A Final Report

On

"The Alaknanda Basin (Uttarakhand Himalaya): A Study on Enhancing and Diversifying Livelihood Options in an Ecologically Fragile Mountain Terrain"

Under the Scheme of

General Fellowship

Submitted to

Indian Council of Social Science Research
Aruna Asaf Ali Marg
JNU Institutional Area
New Delhi

By

Vishwambhar Prasad Sati, Ph. D.
General Fellow, ICSSR, New Delhi
Department of Geography
HNB Garhwal University
Srinagar Garhwal, Uttarakhand
E-mail: vishwambhar.sati@yahoo.com

ABBREVIATIONS

- **AEZ-** Agri Export Zones
- **APEDA-** Agriculture and Processed food products Development Authority
- **ARB-** Alaknanda River Basin
- **BDF-** Bhararisen Dairy Farm
- **CDPCUL-** Chamoli District Dairy Production Cooperative Union Limited
- **FAO-** Food and Agricultural Organization
- **FDA-** Forest Development Agency
- **GBPIHED-** Govind Ballabh Pant Institute of Himalayan Environment and Development
- **H and MP-** Herbs and Medicinal Plants
- **HAPPRC-** High Altitude Plant Physiology Center
- **HDR-** Human Development Report
- **HDRI-** Herbal Research and Development Institute
- **HMS-** Himalayan Mountain System
- **ICAR-** Indian Council of Agricultural Research
- **ICIMOD-** International Center of Integrated Mountain and Development
- **ICSSR-** Indian Council of Social Science Research LSI- Livelihood Sustainability Index
- **IDD-** Iodine Deficiency Disorder
- **IMDP-** Intensive Mini Dairy Project
- **JMS-** Journal of Mountain Science
- **MPCA-** Medicinal Plant Conservation Area
- **MRD-** Mountain Research and Development
- **NAGI-** National Association of Geographers, India
- **NAP-** National Afforestation Programme
- **NORAD-** Norway Research and Development
- **NSP-** Nauti Sub-Projects
- **NTFP-** Non-Timber Forest Products
- **PIB-** Public Investment Board
- **PRA-** Participatory Rural Appraisal
- **SC-** Scheduled Caste
- **ST-** Scheduled Tribes
- **TF-** Terraced Farmland
- **ULDB-** Uttarakhand Livestock Development Board
- **UTDB-** Uttarakhand Tea Development Board
- **VFDC-** Village Forest Development Committee
- **VFDC-** Valley Flower Development Corporation

GLOSSARY

Agriculture: the occupation, business, or science of cultivating the land, producing crops, and raising livestock

Agronomy: The science of soil management, land cultivation, and crop production

Bugyal: Bugyal is a nomenclature for alpine meadows

Cash crops: A crop grown for direct sale rather than personal consumption

Danda: Highland forested land

Diversification: The provision or development of greater variety

Ecology: The study of the relationships and interactions between living organisms and their natural or developed environment

Emigration: The act of leaving a native country to live in another country

Enhancement: To improve or add to the strength, worth, beauty, or other desirable quality of something

Fragile: easy to break, damage, or harm, usually because delicate or brittle

Gad and Gadhera: Gad and Gadhera is synonym to stream

Gangar: Lowland residential area

Immigration: The act of people entering into a new country to settle permanently

Khet and Bari: Synonym to agricultural fields

Livelihood: Work done to earn a living or whatever provides a source of income

Niche: Any recess or hollow, such as in a rock formation

Off-season: A time of year when activity or business is at a low level

Sectoral: A component of an integrated system such as an economy or a society

EXECUTIVE SUMMARY

Enhancing and diversifying livelihood options in the mountain regions need attention in the wake of framing an integral strategy for coping with physical hazards and food insecurity. It must also seek ways to improve livelihood and generate economic growth through which increased security- physical, economic, and social- can be obtained. The populace of the mountain regions is fully depended on the mixed agriculture systems, which include farming of subsistence cereal crops and animal husbandry for their livelihood. Low production and productivity (per ha yield), home consumption of produced materials, and limited access to market characterizes the systems. The potentials to avail sustainability through enhancing and diversifying livelihood options, within the context of vulnerability and fragility of mountain terrain, has largely been untapped by mountain residents. Thus, the phenomenon of poverty, food insecurity, and malnutrition is common. In addition, dependency on forest resource for firewood and fodder and population pressure on the mountain niche is high, which is leading for severe environmental degradation. Most of the mountain areas have not been able to adequate harness their unique resources to improve mountain livelihoods because of inadequate and unfavourable policies towards mountains. Harnessing mountain niches appropriately through better management of natural resources and application of technologies and new methods of production and exchange do generate employment and income opportunities in the mountains. However, the cultivation of off-season vegetables, fruits, medicinal plants, and appropriate use of non-timber based forest products and the other unique resources of the mountains demonstrate their high potential to provide viable bases for households to rise above poverty and subsistence.

In mountain areas, livelihood options are often linked to a range of economic activities, products, and productivity of cereal farming, the natural assets of mountains, as well as economic and human assets. Harnessing mountain resources for hydropower and tourism development and for the production of food and non-food products for urban centers and conserving resources to generate valuable environmental services, among others, can create new employment and income opportunities in these areas. Human resource development, on the other hand, is vital for all round development of the mountain regions. The hill farming system is complex and crop production, animal husbandry, and forestry are intricately linked. They simultaneously determine the living standards of the farm families, income, and employment levels, as well as affect their surrounding environment. Forestlands provide fuel wood, fodder, and timber. Croplands provide food, fodder, and crop residue. However, croplands also require manure, which is available from cow dung and litter from forestlands. Thus, livestock connect these land resources by converting fodder into drought power and dung nutrient, in addition to providing food and income to households.

Large parts of the basin are still isolated pockets and located in remote areas, which are insulated from market forces. Transport network and communication facilities have not reached many parts of the basin. Movement of the people and farm products to urban centers is difficult. Tourism can play an important role in some the picturesque areas of the basin. Development of educational facilities is a major aspect, which will surely lead a way for overall development. Similarly, installation of micro-hydro power projects will provide power for ropeways, which are very useful to cope with transportation problems, particularly with road transportation. It is major assumption of this study that enhancing and diversifying livelihood options may increase the food security among the households.

Global changes can be noticed everywhere in mountain regions. Population increased manifolds. The changes in farming systems have been observed apparently. The cereal crop farming was not enough to meet the increasing food demands resulted in change in cultivation from millets to paddy and wheat. During the past, paddy and wheat was rarely sown but now it is very common food. It was observed that cultivation of wheat and paddy has increased production and food security as the people became self-reliant. Even today, a large proportion of sown area is devoted for paddy and wheat crops. The reality of climate change, particularly in the mountain regions, is required an appraisal of climate data for a century or more. Currently, the perception of all groups of society towards the impact of climate change in mountain regions is parallel. The areas where intensive cultivation of apple fruit was carried out during the past are no more for its cultivation.

During the 1980s and 90s, a large-scale cultivation of fruits and off-season vegetables was carried out. The production of potato and onion tremendously got a momentum but it was reduced considerably and currently more land is devoted to paddy and wheat. The increasing trend of cultivating paddy and wheat shows its importance in cropping pattern. It does not need market because it is grown for self-reliant. Cash crops need market and other necessary facilities, which is seldom available in the region. Developmental intervention through government agencies needs a considerable policy framework. Crops diversity needs conserved but at the same time a considerable proportion of cultivable land has to be devoted for case crops. Both situations are favourable for sustainable livelihood.

For the centuries, the local people are practicing different systems of cultivation in this hilly region as trial and error. No doubt, sustainability in livelihood has been achieved to a certain extend but hard working nature, particularly of women is still prevailed. In the highlands, development of infrastructural facilities could not take place. The people are struggling for basic needs of food, cloth, and shelter. Many studies have been carried out by the researchers and academicians so far for enhancing and diversifying livelihood options. The government has also initiated people's supportive programmes for speedy development and welfare of the local people. Earlier, all segments of society have the perceptions that due to the uniqueness of the region and its ruling from a large state, development formulas could not be fitted and then struggle was started for a separate state. Finally in 2000, a part of the hilly region as Uttarakhand State was carved out. Eight years have been gone and nothing has been done.

Institution involvement in terms of encouraging farmers to cultivate certain cash crops e.g. herbs and providing them financial assistance, insurance of their crops at the time of crop failure, and prepaid cash of their crops. Government initiatives for any development programmes have the multiple impacts on the area or region particularly at the situation, when the government has to control over entire affairs of the state. The impacts may be negative or positive depending upon the degree of involvement and rationale of planning. Political instability and lacking in involvement towards development planning further deteriorates the aspect of livelihood. Lacking in proper marketing remains a major hurdle for the growers of various cash crops. Farmers do not get even their returns. Infrastructural facilities as transportation and cold storages are slackened. In many occasions, the products do not sold out. The villages, where the agro-ecological conditions are suitable for growing cash crops are inaccessible. Farmers intend to grow them extensively. Smooth marketing will be a base for growing cash crops.

PREFACE

Diversifying and enhancing livelihood options for reducing poverty and securing livelihood is an essential activity. It has greater relevance in the areas where subsistence economy dominates. About 70% of the world economy is based upon the cultivation of subsistence cereal crops. This practice is a major characteristic feature of the developing countries.

Mountain constitutes about 20% of the total Earth land-surface with underdeveloped economy. Agriculture is carried out in the narrow and terraced fields. Cultivation of subsistence cereals dominates the cropping pattern. Production and per ha yield of corps is considerably low. It does not meet even two times food requirements of the poor marginal farmers. The Alaknanda basin constitutes one of the major sub-systems of the Ganges. It has four vertical zones from the valley regions to highly elevated Himalayan ranges i.e., sub-tropical, sub-temperate, temperate, and alpine. Human interaction is limited upto to the temperate zones.

Intensive agricultural activities are carried out on the niches of the mid-altitudes and highlands. In the valley regions, wherever terraced fields are found, an agriculture practice is done. Suitability in agro-ecological conditions for growing cash generating crops; fruits and off-season vegetables in particular, presents a way for sustainable development of the region. Similarly, presence of dense forest with high diversity manifests a way for diversifying livelihood. Multiple uses of timber and non-timber forest products such as bees and bee keeping, natural dyes, bamboo and bamboo based products, herbs, wild fruits and its products- juice, jams, morrabba etc., oak bark and its products and number of other products can enhance the livelihood of the people.

I felt a need to carry out a precise study on the sustainable livelihood in the Uttarakhand Himalaya. The Alaknanda basin was selected as a case study area. A research proposal was submitted to Indian Council of Social Science Research New Delhi under 'General Fellowship Scheme'. The present study was carried out under such scheme and commenced at the Department of Geography, HNB Garhwal University, Srinagar Garhwal, Uttarakhand, India. The main purpose of the study is to find out the options for diversifying and enhancing livelihood under the rich geo-environmental and agro-ecological conditions.

The study reveals that the Alaknanda basin has tremendous scope of sustainable livelihood. Development of infrastructural facilities and quality education is the key of development. Government intervention for development activities and community participation together will assist for implementation of policies and planning. All matter from production to marketing of products should be given in the hand of community people.

Vishwambhar Prasad Sati

ACKNOWLEDGEMENT

This study is an output of *'General Fellowship'* scheme of the Indian Council of Social Science Research, New Delhi. It was commenced at the Department of Geography, HNB Garhwal University, Srinagar Garhwal, Uttarakhand. I acknowledge my sincere thanks to the Indian Council of Social Science Research, New Delhi for awarding me 'General Fellowship'. I am obligated to Dr. G. S. Saun and Dr. Sara John for their valuable assistance from time to time. Similarly, I acknowledge my gratitude to the Vice Chancellor, Registrar, and Department of Geography, HNB Garhwal University for providing me necessary facilities to commence this project.

I am greatly thankful of the Head, Department of Geography Prof. D. D. Maithani for his sincere guidance. I had a comprehensive discussion on the issues of sustainable livelihood with Prof. Kamlesh Kumar, retired Professor of Geography. I thank him very much. I acknowledge my gratitude to Dr. I. K. Mansoori, Deputy Registrar, Jiwaji University, Gwalior, Madhya Pradesh for his sincere assistance from time to time. I tender my thanks to Dr. M. S. Negi who help me during my field visit. I am grateful of the GBP Institute of Himalayan Environment and Development especially of Dr. Maikhuri for his valuable suggestions. The faculty members of the Department of Geography- Prof. R. S. Panwar, Prof. M. S. S. Rawat, Dr. M. S. Panwar, Dr. B. P. Naithani, and Dr. Lakhera are greatly thankful.

I am thankful of the people of Khanda Gad and Kewer Gadhera villages who provided precise information about their livelihood through interview and questionnaire. The extension workers of the various departments working in the field of agriculture, horticulture, and other related departments are equally thankful for providing me valuable information. I had a wide discussion with the experts of various departments regarding sustainability of livelihood. I am thankful of them. I am thankful of statistical departments of Chamoli and Pauri districts for providing secondary data on land use and population. It will be unwise, if I will not mention the contribution extended by my family member wife Nirmala and daughter Vishwani. They allow me to join the Garhwal University while they were staying at Shivpuri, Madhya Pradesh. I am also grateful of my elder sister Mrs. Rajeshwari Kanti and brother in law Sh. Girdhar Prasad Kanti for helping me a lot. I am also thankful of Sh. Bhagwati Prasad Sharma, who assisted me during field visit.

In the last but not the least, I dedicate this work to my parents- mother late Smt. Saradi Devi and Father late Shri Shiv Dutt Sati and those working for the welfare of mountain people.

