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# Environmental, Ecological and Socio-Economic Impact of Introduced Crops in Western Himalaya : A Case Study of Kullu Valley

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**KEY WORDS** Western Himalaya. Traditional Subsistence Farming. Transition Phase. Horticulture. Sustainable Development.

**ABSTRACT** This paper describes and analyses the impact of introduction of high yielding varieties of food crops and fruit bearing trees in the area of once traditionally operated land use system in Kullu district of Western Himalaya. It has been found that indigenous agricultural practices that have evolved locally and have been inherited for generations, are now gradually being replaced with the introduction of new on-farm technologies and subsequently has left the system in 'transition phase'. The introduction of apple, inparticular, has imposed an adverse impact over the system. It has not only accelerated the immense pressure over the forest but has tremendously reduced the crop and animal diversity; some of the crops have already disappeared from the area. This study also suggests that commensuration with the environmental and ecological disbalances as widely caused by apply introduction, the traditional on-farm based sustainable development approach should find the highest priority in village level development planning and for overall ecological and sound economical development of the area. Farmers also want the subsidy as provided by government agency to continue, as subsidy over some items has presently been withdrawn. Farmers perceived that improvement in infrastructural facilities, market and storage facilities and value added technological innovation in the area would certainly increase sustainability. About 34 per cent farmers feel that people participatory approach is urgently required to heal the damage caused to the traditional system because of introduction of apple in the area.

## INTRODUCTION

Geographical area of the Western Himalaya is 1.69 per cent of the country's area and 10.54 per cent of Himalayan land mass, where 92.39 per cent rural mass lives in villages characterised by subsistence and marginal farming operations. Of the total geographical area of the Himachal Pradesh, Kullu constitute about 10 per cent, where 93.1 per cent population lives in rural areas and nurture agriculture land for their prime economic activities. Like Eastern Himalaya (Ramakrishnan, 1992) and Central Himalaya (Rao and Saxena, 1994) in Western Himalaya too, agriculture is the prime economic activity of the hill people. Land use is one of the essential components of a development plan for any area. Subtle geographic and geo-climatic differences in the Himalaya create a fine mosaic of micro-environments of discrete land use types. In the past, there used to be little population pressure on the land resulting into a balance between environment and society but recently over-increasing population pressure has interrupted the congenial relationship between mountain society and the habitat.

Introduction of new on-farm technologies (HYV wheat, apple tree, chemical fertilizers, pesticides) in the study area, tends to bring extensive changes in socio-economic, socio-cultural, environmental and ecological milieu. This *inter-alia* includes changes in the traditional value based system, changes in traditional ways of crop cultivation, increase of competition for the available human and natural resources; uncontrolled use of a monetary system rather than mutual exchange system has accelerated the environmental damages on subsistence lands. The emphasis of the paper is to discuss the factors responsible for changing traditional subsistence land use operations and subsequently to find out the possible solution for sustainable development.

## METHODS OF STUDY

All households of the study village were surveyed to determine the village and family structure, demographic profile, land use types, land allocated under different crops and fruit

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bearing trees, livestock distribution, cropping patterns, crop diversity and their yield. Important points regarding advantages and disadvantages of introduction of high yielding varieties (HYV) of crop and fruit bearing apple tree over the landscape were recorded. All these informations were gathered through informal discussion with head of the each households and filling up the questionnaires for the years 1970-71, 1990-91 and 1994-95.

For estimating the crops' yield, three replicate farm fields for each crop were monitored over a period of one year 1994-95. Density of food crop species was measured in twenty five $1m^2$ randomly placed quadrats and for apple tree in twenty five 10 m x 10 m randomly placed quadrats. Fifteen random individual of each matured crop species were harvested for determining mean plant yield and finally the yield was extrapolated in per unit area. Nine different ages of apple trees' fruits were harvested to estimate the apple production per unit area.

