

# Reservoir induced impact on Agricultural patterns and Livelihood practices: A case study of Pratapnagar block in Tehri dam rim area

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**Abstract:** The mega hydropower project of (1000MW) Tehri dam has affected 125 villages directly or indirectly located in its vicinity. The 42 sq. kms reservoir resulting from 260 meters high dam formed in 2006 have caused severe environment and social impacts. 37 villages completely and 88 villages partially have faced problems of submergence, displacement, rehabilitation, livelihood. Since agriculture is the main stay of the surrounding villages, it has been severely affected due to submergence of fertile agricultural land (called Talon locally), reoccurring landslides, water availability problems etc. All the five blocks located in the rim of the dam's lake have witnessed the tumult in the socio- economic dynamics. This paper tries to contemplate the impact of Tehri dam on agriculture and livelihood patterns in adjoining villages of Pratapnagar block located on the southern and south western slopes facing dam. The most severely affected 10 villages from Pratapnagar block located within 1.5 kms distance from the reservoir have been taken up to study the changes in agricultural patterns and livelihood practices. The total land area before the dam construction of these villages was 3695.94 acres which was reduced to 3336.82 acres in 2008. 188.92 acres of land area has also been exposed to constant landslides. It was observed that agricultural land area was reduced to 2072.76 acres in 2008 from 2503.46 acres in 2000. Besides this, changes in economic conditions, traditional livelihood practices were also observed due to disruption in transportation and road network systems. The study includes extensive field survey to selected villages, forest area, agricultural lands, water bodies, landslide sites. Collection of qualitative and quantitative data was done through semi structured questionnaire, focus Group discussion with the farmers, PRA activities with the locals, local government agencies, THDC's records coupled with literature appraisal at local and regional scale. Statistical and cartographical techniques have been used to analyze the acquired data. The Study indicates that the existing land use patterns have increased the vulnerabilities of the local people. It also attempts to develop user oriented resource management framework for alternative agricultural practices and better adaptation strategies for the region.

**Key words:** Agricultural practices, Land use change, Participatory resource management, Rural livelihood, Tehri Dam,

## I. INTRODUCTION

Tehri dam is one of the most magnificent structural marvels of 21<sup>st</sup> century. It is the 4<sup>th</sup> largest earth and rock filled dam in the world and biggest in India, located at the confluence of Bhagirathi and Bhilangina rivers, in Tehri district of Uttarakhand. The genesis of Tehri dam projects dates back to 1969 when it was prepared and submitted to Govt. of India and originally approved in June, 1972, but till the year 1977-78 the pace of the construction of the project could not pick up due to paucity of funds. Subsequently, without increasing the height of the Dam as earlier proposed, the installed capacity was revised from 600MW to 1000 MW in 1983. Consequently, In July 1988, the Tehri Hydro Development Corporation (THDC) was set up as a joint venture of the Government of India and Government of U.P. for executing the Tehri Hydro Power Complex project (2400MW) in 2 stages, stage one including Tehri Dam & Hydro Power Plant (1000 MW), Tehri Pumped Storage Plant (1000 MW) and the later including Koteshwar Hydro Electric Project (400 MW).

Government of India, in March, 1994 approved implementation of Stage-I i.e. Tehri Dam and Hydro Electric Project (1000 MW). It was subsequently completed in 2006 forming 42 sq. km. of storage lake and started electricity production in 2008. But that is not all, it is also one of the most controversial dam sites in the world. It epitomizes decade's long struggle between environment conservation and economic demands, where finally the former was compromised to achieve the later. As a result though the electricity needs of northern India were eased nearly 11 lakh people across 125 villages in the vicinity of the reservoir were

displaced, migrated and rehabilitated. Hectares of good agricultural land, forest area was drowned causing serious environmental impacts and livelihood challenges for the local people who were left to make peace with their unknown fate. There were agitations, mass protests, struggle which led to enormous time and cost overruns, so much so that the dam which was originally approved in 1972 could only be completed in 2006. But the loss transcends beyond finances: the loss of 100 years of socio-cultural history and heritage of old Tehri town which was submerged in 2008 is irrevocable. The town's demise came as a result of the 261-meter-tall Tehri Hydroelectric Dam which was built to ease water and electricity problems for Northern India (Tripathi 2005).

With thousands of people left stranded, forest and agricultural lands gone, livelihoods compromised, it flares a very important question i.e. what is the limit to which we can compromise anything and everything to attain certain economic gains? Further the main cause of concern over the years, are 88 villages which were partially affected and have not been compensated adequately, (their major agricultural lands and forest area vastly submerged). Today the biggest challenge for the native villagers is to adapt themselves for better livelihoods in given conditions of social isolation, unemployment, meagre compensations and social insecurities. Therefore, this dam is beset by a paradox: it attempts to bring modernization and development to the far reaches of the territory, while creating displacement conflicts which can change a relatively few people's lives for the potential benefit of millions of others.