Vishwambhar Prasad Sati

LIST OF TABLES

Table 6.10: Land Use/Cover Changes in Cluster of Villages in Kewer Gadhera Sub-Watershed between 1971* and 2007**

Table 6.11: Employment Status, Farming Community, and Emigration

LIST OF FIGURES

LIST OF ILLUSTRATIONS

Photo 35: Bottle packed Orange and Buransh juice is processed through small-scale entrepreneur with local people participation
Photo 36: Geranium, an herbal grown in poly house in a bio-village near Gwaldom town
Photo 37: A newly established tea garden in Kalimati village
Photo 38: A highland natural pond using for fisheries in Gwaldom town
Photo 39: Women are being empowered slowly but steady after involving with various enterprises. This woman of Khanda Gad village is fully involved in enhancing livelihood.
Photo 40: A small-hydropower project with 2x2.5 mw capacity in the Kail Ganga near Deval

"The Alaknanda Basin (Uttaranchal Himalaya): A Study on Enhancing and Diversifying Livelihood Options in an Ecologically Fragile Mountain Terrain"

CONTENTS

INTRODUCTION

Enhancing and diversifying livelihood options in the mountain regions need attention in the wake of framing an integral strategy for coping with physical hazards and food insecurity. It must also seek ways to improve livelihood and generate economic growth through which increased security- physical, economic, and social- can be obtained. The populace of the mountain regions is fully depended on the mixed agriculture systems, which include farming of subsistence cereal crops and animal husbandry for their livelihood. Low production and productivity (per ha yield), home consumption of produced materials, and limited access to market characterizes the systems. The potentials to avail sustainability through enhancing and diversifying livelihood options, within the context of vulnerability and fragility of mountain terrain, has largely been untapped by mountain residents. Thus, the phenomenon of poverty, food insecurity, and malnutrition is common. In addition, dependency on forest resource for firewood and fodder and population pressure on the mountain niche is high, which is leading for severe environmental degradation.

Most of the mountain areas have not been able to adequate harness their unique resources to improve mountain livelihoods because of inadequate and unfavourable policies towards mountains. Harnessing mountain niches appropriately through better management of natural resources and application of technologies and new methods of production and exchange do generate employment and income opportunities in the mountains. However, the cultivation of off-season vegetables, fruits, medicinal plants, and appropriate use of non-timber based forest products and the other unique resources of the mountains demonstrate their high potential to provide viable bases for households to rise above poverty and subsistence.

In mountain areas, livelihood options are often linked to a range of economic activities, products, and productivity of cereal farming, the natural assets of mountains, as well as economic and human assets. Harnessing mountain resources for hydroelectricity and tourism development and for the production of food and non-food products for urban centers and conserving resources to generate valuable environmental services, among others, can create new employment and income opportunities in these areas. Human resource development, on the other hand, is vital for all round development of the mountain regions.

Agriculture and its associated activities continued to have been forming the economic base. It is a major source for providing employment opportunities to the rural labour force. For the past several centuries, agriculture practices have been becoming avenues of income - sustaining the livelihood of rural households in India. Over the years, unprecedented increasing trend of population pressure on land both for employment and livelihood has returned in an ever declining rate of land-man ratio. Further, increasing fragmentation of agricultural holdings and inequalities in the distribution of arable land or cultivation among farming households, have caused decline in per household income from farming system. Despite increasing application of labour saving farm production technologies, the agriculture sector would hardly be in position either to provide gainful employment opportunities at the pace with increasing workforce or to sustain the livelihood of rural households.

Carrying out a large scale diversification and modernization of economic system through initiating industrialization and large scale production system is severely limited in hilly and mountainous areas because of a number of factors such as the availability situation of limited environmentally sensitive resource base, the spread of usable resources across different and inaccessible areas, inaccessibility to markets and modern inputs and

technology, deficient infrastructure and high transport costs leading to non-competitiveness of products (Mehta, 1966).

Statement of Problems and the Area

The Alaknanda Basin lies in the center of Himalayan Mountain System (HMS). It is one of the richest regions in terms of biodiversity resources and poorest in respect of economy and development. The livelihood of the people depends heavily on the biomass-based production and natural resources such as forest, grassland, and fresh water. Agriculture is based upon the centuries old practices, which are carried out mainly on the narrow patches of terraced fields. It is characterized by the dominance of subsistence cereal farming, which is the main occupation of the populace. Rice, wheat, barley, millets, oilseeds, and pulses are the main cereal crops. The economic viability of these crops is insufficient even to meet the daily requirement. The scope of modernization and expansion of agricultural crops is just negligible. Fragility of the terrain further minimized the scope of implementation of modern innovation. Mounting pressure of human population on the land and high man-land ratio compelled the farmers for land abundant. This process led to low fertility of soil and degradation of land. Apart from adverse climatic stress, increased human population and the insatiable demand for more natural resources including land, forest, and food are major factors contributing to natural resources depletion and losses in biodiversity (Arimoro et al. 2002; Okali 1985). Furthermore, inaccessibility and the low level of infra-structural facilities are significant constraints to generating opportunities. As a result, the resources of the region have remained grossly underutilized and undervalued. These circumstances manifested a way for poverty, malnutrition, and food scarcity. Coping with these severe impediments, exodus of the people out-migrated in the foothills of Himalaya and Ganges plain and it became a common phenomenon. There are instances in Garhwal Himalaya where about 3/4 of the total families in a village migrated out during the period 1972-88 (Maikhuri et al. 1995). Unsustainability of agriculture and lack of other economic opportunities together with higher literacy rate in the hill region lead to very high rate of out migration of the youth in search of jobs (Khanka 1984).

In the Alaknanda Basin, the impediments related with the development processes are not only due to the adverse geo-environmental conditions, but also due to the policies and planning framed by various governments (State and Central) based institutes and departments. Lack of systematic planning was accentuated by inadequate and improper coordination between different governmental departments involved in the different stages of development programmes. These programmes include scanty attention to the need for and requirements of various infra-structural facilities for sectoral scheme, inefficiency of the administration in the implementation of programmes, a multiplicity of programmes to meet the same goals, and faulty criteria for identifying beneficiaries in assistance linked to employment generation (Mehta 1990).

The landscape, geo-environmental conditions, and availability of natural resources have heterogeneity in all respect and can be reflected on the agrarian system, occupation, working potential, and migration. Less-availability of agricultural land and harsh environmental conditions including temperature and rainfall, inaccessibility of forestland, and instability of terrain are other aspects, which affect the livelihood of the Himalayan people (Sati and Kumar 2004a). With increasing needs as well as pressure of population, the traditional farming has become unsustainable both economically and ecologically (ICIMOD 1996). Bhatt and Bhatt (1992) have perceived the threat of increasing pressure on land in Garhwal region. The human pressure on land increases extensive tracts of U.P., slopes are put under plough, fertile lands are reduced, and the food becomes scarce. Adaptive responses to stress factors by farmers (Scott & Walter 1993) played a significant

role in evolution of traditional agriculture in the past when farming was the only option for securing livelihood. Further, expansion of agriculture on marginal land and declining crop yields are considered to be major unsustainable trends in the Himalaya (Eckholm 1979; Jodha 1990).

Horticulture including cultivation of fruits and off-season vegetables will play a major role for determining the economic development of the region (Sati 2004). The present vegetable production of 90.8 million tones (ICAR 2002) is to be raised to 250 million tones by 2024-2025. Promotion of protected cultivation of vegetable, according to Singh (1998) and Singh et al. (1999) is another potential approach. There are different ways and means to achieve this target, e.g., bringing additional area under vegetable crops, using hybrid seeds, use of improved agro-techniques. A cultivable wasteland may have potential for the development of horticulture, where the uncultivable wastelands do not have such potential (Singh 1991). In addition, non-timber forest products such as medicinal plants and herbs, essential oils, fibers and silks, natural dyes and organic products, bamboo and bamboo products, bee and bee products, and enterprise-based pollination services can provide the bases for increasing incomes and improving livelihoods. It is the common experience that the ecological conditions of the regions are more suited to fruit cultivation rather than cereal farming (Atkinson 1889 a). Along with cultivation of fruits, off-season vegetables, and tea cultivation will boost up the regional economy (Sati and Kumar 2004b). In the Alaknanda Basin from the valley region to the north border, sub-tropical humid and bio-climatic conditions change step by step in to temperate, sub-temperate and alpine zones (Atkinson 1889 b), which are very useful for the cultivation of fruits and vegetables. Likewise, mountain tourism, hydroelectricity, and other renewable energy sources may be the tool for enhancing livelihood. These niche-based mountain products and services hold some of the keys for helping mountain people, diversity, and enhance their livelihood options while reducing pressure on traditional occupation and the environment.

The development process must also ensure that communities, especially disadvantaged groups, women and geographically excluded areas are not left out of mainstream development. Mountain areas are highly diverse in renewable natural resources and environmental services. The diversity is helping reduce internal competition in mountain areas and partially offsetting the physical vulnerability of the fragile mountain environment. It requires a highly decentralized areas-based approach (Papola 1996 b), which has to be distinct not only from approaches for the plains, but should also differ significantly from area to area within the hill region. The mountains' biodiversity provides important values of agriculture, medicine, food security and industry, besides spiritual, cultural and aesthetic, and recreational values. In order to meet the present and future challenges meeting sustainability criteria, the traditional systems need to be adapted in ways which enhance crop yields but not at the environmental and social costs (Ramakrishnan et al. 1993).

The Alaknanda Basin is extended between 30° 0' N-31° 0' N and 78° 45' E - 80° 0' E, covering an area of about 10882 Km^2, represents the eastern part of the Garhwal Himalaya. Out of the total area of the basin, 433 km^2 is under glacier landscape and rest of 288 km^2 under fluvial landscape. The total number of villages is approximately 2310. The land under agriculture is 644.22 Km^2, which is 5.9 percent of the total geographical area while only 64.8 Km^2 (0.6%) land is under horticultural crops.

Relevance of Available Literature

Diversification of livelihoods is becoming a prime concern in the wake of food security and poverty reduction. A number of different sustainable livelihood approaches have emerged (Ashley and Carley, 1999) but most rely on analytical framework which owe a significant to

the version developed by the IDS sustainable livelihood programmes (Scoones, 1998) and subsequently adopted in slightly modified from by the UK Department for International Development. Rural Livelihoods Department of the UK Department for International Development is funding four parallel studies between 2000 and 2003 to identify how the livelihoods of the rural poor can be enhanced. These are located in southern and eastern Africa and in South Asia. The studies aim to identify innovative ways of enhancing livelihoods, and to promote exchange of experience among donors and governments across the regions. One of the four studies, conducted by the London-based Overseas Development Institute is concerned with livelihood options.

Studies have stressed that the traditionally emphasized determinants of production are not the only ones that are important. Reardon *et al.* (1994 and 1995) have stressed that in addition to these traditionally emphasized determinants of productivity and capital investments important are non-farm income, soil conservation investments and market infrastructure improvements. Similarly, Guyer and Lambin (1993) have noted that agricultural practice is developing in dynamic fashion in advance of population pressure, largely due to market responses. Schelhas (1996); Roumasset *et al.* (1979) have suggested that risk, and the perception of risk, is a key factor influencing the nature and timing of intensification and diversification decisions. A recent study of the evolution of commercial vegetable gardening from 1971-88 in the Philippines (Eder, 1991) found that there had been a two to three fold increase in labour invested per unit of land in gardening itself. Binswanger and Khandker (1993) have taken the latter point further in their examination of how financial institutions and interest rates determine investment, input and output decisions in India. The importance of understanding the broader political and economic issues to explain the presence (or absence) of sustainable livelihoods has been highlighted by a number of studies. For example, Conelly (1994) sought to explain why farmers on Rusinga Island in Kenya have abandoned intensive agricultural practices. Similarly, in Usagara, Tanzania a change from cotton to rice, and the increased use of manure as fertilizer, can be explained in part by the changing factor prices, related to the removal of subsidies on fertilizers (ICRA 1990). Kelly *et al.* (1995) has observed that in Senegal the use of fertilizer has declined over the years of structural adjustment. A more recent study by Diagana and Kelly (1996) examines how the profitability of main crops has changed and affected the choice of crop mix and technology; and argues that devaluation has not encouraged farmers to sustainable patterns of intensification characterized by high fertilizer use.

The complex of ideas, principles and analytical tools, which has been labeled the sustainable livelihoods approach has acquired, and extraordinary prominence in developing thinking and activity with a very short time. Our understanding of livelihoods and poverty has undergone considerable change over the last few decades and this has implications for the way in which we define research and analyze these concepts. Walker and Ryan (1990) considered agricultural household economics in villages to enhance 'the understanding of the dynamics of agricultural development in one of the poorest rural regions of Asia'. In sub-Saharan Africa, this diversification is frequently interpreted as a response to the difficulties that poor households face in the context of structural adjustment and liberalization (Bryceson, 1999; Ellis, 1998, 2000). The ways in which households in India are responding to the processes of liberalization that began in the early 1990s are the subject of increasing debate and continue to be disputed (Meenakshi and Ray, 2002; Datt and Ravallion, 2002). Research elsewhere has shown that diversification is not necessarily a strategy pursued by poor people, nor is it just about coping. For some people it can help in mitigating risk or coping with vulnerability where risk remains high and in setting poor people on a cumulative path towards greater livelihood success (Davies, 1996). The above-cited studies explain about the intensification of agriculture for sustainable livelihoods and focus on the current trend of

diversification of agricultural crops. Likewise, many other studies are currently emphasizing on agricultural intensification, diversifying and enhancing livelihood options in worldwide.