## DESCRIPTION OF THE STUDY AREA

### *Geographial Location*

Himachal Pradesh, is a hilly state with an altitudinal range of 350 m to 6975 m amsl. In general, Kullu valley and the study area too, have difficult terrains with gorges and ravines and extreme climatic variability. The elevation of the valley varies from about 1000 m at hill base to 4500 m at spur hill top. The valley is popularly known as *Dev Bhumi* (land of God). It starts from Rohtang Pass on upper side of geographically delineated area and ends close to Aut at lower side. It extends about 80 km in length and 3-5 km in width. The valley spreads on either side of the river Beas and extensively supports variety of land use types. The far flung hamlets are located across the valley commencing from hill base and it spreads up to middle slope; rarely one can find hamlets located at higher elevation (>2300 m). The Rumsu village (32°3' - 32°7' N latitude and 77°9' - 77°15' E longitude) is selected for the study because it lies in the heart of Kullu valley and represents all characteristics of the valley. The elevation of the landscape in the study area ranges from 1500 m to 3500 m but the village is situated at an altitude of 2050 m. The agricultural fields start from the base of riverbelt (1500 m) and end close to the forest fringe (2250 m).

### *Climate*

The study area has an extreme climate ranging from mild summer to severely cold winter. This remarkable variation is due to its peculiar geographical setup, characterising diversity in altitude, slope, local relief, nearness to snow line and relatively higher latitudinal extensions. Broadly, the area has three discrete seasons: summer season (April-June), rainy season (July-September) and winter season (October-February). Rainfall occurs throughout the year; winter season is characterised by heavy snowfall followed by rain. The total annual rainfall is about 120.3 cm of which 49 per cent occurred in rainy season. Average maximum temperature varies form 11.7°C to 30.3°C whereas the average minimum temperature ranges from-2.8°C to 18.1°C.

### *Soil and Vegetation*

The parent material in the area is represented by colluvium on meta-sediments. Mica schists, phyllites and sandstones are the common minerals. The soils, in general, are deep, loam to sandy loam and well to excessively drained. The soil is acidic in nature; pH ranges from 5.70-6.85. Widely, two types of vegetation-subtemperate to temperate and alpine types were recorded in the study area. However, a number of vegetation types were recorded based on their dominancy. Species of *Pinus, Cedrus, Abies, and Picea* are among the most dominated tree species at lower to middle elevation zone (1600-2500 m) whereas, broad leaf bearing species like *Aesculus, Eugenia, Betula* and *Quercus* are found at higher elevation. In alpine zone some sparsely scattered and discontinuous shrub species of low stature are observed. Grasses and forbs profusely grow in the alpine zone, though for a shorter duration.

### *The People and Village*

About, 302432 persons reside in the Kullu district in an area of 5503 $km^2$ (Anonymous,

1994). Hindus constitute the majority of the population, about 96 per cent of whom are located in the Kullu district. The people and culture of the Kullu valley are specifically identified by the collective term, *pahari* (of the mountains). The people of Kullu valley speak many dialects. The roots of dialects are traceable to Sanskrit (Hutchinson and Vogel, 1993) and these dialects are related to Indo-Aryan languages (Berreman, 1970). Of the total population about 93 per cent live in rural areas. Two distinct castes - Thakur/Rajput (higher section of the society) and Scheduled castes (weaker section of the society) were noted; Rajput are the primary land owners in the area. Nonetheless, blend culture of the people of the Kullu valley closely follow the distinction among local people, migrants from the plains, Nepalese, Tibetans and Kashmiris.

From isolated hamlets to conglomerated settlements are the characteristic features of the villages in the Kullu valley. The houses which are commonly 2 to 4 storeies are made up of stone, timber and mud.

### *Land Utilization Pattern*

Land utilization patterns of the Kullu district and that of the Himachal Pradesh are given in table 1 for years 1970-71 and 1990-91. Area under cultivation has increased considerably during the period for the district and the state. The increase in the area might have occurred because of conversion from cultivable waste and pasture land lying close to the settlements. At the district level, uncultivable waste land, located close to settlement which once have not been utilized for agricultural purposes, have recently been started to be utilized for the agriculture purpose. This has resulted in the increase in the area under cultivation tremendously during the last 25 years. This has happened because of increase in population has eventually demanded to fulfil the food requirements by cultivating and expanding the area under food crops and by planting cash fetching apple trees. Area under horticulture has increased sharply (145.3% at district level and 268.5% for the state level).