## I. STUDY AREA

The site of Tehri dam is located in the Tehri Garhwal district of Uttarakhand. The study area includes 10 villages located in close proximity of dam's reservoir. These villages are located between 30°41" to 30° 48" latitude and 78°42" to 78°48" longitudes on the southern and south western slopes facing the dam. The study area is part of Pratap Nagar block, one of the five blocks surrounding the reservoir. The selected villages are located within 1.5 kms of distance from the reservoir. These villages have faced problems of submergence, and inundation of fertile agricultural lands, community forests, road networks etc. Most of the villages were directly dependent on subsistence type of agriculture and have suffered severe livelihood challenges post dam construction. Since these villages were not completely drowned therefore they were deprived of essential compensation, rehabilitation etc. Further over the years it has been realized that the area has become an isolated zone in terms of social, infrastructural and economic aspects resulting in degradation of natural resources which has made people more vulnerable to existing conditions.

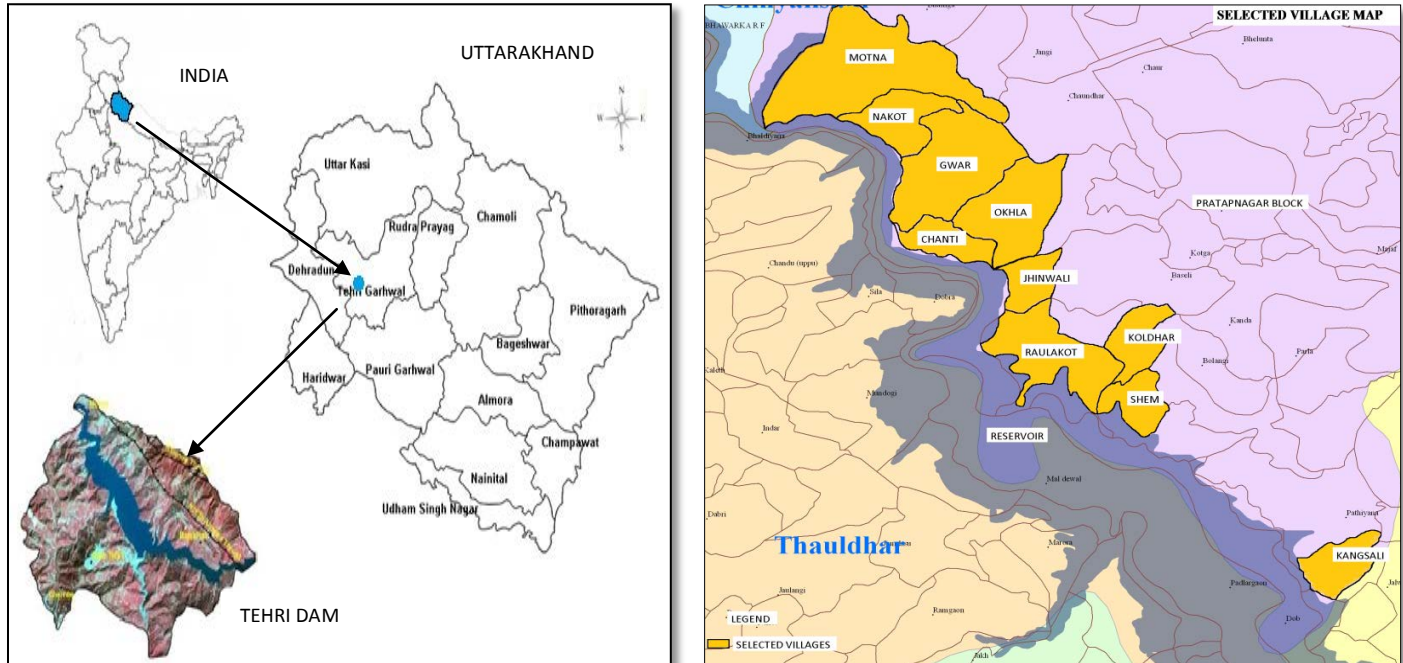


Figure 1: LOCATION MAP OF THE STUDY AREA

## II. SCOPE

This paper tries to contemplate the socio economic problems existing in the vicinity of the dam, by analyzing the socio economic dynamics of the selected 10 villages in Pratapnagar block (one of the five blocks of the rim area). It intends to highlight the impact of Tehri dam on agriculture and livelihood patterns in adjoining villages of Pratapnagar Block located within 1.5 kms from the reservoir. The study also analyses the present adaptation practices for sustaining livelihood in these villages for reiterating the need, scope and management of future socio economic developments in the whole area.