HMS is one of the poorest regions of the world, which is inaccessible, remote, and far away from the main stream of development. Similarly, in terms of theoretical and practical research work, on the various aspects, it is lagged behind because very little work is done so far in this regard. Although, some noteworthy works have been done in the HMS in general and Garhwal Himalaya in particular on farming system, development aspects and natural resources management yet, the present study area (Alaknanda Basin) is still remained untouched for any specific and general study. Many scholars of the two universities, located in the region (Garhwal and Kumaon), and some research institutes such as 'Govind Ballabh Pant Institute of Himalayan Environment and Development' (GBPIHED) and 'High Altitude Plant Physiology Research Centre' (HAPPRC) presented a noteworthy contribution through various research projects and Ph. D. works. Kamlesh Kumar (1974) submitted a Ph. D. thesis in Meerut University entitled, "Study of Population Geography in Garhwal Himalaya". It is mainly confined to demography. Only the first chapter 'Geographical background' attempts the study of general resource pattern of the region. The study concluded that the populace of the region, by and large, migrated to the plains in search of job. K. C. Purohit (1974) did a precise study in his unpublished Ph. D. thesis entitled, 'Resource Utilization in Chamoli District, in which he specified the resources and their utilization pattern in the hills and emphasized the need to bring changes in the utilization pattern. Anita Sharma submitted a Ph.D. thesis in Garhwal University in 1989 on 'Population Geography of Chamoli District'. This study is too limited to demography and its components. Some noteworthy attempts have been made on the farming system, resource utilization pattern and development, and horticulture practices in the region by the present author. He submitted a Ph. D. thesis (1992) in Garhwal University on 'Horticultural Development in the Alaknanda Basin'. The basin was divided into several agro-climatic zones suitable for growing different types of fruits. An attempt was also made for regionalization of fruit cultivation in the basin, giving a way to manifest the development of horticulture. However, this thesis was too limited to horticulture and its development. Along with these thesises, some books are also carrying some relevant study on the region and its resources. Etkinson's (1882) 'Gazetteers of Himalayan District' and Walton's (1910) 'Gazetteer of Garhwal' carry information on contemporary states of flora, fauna and resource utilization. 'The Holy Himalaya- A Geographical Interpretation of Garhwal Himalaya' (1989) by Nitya Nand and Kamlesh Kumar is a great contribution on this region. The study deals geographical, historical, social and economic setting of the region. Suggestions were made after dividing the region into zones for speedy development. P. B. Saxena elaborated the agricultural resources and techniques, which are used in the field of agriculture in his book, 'The Alaknanda Basin, A Modern Approach in Geography' (1987). 'Agricultural Economy of Garhwal' a book written by R. Swarup (1993) described how the economy of Garhwal in influenced by subsistence cereal farming. This book further deals with the study of population, animal husbandry, agriculture, cropping pattern and crop rotation. Geological portion of the basin is described in K. S. Waldia's book, 'Geology of Garhwal'. 'Uttaranchal: Dilemma of Plenties and Scarcities' (2004) is written by the present author and Kamlesh Kumar, which is a noteworthy contribution in the field of evaluation of natural resources and their utilization pattern and strategic planning for speedy development of the Uttaranchal State. A book on "Horticultural Development in Hills: A Case for the Alaknanda Basin" (Ph. D. thesis of the present author) is also a noteworthy contribution. Some edited books covering resources, environment and development aspects of Himalaya by D.D. Maithani (1991) and M.S.S. Rawat (1993) have also contributed in the field.

Research papers on 'Problem of Agricultural Ecology and its Management in the Pindar Basin', 'Cropping Pattern in the Hill Environment of Garhwal Himalaya', 'Pattern of Resource Utilization and Development in Hills: A Case for the Pindar Basin of Garhwal Himalayan', Fruit Cultivation in Hills: A Case for the Alaknanda Basin', 'Vertical Zonation of Horticultural Farming in the Alaknanda Basin', 'Systems of Agricultural Farming in the Uttaranchal Himalaya', 'Natural Resource Conditions and Economic Development in the Uttaranchal Himalaya, and many other papers are published in peer reviewed International Journals and several leading research journal of India by the present author.

In terms of demonstration of practical works, there are many developmental agencies working in entire HMS. Since 1993, Govind Ballabh Pant Institute of Himalayan Environment and Development has been working in the Indian Himalayan Region along with many donor agencies of the world such as NORAD. After Chinese aggression of 1962, Govt. of India has initiated several developmental works. Now, motorable road have traversed Alaknanda Basin and infra-structural facilities are being developed. In the field of horticulture and herb culture, block mobile teams and tea garden nurseries have been set up in each and every block in the district. In the world wide, the two distinguish institutes, International Centre for Integrated Mountain Development (ICIMOD), Katmandu (Nepal) and Mountain Research and Development (MRD) are working in the field of development of fragile mountain system. Many other non-governmental organizations are also working and demonstrating the knowledge and ideas in the field of development of the region.

On the basis of the above review of literature, it becomes evident that despite of increasing volume of research works in Garhwal Himalaya, no specific work on the Alaknanda Basin has yet been initiated, more particularly on the sustainable livelihood options, food security, and resource development. This study presents a comprehensive picture on diversification of agriculture and livelihood option. It suggests details of policies and planning and their implementation in a rational manner.

Conceptual Framework

The hill farming system is complex and crop production, animal husbandry, and forestry are intricately linked. They simultaneously determine the living standards of the farm families, income, and employment levels, as well as affect their surrounding environment. Forestlands provide fuel wood, fodder, and timber. Croplands provide food, fodder, and crop residue. However, croplands also require manure, which is available from cow dung and litter from forestlands. Thus, livestock connect these land resources by converting fodder into drought power and dung nutrient, in addition to providing food and income to households.

Large parts of the basin are still isolated pockets and located in remote areas, which are insulated from market forces. Transport network and communication facilities have not reached many parts of the basin. Movement of the people and farm products to urban centers is difficult. Tourism can play an important role in some the picturesque areas of the basin. Development of educational facilities is a major aspect, which will surely lead a way for overall development. Similarly, installation of micro-hydro power projects will provide power for ropeways, which are very useful to cope with transportation problems, particularly with road transportation. It is major assumption of this study that enhancing and diversifying livelihood options may increase the food security among the households, which are facing the problems of existence.

The food demand of rural households depends on their dual functions, i.e., as households and as firms. As households, their demand depends on income, household size, and relative

prices, but unlike other consumers, their incomes also depend on changes in relative farm prices because these also change their farm income through crop supply functions. The present exercise limits itself to major food commodities cereals, cultivation of vegetables and fruits, livestock farming, and timber wood and non-timber forest products. The per capita domestic consumption of these food groups was derived from the total production adjusted for losses and seed allowances.

Murray (2001) derives the following 'principles' of livelihoods research.

1. Livelihoods research, of its nature, is essentially carried out at the micro-level: that of 'households' and 'communities'. It involves empirical investigation of combinations of modes of livelihood and, above all, of the relationships between them. It also involves pushing to the limit of their potential various methods of understanding changes that have taken place over time.

2. For research into changing livelihoods to be illuminating and useful, however, it is essential to define the structural, historical and institutional elements of what may for convenience be called its macro-context. A time-frame must be specified, key variables identified, important trends of change discerned.

3. In so far as livelihoods research is directed to the diagnosis of the causes of chronic poverty, the circumstances of poverty and the reasons for poverty should be understood through detailed analysis of social relations in a particular historical context. This implies a structural or relational view of poverty, and, in turn, that understanding of its 'persistence' or its intractability or its 'deepening' should be driven by questions about inequalities of power.

4. It also implies that livelihoods research and discussion of its implications for 'policy-making' should contain explicit reflection on the particular, relevant, contexts in which 'policy' is made, with reference to key questions such as the following. Who makes policy? How is it made? For what purposes? For whose benefit? With what outcomes?

Objectives of the Study

The basic objective of this study is to examine the livelihood options, other than the traditional farming system, in the Alaknanda Basin of Uttaranchal Himalaya. The main objectives are:

1. To assess the availability and suitability of non-timber based forest products, upon which the survival of the people may depend (medicinal plants and herbs, essential oils, fibers and silk, natural dyes and organic products, bees and bee products, housing and cash generating products).
2. To assess the viability of biomass based productions, other than subsistence cereal farming i.e., cultivation of off-season vegetables and fruits.
3. To examine potential of eco-tourism, hydroelectricity, other renewable energy sources, and development of educational facilities.
4. To find out a way for improving the productivity of subsistence cereal crops.
5. To develop valuation methodologies especially for natural systems that would bring increasing benefits to service providers.
6. To frame a draft for eco-development planning.

Research Questions

The following questions were raised during the study:

1. What are the major potential areas (livelihood options) and how will they contribute for sustainable development of this fragile landscape?
2. How will non-timber based forest products contribute in the development of the region?
3. What would be the role of off-season vegetables and fruit cultivation?
4. How can eco-tourism, small-scale hydroelectricity plants, other renewable based energy sources, and development of educational facilities enhance the livelihood?
5. What would be the modern innovations for enhancing productivity of subsistence cereal crops keeping the fragility of terrain in view?
6. What would be the scale of harnessing natural resources, available in this region?

Hypothesis

1. In mountain environment transformation of subsistence agrarian economy is based upon specialization and diversification of products taking consideration of heterogeneity and sustainability dimensions, natural resource base, and as well as population size. Enhancing and diversifying these natural resources base for vital livelihood options is the major dimension of sustainable development.

2. Enhancing and diversifying livelihood options in the Alaknanda Basin has to search compromise with the mountain trios i.e., verticality, angularity, and instability.

3. Mountain environment is deterrent to high input of the capital but feasible to high input of human resource. This should be taken into consideration while searching the livelihood options.

Methods and Materials

Data Collection

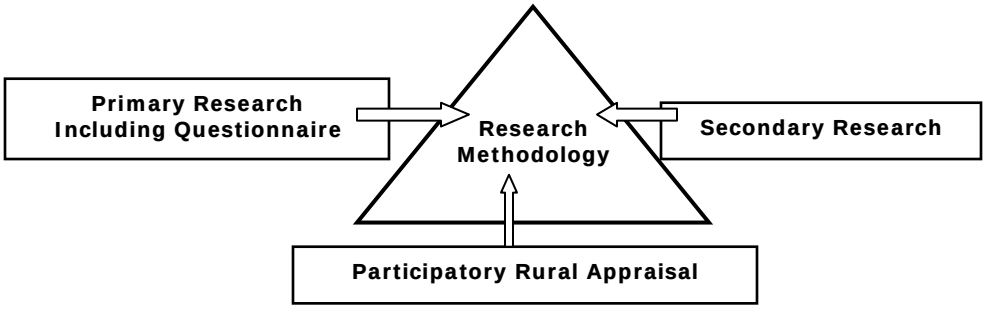
Two types of survey were carried out for this study. First, a household survey was conducted at village level to obtain information on socio-economic conditions. A structured questionnaire was prepared to record relevant information. The households were randomly selected from the villages of every micro-messo drainage basin for interview. Second, a block level survey was conducted covering 13 developmental blocks to study farming system and level of livelihood. Topographical maps at the scale of 1: 25000, 1: 50000 and 1:250000 were obtained from the survey of India office at Dehradun for mapping of physical characteristics, drainage system, infrastructure facilities and land use pattern. An inventory sheet was prepared to record information such as types and extent of diversifying livelihood options in the selected areas. Local people were consulted to collect additional information about the possibilities of enhancing the options of livelihood rather than the prevailing traditional system of agriculture. Maps were digitized and the necessary information was derived.

In order to gather information on resource use practices over time, the archival research were broadened to obtain more analytical accounts of livelihood issues in journal articles and various government reports. The object was to obtain first hand accounts of livelihood

options in different locations. Individual interviews were conducted in the form of open-ended policies framing and implementation as well as group discussions and informal interactions with all groups of society.

Throughout the study, the different sources of information were compared and crosschecked for consistency and credibility. The interview questions were grouped into 3 sets. The respondents were asked to describe (1) sustainability of existing farming system (2) responses towards adoption of diverse crops (3) reliability of diverse livelihood options. Case study regions were selected based upon the macro-drainage basins. Twenty nine villages of two sub-watersheds- Kewer Gadhera and Khanda Gad of the Pindar and Alaknanda rivers respectively, were selected for case study.

Operations Research models are useful tools of analysis to simulate and analyze farmers' strategies under actual and potential technologies and policy conditions. Mathematical modeling can play an important role in simultaneously studying the large number of interrelated factors that influence the decisions of rural households (Schweigman, 2005). A village-level mathematical model that captures the interactions between biophysical (environmental) and socio-economic factors was developed which was used to assess the impact of technological changes and policy incentives.



Interpretation of Data

Collected data were interpreted by using various statistical and cartographical methods. SPSS mehtod was used for calculating co-relation, co-efficiency, exponential trends, and regression. The primary data on livelihood sustainability were further interpreted by SPSS. In cartography, digital maps were prepared along with using the various methods of cartography, such as choropleth, isopleth, and dot methods. For computer graphing, MS Excel was used appropriately to prepare flow charts, pie diagram, bar diagram, simple diagram, and profiles.

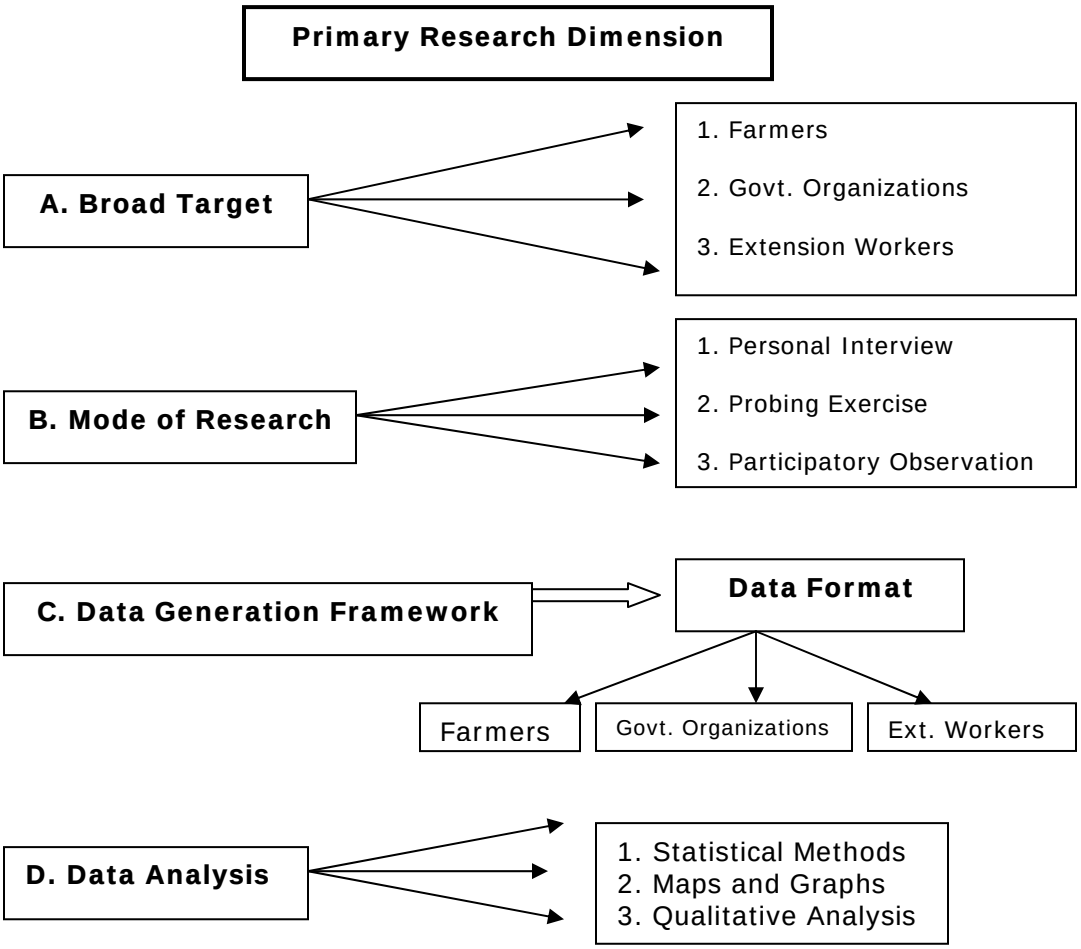
Livelihood Analysis

Livelihood analysis of case studied cluster of villages was carried out. A formula for livelihood sustainability index was prepared by the author to know the livelihood sustainability of the people.