## RESULTS AND DISCUSSION

### *Village Demographic Structure*

Table 2 shows the structure and demographic profile of the study village. There are 76 families with a total population of 508, comprising 89 per cent Thakurs and the remaining Scheduled castes. The total livestock population is, more or less, close to human total population. The sex ratio (females per 1000 males) is remarkably high in the study village (1024) as compared to the district level (920) and state level (976) (Anonymous, 1994). The percentage of literacy in the surveyed households is 44.5 per cent which is sharply lower than that of Kullu district (54.8%) and state level (63.9%) (Anonymous, 1994). Male literacy is relatively higher as compared to the female literacy. Agriculture is the prime occupation of the village people. It has been found that 97 per cent of the work force are cultivators and

**Table 1 : Land utilization patterns (ha) of district Kullu and Himachal Pradesh**

| *Land Categories (ha)* | *Kullu District* | | *Himachal Pradesh* | |
|---|---|---|---|---|
| | *1970-71* | *1990-91* | *1970-71* | *1990-91* |
| Total area (Revenue Record) | 47282 | 50021 | 2932500 | 3367600 |
| Forest area (Forest Department) | NA | 414859 | 2143538 | 3759140 |
| Land not available for agriculture use | 9032 | 7259 | 290900 | 377000 |
| Cultivable waste | NA | 3793 | 167700 | 125100 |
| Permanent pasture | NA | 8 | 1188000 | 1135400 |
| Land under miscellaneous use | 600 | 259 | 40800 | 48200 |
| Net area sown | 33249 | 36539 | 546300 | 582800 |
| Total cropped area | 51097 | 64047 | 911700 | 983600 |
| Land cultivated more than once | 17848 | 27508 | 365400 | 400800 |
| Total horticulture area | 6924 | 16982 | 44327 | 163330 |

*Source* : Statistical Outline Himachal Pradesh, 1972, 1994; District Statistical Abstract Kullu, 1973, 1992
NA - Not Available

rest have migrated out side the village boundary either in search of a job or for some business. Of the total cultivators about 15 per cent work as labour force on daily wages in or around the village whenever they are free from agricultural works in their own fields.

**Table 2 : Structure and demographic profile of village Rumsu**

| *Parameters* | *No. / %* |
|---|---|
| Total households (No.) | 76 |
| Total cultivated land (ha) | 60 |
| Human population (No.) | 508 |
| Male | 248 |
| Female | 260 |
| Children (<12 years) | 169 |
| Sex ratio | 1042 |
| Castes groups (No.) | 2 |
| Thakur (%) | 89 |
| Scheduled caste (%) | 11 |
| Livestock population (No.) | 506 |
| Cattle | 245 |
| Horse/mule | 29 |
| Buffalo | 16 |
| Sheep | 169 |
| Goat | 47 |
| Literacy (%) | |
| Male | 58.1 |
| Female | 31.5 |
| Total | 44.5 |

### *Land Use and Land Capability Classification*

Four major types of land use patterns and their subsequent land characteristics are given in table 3. Land under cultivation has categorically been divided in two groups based on their use and distribution pattern. Valley cultivated land is generally distributed across the river belt in a wide range of 1-1.5 km and are well facilitated for irrigation while terraced cultivated land are unirriagated and spread up to a wide range of about 2 km commencing from moderate slope to steep slope. Paddy and wheat are the major cultivated crops in the valley field characterising low crops' diversity while wheat, barley, maize, pulses, fingermillets, amaranths, and other mixed crops are the major harvested crops over the terraced field emphasizing high crops diversity. Grass land (17.24%), forest (61.72%) and alpine pasture (15.86%) are other three discrete types of land use patterns which are basically owned by the Forest Department. From these areas one can bring fuelwood, fodder and other minor forest produce for their daily use; even any one can bring timber for their house construction after taking permission from the forest agency. Nonetheless, rules and regulations of use of forest owned resources are ambiguous to farmers. Therefore, there is a strong need for modification of such rules so that the confusion, confrontation and conflict often arising between farmers and forest agency could be resolved. Usually, grassland and alpine pastures are used for rearing and medicinal plants collection. Medicinal plants are restricted to alpine and nearby forest zone. Such types of land utilization patterns are distinct as compared to other parts of Western Himalaya (Sharma and Minhas, 1993), Central Himalaya (Pandey and Singh, 1984; Rao and Saxena, 1994) and Eastern Himalaya (Ramakrishnan, 1992).