### III. MATERIAL AND METHOD

The study includes extensive field survey of selected villages, forest area, agricultural lands, water bodies, landslide sites. The given 10 villages were chosen on the basis of stratified random sampling. Further, purposive sampling has been used to identify households and includes a sample size of 20 households ( i.e. 2 from each of the selected 10 villages).Twenty(20) respondents were randomly chosen for semi structured questionnaire (again 2 from each village). Also focus Group discussion with the farmers, PRA activities with the locals, local government agencies were conducted for personal observations. Secondary data includes population data from census 2001 & 2011, THDC's records, and literature appraisal at local and regional scale. Base map and other thematic maps have been prepared with reference to toposheet 53 J/7, Remote Sensing Land sat, LISS III & LISS IV data using ARC-gis 9.3 software. Statistical and cartographical techniques have been used to analyze the acquired data and for the simplified presentation of results.

### IV. RESULT AND DISCUSSION

In general, it was observed that the selected villages were having suitable natural resource base in the past and self sustained livelihood. These villages were self dependent on their self produced crops which were sufficient for their local demands and livelihood. It was mainly observed during the study that after the dam completion regions main economic activity agriculture was most adversely affected due to issues of submergence, seasonal inundations, degradation, lack of water availability and reoccurring landslides. Prior to dam construction, the agricultural terraces were located towards the river margins, were fertile, and well drained (locally called as *Talaon* or *sera*). Crop intensity and production was enough to support village economies efficiently producing surplus for the whole year. Other subsidiary activities like animal husbandry, fishing, transportation of local goods etc have also been affected due to disruption of transport networks. Villagers are forced to practice agriculture in upper regions of the valley with low quality soil which does not produce efficiently for the whole year. Therefore the villages which were self sustained at one point of time have become more dependent on the government owned Public distribution shops, and employment schemes for their survival.

#### **Land use land cover change:**

It was observed that the total geographical area of the selected villages was 3695.94 acres which was reduced to 3336.82 acres post dam construction, highlighting the fact that nearly 360 acres of land is either lost to submergence or inundation. Nearly, 2503.46 acres or 68% of fertile 'Talon' agricultural land area was considerably reduced to 2072.46 acres or 62%. Kangsali, Raulakot are the most affected village, which lost nearly 219 and 114 acres of fertile lands respectively followed by Motna (53 acres), Nakot (45 acres). It was also observed that although the total waste land area significantly reduced to 628 from 700 acres (submerged) but there has been addition of 122 acres of landslides tracts with regional and seasonal variations.

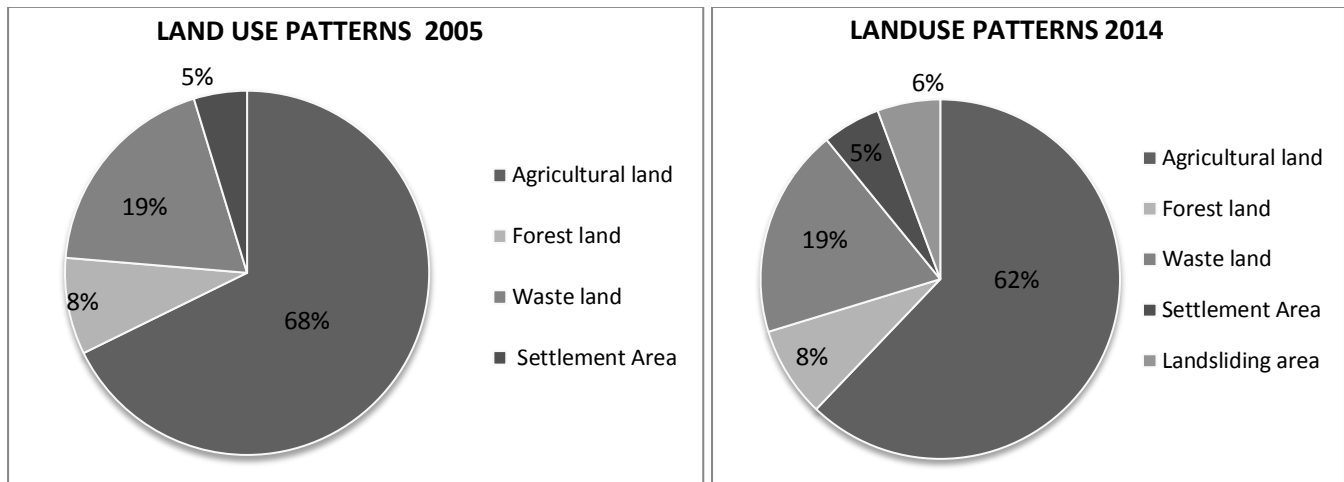


Figure 2 :Comparative landuse pattern in the selected villages( 2005&2014)

The incidences of landslides in the area have increased both in intensity and frequency degrading the natural resources of the region mainly natural aquifers, small water streams/channels etc. The main reason is attribute to weak geological profile of the region and fluctuating hydrostatic pressure of the reservoir. Identifying the broad 7 land use categories in the region comparative land use land cover map for the year 2000 and 2010 has been prepared(shown below)which clearly depicts the inundation of fertile agricultural and forest lands in the later. Expansion of the reservoir and addition of the land sliding area is also clearly evident.

