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# Rural Transformation by Agriculture Diversification and Innovation Adoption: A study from Rudraprayag district, Garhwal Himalaya, India

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## Abstract:

Rural communities in Garhwal Himalayan region face a range of socio-economic and environmental problems. The area of the present study is district Rudraprayag, Uttarakhand. This hill district has subsistence farming as their main economic activity. Due to subsistence livelihood, migration and a remittance based economy operate in the district. The potential of innovation/technology has not yet been adequately and appropriately harnessed to overcome the development constraints posed by the fragile Himalayan environment. As government made many efforts to boost the process of innovation adoption, the technologies currently restricted with only few progressive farmers. Thus, there is a need for agriculture diversification and large-scale extension of region specific technologies for enhancing the economic condition of rural poor/smallholder household. This study focuses on the issue of agriculture diversification, potential areas of diversification and need of diversification with the need of technological adoption.

Keywords - **Livelihoods, Capacity building, Technology adoption, Diversification**

## 1. Introduction:

The Himalayan regions are well known for its rich and varied natural bio-resources. However, recently the population pressures within the region leading to major changes in the environment and associated rapid reduction of natural resources. The economy of Uttarakhand is predominantly agrarian. More than 80% of the working population is directly engaged in agriculture even though only 12.5% of the total land area of Uttaranchal is under agriculture (Deolia *et al. 2009)*. Around 70% of the operational holdings of the hill region are less than 1 ha (census 1991). In addition, these land holdings are located in various sites and in the form of various fields. There is the geographical inequality between the hill and the plain regions of Uttarakhand, this geographical disparity marked itself in the form of inter-district inequality, which is the most acute in the areas of infrastructure like roads, electricity, irrigation and other necessary infrastructural facilities. The inter-district disparity in infrastructure leads to inequality in terms of income and livelihood between the hills and the plains, and results in rampant underdevelopment in the hills while the plains are relatively prosperous (Mittal *et al.* 2008). In order to transform

this situation, a long-term planning is needed. The first step is identification of sectors that impede growth and region has a comparative advantage. The current state of infrastructure is clearly a restraint on development in this Himalayan region and must be the focus on a strategy for inclusive growth. The study identifies priority sectors in the district that need to be developed in order to achieve the aim at inclusive growth; these include education, health, infrastructure, tourism and horticulture. A large section of the population of this region depends upon agricultural and allied activities for their livelihood, consisting of crop production, animal husbandry and forest based production systems. Terraced slopes covering 85% of total agricultural land are largely rainfed, while the valleys (15%) are irrigated (Palni *et al.* 1998; Maikhuri *et al.* 2001). Agricultural development in the region is poor because of a lack of appropriate technology, inaccessibility, varied landscape, extreme ecological conditions and proper policies. In addition, small and scattered landholdings are another common feature of low agricultural production (Maikhuri *et al.* 1994, 1996, 1997). All the above factors compel the local poor to migrate and search better livelihood options in urban and semi-urban areas in the plains (Rawat *et al.* 1996; Rao *et al.* 1999; Maikhuri *et al.* 2005). Better agricultural productivity and movement from a traditional to a modern system are crucial for growth and development of the region. Innovation adoption is an important device in the continuous process of socio-economic development but, due to poor access to suitable technologies, this is a major factor of poverty and natural resources degradation in the region. So, to restrain the migration in the area, agriculture diversification with promising technologies in the rural economy is urgently required, which would not only provides livelihood and food security locally but also contribute towards minimizing existing pressure on natural resources (Maikhuri *et al.* 2007a, 2007b).

The suitable intervention mechanisms with location specific technologies play an important role to bridge the information gap between technology developers and the local resource users. These new technologies could provide feasible options for improving the yield of a farm produce, income generation from farm as well as off-farm activities. Therefore, this is necessary to train and build capacity of local farmers and motivates them to adopt promising, low cost, hill-specific rural technologies for agriculture diversification and enhances the income.

So, the present study was conceived to find out the existing status of agriculture diversification and usage of agro-based innovations in the hills. As additional economic actions, these activities, namely, protected cultivation, dairy and beekeeping contribute more than 50% to household income. These activities could be helpful to provide a level of income higher than the poverty line income of the region.