Livelihood Sustainability Index (LSI) = In (Fa+Bu+Gs+La) - Ex (Fo+Sh+Cl+Ed+Ot) = Sa

Where 'In' stands for Income, Fa for farming, Bu for Business, Gs for Government Service, La for labour, Ex for Expenditure, Fo for Food, Sh for Shelter, Cl for Cloth, Ed for Education and Sa for Saving. The objective of formulation of this index was to understand the level of

sustainability in livelihood. Based upon this, LSI at village level and household level was prepared.



Outcome Expected from the Study

The basin has poor performance due to limited uses of resources and almost the basin's populace (about 80%) is engaged in the traditional farming. In this context, the development in the field of horticulture, bee keeping, hybrid animals, and construction of micro-hydropower project will ultimately generate not only the sustain growing population with increasing standard of living of the region, but also compromise development and environmental restoration as well. The present study is an authentic database, which evaluated the current developmental programmes of the basin an ultimately manifested the ways to fixation of priorities. It is hoped that this study will be useful to planners for formulating development of the mountain region and will give opportunities to scholars working in this region for further research.

References

Anita. 1989. Population Geography of District Chamoli. Unpublished thesis submitted for Ph.D. degree to HNB Garhwal University, Srinagar, Uttaranchal.

Arimoro, A.O. M. A. Fagbeja, and W. Eedy. 2002. The Need and Use of Geographic Information Systems (GIS) for Environmental Impact Assessment (EIA) in Africa: With Example from Ten Years Experience in Nigeria. *African Journal of Environmental Assessment and Management.* Vol. 4. No.2 Pp. 16-27.

Ashish Madhav. 1979. Agricultural Economy of Kumaon Hills, Threat of Ecological Disaster. Economic and Political Weekly. June 24.

Atkinson, E. T. a&b. 1882. *The Himalayan Gazetteer*. Cosmo Publication, Delhi, Vol. II, p. 369

Azad, Swarup and Sikka. 1989. *Horticultural Development in Hills*. Gyanodaya Publishing House, Nainital.

Banskota, K. and Sharma, B.1995. Economic and Natural Resources Conditions in the Districts of Bagmati Zone and Their Implications for the Environment: An Adaptive Simulation Model. ICIMOD discussion paper MEI series no. 95/9

Bhatt, HP and Bhatt S. 1992. Environmental Degradation in Garhwal Himalaya: Can We Stop It? *Environmental Management: Socio-Economic Facts* **Vol II** (ed) R. K. Rai, A. C. Mohapatra and Goel N. P.,): 117~121

Binswanger, H.P., Khandker, S.R., Rosenzweig, M.R., 1993, 'How infrastructure and financial institutions affect agricultural output and investment in India', Journal of Development Economics, Vol 41 No 2: 337-366

Bryceson, D.F. (1999) 'African Rural Labour, Income Diversification and Livelihood Approaches: A Long-term Development Perspective'. *Review of African Political Economy* 26 (80): 171–89.

Chadha GK. 1993. Non-Farm Employment for Rural Households in India: Evidence and Prognosis. Indian Journal of Labour Economics. Vol. 36.

Chadha, GK. 1994. Employment, Earning and Poverty: A Study of Rural India and Indonesia. Sage Publications, New Delhi.

Chadha, GK. 1994. Himalayas: Environmental Problems. Ashish Publication Co. New Delhi.

Conelly, W. T., 1994, 'Population pressure, labor availability and agricultural disintensification: the decline of farming on Rusinga Island, Kenya' Human Ecology 222: 145-70

Dabral, S. P. *Uttarakhand Ka Itihas. (in Hindi),* Garhwal publishing house, Doggada Kotdwar, Uttaranchal.

Datt, G. and Ravallion, M. (2002) 'Is India's Economic Growth Leaving the Poor Behind?' *Journal of Economic Perspectives* 16 (3): 89–108.

Davies, S. (1996) *Adaptable Livelihoods: Coping with Food Insecurity in the Malian Sahel*. London: Macmillan.

Diagana, Bocar, and Kelly, Valerie, 1996, Will the CFA Franc devaluation enhance sustainable agricultural intensification in the Senegalese peanut basin? USAID and Michigan State University

Eapen, M. 1992. Rural Non-agricultural Employment in Kerala: Inter-District Variations. Economic and Political Weekly. March 25.

Eckholm, E. 1979. Planting for the Future: Forestry for Human Needs. World Watch Paper 26, World Watch Institute, Washington, DC.

Eder, J. F., 1991, 'Agricultural intensification and labor productivity in a Philippine vegetable gardening community: a longitudinal study', Human Organization, Vol 50 No 3: 245-55

Guyer, J.I. and Lambin, E.F., 1993, 'Land-use in an urban hinterland - ethnography and remote-sensing in the study of African intensification', American Anthropologist 95, no. 4: 839-859

ICIMOD. 1996. Background Note for Regional Meeting of Experts on Development of Micro Enterprises in Mountain Area 25-26 July, Unpublished Text

Indian Council of Agricultural Research. 2002. Agricultural Research Data Book, ICSSR 2004.

ICRA, 1990, 'Intensification and differentiation in Agricultural and Livestock Production, Usagara Division, Tanzania'

Jodha, N.S. 1990. Mountain perspective and sustainability: a framework for development strategies. Paper presented at International Symposium on Strategies for Sustainable Mountain Agriculture, International Centre for Integrated Mountain Development, Kathmandu, Nepal.

Kelly, V., Diagana, B., Reardon, T., Gaye, M., Crawford, E., 1995, Cash Crop and Foodgrain
Khanka, S. S. 1984. Migration from Kumaon Region: some Findings Based on Sample Study of Pithoragarh district. I*ndian Journal of Labour Economics* **Vol. XXVI** No. 4 (January): 302~12

Kulkarni, GA and others. 1982. A Note on Identification of Economically Backward Regions in India. Sarvekshan. Vol. VI No. 1-2, July-Oct.

Kumar, K. 1974. Garhwal Himalaya: A Study on Population Geography. Unpublished thesis submitted for Ph. D. in Meerut University, Meerut.

Maikhuri, R.K., Saxena, K.G. & Rao, K.S. 1995. Experiences in developing a village agroforestry project in Garhwal Himalaya, India. *International Tree Crops Journal*. 8: 213-221.

Maithani, D. *Environment, Resources and Development.* (ed). New Delhi. Daya publishing house.

Murray Colin. 2001. Livelihoods research: some conceptual and methodological issues. Department of Sociology University of Manchester Background Paper 5 Chronic Poverty Research Centre ISBN Number: 1-904049-05-2

Meenakshi, J.V. and Ray, R. (forthcoming, 2002) 'How Have the Disadvantaged Fared in India? An Analysis of Poverty and Inequality in the 1990s' in Sharma, K. (ed.), *Trade Policy Regim,*

Mehta, G. S. 1990. Problems and Potentials of Horticulture Development. *Planning Strategies for a Development Region*. (ed) Singh, A. K Lucknow: Print House.

Mehta, GS. 1989. Economics of Apple Growing in India. Report Submitted to DRI, Tiburg, The Netherlands.

Mehta, GS. 1996. Uttarakhand: Prospects of Development. Indus Publishing Company, New Delhi.

Mehta, GS. 1997. Development Experiences and Options in a Hill Region: A Case of Uttarakhand, India. ICIMOD, Kathmandu, Nepal.

Mehta, GS. 1999. Development of Uttarakhand: Issues and Perspectives. APH Publishing Company, New Delhi.

Nand and Kumar. 1989. *The Holy Himalaya: A Geographical Interpretation of Garhwal Himalaya*. New Delhi. Daya publishing house.

Okali, D. U. U. 1985. The Nigerian Environmental; Ecological Limits of Abuse. Keynotes paper in the Nigerian Environment; Ecological Limits of Abuse. Proc. Annual Conf. And General Meeting of the Ecological Society of Nigeria (ECOSON) Held at the River state University of Science & Technology, Port Harcourt, 3rd -5th May, 1985, S. Nokoe (ed) Pp. 1-16.

Papola, T. S. 1996 a&b. Planning for Environment and Economic Development in Mountain Areas: Concepts, Issues and Approaches. Discussion Paper No. MEI 96/2. Kathmandu, Nepal: ICIMOD.

Purohit, K. C.1994. Chamoli District: Resource Utilization Pattern. Unpublished thesis for Ph. D. degree submitted to HNB Garhwal University, Srinagar, Uttaranchal.

Ramakrishnan, P.S., Saxena, K.G., Swift, M.J. & Seward, P.D. (Eds.). 1993. *Tropical Soil Biology and Fertility Research: South Asian Context*. Oriental Enterprises, Dehra Dun.

Rawat, M. S. 1993. "Environment, Resources and Development. (ed) New Delhi. Daya publication house.

Reardon T., Berdegué J. and Escobar G. (2001). Rural Nonfarm Employment nd Incomes in Latin America: Overview and Policy Implications. World Development Volume 29, No. 3. Elsevir Science Ltd, UK.

Roumasset, J.A., Boussard, J-M. and Singh, I., 1979, Risk and Uncertainty in Agricultural Development, New York: Agricultural Development Council.

Sati, V. P. 1993 a, b & c. Cropping Pattern in the Hill Environment of the Garhwal Himalaya (A case study of a village). *National Geographer* **Vol. XXVIII.** No. 1, 31~37 www.mtnforum.org

Sati, V. P. 2004. Systems of Agricultural Farming in the Uttaranchal Himalaya. '*Journal for Mountain Science*' Vol. 2, No. 1 www.imde.ac.cn/journal

Sati, V. P. 2004. Resource Utilization Pattern and Development in Hills: A Case for the Pindar Basin of Garhwal Himalayan. '*Journal for Mountain Science'* Vol. 1, No. 2 130-141 www.imde.ac.cn/journal

Sati, Vishwambhar Prasad. 2005. Natural Resource Conditions and Economic Development in the Uttaranchal Himalaya, India. *Journal of Mountain Science,* Vol 2, No 4, 336-350 www.imde.ac.cn/journal

Sati, Vishwambhar Prasad. 2006. Forest Resource Management in Mountain Regions: A Case for the Pindar Basin of Uttaranchal Himalaya'. L*yonia: A Journal of Ecology and Application,* Vol 11 (1) Pp. 75-84. www.lyonia.org/journal

Sati, V. P. & Rawat, MSS. 1993. Problems of Agriculture Ecology and their Management in the Pindar Basin. *National Geographer* **Vol. XXVIII** No. 2 143~148 www.mtnforum.org

Sati, V. P. 2004. *Horticultural Development in Hills: A Case for the Alaknanda Basin of Garhwal Himalaya*. Mittal Publishers. New Delhi

Sati, V. P. and Kumar, Kamlesh a&b. 2004. *Uttaranchal: Dilemma of Plenties and Scarcities. New Delhi*. Delhi. Mittal Publication.

Saxena, P. B. 1989. *The Alaknanda Basin: Modern Approaches in Geography.* New Delhi. Concept publication house.

Scoones I. 1998. *Sustainable Rural Livelihoods: A Framework for Analysis.* Working Paper 72, Institute for Development Studies, Brighton, UK.

Schelhas, J., 1996, 'Land use choice and change: Intensification and diversification in the Lowland Tropics of Costa Rica', Human Organization, Vol 55 No. 3: 198-306

Scott, C.A. & Walter, M.F. 1993. Local knowledge and conventional soil science approaches to erosional processes in the Shivalik Himalaya. *Mountain Research and Development.* 13: 61-72.

Singh, B. M. 1991. Land Capability Classification for Wasteland Management in the Himalayan Terrain. *Mountain Resource Management and Remote Sensing* (ed) Gupta, P. N. and Roy, A. K.), Surya Pub Dehradun 122~135

Singh, Brahma, 1998. Vegetable production under protected conditions: Problems and Prospects. Indian Soc. Veg. Sci. Souvenir: Silver Jubilee, National Symposium Dec. 12-14, 1998, Varanasi, U.P. India pp. 90.

Singh, Narender; Diwedi, S.K. and Paljor, Elli, 1999. *Ladakh Mein Sabjion Kei Sanrakshit Kheti*. Regional Research Laboratory of DRDO, Leh. Pub. By D.R.D.O., Leh. Pub. By D.R.D.O. 56 A.P.O.

Waldia, K. S. 1964. *Geology of Garhwal Himalaya.*

Walker, T.S. and Ryan, J.G. (1990) *Village and Household Economies in India's Semi-arid Tropics.* Baltimore: Johns Hopkins University Press.