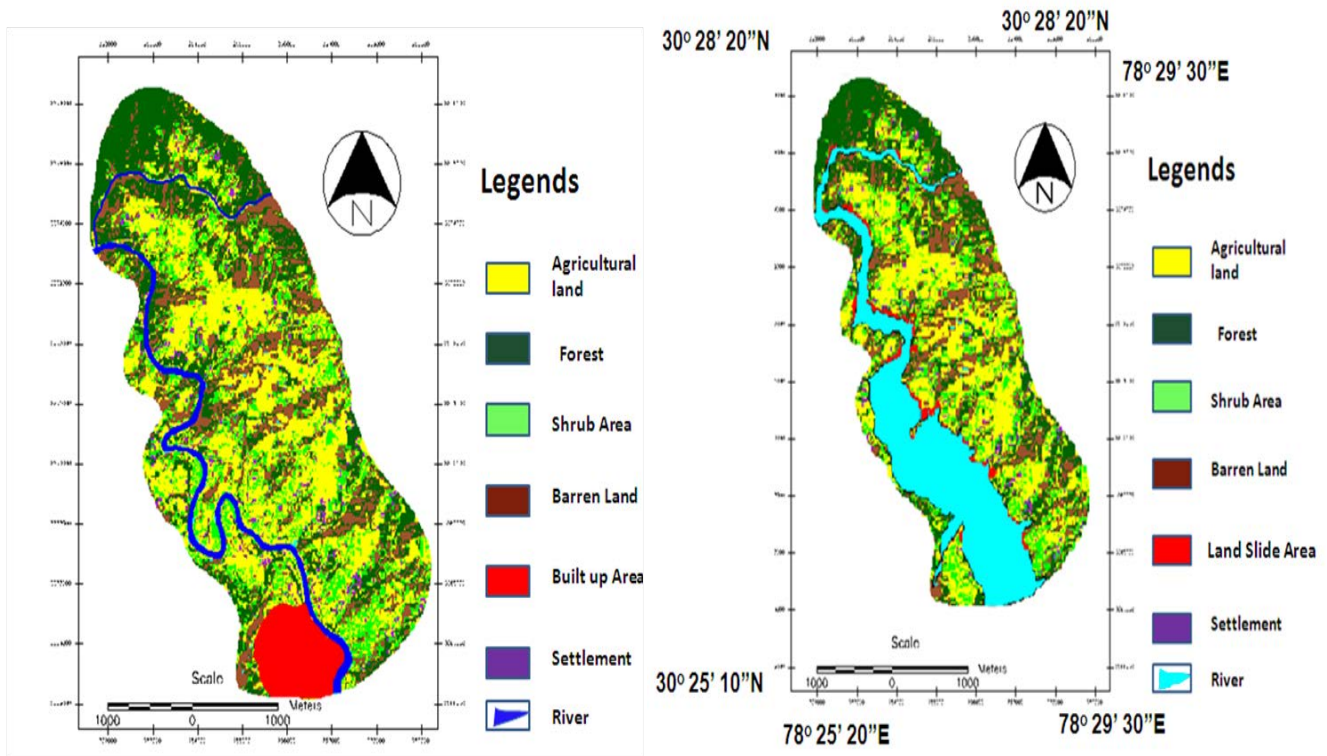


Figure: 3 Comparative land use /land cover map of the region.

Raulakot (66.92 acres), Kangsali (66.46 acres) and Motna (29.84 acre) have become most vulnerable to Landslides. Out of the selected villages, 4 villages namely Kangsali, Motna, Nakot, and Raulakot have completely altered their land use patterns ever since the dam came into existence. Further, 46 acres of rich forest tracts was also lost reducing it to 271.76 acres, where village Motna was most severely affected losing its 46 acres of community forest area as shown in Figure 4.