## 2. Study area

The area of the present study is district Rudraprayag of Garhwal Himalaya. The study area is situated in the north western part of the Garhwal Himalaya. The district is divided into three developmental blocks viz. Agastyamuni, Jakholi and Ukhimath. Rudraprayag district covering an area of about 2439 sq. km lies between latitude $30^0$19' and $30^0$49' North and longitude $78^0$49' and $79^0$21' East. The district consists of 688 villages. According to the 2011 census Rudraprayag district has a population of 242,285 and it is the least populous district of Uttarakhand. The district has a population growth rate 6.53 %. The region contains diverse vegetation type, ranging

from tropical deciduous to temperate, subalpine forest and alpine forest. Forest is one of the most important natural resources of the district.

## 3. Methods

Field surveys were undertaken in nine villages namely Jakholi, Bajira, Dhankurali, Jakhwari Talli, Kapniya, Dharkuri, Badhani, Khalyan and Jethana located in the Jakholi block of Rudraprayag district of Uttarakhand. This study is intended to address household level agriculture diversification and impact of innovative technology adoption in sustainable livelihood of smallholders. The study is based on primary and secondary sources of data and analysis of these data's. For collection of primary data, an in-depth survey was carried out in selected villages in the region to identify the priorities and perceptions of local farmers on the issue of diversification and technology adoption.

For the collection of primary data random sampling method was used. A complete inventory was made at household level for each selected village, covering more than 10% of households, with semi-structured questionnaires and personal interviews with local knowledgeable persons. The survey follows existing agriculture practices, and future sustainability as influenced by new technology adoption. Observations made on each category of livelihood options through detailed observations. To understand the agriculture strategy changes over the last decade, all the selected villages were surveyed in-depth and the heads of households were interviewed. Data were analysed through simple analytic tools viz. frequencies, proportions etc.

**Figure 1: Panoramic view of agriculture fields in study area**

## 4. Result and discussion

**4.1. Land Use Pattern:** Land use pattern is highly controlled by the underlying lithological types, topography and hydrology in the district. Human settlements are mainly located in the shallow water zones or around the vicinity near to springs. Farm practices are mostly restricted to areas of low relief. Forest are more frequent over steeper slopes than or moderate slopes. The study area is a well forest covered area, most of the part of the valley covered non-wasteland. In the district a small number of places where degraded forest and pasture in the region. The land use and land cover area covered i.e., Forest area (30.97%), Agricultural Land (37.68% both irrigated and un-irrigated), Water bodies-River/Stream/spring (3.21%), land under

non-agriculture use (26.32%) and Current fellow land (1.82%) (Table 1).

**Table 1 : Land use pattern of the district (Area in Hac.)**
Source: District revenue department, Rudraprayag, 2014 Uttarakhand

| Total Geographical area | Forest area | Water Bodies | Land under non-agriculture use | Current fellow | Agriculture Land | | |
|---|---|---|---|---|---|---|---|
| | | | | | Irrigated | Un-irrigated | Total |
| 55214.684 | 17100.255 | 1770.326 | 14534.61 | 1006.99 | 2323.853 | 18478.67 | 20802.5 |

### 4.2. Agriculture Diversification

Nowadays, agriculture diversification is extensively being seen as an approach for sustaining agriculture development as profitable returns from traditional crops like wheat, paddy which have either reached plateau or on decline in the hills. This would not only ensure some assured return from a piece of land but also would create more job opportunities for farm people in high value crops cultivation. In this context, diversification into horticulture crops like fruits, vegetables, medicinal and aromatic plants and livestock, bee-keeping etc. holds a great pledge. Importantly, there exits good scope for smallholders to participate in high value agriculture. The large number of family labours in the region can be effectively utilized in the production of high value commodities.