### *Socio-economic Profile*

Some important socio-economic attributes at household level are given in table 4. It has been observed that the family size has sharply increased (59.6%) and moderate increment was also noted in land area under cultivation (6%). Increment of about 6 per cent area under agricultural fields during last 25 years could be due to introduction of the apple tree in the area. Steep slopes having grasses, hedgerows and bushes which are basically unsuitable for crop cultivation have recently been slashed and cleared for apple plantation. Ever-increasing population pressure in last two decades has reduced (36%) the per capita land availability in the area forcing the people to opt for off-farm employment in the nearby town of Manali and Kullu. Apple introduction in the area might have started in 1960s but the overall apple planted area has increased by 157.8 per cent during 1970 to 1995. Apple introduction in the area has left many negative impact over the agro-ecosystems, for instance, earlier lands were left fallow (gap between two subsequent cropping phase) for the replenishment of nutrients by natural means but recently negligible

**Table 3 : Land utilization pattern and land capability classification of village Rumsu**

| *Land use types* | *Land characteristics* | *Land use patterns* |
|---|---|---|
| Cultivation<br>Valley land (1.12%) | Gentle slopes (0-5°), elevational gradient 1500-1600 m, inward facing, deep soil depth (>1m), no erosion susceptibility, soil texture-sandy loam/silt loam, yellowish brown colour. | Rice is a major *kharif* crop and wheat is the major *rabi* crop, apple trees are being introduced recently. |
| Terraced land (4.05%) | Moderate (5-10°) to steep slopes (>10-45°), elevational gradient 1600-2200 m, outward facing, moderate deep to shallow soil depth (<1m), slight to moderate erosion susceptibility, soil texture-sandy loam, dark yellowish colour. | Food and fruit crops are the main crops (*kharif* crops-maize, pulses, amaranths, fingermillet; *rabi* crops-wheat, barley, mustard; fruit crop-apple). |
| Grassland (17.24%) | Strongly (10-20°) to very steep slopes (30-50°), elevation gradient 2500-3000 m, shallow soil depth (<1m), slight to severe soil erosion susceptibility, soil texture-loam to silt loam with moderate fine crumby structure, dark brown to yellowish brown colour. | Forest department owned land (FDOL) used for animal grazing, small 1-2 ha land were found scattered in forest area, snow prone area. |
| Forest (61.72%) | Strongly (10-20°) to very steep slope (30-50°), elevation gradient 1700-3200 m, shallow soil depth (<1m) occassionally deep (>1m), severe soil erosion susceptibility, soil texture-sandy loam to silt loam, dark brown to brown soil colour. | FDOL, encompassed with coniferous evergreen tree species at lower forest fringe and broad leaf bearing tree species at higher forested zone, snow clad area in winter season. |
| Alpine pasture (15.86%) | Steep (15-30°) to very very steep (>50°), elevation gradient 3300-3800 m, very shallow soil depth, (<1m), very severe soil erosion susceptibility, soil texture-silt loam, brown to yellowish soil colour. | FDOL, no tree cover, alpine grasses, medicinal herbs and alpine shrub species dominated area used for animal rearing, covered with snow in winter season. |

areas were being left as fallow. Similarly, not only cropping intensity has reduced (32.3%) but also net cropped area (50.2%) and animal population has declined drastically (cattle 25.3% and sheep and goat 69.3%). Earlier people were self sustained (none of the food items were purchased from the market) but presently introduction of the apple has accelerated the dependency of farmers on the market to fulfil their food requirements; thus frequently purchased items being pulses, paddy and potato.

**Table 4 : Per family socio-economic attributes of village Rumsu**

| *Parameters* | *1970-71* | *1990-91* | *1994-95* |
|---|---|---|---|
| Total agriculture area (ha) | 1.67 | 1.73 | 1.77 |
| Family size (No.) | 6.70 | 9.92 | 10.69 |
| Per capita land (ha) | 0.25 | 0.17 | 0.16 |
| Cattle (No.) | 6.67 | 4.73 | 4.98 |
| Sheep and Goat (No.) | 11.56 | 4.55 | 3.55 |
| Net cropped area (ha) | 2.11 | 1.66 | 1.05 |
| Intensity of cropping (%) | 69.34 | 50.31 | 46.96 |
| Fallow land (ha) | 0.42 | 0.15 | 0.05 |
| Apple plantation area (ha) | 0.64 | 1.25 | 1.65 |
| Gross agronomic yield (kg) | 5285 | 4125 | 5700 |
| Food purchased from market (kg) | - | 60 | 95 |
| Apple production (kg) | 1085 | 9050 | 8580 |