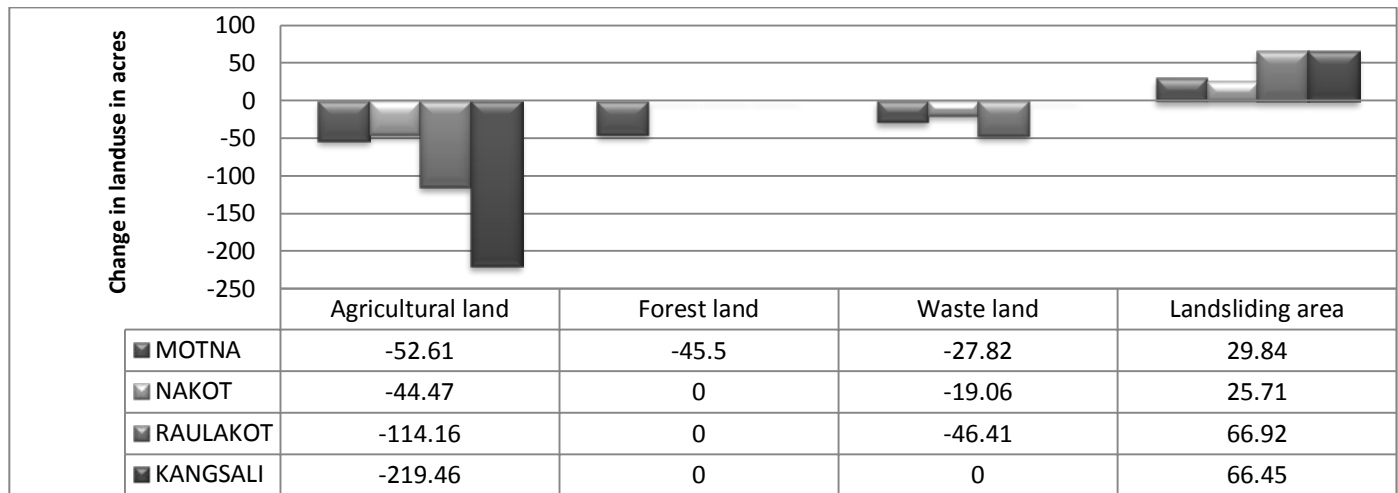


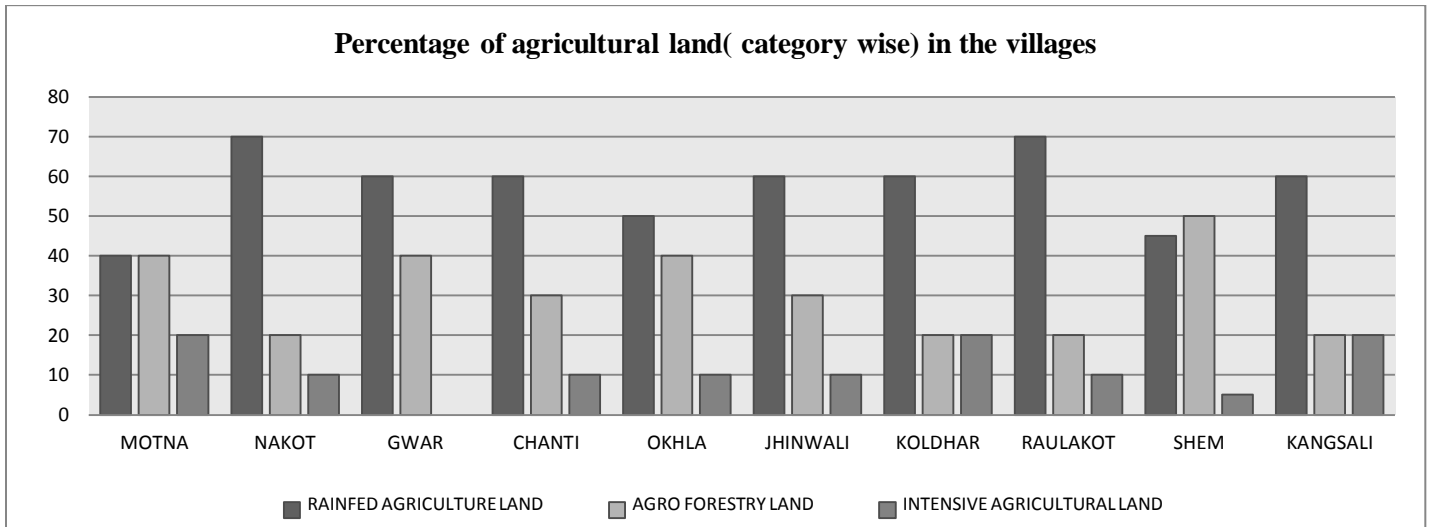
Figure: 4: Land use Changes in the 4 most affected villages.

**Agriculture and allied sectors:**

Agriculture and allied activities not only provide livelihoods to large sections of the Rim Area Villages population, but also form a pivotal part of their way of living. Environmental, biological, socio-cultural and economic factors prevailing in the region have resulted in the evolution of diverse agro ecosystems. Agriculture is the main occupation of the people of the region. Agriculture in these villages is mostly subsistence type and mainly practiced through terrace farming. Inaccessibility, environmental heterogeneity, ecological fragility and marginality have favored the evolution of subsistence production systems sustained with organic matter and nutrients derived from the forests, with the emphasis on optimizing productivity in the long term (Maikhuri *et al*, 1997, 2001b; Palni *et*



al, 1998). Village Wise Agriculture Land Categories in the study area are given in graph 5. The graph clearly reflects the dependency of agriculture on rain fed farming since 57% (average) of land area in this category. However the area under intensive agriculture with established irrigation systems constitute less than 11% (average) of agriculture lands in these villages. This reflects the dependency as well as the vulnerability of agricultural systems to climatic fluctuation. Traditional crop diversity holds the key of food security and sustainable agricultural development (Swaminathan 1984, 1986, 1991,1992, Maikhuri et al 1996). This huge diversity has been maintained through a variety of crop compositions, cropping patterns and crop rotations (Maikhuri et al 1997).