**Table 2 : Agriculture land use in the district**

| Agricultural land use | Area (000 ha) | Cropping intensity % |
|---|---|---|
| Net sown area | 19.5 | 143.6 |
| Area sown more than once | 8.5 | |
| Gross cropped area | 28.0 | |

Source: statistical-handbook-2009

### 4.3. Need for Agriculture Diversification

The altitudinal and climatic variations in this region offer natural advantage for crop diversification. As such, alternative strategies for agriculture related enterprises viz., horticulture, floriculture, medicinal and aromatic plants, animal husbandry, bee-keeping needs to be strengthened. Besides, less remunerative crops can be replaced with more profitable crops on the rotational basis. Utilization of fallow and wastelands for this purpose may also provide additional profit. Considering the composition of hill agriculture and the constraints it faces, the government strategies or policies should be formulated based on ground realities. The variations in altitude and climate may be also utilized for gains of small farmers through diversification. The traditional and scientific resources or know-how should be intermingled and disseminated to improve the agricultural economy of hills. Thus,

adoption of new innovation with diversification provides better options to enhance income of smallholders in this fragile region. It is essential to amalgamate the available natural resources, tap the unexploited potential of crops/varieties and technical know-how in an eco-friendly method to enhance agricultural productivity for nutritional and food security. Introduction of vegetable/fruit crops in the cropping cycle is capable of enhancing profitability. Therefore, it is vital to made serious attempts in this direction.

**Table 3 : Major crop grown in the study area during Kharif and Rabi season**

| | Major field crops cultivated | Total area | Production (MT) | Productivity (Qt/ha) |
|---|---|---|---|---|
| **Kharif Season** | | | | |
| **Cereals** | Paddy | 10.4 | 13947 | 13.10 |
| | Figermillet | 6.3 | 7881 | 14.61 |
| | Barnyard millet | 3.2 | 4082 | 12.15 |
| | Maize | 0.2 | 242.25 | 12.75 |
| | Amaranthus | 0.2 | - | - |
| **Pulses** | Black Gram | 0.4 | 82 | 2.27 |
| | Horse Gram | 0.2 | 132 | 6.90 |
| | Pigeon Pea | 0.2 | - | - |
| | French bean | 0.2 | - | - |
| **Oil Seeds** | Soybean | 0.160 | 130.61 | 19.79 |
| | Sesame | 0.02 | 7 | 1.63 |
| **Rabi Season** | | | | |
| **Cereals** | Wheat | 12.8 | 12849 | 12.05 |
| | Barley | 1.1 | 1906 | 1.4 |
| **Pulses** | Gram | 0.02 | 1.5 | 7.5 |
| | Pea | 0.08 | 42 | 7.5 |
| | Lentil | 0.07 | 11 | 4.5 |
| **Oil Seeds** | Mustard | 0.3 | - | - |

Source: statistical-handbook-2009

### 4.4. Horticulture

Horticulture is one of the most important sectors in the rural economy of the district Rudraprayag. It offers much desired opportunity for diversification and increased employment options in the region where scope of higher rate of expansion in conventional agriculture is rather restricted due to weird topography and majority of scattered and marginal holdings. Horticulture expansion can become an effective tool for accelerating development in the area through enhancing the income of farmers outside the subsistence level. For acceleration of horticulture, the area under horticulture crops can be increased by the utilization of cultivable wastelands and the land belonging to truant landowners. Citrus fruits viz. malta, lime, mandrarin, and galgal is the important horticulture crop of the area and has significant share in production. Many minor fruits are also available in the area, value addition of citrus and other fruit provides a significant income to the deprived household. But there is scarcely any database available on minor fruits like Aonla, Chyura (butter fruit), wild Apricot (chulu), Timla (fig) and Kafal (Myrica). In

particular kafal has commercial value even though it is an uncultivated plant.

Government and other agencies have made many efforts for encouraging the adoption of horticulture development technologies in the area. As a result of these efforts, there are a number of farmers adopted horticulture development technologies with different level of success that enhanced their livelihood significantly (Table 5).