Walton. 1910. *Gazetteer of Western Himalaya.* reprinted by Natraj publication, Dehradun.

CHAPTER 1

GEOGRAPHICAL BACKGROUND

Introduction

Natural resource management and food security is the prime concern in the whole world particularly in the wake of globalization, high growth of population and changing livelihood options. This remains greater in the third world countries where livelihood is depended on subsistence agriculture. The Alaknanda Basin of Garhwal Himalaya is very rich in terms of presence of natural resources i.e., flora, fauna, and water. Further, rich agro-ecological conditions are also available for cultivation of various kinds of crops- subsistence and cash generating crops. Water resource has abundance as the major rivers origin and flow from the region. These abundant natural resources and suitable agro-ecological conditions are fully unutilized and thus the issues of food security are getting attention in the whole basin. This resulted in food insecurity and malnutrition, which is common and growing phenomenon. Lacking in infrastructural facilities further accelerate this problem. The economy of the region is largely depended on traditional agriculture and on remittances. Meanwhile, the optimum utilization of these abundant natural resources can enhance livelihood and the people of the basin can attend food security. This paper aims to discuss on the management of natural resources and food security in the Alaknanda Basin of Garhwal Himalaya and to give suggestion for optimum utilization of natural resources for attending food security.

Location

The Alaknanda Basin is extended between 30° 0' N to 31° 0' N and 78° 45' E to 80° 0' E, covering an area about 10882 Km^2, represents the eastern part of the Garhwal Himalaya. Out of the total area of the basin, 433 km^2 is under glacier landscape and rest of 288 km^2 is under fluvial landscape. The total number of villages is approximately 2310. The land under agriculture is 644.22 Km^2, which is 5.9 percent of the total geographical area while only 64.8 Km^2 (0.6%) land is under the horticultural crops.

Physiographic Division

The Alaknanda Basin is characterized by hilly terrain, deep gorges, and river valleys. The region is broadly divided into four major divisions (i) the Great Himalayan Ranges (snow covered regions), (ii) Alpine and pasture land (covered by snow during the four months of winter season), Middle Himalaya (characterized by high concentration of population) and (iii) river valleys (characterized by mushrooming service centers and institutions). Among the major rivers of India, the Alaknanda River and its tributaries (Dauli Ganga, Vishnu Ganga, Nandakini, Pindar, Mandakini, and other numerous perennial streams) originate and flow here. The highest mountain peaks of the Himalayan Ranges such as Nandadevi, Kamet, Trisuli, and Chaukhamba are also located here.

Climate: Temperature and Rainfall

The altitudinal differences coupled with varied Physiography contributes to climatic variations in the Alaknanda Basin. The climate varies from sub-tropical to alpine. Despite diverse physiographic characteristics, sub-regional variations in the average seasonal temperature are not striking. Temperature varies from season to season and from valley regions to highly elevated regions as highest temperature is recorded in Srinagar in the

month of June (30° C) and lowest in Tungnath in the month of Jan (0.5^o). As shown in **table 1.1**, the whole Alaknanda Basin receives lowest temperature and the area above 2000 m receive heavy snowfall during four months of winter. Global impact of climate change can be noticed in this basin as heavy snowfall occurred in Jan 1993 when the low-lying areas (900 m elevation), have covered by snow. Summers are conducive and favourable for health except a belt extending between Karanprayag to Devprayag comprising (low-lying areas) where monthly temperature remains about 30° average. The farming community, during this period, migrates to upland for pastoralism. During summer, heavy flow of tourist can be seen in the basin mostly pilgrims because this basin has two world famous pilgrimages; Badrinath and Kedarnath, five prayags (confluence points of major rivers), and other places of cultural interest. Similarly, there are many natural places of tourist interest.

Table 1.1: Mean Monthly Temperature in the Alaknanda Basin

Name of place	Altitude (m)	Mean monthly temperature ^{o} C											
		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Srinagar	550	14	18	20	25	25	30	29	28	25	27	17	15
Mastura	1800	4	6	12	14	15	20	20	18	17	14	8	4
Joshimath	1875	2	3	7	11	14	17	18	17	16	10	7	4
Tungnath*	3600	0.5	1	3	6	7	12	12	11	5	4	2	1

Sources: * HAPPRC Srinagar Garhwal (Uttaranchal)
India Meteorological Department, Pune.
Adopted from Vishwambhar Prasad Sati's paper. Systems of Vertical Horticulture in the Alaknanda Basin. ANNALS, NAGI.

Rainfall mostly occurs during Monsoon season from June to October. It also varies from the valley regions (low) to highlands (high) and from north-facing (leeward) to south-facing (windward) slopes. Rainfall recorded in four stations of the basin **(Table 1.1)**. These stations are located in different altitudes varies from 550 m to 3600 m. Highest rainfall is recorded in Okhimath (1578 mm and 199.4 cm) followed by Karanprayag (883 mm and 147.1 cm) while lowest rainfall is recorded in Srinagar (550 mm and 92.5 cm). This data reveals that in high altitude, rainfall is high and vice-versa. In case of Joshimath, which is located at 1875 m, annual rainfall is 107.5 cm, which is very less than Karanprayag. The only reason is behind that Joshimath is located at leeward direction.

Table 1.2: Rainfall Data of the Alaknanda Basin

Months	Average rainfall (cm)	1999-00	2000-01	2001-02	2002-03	2003-04
May	49	28.9	70.47	93.03	55.87	30.23
June	172.96	135.94	242.65	235	136.36	121.58
July	419.38	314.02	323.99	337.31	183.69	343.48
August	417.41	275.22	374.47	248.84	334.34	347.63
September	201.67	246.6	111.41	40.88	266.9	239.94
October	34.98	39.91	12.97	2.51	10.16	0
November	6.78	0.88	1.36	0.23	3.93	1.8
December	21.92	4.78	13.3	2.56	11.64	13.42
January	51.9	23.54	30.86	30.8	39	45.45
February	59.9	56.15	17.48	39.11	29.69	5.95
March	43.52	24.84	66.82	16.46	16.12	0

April	28.51	28.67	19.09	42.11	30.16	26.33
Total (average)	**125.7**	**98.23**	**107.1**	**90.7**	**91.1**	**97.9**

Source: compiled by the authors from different sources

Climatic conditions of the Alaknanda Basin vary from valleys to highlands depending upon altitude, aspect of slope, and nearness to the Great Himalayan Ranges. The cold chilly winters of highlands and humid monsoon climate in valley regions characterize the climate and consequently the farming system and working potential of populace influences. Leeward and windward direction of slope determines the amount of rainfall. In this basin, the lowest place is Devprayag (618 m) while Nandadevi peak with 7817 m height is the highest point. The physiographic characteristics also determine the climatic conditions. Vertically, this basin can be divided into four physiographic zones; low-lying river valleys, middle altitude, uplands including alpine pastures, and snow-caped mountain peaks. Temperature varies from valley regions to the uplands and from winter to summer. It recedes to 0° C during winter. The regions located above 1600 m receive heavy snowfall during four months of winter. The winter's snowline is subliming as it is rarely seen upto that height. Summer is hot and rainy season is humid for valley regions. Meanwhile, middle altitudes are mild during summer and receive heavy downpour during monsoon season. Highland pilgrimages and natural places are the major attraction for pilgrims and tourists respectively. Tourists from Indian sub-continent and abroad visit these places during summers.

Rainfall variability in the basin is due to direction of slope- leeward and windward. Joshimath, Karanprayag, Okhimath, and Srinagar are the places located in leeward direction. Therefore, these places receive less rainfall in comparison to the places located in windward direction as Mandal, Gopeshwar, Gwaldom, Diwalikhal, and water dividing facing east slope. Mandal region receives highest rainfall (400 cm) and known as Cherrapunji of Garhwal. Average annual rainfall is 125.7 cm. November and December months receive minimum rainfall i.e. 6.78 and 21.92 respectively. During monsoon period, mainly two months (July and August), highest rainfall (above 400 cm) occurs. In some regions, winter and summer seasons are also wet. Humidity reaches 100%. Valley regions remain foggy with least visibility during winter. The stretch valley of Alaknanda near Srinagar Garhwal gets dense fog. Heavy rainfall occurs during July and August when the main rivers and their numerous tributaries flow above danger marks. Cloud bursting, debris flow, landslide, mass movement, and consequently flash flood are very common. The entire region is worst affected due to these catastrophe during monsoon resulting in heavy losses of life and property every year. There are many instances when major catastrophes took place from time to time.

Table 1.3: Rainfall in the Alaknanda Basin

Station	**Altitude in m**	**Annual rain in cm**	**Seasonal rainfall %**			
			Winter	Pre-monsoon	Monsoon	Post-monsoon
Srinagar	550	92.5	16.0	17.7	58.8	8.5
Karanprayag	883	147.1	10.5	13.4	15.9	10.2
Okhimath	1578	199.4	8.8	11.3	71.3	8.6
Pauri	1630	130.3	14.8	14.7	61.5	9.0
Joshimath	1875	107.5	15.4	10.3	53.1	12.2

Source: Forest working plan, Nainital Working Circle.

The basin is characterized by presence of high moisture throughout the year. The Great Himalayan Ranges regulate the climatic conditions; temperature, rainfall, and moisture as it occupy 433 km^2 area of the basin. This fact (high percentage of moisture) was noticed in 1987 when entire country observed drought, its impact in the Alaknanda Basin was negligible (Sati and Kumar 2004).

Major Natural Resources

The Alaknanda Basin obtains a high degree of availability of natural resources in the forms of water, soil, flora, fauna, and climate and consequently is rich in biodiversity and agro-climatic conditions. The abundance natural resources could not utilize optimally due to rough and rugged terrain, inaccessibility, and harsh climatic conditions. The conditions of natural resources are discussed in the following manner.

Soil Resources

Soil contains and texture varies from the Greater Himalaya to the mid-slopes and valley regions and accordingly their potentials of growing crops are also varied. Soils of greater Himalaya consists of very steep to steep slopes, are dominantly occupied with very shallow to moderate shallow, excessively drained, sandy-skeletal and loamy skeletal, neutral to slightly acidic with low available water capacity soils without profile development in association with rock outcrops. In the Lesser Himalaya, soil is encountered on steep to moderately steep slopes, is shallow to moderately shallow, excessively drained, sandy/loamy-skeletal/loamy with moderate erosion and moderate to strong stoniness. In the side slopes or terrace slopes, soils are moderately deep to deep, excessive drained, fine loamy slightly too moderately acidic with slight to moderate erosion and stoniness. Soils in glacio-fluvial valley consist of moderately shallow excessive drained, coarse loamy, slightly acidic and moderately stony. Fluvial valley's soils are deep well drained, moderately acidic, slightly eroded, and Typic Dystrochrepts (Velayutham et.al 2001). **Table 1.4** shows the chemical analysis of ten sample areas of the Alaknanda Basin. These sample areas are located in different elevation ranging from 660 m to 3000 m and characterized by various contains and texture of soils.

Table 1.4: Chemical Analysis of Sample Areas of the Alaknanda Basin

Situs structure of localities	Elevation in m	PH value	EC mm/hr	Organic material	Nitrogen	Lithos-stratigraphic groups
Mana glacial drift	3000	6.50	1.10	2.40	0.01	Central Crystalline Group
Malari glacial drift	2760	5.40	0.11	2.50	0.30	
Jelum structural terrace	2700	7.05	0.05	2.60	0.13	
Joshimath terrace	1880	7.05	0.10	4.52	0.22	Main Central Thrust
Helang	1800	6.50	0.11	5.00	0.30	
Pipalkoti terrace	1210	7.50	0.10	1.77	0.06	
Gaucher alluvial terrace	1135	8.00	0.14	10.67	0.56	Garhwal Group
Nagrasu alluvial terrace	1000	7.20	0.13	9.51	0.47	
Kaliasaur alluvial terrace	660	7.00	0.11	11.26	0.56	Pudhatoh Group

Water Resources

Water is the most underutilized, at the same time most abundant resource of Himalaya. It is estimated that about 11,00,000 million cubic meter water flows every year down the Himalaya offering a potentiality of generating electricity to the tune of 28,000 MW and making as much as 247,000 million cubic meters water available for irrigation in the Indo-gangetic plains (Valdiya, 1985). Per capita fresh water availability in the Himalayan Region is evaluated to range from 1757 m^3/yr in Indus, 1473m^3/yr in Ganges, 18417 m^3/ yr in Brahmaputra with an all India average of 2214m^3/yr. The Alaknanda Basin is endowed with bounty of water resources accounting for about 8% of the total water resources in the country. Unfortunately, this vast potential has not been rationally exploited yet. Endowed with huge water resources potential, it has also the worst water resource problems rendering untold sufferings to millions every year. The region experiences excessive rainfall and high floods during monsoon months and also suffers from acute shortage of drinking water in many areas due to lack of management. The Alaknanda river and its numerous tributaries; Dauli Ganga, Vishnu Ganga, Nandakini, Pindar, and Mandakini and sub tributaries, which are perennial and glacial fed presents huge water resources reservoir. In many areas, the tributaries and sub-tributaries provide ideal sites for micro-hydropower projects. Since the area of unlimited water resources facing acute water shortage for drinking and irrigation purposes, sustainable utilization of water through construction of micro-hydropower projects will surely solve the duo problems (Sati, 2008a). The basic issue underlying the water resources problems are: recurring floods, drainage congestion, soil erosion, human influence on environment and so on and calls for its integrated use for drinking, irrigation generation of hydropower, and recreation.

Management of water resource in the basin is a crucial issue because of the undulating terrain and fragility of landmasses, which does not permit for construction of macro-level dams. Developmental interventions at micro-level considering drinking water, irrigation, and hydroelectricity generation in an integrated manner have yet to be properly designed and tested. Traditional management of water resource as a form of *gharat* (water mills) and *gools* (small canals) did not involve any advance technology, while they are absolutely fit in this ecologically fragile mountain terrain (Sati 2006). Their values and efficiency is rest in low levels of financial investments, local controls, and quick responses in taking corrective actions in the event of damages.