The Nature of traditional farming in the region illustrates the practice of *Barahnaja* i.e. sophisticated inter cropping (12 crops) system of rain fed hill farming. This practice is considered beneficial mainly because diverse canopies of a variety of crops help to check the soil erosion, minimize the weed growth and reduce competition for soil. *Mandua* (finger millets), *randana* (amaranthus), *rajma* (common beans), *ogal* (buckwheat), *urad* (green gram), *moong* (black gram), *naurangi* (mix of pulses), *gahath* (horsegram), *bhat* (soybean), *lobiya* (French beans) *kheera* (cucumber), and other crops are grown together in a mixture which is finely balanced to optimize productivity and maintenance of soil fertility, and is geared towards meeting diverse household requirements. However this practice is degrading fast because of changing land use dynamics in the region.

The change in Land use patterns and has negatively affected the production of seasonal crops grown in the region. Figure 5 & 6 represents the comparative output of major kharif and rabi crops grown in the villages. The sharp reduction in crop output is only able to meet the food demands of 3-4 months today from 8-9 months in 2005, It has therefore increased the dependency of people on government owned public food distribution shops, further reducing the agricultural prospects in the region.

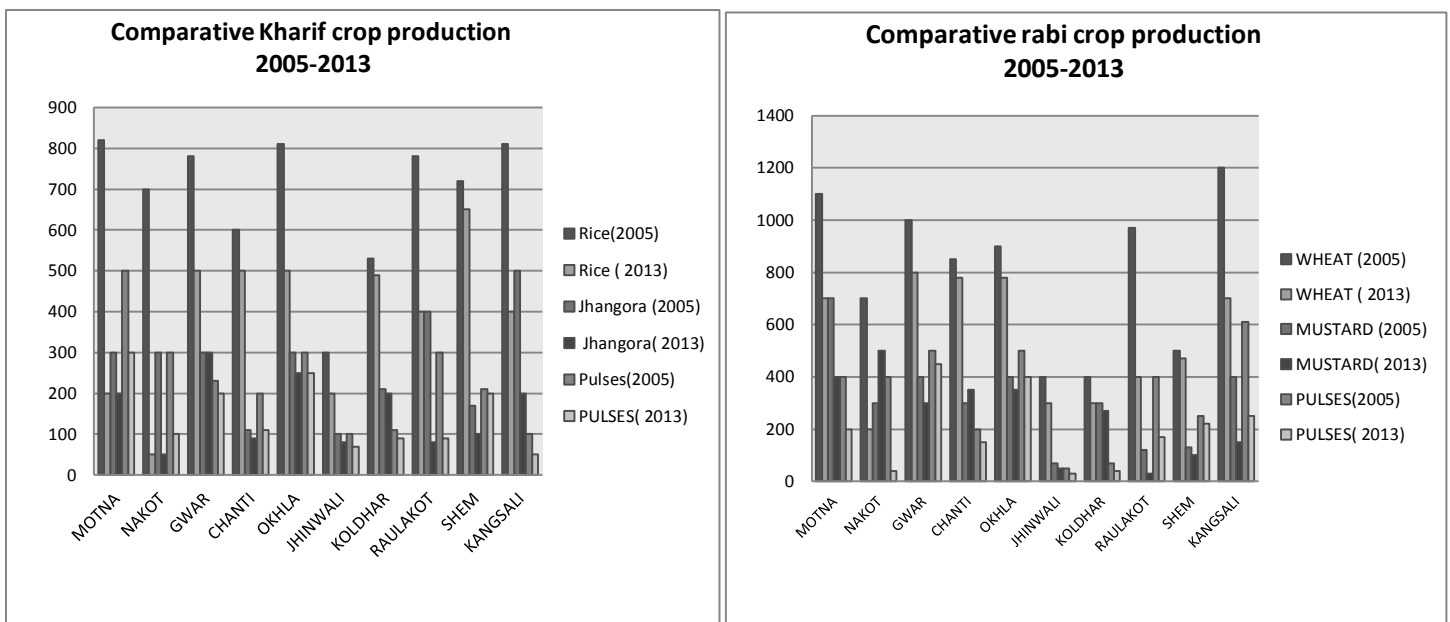


Figure 5&6

**Agro Forestry: Linking agriculture and animal husbandry**

Traditional agro-ecosystems in the region combine various crops, animal husbandry and forest resources, which constitutes complex, interlinked and stable production systems. An indigenous agro-forestry system not only supports the livelihood through production of food, fodder and firewood but also mitigates the impact of climate change through carbon sequestration (Pandey 2002, 2007). In the agro-forestry system, the soil is enriched through continuous biomass flow (bedding material in the animal sheds, fodder and mulch material from the surrounding forest areas. The system of tree grown in combination with agriculture needs to be maintained, especially in the hills to maintain land stability and reduce soil erosion. Traditionally, the hill farmers have maintained close linkages and balances between agriculture, forestry and animal husbandry, and based on these linkages the land use patterns have been determined in the area. Some 20 years ago, about 76% of the human population was reliant for livelihood on 21% of land suitable for agriculture in the Garhwal hills (Dadhwal et al. 1989).