### *Crop Diversity and Yield*

Table 5 shows the crop diversity and average yields of different crops grown in the study area since 1970s. In 1970-71, three *rabi* crops and eight *kharif* crops were grown but in 1994-95, only 5 *kharif* crops were grown. There are six types of pulses which are grown in the area, mixed with other crops like maize, amaranths, buckwheat and finger millet. Three species of buckwheat (*kathu-Fagopyrum esculentum*; *gangri-F. tataricum*; *besha-F. debotrys*), one

**Table 5 : On-farm crop diversity and yield (kg/ha) of different crops of village Rumsu**

| *Crops* | *1970-71* | *1990-91* | *1994-95* |
|---|---|---|---|
| *Rabi* crops | | | |
| Barley | 1458 | 1287 | 1200 |
| Mustard | 514 | 510 | 685 |
| Wheat (local variety) | 1492 | 1344 | 1037 |
| Wheat (HYV) | - | 1938 | 2050 |
| *Kharif* crops | | | |
| Amaranths | 599 | 486 | 865 |
| Buck wheat | 398 | 313 | - |
| Finger millet | 1667 | 910 | 1120 |
| Foxtail millet | 375 | - | - |
| Hog millet | 281 | - | - |
| Maize | 1521 | 1559 | 2985 |
| Paddy | 3641 | 3538 | 1600 |
| Potato | 9375 | 15000 | 18000 |
| Mixed cropping | 1805 | 1340 | 1750 |

species of foxtail millet *(kavani-Setaria italica)* and one species of hog millet *(chini-Echinochloa frumentacea)* once grown in the area are presently not growing and finally have disappeared from the area. High yielding varieties of wheat were introduced in the area around 1975 not because of response of farmers itself but was promoted by government with heavy subsidy. It has been noted that decrease in some of crop yields in year 1990-91 as compared to that in 1970-71 and 1994-95 could be because of the inadequate availability of organic manure coupled with environmental unfeasibility. Apple introduction in the area required high amount of usage of organic manure and chemical fertilizers. Traditional crops do not give congenial response to inorganic fertilizers; it has resulted into extra shoot growth and does not help in achieving maximal production. Apart from that over this spatio-temporal scale, the system could remain in 'transitional phase' and could not adjust with the use of organic and inorganic manure. Paddy yield has decreased tremendously in valley because earlier after harvesting the crops, fields were left fallow to rejuvenate the nutrients. However, recently, due to ever-increasing demand of food, as the result of increasing population (decreasing area under food crop cultivation due to apple introduction) farmers are harvesting two crops in a year. Maize and potato yield has increased drastically may be because of improvement in their seed bank over a period of time and due to shifting potato cultivation from lower to upper terraced field recently.

The average yield of local wheat, introduced wheat and mustard as recorded in the area is very close to the values recorded in Spiti area of western Himalaya (Oberoi et al., 1992). The observed values are slightly lower for rice, wheat and mustard and considerably higher for maize and potato as compared to all India average values of 1990-1991 (Anonymous, 1992). The presently observed yield values of wheat, fingermillet and mustard are very close to the values of Central Himalayan region, but remarkably lower value was recorded for rice (Sharma, 1991). Crop diversity in the study area were significantly higher from North-Eastern Himalayan region (Mishra and Ramakrishnan, 1982) and Central Himalayan region (Pandey and Singh, 1984) and considerably higher from other mountainous regions too (Goland, 1993; Dougherty, 1994).

### *Introduction of New On-farm Technology*

Table 6 summarises the introduction of new on-farm technological input in the study area for the last twenty five years. Presently, all farmers are sowing HYV wheat. Conspicuous use of chemical fertilizers was initiated in early 1980s due to the introduction of HYV wheat but the quantum has accelerated parallel due to the apple plantation. Around 1970s, none of the families were using nonrenewable resources like chemical fertilizers and pesticides but its use has tremendously increased (78 per cent families responded using these) presently. This shows that introduction of new variety of crop and fruit tree has, no doubt, accelerated the use and demand of nonrenewable resources in the area. Highly skilled labours engaged in packing and grading of apple do come from distance places. Similarly, in 1970s hardly 5 per cent families had the jersey cattle but upto 1995, 70 per cent families are owing the jersey breed cattle. Moreover, earlier hydropower operated grinding machine was the only means for grinding of wheat, maize and other food crops but recently, this has reduced to 14 per cent due to introduction of electric appliances.