**4.4.1. Polyhouse:** This is the structure made by the help of polythene sheets with iron/bamboo frame. The 150 gsm thick polythene sheet is used in the construction of polyhouse which prevents the entry of ultraviolet rays and conserves green house gases and enhances the efficiency of plant growth. The temperature and moisture level inside the polyhouse is higher as compared to outside environment, which increases the rate of photosynthesis and helps in better and uniform growth of plants (Palni 1996; Palni & Rawat 2000). Polyhouse is used for enhancing the production of vegetables, medicinal and aromatic plants, flowers etc. It also provides protection to crops from rigorous effect of frost, cold and diseases. It is very helpful in higher altitudinal areas for vegetables cultivation round the year as temperature is relatively low in high altitudes and polyhouse provides suitable temperature for plant/seedling growth. The area of per unit productions can also be enhanced through the proper use of polyhouse. It is predominantly useful for the farmers having small and marginal landholding in which multi-tiered cultivation in trays with the help of racks is possible. The size of polyhouse subsequently depends upon the requirement and resource availability of the farmers.

**Table 4 : Polyhouse adoption, income and uses in study area**

| Village | Elevation (m amsl)) | No. of Farmer adopted polyhouse | Income per month before adoption (In Rs.) | Income per month after adoption (In Rs.) | Use |
|---|---|---|---|---|---|
| Bajira | 1685 | 1 | 2500 | 4500 | Seedlings (Vegetables), vegetables |
| | | 2 | 7000 | 8000 | Seedlings (vegetables) |
| | | 3 | 8500 | 12000 | Seedlings (vegetables, fruits), vegetables |
| | | 4 | 2000 | 5000 | Seedlings |
| | | 5 | 2500 | 7500 | Seedlings, vegetables |
| Talli Jakhwari | 1777 | 1 | 42000 | 59000 | Medicinal plant (satawar, amla, kutki etc.) seedlings (vegetables, fruit) |
| Dhankurali | 1932 | 1 | 9000 | 18000 | Seedling (vegetable), vegetables |
| Kapniya | 1884 | 1 | 8000 | 20000 | Vegetables, seedlings (vegetables and fruits) |
| | | 2 | 6000 | 12000 | Medicinal plant (Kuth, kutki etc.), Vegetables, seedlings (vegetables and fruits) |

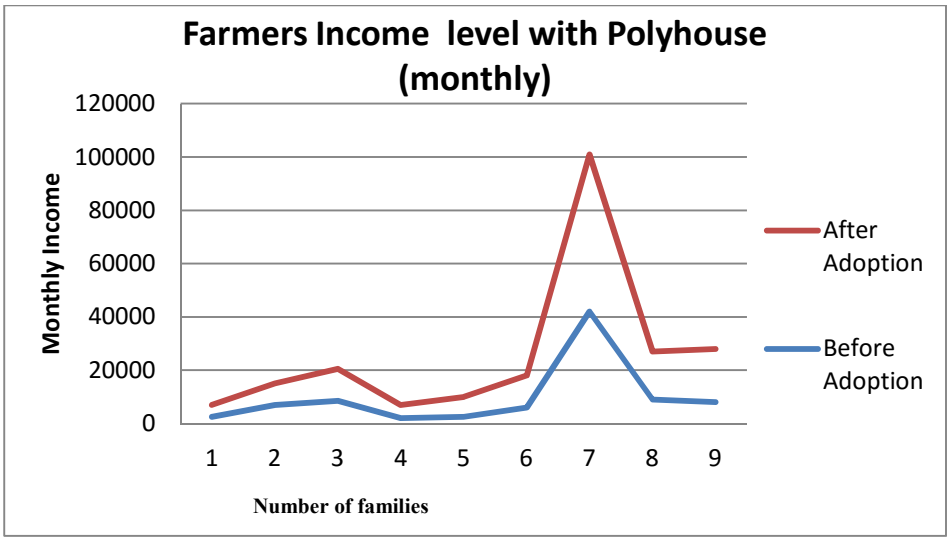


**Figure 2 : Monthly income of farmers in the surveyed villages by polyhouse adoption**

### 4.4.2. Organic composting

**Bio-composting**: Farm based composts or bio-compost are crucial for subsistence mountain farming system where rate of soil erosion and nutrient loss is high and its replenishment is slow causing the degradation in soil fertility. In such situations, bio-compost is highly useful. The traditional methods of compost preparation usually take 8-10 months for fully decomposing. However, improved techniques of compost preparation in which weeds/dry leaves, mixed with animal dung, poultry waste, vegetable waste etc. and kept inside the pit. This pit is covered with polythene sheet over a bamboo frame to check the heat loss during the process of decomposition and entry of rain water. Through this method compost gets ready for use between30-45 days depending upon the materials used (Palni 1996; Maikhuri *et al.* 2007a). The preparation of compost through this method is richer in nutrients compared to the traditional method. Through this technique, the decomposing time as well as losses of nutrients can be minimized significantly.