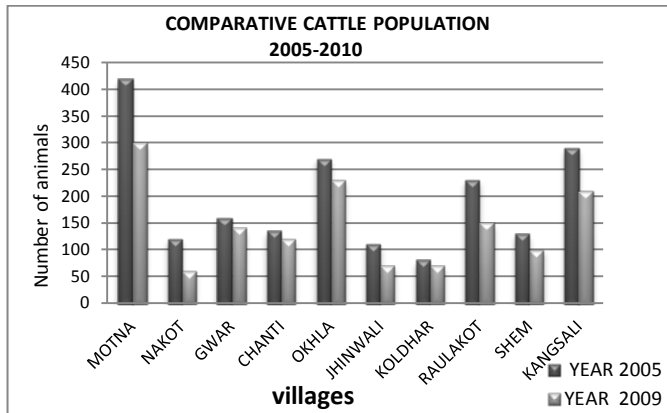


Figure: 7

However, several factors including the continuous shortage of water over the years have severely impacted the traditional cropping systems. Degrading forest and water resources in the region have not only affected agriculture in the region but also significantly reduced the number of cattle population. The worst affected villages being Motna, Okhla and Kangsali where inundation of community forest (the primary source of fodder) have reduced the availability of fodder, resulting into sharp decline of cattle population between 2005-2010. (clearly shown in Figure 7)

**Livelihood pattern:**

The livelihood of people was highly dependent on the agriculture practices in the lower slopes of Bhagirathi river valley. These regions with fertile, well irrigated soil are referred to as “Talon” locally. However much of the area (almost 60% of it has been subjected to submergence post dam construction. Which has severely affected the food security, availability and livelihood of people in these villages. But, Subsistence Agriculture with terrace farming yet remains the predominant activity of the villages even though most of their fertile lands have been lost. Most of the villages are bound to shift their agriculture to the less fertile agricultural patches called *Upraon* (mid valley rugged slopes) and *Katil* (narrow fields located on high spurs). These regions do not have abundant supply of water for irrigation and are mostly rain fed which has significantly changed the crop intensity, cropping pattern, and production. The practice of ‘Baranaja’ (growing 12 crops in a year) was previously predominant in the area because of fertile, well irrigated soil, which has significantly reduced to 2-3 crops in a year now. Further, local products had good market in the nearby old Tehri town, which drowned completely after 2006, eroding the economic base for many villages affecting their daily livelihood. The economic instability has forced people to migrate other areas for better livelihood opportunities.

**Traditional livelihood systems:**

The reservoir has also resulted in disruption and alteration of road networks, transportation systems affecting the accessibility of people to their nearest market centre, which has given a big blow to existing traditional livelihood practices other than agriculture.

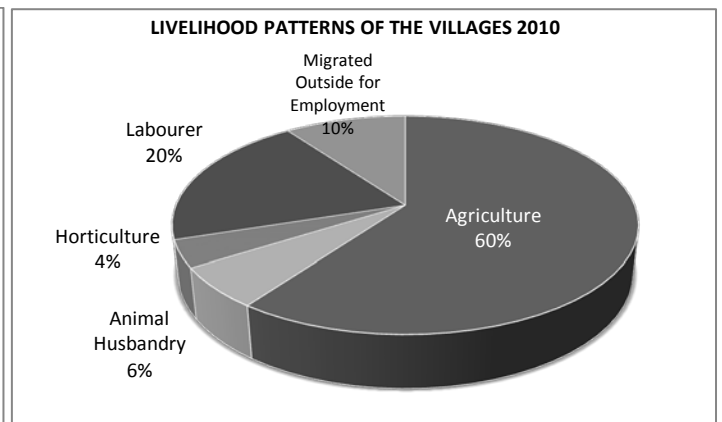
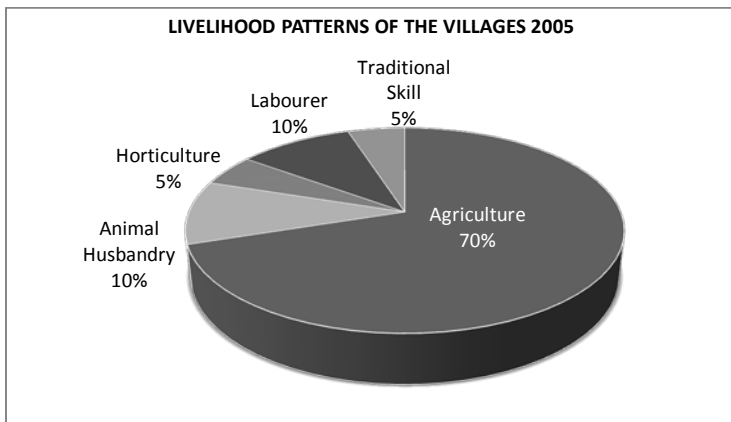


Figure: 8 & 9 represents the differences in dominant livelihood practices in these villages before and after the construction of dam.

