their land use for the subsistence level. There is a need to identify the way with the potential for use in food industry and multiplication of Himalayan crops for both local and urban consumption. Institutional support is also required for creation of specialized niche markets for biodiverse food. Increasing the value of elite landraces for direct sale as genetic resources, either under contract or intellectual property, is another incentive to farmers as policy support and management of land use. Sustainable land use is crucial not only for the sustainable livelihood of 115 million Himalayan/ mountain people but also the many more people living in the adjoining Indo-gangetic plains as accelerated erosion due to inappropriate land use in the Himalayas partly contributes to devastating floods in the plains (Ives and Messerli, 1989; Semwal, et al., 2004). Efforts have been made to analyse changes in broad land-use/land-cover types in the Himalayas (Rao and Pant, 2001; Gautam et al., 2002). Yet, knowledge on changes in spatial patterns of agricultural land use, driving

factors and their implications within the context of sustainable development is limited (Hurni, 2000; Sankhayan et al., 2003). Therefore, there is need to develop a model for sustainable land use in Himalayan region.

6. CONCLUSION

In continuation of the work carried by us currently our research work focuses on the development of the research and model framework, with emphasis on land use, land cover change, bio-resources of the Himalayan region of India and socio-economic conditions of the rural people. And we are analyzing the data gathered at various spatial scales in a part of Himalayan region for modeling. We are applying satellite Imagery (remote sensing) and Geographic Information Systems (GIS) based Modeling to study and analyze the land use land cover change in the region. We hope that this work will help in understanding the socio-economic scenarios of change and its impact on these fragile ecosystems within the larger context of sustainable development of the area.

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