Forest Resources

Forests are most important, both economically and environmentally among the other natural resources in the Alaknanda Basin. The geographical area covered by forest is reported to be 1021156 hectares, which accounts for around 42.2 per cent. Ownership of the forest in the state is mainly shared between the forest department (69.1) and Civil and Soyam (community forest (23.4). Forest Panchayats (6.9) and private (including cantonment) forests manage the remaining area. The alpine, temperate and sub-temperate forests that cover most parts of the basin make natural habitats of some of the best-known wildlife creatures. Alpine forests in the region include Valley of Flowers National Park (known for its amazing variety of flowers), Nanda Devi National Park, Govind Ghat National Park, and Gangotri National Park.

The Alaknanda Basin is very rich in terms of forest and its diversity. Right from the valley region to the highly elevated Alpine meadows, locally known as *Kharak* or *Bugyal*, the diversities in plants are found extensively. In the middle altitude, Pine (*Chir*) are found while in the upper reaches, temperate coniferous forest mainly *Kharsu* (*Quercus semicarpifolia*). *Tilonj* (*Q. dilitata*), *Rianj* (*Q. lanuginose*) and *Banj* oak (*Q. leucotricophora*) are abundantly

found (Sati 2006). Except these forest types, many other fodder plants like, *bhimal* and *khadik*, are also grown along with edges of agricultural fields. The main forests are (i) Deodar **Forests** (*Cedrus deodara*) are found between the heights of 1650 and 2300 m in the basin, (ii) Blue **Pine Forests** (*Pinus wallichiana*) are also known as *Kail*. It is found in Joshimath areas. These are found mostly mixed with Deodar Forests. The tree occurs between 1650 and 2300 m. Timber is used in making sturdy cupboards and pelmets in houses, (iii) ***Chir* Forests** (*Pinus roxburghii*) are found in the entire basin. Its forests exist mostly between the altitudes of 1000 and 1650 m. It is used for making packing cases and paneling in interior decoration. It is also used as fuel wood, (iv) **Oak Forests** (*Quercus species*) are found in the basin between the heights of 1325 and 1625. It is used for fuel wood and charcoal manufacturing. It is the best firewood having high caloric value. It is a broad-leaved tree, (v) **Fir** (*Abies pindrow*) **& Spruce** (*Picea smithiana*) **Forests** are found mostly between 2300 m and 2950 m.

Altitude regulates diversity in flora in the Alaknanda Basin. According to altitudinal zones, various kinds of flora with great economic value are found. Most of the forests belts in the basin are inaccessible. Consequently, their economic use is just negligible. In the high altitude, these forests help to increase in soil fertility, which is brought with rainwater and deposited in the lowlands. The entire basin is ecologically fragile. Land slides and landslips are very common, particularly during the rainy seasons. Due to heavy rains (known as cloudburst) and steep slopes, this situation is further accentuated. Forests are the main tool for conserving soil and land. To conserve the soil and land, diversity in flora is required.

Diversity in flora is found in all altitudinal zones, dominated by oak and pine forests. Forest covers about 42.2% of land and it is increasing constantly. A study on land cover change shows that about 1.3% forest cover increased in the last three decades (Sati, 2008b). Forest is the main source of livelihood of the populace. It provides fodder, firewood, timber, non-timber products, herbs, and environmental services. Altitudinal variations in forest resources are due to changes in the climatic conditions. The region characterizes subtropical to temperate, alpine, and cold climatic zones resulted in diversity in natural vegetation gradually from valley regions to uplands. Oak and pine forests are useful for firewood, fodder, and timber and the farming community of the region is highly depended on them for their livelihood. Pine forest found mostly in the valley regions and mid-altitude patches while oak forests have monopoly over highlands. The impact of global change can be noticed here as pine trees invaded oak in many areas.

Animal resource implies wider and foremost role in livelihood as it is the second main occupation after farming of subsistence crops. On the other, it helps agriculture systems as plowing the field and providing manure. For centuries, organic fertilizer, as manure, is used for production of crops that avail only from animals. Besides, production of milk plays substantial role to run livelihood. While, mostly consumed domestically milk is seldom sold in the nearby service centres. Draught animal constitutes the composition of domestic animal kingdome mostly uses in the field of agriculture as draught power. Cows and oxen are outnumbered followed by buffaloes. In the upland areas, goats are reared and used for wool and meet. Recent study on livestock farming reveals that the numbers of animal are decreasing recently. The households earlier had more than five cattle now have one or two each. However, the changes in rearing livestock vary from valley regions to uplands. Valley regions are connected by motorable roads. The households have changed their occupation from agriculture to tertiary sector as emergence of small service centres took place on the road heads. Consequently, the numbers of livestock reduced considerably. Contrary, in the upland areas, subsistence farming system is the main stay, which is based upon the mixed agriculture-livestock farming. Since, livelihood options have also changed in the uplands as emigration continues to the metropolitan cities of India and the major source of income is

from remittances, agricultural practices were lessened. This led to considerable decrease in livestock.

The climate and agro-ecological conditions provide a base for rearing of high yield variety (HYV) of animals as temperate climate and alpine meadows are widespread in the region. During the 1980's, veterinary centres where established in each block headquarter and HYV lactating cows were given to the farming communities. Nevertheless, this scheme could not get success. A study reveals that this was due to mismanagement. The government distributed HYV animals to the poor farmers who were unable to manage them. *Murrah* buffaloes, reared in the upland areas, are high lactating animal. Meanwhile, their numbers are less as compared to draught animals. Rearing of *murrah* buffaloes and high lactating cows can contribute substantial household income.

Livestock rearing constitutes major segment in the income and economy of the farming community. It received more significance, when high attention was paid to organic farming during recently. Keeping suitability of landscape, climate, and agro-ecological conditions in view, rearing of draught animals, and lactating cows and buffaloes for enhancing income and economy is inevitable.

Reference

Sati, Vishwambhar Prasad a&b. 2008. ***Natural Resources Management and Sustainable Development in Pindar Valley, Himalayas.*** Bishen Singh Mahendrapal Sinsh, Dehradun. P 142

Sati, Vishwambhar Prasad. 2006. Water Resource Potentials and Management in the Pindar Basin. Included in Chapter 4 of 2006 Rosenberg Water Policy forum: Preliminary Public E-consultation. A focused e-discussion held from July 31-August 28, 2006. http://www.banffcentre.ca/mountainculture/mtnforum/conferences/rosenberg/week2.asp

Sati, Vishwambhar Prasad. 2004. *Uttaranchal: Dilemma of Plenties and Scarsities*, published by Mittal Publications, New Delhi, www.vedamsbooks.com/38930

Valdiya, K.S. 1985a. Himalayan tragedy. Big dams, seismicity, erosion and drying-up of springs in the Himalayan region. Central Himalayan Environment Association Bulletin. 1: pp. 1-24.

CHAPTER 2

SOCIO-ECONOMY AND POPULATION PROFILE

Introduction

Agricultural practices are main occupation of inhabitants of the Alaknanda Basin. It is also a main source of livelihood of majority of the people. About 80% population is engaged in the production of cereal crops and livestock farming. Along with subsistence cereal farming, rearing of animal has an equal proportion in economy and income of farmers. Horticultural practices are also carried out but its proportion in terms of land cover, production, and productivity is just negligible. The farming system in the basin is peculiar, which is based upon the centuries old practices and carried out mainly on narrow patches of terraced fields. The main crops grown are paddy, wheat, barley, millets, pulses, and oilseeds. The economic viability of these crops is insufficient even to meet the food requirement of the populace but these crops are environmentally sound and suitable for this ecologically fragile terrain. The scope for further expansion and modernization of agriculture practices is not viable due to fragility of terrain and precipitous slope. Therefore, an exodus of population migrated to the foot-hills of Himalaya for the search of job or recruited in national Army. Enhancing and diversifying the livelihood options, other than biomass based production, will definitely raise the income and food-security of the rural mountain people. This study reveals that the scope of cultivation of off-season vegetables, fruits, medicinal plants, and collection of non-timber based forest products are tremendous. It is suggested that the optimum harnessing of these products will surely provide a base for sustainable livelihood in the region.

Land Use Pattern

In the Alaknanda Basin, a large percentage of geographical area is covered by snow-clad mountain peaks, rocky and precipitous surface, and barren land (21.3%), which is no more useful for cultivation and other development activities. About 42.2% land is covered by forest. Pasture land and land under horticulture occupy 7.6 and 6.8% area respectively while net sown and gross sown area is 9.2 and 13.9% respectively (Total 79.7%). This figure also varies from block to block based upon the location of blocks. Area under net sown and gross sown is considerable low in the development blocks that are located in the highlands. **Table 2.1** shows that Joshimath block has 1.0% net sown and 1.3% gross sown areas while Karanprayag block has 18.4% net sown and 29.0% gross sown areas.

Table 2.1: Land Use Pattern in the Alaknanda Basin 2004 (ha)

Name of DB	Forest land	CWL	Fellow	Other Fellow	UNCL	LOTA	Pasture	LUH	NSA
JMT	61.6	7.1	0.3	0.8	1.3	0.8	15.0	5.5	7.3
DSL	16.1	12.4	0.01	0.1	54.1	1.6	7.2	7.2	0.9
GHT	21.7	1.9	0.1	0.3	27.1	1.5	16.9	11.7	18.3
KPR	40.9	11.5	0.2	0.4	7.0	0.8	16.	9.1	13.2
NBR	44.3	12.3	0.5	0.6	5.2	0.9	16.5	6.0	13.3
GRS	22.0	2.5	0.2	0.5	9.5	3.2	21.1	14.5	26.1
TRL	34.1	14.9	0.2	0.8	9.3	0.6	19.0	7.2	13.4
DBL	42.6	6.4	0.2	0.5	6.9	0.5	10.2	8.2	24.1
PKR	40.5	8.7	0.5	0.3	15.4	0.5	7.8	18.3	7.6
OKM	30.2	4.4	0.4	0.5	14.4	7.3	12.3	14.8	15.1

AGM	52.2	4.7	0.01	0.2	23.6	2.5	3.1	5.4	7.8
JKL	52.2	4.7	0.01	0.2	23.6	2.5	3.1	5.4	7.8
DVP	52.2	4.7	0.01	0.2	23.6	2.5	3.1	5.4	7.8
KTN	36.1	1.7	3.1	3.2	1.2	28.2	0.1	0.02	25.9
KOT	69.3	0.4	0.9	1.9	0.5	11.7	0.	0.01	14.8
PRI	57.7	4.6	1.3	3.0	10.2	3.4	3.1	4.9	12.5
KRS	53.6	4.5	1.3	3.4	4.7	3.3	4.7	12.6	11.9
KPT	67.9	3.7	1.4	2.0	4.4	3.3	2.9	4.7	9.3
ARB	**42.1**	**7.2**	**0.4**	**0.8**	**22.1**	**3.6**	**7.6**	**6.8**	**9.1**

Source: Calculated by the author from statistical diaries of Chamoli, Rudraprayag, Bageshwar, Tehri, and Pauri Districts.
Abbrev. CWL for cultivable waste land, UNC for uncultivable land, LOTA for land other than agriculture, LUH for land under horticulture, NSA for net sown area

Cropping Pattern

Cropping pattern varies from low-lying area to the highlands. Diversity in cropping pattern is found in all three agro-climatic zones. **Table 2.2** shows cropping pattern in the Alaknanda Basin. It shows cropped area in ha and percentage of cropped area. The major crops that are grown in the Alaknanda basin are wheat (34%) followed by rice (25.4%) and *mandua* (finger millets) i.e. 19.9%. Sava occupied 11.0% cropped area. Other important crops are barley (2.9%) and potato (2.6%). Maize, urd, masur, pea, tour (pulses); and mustered, linseed, and soya bean (oilseeds) have less cropped area.

Table 2.2: Cropping Pattern in the Alaknanda Basin

Crop	Cropped area in ha	Percentage of cropped area
Rice	33216	25.4
Wheat	45047	34.4
Barley	3797	2.9
Maize	1090	0.8
Mandua	26117	19.9
Sava	14458	11.0
Urd	1041	0.7
Masur	498	0.3
Pea	41	0.03
Tour	288	0.2
Mustered	950	0.7
Linseed	389	0.2
Soya Bean	299	0.2
Potato	3476	2.6
Total	**130707**	**100**

Source: Calculated by the author from statistical diaries of Chamoli, Rudraprayag, Bageshwar, Tehri, and Pauri Districts.

Irrigation

Entire Alaknanda basin is fragile and prone to high soil erosion. Landscape is undulating. Construction of canals and other means of irrigation on the mid-slopes and highlands are not feasible. Agriculture is therefore rain-fed. Only 8.8% percent of the cropped area is irrigated. Irrigation is mainly done by small canals locally known as *gools*. It is done mostly on the valley regions. **Table 2.3** shows irrigated area in ha and in percentage. Okhimath, Agustyamuni, Jakholi, Devprayag, Kirtinagar, and Kapkot development blocks have almost equal irrigated area (12-13%). The other blocks have 1 to 9% area under irrigation.

Table 2.3: Irrigated Area (ha)

Name	Net irrigated	
	Area (ha)	Percentage
JMT	62	2.7
DSL	442	8.4
GHT	191	3.5
KPR	52	2.9
NBR	196	3.9
GRS	198	3.9
TRL	161	4.3
DBL	34	1.8
PKR	314	7.6
OKM	523	12.6
AGM	1301	12.6
JKL	589	12.6
DVP	1235	12.7
KTN	1121	13.0
KOT	258	4.9
PRI	300	6.0
KRS	269	7.2
KPT	1053	13.4
ARB	**8299**	**8.8**

Crop Diversity and Productivity

Even though holdings are small (average < 1 ha), number of crops cultivated by a household may vary from 17 to 30 (Sharma and Sharma, 1993; Rao and Saxena, 1994; Maikhuri et al., 2000; Sen et al., 2002). Mixing of three species of buckwheat and six of pulses is the most diverse crop system reported from the region (Singh et al., 1997). High crop diversity is achieved through rotation of pure crops in space and time and through mixed crop systems. Except for paddy, local cultivars of a given crop are randomly mixed. Crop diversification is traditionally valued for securing survival in isolated settlements in a highly variable and uncertain biophysical environment. High levels of crop yields (e.g., 6.5 t of wheat and 14 t of potato ha-1) and food sufficiency in many villages insulated from external forces due to extreme inaccessibility (Chandrasekhar, 2003; Semwal et al., 2003) testify the potential of indigenous knowledge.