**Vermi-composting**: This is a simple technique in which biodegradable waste i.e. animals excreta, poultry waste, agricultural and vegetable residues, weeds etc. are converted into valuable organic compost with the help of earthworms. In this method the earthworms are bred in a combination of cow dung, soil and agricultural residues (Maikhuri *et al.* 2007a). This manure provides the necessary soil nutrients for optimum growth of cultivated plants. Continuous use of vermi-compost in the fields replenishes soil fertility rapidly by improving physico-chemical and biological properties of the less fertile soils. The application of vermi-compost is also helpful in reducing the use of pesticides.

Among all the available or adopted technologies in the region polyhouse/protected cultivation was most favoured by the farmers for enhancing their income but adoption rate is very low only 09 farmers adopted. Low adoption of polyhouse, may be due to its high installation cost, unavailability of raw material and lack of technical knowhow. Out of 135 surveyed household 89 were aware about the presence of this technology. Almost 80 percent of these farmers were ready to adopt it but lack of funds and lack of awareness about government subsidy

schemes they were incapable to adopt it. However adoption of bio/vermin composting is accordingly high but this is because of government and non government subsidies for construction. Farmers not using it properly while well known about the benefits, they use it as a dung store pit.

Table 5: Innovation adoption by the farmers of surveyed household

| Innovation/technology adopted | Frequency of adoption | Percentage |
|---|---|---|
| Inorganic fertilizer | 93 | 68.9 |
| Improved seeds | 44 | 32.6 |
| Polyhouse | 09 | 06.7 |
| Bio-compost | 18 | 13.3 |
| Vermicompost | 23 | 17.0 |
| Improved agriculture implements (Power tiller, thresher etc.) | 2 | 01.5 |

The distribution of the farm households according to their use of improved innovations is presented in the Table 5. The Table revealed that the most adopted technologies were the use of inorganic fertilizer (68.9%) followed by improved seed, vermi-composting, bio-composting, polyhouse and other improved agriculture implements. The high rates recorded may be due to their large dissemination which in itself results from a sequence of individual decisions to begin using the innovative technology, decisions which are often the result of an evaluation of the uncertain benefits of new invention with the tentative expenses of adopting it. The small technology usage as in the case of improved agricultural implements is constrained by land disintegration which hinders farm mechanization, non-viability of implements in mountainous region and their high cost. The result in Table 1 suggests that ample opportunities exist for the farmers to enhance use of the new technologies for farm mechanization and thus improve on the farm productivity.

**4.4.3. Factors influencing adoption of innovations**

The estimates of the factors influencing adoption of the new farm technologies were observed through field data. The considerable factors influencing the adoption of new technologies were education of household head, household income and extension contact. According to Iheke (2010), education increases the ability of the farmers to adopt agricultural technologies and hence improve their productivity and efficiency by understanding the correct method of its handling. This explains the straight relationship between education attainment and adoption level. Obasi (1991) stated that the level of education of a farmer not only enhances his farm productivity but also augment his ability to understand and evaluate new production techniques.

The household income was also related to innovation adoption. This implies that innovation adoption increases with increase in income particularly in case of costly innovations i.e. polyhouse, improved agricultural implements etc.. Krause *et al.* (1990), Immink and Alarcon (1993) and Iheke (2006) noted that lack of fund and access to credit prohibits smallholder

farmers from assuming hazards of financial leverage related with the adoption of new technology. While the extension services provide information and technical knowhow through informal training that helps to unlock the hidden talents and inborn enterprising qualities of the farmer. So, enhancing the farmer's ability to understand and evaluate the new production techniques and adoption of these techniques leading to increased farm productivity. The cooperative societies and farmers' associations are the good sources of information, quality inputs, labour, credit and organized marketing of products and positively related with the adoption of improved technologies. They help farmers to receive and synthesize new information and innovations in his locality and beyond.