**Table 6 : Farmers' response (%) of the use of modern/introduced farm technology in village Rumsu**

| *Parameters* | *1970-71* | *1990-91* | *1994-95* |
|---|---|---|---|
| Sowing of wheat (HYV) | - | 100 | 100 |
| Apple plantation | 18 | 82 | 96 |
| Use of chemical fertilizers | - | 78 | 78 |
| Use of pesticides | - | 72 | 78 |
| Use of spraying machine | - | 72 | 78 |
| Labour dependency from out side the village boundary | 12 | 42 | 48 |
| Use of jersey cow | 5 | 70 | 70 |
| Use of electric machine | - | 80 | 86 |

### *Impact of Apple Introduction on The Traditional System*

Fast introduction of apple cultivation in the area has imposed directly and indirectly many negative/adverse effects in the natural as well as man made system (Table 7). Overall ecological and environmental disbalance as caused by apple introduction has categorically been grouped into 5 sections. 24 per cent families have responded that apple introduction in the area has inevitably imposed pressure over the forest for collection of fuelwood and fodder and use of *Pinus* and *Abies* trees for making apple's packing boxes (Singh, 1991; Ram and Singh, 1995). Subsequently, 92 per cent families have responded the loss of agroforestry tree species from their agriculture system. Market demand of coal is also responsible for the depletion of *Quercus* species which are suppose to be one of the important fodder tree species through out the Himalayan belt. The sudden disappearance of *Principea utilis* (oil fetching wild shrub species) is unaccountable, as 50-58 per cent farmers have responded. About 84 per cent farmers responded that it has altered the crop diversity and cropping patterns (Table 5). Earlier, crop production was absolutely depend upon the use of locally produced organic manure and leaving the field fallow for natural process of nutrient replenishment but, the introduction of apple and wheat (HYV) crops in the area, has accelerated tremendously the uninterrupted use of yield increasing inputs like chemical fertilizers and pesticides and subsequently has started forcing the farmers to depend on the market forces.

**Table 7 : Farmers' response (%) for ecological and environmental imbalance caused by introduced crops in village Rumsu**

| *Parameters* | *1970-71* | *1990-91* | *1994-95* |
|---|---|---|---|
| Forest sub-system | | | |
| Loss of forest cover | 3 | 24 | 24 |
| Agriculture sub-sustem | | | |
| Loss of agroforestry species | 2 | 78 | 92 |
| Loss of wild edible species | - | 30 | 32 |
| Loss of oil producing wild species | 5 | 50 | 58 |
| Decrease in crop production | - | 56 | 64 |
| Risk of crop failure | - | 30 | 32 |
| Loss of crop diversity | - | 86 | 86 |
| Change in cropping patterns | - | 80 | 84 |
| Weed infestation | - | 30 | 30 |
| Disease attack on apple tree | - | 52 | 58 |
| Livestock sub-system | | | |
| Loss of sheep and goat | 5 | 80 | 83 |
| Loss of cattle | 2 | 30 | 36 |
| Environmental changes | | | |
| Change in rain and snow fall | 6 | 74 | 74 |
| Change in temperature | 6 | 55 | 55 |
| Acceleration of landslide and soil erosion | - | 45 | 58 |
| Socio-economic changes | | | |
| Change in human perception | 3 | 30 | 38 |
| Change in socio-economic profile | - | 68 | 70 |
| Traditional knowledge elimination | 2 | 25 | 25 |

Apple introduction in the area is imposing more and more long term irreparable effect over the traditional system in comparison to the short term monetary benefit. As the apple tree becomes older its canopy size increases and it starts imposing shade over the staple food crops which require sunlight for optimal grain production. It has been observed that the biological yield reduces just below the apple tree canopy and none of the food crops can be grown in the field cultivating apple for above 20 years. (Singh, 1995). This is the reason why net cropped area has reduced to 50.2 per cent in the area (Table 4). Moreover, apple introduction in the area is tremendously boosting up the monoculture cultivation of crop and is also drastically decreasing the crop diversity in the area.