Table 2.4 shows taluk wise population structure in the Alaknanda basin. It reveals average family size, sex ratio, rural, and urban population. Average family size in the basin is 4 persons in a family. It is almost equal in all taluks. Interestingly sex ratio is high (1071 women/thousand men). Except Joshimath, Srinagar, and Chamoli taluks (773, 937, and 964 respectively), other taluks have high sex ratio. It is much higher than national average (934) according to the census of 2001. Rural population accounts 88.6% of the total population. Remaining 11.3% population is urban. In Tharali, Gairsain, and Pokhari taluks, urban population is zero. Ukhimath taluks accounts 0.6, Rudraprayag 1.5, and Devprayag taluk registers 3.1% urban population. The highest percentage of urban population is found in Srinagar taluk (39.4%) followed by Joshimath taluk (37.2%) and Karanprayag (25.8%). Chamoli taluk accounts 23.4% and Pauri taluk accounts 17.3% urban population.

Table 2.4: Taluk Wise Population Structure

Taluks	Average Family Size	Sex Ratio	Rural Population	Urban Population
Joshimath	4	773	62.7	37.2
Chamoli	4	964	76.5	23.4
Karnaprayag	4	1013	74.1	25.8
Tharali	5	1088	100	0
Gairsain	5	1129	100	0
Pokhari	4	1112	100	0
Ukhimath	4	1071	99.3	0.6
Rudraprayag	4	1139	98.4	1.5
Devprayag	4	1143	96.8	3.1
Srinagar	4	937	60.5	39.4
Pauri	4	1156	82.6	17.3
Total ARB	**4**	**1071**	**88.6**	**11.3**

Source: Calculated by the author from the data, Census of India 2001.

Table 2.5 presents taluk wise literacy and working population. According to the census of 2001, total literacy in the basin is 64.1% which is higher than national average (62.2%). Male literacy is 75.5% and female literacy is 53.3%. Literacy rate varies from one taluk to another. Lowest literacy rate is registered in Devprayag 58.6% followed by 58.7% in Gairsain taluk. Highest literacy rate is found in Srinagar taluk (75.4%). The other taluks have 60 to 70% literacy rate. Male literacy is highest in Srinagar (86.6%) and lowest in Devprayag (70.8%). Similarly, highest female literacy is recorded by Srinagar (67.7%). While female lowest literacy is recorded in Gairsain taluk (47.3%). Differences in literacy rate are due to availability of educational institutions. Srinagar town has out numbered educational institutional than to Gairsain taluks. Working population is 48.2%. Female workers (52.6%) are much more than male workers (47.3%). Joshimath registered highest male workforce (68.7%) and lowest female workforce (31.2%). Gairsain registered lowest male workforce (42.3%) and highest female workforce (57.6%).

Table 2.5: Taluk Wise Literacy and Working Population (Percentage of Total Population)

Taluks	Literacy	Male	Female	Working Population	Male	Female
Joshimath	68.1	77.9	55.5	47.5	68.7	31.2
Chamoli	64.1	75.5	52.2	42.5	53.4	46.5
Karnaprayag	68.9	78.7	59.3	70.9	53.4	46.5
Tharali	62.1	74.5	50.8	44.5	45.6	54.3
Gairsain	58.7	71.6	47.3	46.1	42.3	57.6
Pokhari	65.5	76.8	55.3	44.9	43.9	56.0
Ukhimath	63.7	75.9	52.2	46.0	45.6	54.3
Rudraprayag	61.1	73.6	50.1	44.2	44.0	55.9
Devprayag	58.6	70.8	47.9	43.8	45.2	54.7
Srinagar	75.4	82.6	67.7	88.8	45.2	54.7
Pauri	67.2	77.9	58.0	41.5	45.0	54.9
Total ARB	**64.1**	**75.5**	**53.3**	**48.2**	**47.3**	**52.6**

Source: Calculated by the author from the data, Census of India 2001.

Scheduled caste (SC) population is 18.14% and scheduled tribe (ST) population 1.2% as shown in **table 2.6**. Highest SC population is found in Chamoli (21.6%) followed by Pauri (20.7%) and Tharali (20.3). Lowest SC population is found in Joshimath and Gairsain (13.4% each). Joshimath accounts highest ST population i.e. 14.3%. This area is largely inhabited by the Bhotia tribes. It is followed by Chamoli (4.0%) and Karanprayag (1.1%). Other taluks have just negligible percentage of tribal population. It is almost below 1%. The main and only tribal race is Bhotia.

Table 2.6: Taluk Wise SC and ST Population (Percentage of Total Population)

Taluks	SC	ST
Joshimath	13.4	14.3
Chamoli	21.6	4.0
Karnaprayag	18.4	1.1
Tharali	20.3	0.3
Gairsain	13.9	0.1
Pokhari	16.4	0.1
Ukhimath	18.1	0.1
Rudraprayag	17.4	0.06
Devprayag	16.2	0.002
Srinagar	15.5	0.2
Pauri	20.7	0.09
Total ARB	**18.14**	**1.2**

Source: Calculated by the author from the data, Census of India 2001.

This chapter discusses socio-economy and population profile of the Alaknanda Basin. Land use, cropping pattern, irrigation facilities, and crop diversity and productivity are discussed in socio-economy section. Population profile is widely discussed. This includes all aspects of population profile. Other socio-economic indicators such as livestock and case crops are discussed in chapter 3. Here efforts are made to elaborate agriculture on which the livelihood of the population is depended and population structure according to the census of 2001.

Reference

Chandrasekhar, K. 2003. Ecological Analysis of Settled Agropastoral Farming in Cold Desert (Spiti Catchment, Himachal Pradesh). Ph.D. Thesis, Jawaharlal Nehru University, New Delhi, India.

Maikhuri, R.K., Nautiyal, S., Rao, K.S., Chandrasekhar, K., Gavali, R. and Saxena, K.G. 2000a. Analysis and resolution of protected area - people conflicts in Nanda Devi Biosphere Reserve, India. Environmental Conservation 27: 43-53.

Rao, K.S. and Saxena, K.G. 1994. Sustainable Development and Rehabilitation of Degraded Village Lands in Himalaya. Bishen Singh Mahendra Pal Singh, Dehradun, India.

Semwal, R.L., Maikhuri, R.K., Rao, K.S., Singh, K. and Saxena, K.G. 2002. Crop productivity under differentially lopped canopies of multipurpose trees in central Himalaya, India. Agroforestry Systems 56: 57-63.

Sen, K.K., Semwal, R.L., Rana, U., Nautiyal, S., Maikhuri, R.K., Rao, K.S. and Saxena, K.G. 2002. Patterns and implications of land-use/cover change: a case study in Pranmati watershed (Garhwal Himalaya, India). Mountain Research and Development 22: 56-62.

Sharma, S. and Sharma, E. 1993. Energy budget and efficiency of some cropping systems in Sikkim Himalaya. Journal of Sustainable Agriculture 3: 85-94.

Singh, G.S., Rao, K.S. and Saxena, K.G. 1997. Energy and economic efficiency of the mountain farming system: a case study in the north-western Himalaya. Journal of Sustainable Agriculture 9: 25-49.

CHAPTER 3

DIVERSIFICATION OF AGRICULTURE AND SUSTAINABLE LIVELIHOODS

(A) CASH GENERATING CROPS

PROSPECTS OF OFF-SEASON VEGETABLES

India is the second largest producer of vegetables in the world but at the same time, it does not produce that amount of vegetables, which can meet the daily requirement of an individual. Efforts are on to increase the production of vegetable crops at the national level. It is noticed in a report of Indian Council of Agricultural Research (ICAR-2002) that the present production of 90.8 million tones is to be raised to 250 million tones by 2024-2025. The Government efforts are noteworthy to produce the substantial amount of vegetables so that the target could be achieved. The major noticeable efforts are bringing additional area under vegetable crops, using hybrid seeds, and use of improved agro-techniques. Another potential approach is perfection and promotion of protected cultivation of vegetables (Singh, 1998; Singh *et al*., 1999).

Himalaya Mountain is the home for cultivation of all kinds of vegetables, which are grown in the different altitudinal zones and in all geographical locations. In addition, diversity in vegetable crops can be observed everywhere. In terms of production, some areas are producing high quality and quantity of vegetables but production of these crops is not as much as can be desired keeping favourable geo-environmental conditions in view. The villages, which are located in the highland, are exporting vegetables, particularly potato, in the regional market and earning high income. Meanwhile, many regions in the mid-slopes are producing vegetables for domestic consumption. Production of these crops may be enhanced because the agro-ecological conditions are quite suitable in these regions.

The Alaknanda basin constitutes an integral part of the Uttarakhand Himalaya. It is characterized by rough, rugged, and undulating terrain. Agricultural farming is carried out mainly on the narrow patches of terraced field. Subsistence cereal farming is dominating in the entire farming system, which is quite insufficient for livelihood of the people inhabited in this region. As a result of this, poverty and malnutrition is very common phenomenon among the inhabitants and the struggle for livelihood is higher than the other regions of the Himalaya. High rate of out-migration to the foothills and plains is the consequence of these prevailing factors. The terrain is also not fit for the intensive cultivation of agriculture crops due to high rate of soil erosion, instability, and fragility of the landscape. Under such circumstances, cultivation of off-season vegetables can help for sustainable livelihood of the populace and can provide more employment to the unemployed youth of the basin.

Diversity in the agro-environmental conditions provides suitability for growing varieties of vegetables in the hill slopes and high production of these crops can definitely work for poverty alleviation and reducing malnutrition. The hill slopes are very much productive for growing various kinds of vegetables at a large scale. In the Alaknanda basin, the production of potato, onion, and tomato is noteworthy and the region exports potato to the regional markets. The other vegetables are pumpkin, cucumber, beans, reddish, carrot, coriander, and green leafs but these are grown at a domestic level. The commercial importance of these vegetables is very high and the same can be grown abundantly here. Among the spices ginger, turmeric, chilli, tejpat, coriander, and garlic are grown extensively. Recently,

the production of potato has got impressive position among the other crops, which is grown in the high altitude (1500-2200 m) and the cultivation of onion has got its importance in the valley regions and lower-middle slopes (800-1200 m).

Prospects of Sustainable Vegetable Farming

The Alaknanda basin has wide range of prospects for growing various kinds of vegetables with its high quality and quantity. Suitable agro-ecological conditions and low income from cereal crops further enhance a base for cultivation of off-season vegetables. Detail discussion on prospects of sustainable cultivation of off-season vegetables are as follows:

Suitable Agro-Ecological Conditions

The Alaknanda basin provides a great scope for production of off-season vegetables. The vegetable farming varies from the valley regions to the mid-slopes and highlands according to terrain, slope, soil contents, and availability of water. On the mid-slope and highlands, potato is grown extensively, while on the terraces of valley regions, onion is the main vegetable. Besides, all varieties of vegetables are grown in the entire basin, which have high economic value. The vegetable farming can be divided into two vertical zones according to an altitude.

Potato Farming in the Highlands

Potato is the main vegetable of the highlands, which is grown between 1500 m and 2200 m. It is mostly grown on the gentle slope of the mid and highlands (10-15°). During eighties, the farmers of the region started intensive cultivation of potato and they are now able to export potato to the regional market. The main community development blocks where potato is grown in a large scale are the highlands of Narain Bagar, Tharali, Deval, and Kapkot. Along with cultivation of potato other vegetables and spices such as beans, ginger, cucumber, pumpkin, turmeric, and chilly are also grown in this zone. These vegetables are locally consumed.

Onion Farming in the Valley Regions and Mid-Slopes

Onions are grown in the valley regions, where the availability of irrigation water is ample. It is grown during the summer in different localities along the river terraces in all the community development blocks. Presently, the farmers are able to export onion to the regional markets (foothills of *Shivaliks*). These localities are found between 800 m and 1200 m, mainly between Karanprayag and Tharali service centers on the road-head. Along with production of vegetables, the basin has tremendous potential for production of spices. The ecological conditions of the region are highly suitable for cultivation of a large number of spices such as ginger, turmeric, chilli, tejpat, coriander, and garlic. Ginger is one of the main cash crops among spices, supporting livelihood and improving the economic level of many ginger growers of the basin.

Low Outcome from Traditional Cereal Farming

Traditional cereal farming is the main occupation of the people of the mountain regions in general and the Alaknanda basin in particular (Sati 2005). The economic viability of these crops are not sufficient even to meet the two times meal. Nature of terrain, aspect of slope, soil fertility, availability of water, and uses of modern technology in the field of agriculture are the main constraints for food security and sustainable development in the basin. Under such circumstances, the people of the region sought out the possibilities of cultivation of off-season vegetables and they got the tremendous success to a great extent in this context.

Table 1 shows production (quintal) and productivity (per ha yield) of traditional crops and vegetables in 2003.