### 4.5. Agriculture Diversification: opportunities in the area

#### 4.5.1. Livestock Rearing

The region is endowed with a mix variety of livestock: cattle, buffalo, goat, sheep, mule and poultry. The main feature of the animal husbandry in the region is vast livestock population with low or very low productivity. According to the Livestock Census, 2012, the population of cattle, buffaloes, goats, sheep and mule in the district was 11663, 240, 36974, 501 and 2606 respectively. The animals such as cow and buffalo in the region are the main milch animals having large in numbers but with low productivity. Keeping in view these constraints, formulation and execution of a logical policy to realize the potential of this large livestock population, is an urgent need. As dairy and poultry farming are gainful alternatives to traditional farming in the region and at present more than 50% household of the region earn income from milk and milk product viz. Ghee, Curd, butter etc. The income of surveyed households from milk, milk products and other cattle uses raging from 1000 to 4500 per month.

**Table 6: Livestock population in the surveyed villages of Jakholi block**

| | Livestock population | | | | | | |
|---|---|---|---|---|---|---|---|
| **Village** | **Cow** | **Buffalo** | **Goat** | **Sheep** | **Mule** | **Oxen** | **Total** |
| Dhankurali | 77 | 63 | 0 | 0 | 0 | 54 | **194** |
| Jakhwari Talli | 109 | 35 | 0 | 0 | 0 | 48 | **192** |
| Khalyan | 240 | 162 | 249 | 32 | 0 | 268 | **951** |
| Jakholi | 227 | 55 | 0 | 0 | 0 | 137 | **419** |
| Bajira | 306 | 90 | 0 | 0 | 0 | 163 | **559** |
| Kapniya | 146 | 91 | 23 | 0 | 0 | 124 | **384** |
| Badhani | 248 | 73 | 0 | 425 | 0 | 136 | **882** |
| Jethana | 277 | 82 | 0 | 98 | 6 | 162 | **625** |
| Dharkuri | 320 | 80 | 75 | 71 | 0 | 153 | **699** |
| **Total** | **1950** | **731** | **347** | **626** | **6** | **1245** | **4905** |

***Livestock census of Uttarakhand 2012.**

Horses and mules are the strength of the rural transportation system in this hilly region. It contributes significantly in the rural economy and provides income ranges from 2500-6000 per month per owner household. In the surveyed villages 6 mules were observed in 2 household of Jethana village. Increasing road network in hilly areas may be responsible for reducing the population of horses and mules in the region. Sheep rearing is also constantly decreasing in the area due to lack of grazing land. Sheep rearing for wool extraction can

be a good opportunity for alternative livelihood. Buffaloes are the major milch animals, contributing 62 per cent in milk production (NABARD, 2006-07) but now people prefer the cow rearing compared to buffaloes because lack of fodder species in nearby areas.

**4.5.2. Bee Keeping**

Because of prosperous floral diversity, the hills and mountains of region are suitable for bee rearing. Bee keeping has been a traditional practice in the hills from long time, but its potential has not been exploited commercially nowadays. Majority of the flowering plants require honeybees for cross-pollination for higher quality yields (Maikhuri *et. al* 2007a). The species of honeybee nurture in the region is *Apis cerana indica* which perform well in the hilly areas of the district by naturally and artificially. The major feed plants for the bees in the region are apple, peach, plum, mustard, etc. The July and August are the major dearth months of bee foraging. The Khadi and Village Industries Commission (KVIC) is the nodal agency to promote beekeeping in the state or in region. The beekeeping is a useful tool for better pollination which can increase the productivity of agriculture crops by manifold. An increasing production of honey can create huge job opportunities and income apart from mounting productivity of crops. As a primary and supplementary activity a long term programme for beekeeping should be launched this will create requirement for emergence of other additional units such as bee boxes, wax processing and packing material etc. In the study area beekeeping is only done by traditional way and only one farmer Mr. Balkrishna Semwal used bee-boxes for rearing of honey bees.