Table 7, further revealed, that uninterrupted use of chemical fertilizers and pesticides is responsible for the spread of diseases (canker and on scab) on the apple tree; as many as 58

per cent farmers are facing such problems. Animal husbandry too, has changed abruptly; 93 per cent farmers claimed that introduction of apple has forced them to curtail the stock of sheep and goat. This is partly because of plantation of apple tree in the agricultural land (loss of free grazing field) and partly because of involvement of strenuous and intensive labour in rearing. Earlier, cattle were left for free grazing after crops' harvesting but now it is not so because apple tree is highly delicate and perishable and any type of damage and perturbation by cattle became unbearable by apple tree. If such damage is caused, the apple tree goes under callus formation and eventually undergoes a number of secondary disease infection. Hardly 36 per cent farmers claimed that they have reduced their cattle but subsequently realised that the cattle domestication is important to commensurate with the organic manure demand for crops and apple trees as well.

Environmental risk and uncertainty has increased in the area in due course of time. As 74 per cent farmers have responded, that in last 20-25 years abnormal rainfall and snowfall has increased considerably. This abnormality has accelerated the landslide and soil erosion in the area. Similarly, 55 per cent farmers perceived that temperature irregularities have also increasing in the area. These irregularities could be the sole cause of insetting of the apple fruits. A general point has been noted that such irregularities are very high in the lower parts of Kullu valley. Overall changes in socio-economic profile were noted in the study area; 78-82 per cent farmers agreed that their socio-economic status has been upgraded in a short span of time. About 38 per cent families do commit that their attitude related to expectation and desire has improved, therefore, they are diverting from their traditional culture (25%) and finally traditional knowledges are being eliminated from the area (Singh, et al., 1996).

Traditionally female dominated agriculture system is now in the process of changing to male dominated agri-horticulture and horticulture system. Hence, traditional subsistence agriculture system has changed to a transitional agri-horticulture system. Changes in traditional agriculture operation were also recorded in Nepal High Himalaya (Bjonness, 1983) and other mountainous systems (Sarmiento et al., 1993).

### *Strategies and Priorities for Sustainable Development*

Like in other parts of Himalayan region in Western Himalayan too, geographical and geo-climatic constraints, small and fragmented landholdings, economic constraints, inaccessibility, remoteness and lack of infrasturctural facilities could be the prime constraints for sustainable development. However, marginal farmers in the area have no other means of development except agricultural activities. Table 8 reveals that notable demands of the farmers are to start and to expand the developmental activities related to on-farm based priorities coupled with providing the infrastructural facilities. As many as, 98 per cent farmers desired that all developmental priorities should be centred around the on-farm wealth management like development in traditional agricultural practices, agroforestry, horticulture, animal husbandry, ensured irrigation facilities, improving afforestation/forestry programmes and to start making co-operative societies. Whereas, hardly 22 per cent families do aspire for off-farm based priorities like tourism wealth, business and looking for job in town. It has been noted that certain traditional crops like amaranths, fingermillet, buckwheat, pulses and potato are highly energetic and eco-

**Table 8 : Farmers' response (%) for strategies and priorities for sustainable development of village Rumsu**

| *Parameters* | *% Farmers' response* | | |
|---|---|---|---|
| | *For* | *Against* | *No response* |
| On-farm based priorities | 98 | - | 2 |
| Off-farm based priorities | 22 | 31 | 47 |
| Infrastructure based priorities | 70 | - | 30 |
| Continuity of subsidy | 82 | - | 18 |
| Lack of technical know-how | 42 | 30 | 28 |
| Lack of market facility | 60 | 15 | 25 |
| Lack of storage | 68 | 4 | 28 |
| Lack of value loaded technology | 35 | 5 | 60 |
| Participatory approach of development | 34 | - | 66 |

nomically efficient and it should be disseminated in the area (Singh, 1995). Similarly, 70 per cent families want development of infrastructural facilities like *pukka* road and communication facility, health and education security, uninterrupted water and electricity supply. Subsidy provided by the government agency over the farm wealth should be continued as felt by 82 per cent farmers in the area. Recently, government has withdrawn the quantum and magnitude of subsidy over some items. Government has considerably accelerated the introduction of new farm technology (like HYV seed, apple plant, chemical fertilizers, pesticides, farm appliances), but has not adequaely provided technological know-how, as felt by 42 per cent farmers. Similarly, it has not provided market (as felt by 60% growers) and storage facilities (as felt by 68% growers). About 35 per cent families felt that there is strong need to start development in the field of opening of some value added technologies like making of apple juice, jam, jelly and pickles. About 34 per cent farmers felt the need of people participatory approach for development involving foresters, scientists, agriculturists, horticulturists, and planners to sit together and formulate ways and means to rejuvenate the gaps already incurred in the system.