The sudden collapse of socio economic systems have given people less choice than to migrate. The distance to closest urban centre has increased 3 times from 20 kms to 80 kms reducing the livelihood opportunities which were previously available. Severely affected people are Landless labourers of Motna, Chaundhar, Gwar, Raulakot, Kangsali villages who practiced transportation (by mules and horses) of local goods like building material from river bank.

## V. ADAPTATION PRACTICES FOR SUSTAINABLE LIVELIHOOD

Realizing the vast potential of the region to regenerate itself, deliberate resource management activities have been started in the region with the collaborative efforts of the local people, community based organisations, non- governmental organization, THDC, and state government. Numerous action oriented research programmes involving the villagers have been taken up by various governmental and non governmental agencies. Preparing village resource inventories, village resource maps, training of individuals to take up various agriculture allied activities, non farming activities etc have emerged as major component of the community restoration programmes. All the collaborative efforts in the area have been functional under one umbrella term called Community Based Natural Resource Management (CBNRM), where in people are collaboratively participating.

**CBNRM** is seen as a comprehensive tool to facilitate Capacity building, training and community mobilization, so as to sensitize them to participate in conservation and management of their own local natural resources for long term socio economic and environmental stability. Analyzing the change in resource patterns and current availability of resources in the region (physical and human) certain adaptation practices under CBNRM have been adopted by the villagers for better livelihood which includes:

**Off seasonal vegetation cultivation:** During the study 4 out of 10 villages were growing vegetables since 3 years, which has provide them with better employment, economic stability and resistance against harsh natural vagaries which affect general agriculture pattern in the region, in order to adapt themselves to the given condition they have altered the cropping pattern by switching on to vegetable cultivation.

**Organic Farming through Vermi Compost** In order to maintain their livelihood people still practice agriculture in the *Upraon* region although the land is less fertile than *Talon*. Therefore in order to upgrade and restore the fertility of land new methods of organic farming through Vermi compost have been adopted in many villages. It has emerged as an important technique which has helped farmers to revive their traditional agriculture patterns.

**Cultivation of medicinal/ornamental plants:** It was also observed that under various action research programmes promoting cultivation of medicinal plant/ornamental plants has also been taken up as pilot projects in kangsali, Motna etc to diversify economic activities in the region.

**Fodder plantation:** Considering the close linkage between agriculture and animal husbandry, high quality fodder grasses '*Napier*' have been planted in the villages to sustain cattle population as well as to maintain soil quality.

**Micro Water shed management :** The growing problem of water crisis in the region, and increasing incidences of seasonal landslides, reducing soil moisture have reiterated the need for adopting water shed management techniques. Scientific, technical experts and local people have come together in sharing technical expertise along with the villagers, in identifying the conservation sites, in construction of *chaal khaals*, check dams, water harvesting pits etc.

**Promotion of nonfarm activities** like poultry, Sericulture, Animal Husbandry, Bee keeping, Eco tourism, Fisheries are also seen potential sectors of growth in the region for diversification and stabilization of rural economic base in the region.

**Community mobilization through CBO networking and training:** The mobilization of local community is considered as the best way of natural resource conservation henceforth the natural resource inventories are being prepared and shared with the villages so that they become aware of their assets and potential. Various SHG's and local groups are being trained for alternative economic activities.

## VI. CONCLUSION

The villages in rim area of Tehri dam in Pratapnagar block have no doubt under gone tremendous physical, socio economic alteration due to construction of Mega dam structure. The dam has not only altered the land use dynamics of the region but has also degraded the local environment. Such changes are manifested by growing shortage of natural resources, (water, land, climate) etc, and increasing environmental hazards ( landslides, flash floods etc). The flourished traditional agriculture once is now degrading fast affecting the livelihood of people and forcing them to migrate. However the most prudent solution to this situation is collaborative efforts of all the stakeholders, with predefined roles to play. Realizing the untapped natural resource potential of the area and efficiently collaborating it with modern systems of Community based natural resource management remains a goal as well as challenge for achieving holistic regional development. Role of action oriented research have recently been realized for such areas where quick response is required for crisis management. The only way for revival of socio economic strength of the region lies in sensitizing local communities to adapt for better living practices in given scenario.

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