**4.5.3. Sericulture**

The district has excellent opportunity for both mulberry and oak silk production as the region is rich in natural vegetation of oak in the higher altitudes of the district and the its agro-climatic conditions are suitable for mulberry silk production in lower altitudes and foothills. There is a good potential for rearing tropical tasar in the districts. There are 72 mulberry farms in the state, 9 research stations/units of Central Silk Board including 2 Technology Dissemination Centers and 1 Silk Seed Production Centre and Regional Sericulture Research Station in the state to promote this activity in the region. Some villages of the district started cocoon production from mulberry or oak.

**4.5.4. Fisheries**

Fishery resource comprises of fast flowing rivers and their tributaries, high and low altitude natural lakes, ponds and doggies. These water bodies are excellent source for fish production in the region. The upland region provides conducive ecology for culture and capture of cold water fish. Mahseer and Asaila are indigenous important fish of cold water. Mahseer is the most important fish in the region and is rapidly being accepted as exotic food fish. Besides, two other exotic varieties of fish of commercial importance viz. Trout and Mirror Carp, can also be propagated, reared and developed in this hilly region. Only one fish pond of Mr. Mahendra Raj, in the village Kapniya (Saatoli Tok) was reported in whole study area. This pond was made by the financial assistance of Fishries Department, Rudraprayag. He produces a good amount of fish in the year around and earns Rs. 10-15 thousand per year.

**5. Essential Requirements for Enhancing High value agriculture**

Sufficient and timely availability of inputs is essentially needed for agricultural growth. A dynamic and emergent, agricultural sector requires quality seeds, fertilizer, plant protection chemicals, agricultural machinery at reasonable rates to the farmers. Balanced use of quality inputs at the right time brings

the much preferred results in terms of both production and productivity. The damaging effects of imprudent chemicals use is an issue of concern and ways and means have to be found to ensure sustainable agricultural growth by endorsement of balanced use of chemicals with an emphasis on organic farming viz. bio/vermi-composting.

Study region is lagging behind in the use of these inputs and the consumption of fertilizer was extremely low. The nitrogenous fertilizers were preferred over phosphatic and potassic fertilizers but in very low amount as 1-2 kg./nali (local land measurement unit, 50 Nali=1 Hac). The use of improved farming implements were also observed extremely low in the study area only 1 thresher and 1 power tiller was reported in the surveyed villages this may be due to subsistence agriculture and high cost of these implements. In view of rising demand for organic products, the district should exploit this opportunity. Lack of physical infrastructure in hills makes distribution of inputs extremely difficult. So, the government should give priority to this aspect in order to boost growth of agriculture in the region as organic agriculture and banned the inorganic fertilizers in the district or study area.

**5.1. Quality Seeds**

The seed is undoubtedly the fundamental and the most vital input that plays an important role in boosting agricultural productivity. The seed sector is not only playing important role in adequate quantity and timely supply of quality seeds to the farmers but also to enhance varietal diversity by providing suitable seeds which suits to various agro-climatic zones. However, despite the seed being such an important input, seed replacement rate of the region is extremely low this is due to lack of accessibility and timely delivery of quality seed. Ideally, seed should be replaced every three to four years for non-hybrids and every year for hybrids. But the seed replacement rate is higher in horticulture crops as compared to agriculture. Poor quality, higher price and timely availability are other important issues, which have negatively affected adoption rate of new seed varieties by the farmers.

**5.2. Cold storage facility**

Development of cold chain is an extreme requirement of the time as a large proportion of fruit and vegetable production is wasted due to the post harvest losses. These losses take place during post harvest processes. These losses can be minimized by improving cold chain facilities which will help in maintaining quality of the fruits. In the hilly areas, the degree of post harvest losses is higher as lack of transportation facilities the farmers are unable to get remunerative price of their produce. Thus, development of shared cold storage chains for hilly areas can be benefited all the stake holders in the value chain i.e. farmers, private sector, public sector and government.