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## REFERENCES

Anonymous : *Agricultural Statistics at a Glance*. Directorate of Economics and Statistics, Department of Agriculture and Cooperation. Ministry of Agriculture, Government of India, New Delhi (1992).

Anonymous : *Statistical Outline Himachal Pradesh*. Economic and Statistics Department. Himachal Pradesh, Shimla (1994).

Berreman, G.D. : Pahari culture : Diversity and change in the lower Himalayas. pp. 73-104. In : *Change and Continuity in India's Villages*. K. Ishwran (Ed.). Columbia University Press, New York (1970).

Bjonness, Inger-Marie : External economic dependency and changing human adjustment to marginal environment in the high Himalaya, Nepal. *Mountain Research and Development*, **3** : 263-272 (1983).

Dougherty, W.W. : Linking between energy, environment and society in the high atlas mountains of Morocco. *Mountain Research and Development*, **14** : 119-135 (1994).

Goland, C. : Field scattering as agricultural risk management. A case study from Cuyo Cuyo, Department of Puno, Peru. *Mountain Research and Development*, **13**: 317-338 (1993).

Hutchison, J. and Vogel, J.P. : *History of the Punjab Hill States* Superintendent, Government Printing, Lahore (1933).

Mishra, B.K. and Ramakrishnan, P.S. : Energy flow through a village ecosystem with slash and burn agriculture in north-eastern India. *Agric. Systems*, **9** : 57-79 (1982).

Oberoi, R.C., Sharma, A.K. and Moorti, T.V. : Environment, socio-cultural system and economic development in cold desert of western Himalayas (A study of Spiti valley of Himachal Pradesh). *J. Hum. Ecol.*, **3** : 1-7 (1992).

Pandey, U. and Singh, J.S. : Energetics of hill agro-ecosystems : A study from central Himalaya. *Agric. Systems*, **13** : 83-85 (1984).

Ram, S.C. and Singh, G.S. : Grewia oppositifolia : A multipurpose tree species of north-western Himalaya. *Agroforestry Today*, (in press) (1995).

Ramakrishnan, P.S. : *Shifting Agriculture and Sustainable Development : An Interdisciplinary Study from North-Eastern India*. MAB Series Vol. 10. Paris, UNESCO and Carnforth (U.K.), Parthenon Publishing Group (1992).

Rao, K.S. and Saxena, K.G. : *Sustainable Development and Rehabilitation of Degraded Lands in Himalaya*. Bishen Singh Mahendra Pal Singh, Dehra Dun (1994).

Sarmiento, L., Monasterio, M. and Montilla, M. : Ecological bases, sustainability and current trends in traditional agriculture in the Venezuelan high Andes. *Mountain Research and Development*, **13** : 167-176 (1993).

Sharma, P.D. and Minhas, R.S. : Land use and the biophysical environment of Kinnaur District, Himachal Pradesh, India. *Mountain Research and Development*, **13** : 41-60 (1993).

Sharma, S. : Energy budget studies of some multiple cropping patterns of the central Himalaya. *Agriculture, Ecosystems and Environment*, **36** : 199-206 (1991).

Singh, G.S. : Socio-economic evaluation of different land use systems in high altitude of western Himalaya. pp. 127-137. In : *Sustainable Reconstruction of Highland and Headwater Regions*. R.B. Singh and M.J. Haigh (Eds.). Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, (1995).

Singh, G.S., Saxena, K.G., Rao, K.S. and Ram, S.C. : Traditional knowledge and threat of its extinction in Chhakinal watershed in north-western Himalaya. *Man in India*, **76** : 1-17 (1996).

Singh, V. : *Ecological Impact of Apple Cultivation in the Himalaya*. International Books Distributors, Dehra Dun, India (1991).