**5.3. Bioprospecting of wild and semi-domesticated Fruits**

Wild edible bio-resources are being viewed as unexploited or underutilized resources that could play a significant role in hill economy, poverty mitigation, livelihood and nutritional safety of local communities through appropriate technological interventions and local value addition (Maikhuri *et al.* , 1994, 2007b; Dhyani *et al.*, 2007). The area of the present study has a number of wild and semi- domesticated fruits viz. Karonda (*Carisa congesta*), Bedu (*Ficus palmate)*, Kilmor (*Berberis asiatica*), Hinsola (*Rubus niveus)*, Mehul (*Pyrus pashia*) etc. which needs to value addition for promoting rural economy. In the study area farmers have adopted this as a small activity for self consumption and income generation. The various value added products i.e. juice, squash, pickle, jam etc.

are being prepared from more than 10 species by the villagers for their household consumption and also for marketing. The district also seeks to lay thrust on ensuring better market prices to the farmers. This activity also generates additional employment to the villagers and contributes significantly towards check the trend of migration from the region.

**6. Recommendations for Agriculture Diversification**

Since the hill ecosystems are very different from the plains, it is necessary to use a different approach to agriculture in the hill areas. The 1960s green revolution benefited only those areas that had irrigation facilities, but this was not feasible for hills, which lacked irrigation resource. Thus, the recommendations for development of the hill area through agriculture diversification are as follows:

1. Alternative areas of diversification are towards vegetable, fruits, spices and condiments (chilies, turmeric, ginger and garlic), tea plantation, floriculture, oilseeds (sesame, mustard, rapeseed and soybean) and traditional hill crops (finger millet, barnyard millet, glysine soya, black gram, horse gram). Intercropping of aromatic plants and spices with conventional grains can help in diversifying the income of small and marginal farmers.
2. Promotion of agriculture that is based on herbal, medicinal and aromatic high-value plant cultivation. Since markets are a problem, links the cultivators with retailers and ayurvedic & medicinal firms.
3. Organic agriculture can increase income in the hill regions as buyers prefer and are willing to pay more for organic goods. Organic farming is the preferred option for the agriculture-based hill region.
4. A cluster approach should be developed for the hill regions and this approach includes the terms of extension services, financial services, proper inputs supply and facilitation of processing. This will helpful to reduce the cost of production, generate marketable surpluses by improving yields. Performance-based credits and subsidy policies can incentivize small and marginal farmers to adopt the best practices.
5. Development of mandis in regional level and linkages between producers and consumer; even contract farming can be promoted, but under a suitable legislative framework.
6. Rural infrastructure development should be with the focus on rural development.
7. Animal husbandry and forest resource use are an important part of hill livelihood; this needs to be developed on a commercial basis. There is a need to revive the government's agriculture extension and veterinary systems.

**7. Conclusions**

The geographical area of the district is a hilly terrain having primarily rainfed subsistence agriculture. Major crops of the region are amaranths, finger millet, barnyard millet, barley, pulses, citrus fruit, vegetables and potato. The irrigated area is very low but the harvesting of rainwater can create the area irrigated. The varied climate, undulating topography, scant cultivated land, difficult working conditions with low returns on agriculture crops, sparse settlement, natural hazards which caused land degradation, lack of infrastructural facilities like transport, market and storage caused serious constraints to agriculture development in this region. The major challenge in the region is how to promote livelihoods to retain work force through providing them employment in local level for enhancing the quality of life of people living in rural areas of the district. This can be possible through the development of agriculture and allied sectors. Government needs to be developed a system for regular and timely delivery of region specific quality seeds and other necessary inputs in

affordable cost for small and marginal farmers. The diversified agriculture with a healthy mix of animal husbandry, poultry, beekeeping, fishing etc could be a gainful method for enhancing income. There is also an urgent need to improve the productivity of crops and livestock through adoption of improved technologies such as crossbreed etc. There is also a good potential of aromatic and medicinal plant cultivation in the area, which remains unexploited due to lack of serious efforts. So, there is a need to utilize these resources for enhancing local economy. It is also important to introduce organic farming practices in the area to enrich soil and reduce the use of inorganic fertilizer. Transportation facility is the primary requirement for supplying and accessing markets and is associated with economic development of the low and marginal communities. Therefore it is urgent to develop transport facilities for continuous supply of these goods in the region and also area specific research based solutions needed to enhance the agricultural productivity by identifying the local problems.

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