Table 3.1 Production (quintal) and Productivity (per ha yield) of Traditional Crops and Vegetables (2003)

Name of case study village	Elevation	Traditional crops (millets, wheat and rice)			Vegetables (potato and onion)		
		Area devoted	Production	Productivity	Area devoted	Production	Productivity
Kulsari	1150	460 (ha)	1700 (Rice and wheat)	4.7	85 (ha)	600 (Onion and other seasonal vegetables)	7.1
Kwarad	2200	380 (ha)	945 (Millets)	2.5	180 (ha)	1800 (Potato and other seasonal vegetable)	10
Khainoli	1900	385 (ha)	970 (Millets)	2.5	165 (ha)	1745 (Potato and other seasonal vegetables)	10.5
Kewer	1200	510 (ha)	1850 (Rice and wheat)	3.6	65 (ha)	500 (Onion and other seasonal vegetables)	7.6
Dimri	750	465 (ha)	1600 (Rice and wheat)	4.4	55 (ha)	400 (Onion and other seasonal vegetables)	7.2
Lolti	1800	370 (ha)	1005 (Millets)	2.7	136 (ha)	1600 (Potato and other seasonal vegetables)	11.7

Source: Primary collection

The author conducted a case study of six villages of the basin **(Table 3.1)**. These villages are selected on the bases of elevation (varies from 750 to 2200 m). Comparative study of traditional crops (millets, wheat, and rice) and vegetables (onion and potato) has been carried out, which reveals area, production, and productivity of the traditional crops and vegetables. It further denotes that vegetables have high production and productivity both in lowland and highland than to traditional crops (varies from 11.7 to 2.5 per ha yield respectively). High percentage of cropped land is devoted for the cereal crops in comparison to the cropped land devoted for off-season vegetables. Productivity of cereal crops is 4.7 whereas it is 11.7 for off-season vegetables. Land under vegetable crops is remarkably low, this also varies from the villages of valley regions to the highlands villages. The proportion of land under vegetable crops is comparatively high in the highlands. In contrast, with the high proportion of land under traditional cereal crops, production and productivity of vegetable crops is notably high. For instance about 460 ha agricultural land is devoted for

cereal crops in Kulsari village (1150 m), productivity of crop is 4.7 whereas land devoted for cultivation of onion is 85 ha, productivity was noticed 7.1. In the highlands, land under traditional crops in Kwarad village (2200 m) is 380 ha and its productivity is 2.5 whereas 180 ha land is devoted for vegetable crops, which productivity is 10. Similarly, high productivity of vegetable crops is noticed in the villages of highland.

Promotion of Off-Season Vegetable Farming

As it is already mentioned earlier that the basin possesses suitable geo-environmental conditions for the production of off-season vegetables therefore, high variety of vegetables such as onion, ginger, garlic, capsicum, cauliflower, ladyfinger, cucumber, pumpkin, tomato, and potato are produced here. It is noticed that the land under vegetable crops is proportionally very low. With the efforts done by the governmental agencies and innovation in the field of cultivation, the land under cereal crops is being transformed either into off-season vegetables or fruit trees. **Table 3.2** shows income of the farmers from both traditionally cultivated crops and off-season vegetables.

Table 3.2 Income from Traditionally Cultivated Crops and Off-Season Vegetables

Name of village	Accessibility and elevation (in m)	Number of families involving with off season vegetables	Income from traditional crops (Indian Rs.)*	Income from off-season vegetables (Indian Rs.)
Wan-Mundoli	On the road (1900)	24	1000-1500 per season per family	4000-4500 per season per family
Ghais-Blan	15 km away from road (2300)	26	1000-1500 per season per family	4000-4500 per season per family
Kurur-Kwarar	15 km away from road (2200)	28	1000-1500 per season per family	4000-4500 per season per family
Sol-Dungri	15 km away from road (2300)	22	1000-1500 per season per family	4000-4500 per season per family
Binayak-Banoli	4 Km from road (1200)	38	2000-2500 per season per family	3000-3500 per season per family
Narainbagar	On the road (1100)	13	2000-2500 per season per family	3000-3500 per season per family
Kulsari	On the road (1150)	29	2000-2500 per season per family	3000-3500 per season per family

Source: Primary collection
* 45 Indian Rs. is equal to 1 USD (as per the rate in Nov 2006)

Table 3.2 represents that income from the traditional crops is subsistence in nature in all the selected villages, which varies from 1000-1500 Rs. in the highlands to 2000-2500 Rs. in the valley regions. In contrast, income from off-season vegetables varies from Rs. 4000 to Rs. 4500 in the highlands and from Rs. 3000 to Rs. 3500 in the valley regions, depending

upon the various factors. The scope of off-season vegetables in all altitudinal zones of the basin is higher than the cultivation of traditional cereal faming. However, it is higher in the highlands.

Changing Pattern of Cereal Crops

The Alaknanda basin is characterized by the dominance of traditional subsistence cereal farming, which is based upon the centuries old practices and carried on the narrow patches of terraced fields but distribution of crops and their pattern are not uniform that vary from the valley regions to the highlands. Generally, millets are grown in the highlands while valley regions are characterized by the cultivation of wheat and paddy crops. The economic viability of crops in these altitudes is insufficient in terms of meeting food requirement of the populace, due to low production of crops. Uneconomic production from inconveniently located agricultural plots and growing alternative off-farm opportunities for securing livelihood, a significant portion of farmland gets change in agrarian system in the basin. Furthermore, the high growth rate of population and its pressure on the cultivable land on the one hand and modern innovation in the field of agriculture and high literacy rate on the other, have all together sought out a possibility of adopting cultivating more economically viable crops. But, technological innovations such as chemical fertilizers, pesticides, and high yield crop varieties that transformed valley regions, could not change the highlands farming system to a great extent, on account of mountain specific constraints. Dependence on forests for maintaining soil fertility in the croplands or expansion of agricultural land itself thus was not substituted by the new technologies. As forests and livestock provide material and energy inputs in traditional mountain farming systems, expansion of traditional agriculture runs the risk of forest degradation. In order to meet the present and future challenges meeting sustainability criteria, the traditional systems need to be adapted in ways which enhance crop yields but not at the environmental and social costs (Ramakrishnan et al., 1993). Cropping pattern also varies with the variations in the climatic conditions and cropping seasons. The influence of the monsoon on the cropping pattern is very dominant; with the result of the total cropped area about 70.75% is under 'Kharif' or rainy season crops. In the region, whatever may be the type of soil or the amount of rainfall the dominance of food grains in the cropping pattern is obvious everywhere (Sati & Rawat 1993).

Presently, the cultivation of food grain is limited only on the terraced slopes in mid-altitudes (below 2000 m) or un-terraced gentle slopes in high altitudes (above 2000 m). In terms of, diversity in crops, it is high in the highlands in comparison with the crops of valley regions, whereas valleys, all through the area are much more intensively cropped than the slopes. Crop diversity is managed by mixed cropping with crop rotation (Sati 1993).

Table 3.3 Case Study of a Terraced Farmland (TF)

1.	Total area	2 ha
2.	Location	Left bank of the Pindar River
3.	Slope and slope direction	15° to 20° north facing
4. Crops grown before 1990's		
a.	During summer and rainy season	Rice, millets and oilseeds
	Production	15-20 quintal
	Gross income	Average 12000 Indian Rs.
b.	During winter season	Wheat and mustered oil
	Production	6-10 quintal
	Gross income	Average 7000 Indian Rs.

c.	Total	a+b= 19000 Indian Rs.
5. Crops grown after 1990's		
a.	In all seasons (four times in a year)	Tomato
	Production	12-16 quintal/season (about 60 quintal/year)
	Gross income	Average 60, 000/year

Source: Primary collection

A two ha TF was selected for the case study **(Table 3.3)** to show the changing pattern in agriculture and benefits from the vegetable crops. Situated on bank of the Pindar River in the north facing slope along with 15° to 20° slope gradient, this TF was devoted for the cultivation of two seasons cereal crops mainly paddy, millet, and oilseeds during summer and rainy seasons and wheat, barley, and mustered during winter season before 1990. The average gross income from the crops was 12000 and 7000 Indian Rs. respectively. In 1991, this land was taken in lease by a Nepali immigrant and he started cultivation of tomato in this TF and earned average gross income 60, 000 Indian Rs./year. Ample water supply for irrigation and availability of market promoted this crop. Observing the success of this TF, the farmers, who had the farmlands on the course of perennial streams and near the service centers, transformed their land from cereal crops into the cultivation of tomato and other off-season vegetables. This trend can be noticed in the low-lying areas of the basin, where roads are traversed. **Table 3.4** shows cultivated vegetable crops and time availability time.

Table 3.4 Cultivated Vegetable Crops and Availability Time

Local name	English name	Botanical name	Availability season
Lauki	Bottle gourd	*Lagenaria vulgaris* L.	Rainy
Gol Caddu	Pumpkin	*Cucurbita maxima* Duchesne	Do
Tit Karaila	Bitter gourd	*Momordica charantia* L.	Do
Bhindi	Lady's finger	*Abelmoschus esculentus* Moench	Do
Kakadi	Cucumber	*Cucumis sativus*	Do
Muli	Radish	*Raphanus sativus* L.	All
Ogal	Buckwheat	*Fagopyrum esculentum* Moench	Summer
Sagiya Mirch	Capsicum	*Capsicum annum* L.	Summer and rainy
Bean	Bean	*Phaseolus vulgaris*	Do
Tamatar	Tomato	*Lycopersicon esculentum* Mill.	All
Lai	Indian Mustard	*Brassica Juncea* Czern & coss.	Do
Methi	Fenugreek	*Trigonell foenum-graecum* L.	Do
Palak	Spinach	*Spinacia oleracea* L.	Winter
Bakula	Field bean	*Vicia faba* L.	Summer
Matar	Pea	*Pisum sativum*	Winter
Aalu	Potato	*Solanum*	Summer and rainy

		tuberosum L.	
Halang	Garden cress	*Lepidium sativum* L.	Winter
Baigan	Egg plant (brinjal)	*Solanum tuberosum* L.	Summer and rainy
Piyas	Onion	*Allium cepa* L.	Summer
Pinalu	Cocoyam	*Colocasia esculenta* L. (Schott.)	Winter
Gaderi	Taro	*Colocasia* Sp.	Do
Turai	Ribbed gourd	*Luffa acutangula* L. (Roxb.)	Rainy
Chaulai	Garden amaranth	*Amaranthus tricolor* L.	Summer and rainy
Band Gobhi	Cabbage	*Brassica campestris*	Summer
Phool Gobhi	Cauliflower	*Brassica oleracea* Var.	Do
Chichinda	Songe gourd	*Luffa cylidrica* (L.) M. J. Roem.	Rainy
Murch	Chilli	*Capsicum annum* L.	Rainy
Lasun	Garlic	*Allium sativum* L	Summer
Dhaniya	Coriander	*Coriandrum sativum* L.	All
Haldi	Turmeric	*Curcuma longa* L.	Winter

Discussion and Conclusions

Cultivation of subsistence cereal farming dominates in the cropping pattern of the Alaknanda basin; while their economic viability is considerably less. The reasons behind low viability of cereal crops are (i) traditional methods of cultivation, (ii) the seeds are of low quality, and land condition is poor, (iii) low soil fertility, and (iv) no use of modern innovation in the field of agriculture. These factors altogether do not produce sufficient food grains even tremendously less than requirements. Furthermore, fragmentation of agricultural fields and fragility of terrain do not support the poor farmers for intensively cultivating their farmlands. Modern agricultural innovation can not be used properly and sufficiently. This is basically due to undulating terrain and steep slope. The mode of agriculture is traditional and fully depended on draught power. The use of chemical fertilizers is not feasible. The past experiences show the fertility of the soil lessened due to over use of chemical fertilizers in the 1980's. It is because that under the rain-fed agriculture, chemical fertilizers reduced soil fertility. The experts of agriculture and horticulture department have started discussion on viability of subsistence cereal crops. It is being widely accepted that though traditional cereal crops are more suited in the ecosystem of mountain regions yet these crops are economically unviable. The agro-ecological conditions are tremendously high for cultivating cash crops spatially for off-season vegetables. In some areas, it has already attended an impressive success. Under such situation, the efforts for cultivating cash crops, which are already on the way, should be spread in the whole basin particularly the areas suitable for it. The awareness programmes should be launched with full motivation and the farmers should be encouraged to transform their cropped land (cereals) into cash. It will definitively improve the living standard of the people and will enhance the economy of the region.

The study on cultivating off-season vegetable in the Alaknanda basin reveals that the region has ideal conditions for production of vegetables. Potato and onion, as depicted in **table 3.1**, has the potential for food security and sustainable development. The farmers of the

region have already initiated farming of cash crops including spices and green leaf vegetables. The main constraints for producing vegetables are lack of cold storages, means of transportation, improved seeds, and fertilizers. Because most of vegetables are perishable in nature, therefore cold storages are required to preserve them. The following suggestions are given for cultivating off-season vegetables that will lead sustainable livelihood: (1) establishment of cold storages each in a micro drainage basin, (2) proper selection of land and crops according to the agro-ecological conditions, (3) emphasis should be given for cultivating cash crops at a large scale, and (4) proper training should be given to the farmers of the basin for scientific cultivation of crops.

FRUIT CULTIVATION

The Alaknanda basin presents a wide and unique opportunity for cultivation of various kind of fruits-citrus and apple in particular as the agro-ecological conditions in this region are quite suitable. However, this region could not get impressive position in terms of production and productivity of fruits. The neighbouring Himalayan states-Himachal, Jammu and Kashmir, and northeastern states got tremendous achievement in the same field during the recent past. In the basin, there are various geographical locations which bear suitable geo-environmental conditions. These locations can be transformed into 'fruit belts'.

In the Alaknanda basin, cultivated land comprises 12% of total geographical area. The whole cultivable land is utilized for growing subsistence cereal crops while area under fruit trees is considerably low. Out of the total cultivated areas, fruits are grown in 0.6% area mainly on the mid-altitudes and the highlands. When we compare economic viability of subsistence cereal crops and fruits, it is noticed that cultivating fruits is more viable than subsistence crops. It provides a base for enhancing livelihood, generating income, and augmenting of employment. The agro-ecological conditions and landscape of the basin have altitudinal diversity. This provides cultivating various kinds of fruits. Apple is grown in the highlands above 1600 m. Citrus are cultivated between 800 m and 1600 m. Though, mango, guava, papaya, and banana are grown in the low lying areas between 500 m and 800 m yet its proportion in production is negligible. Similarly, nut, stone, pears, peach, almond, strawberry, and wild fruits are grown in the highlands with low area cover and low production.

Distribution of Fruits

Diversity in fruit crops is high in the whole basin. It varies vertically and horizontally. This study is based on the data collected from entire region and drainage basins of the major rivers and their tributaries. The major rivers are the Alaknanda, Dhouli Ganga, Vishnu Ganga, Nandakini, Pindar, and Mandakini. Here, types of fruit and their producing areas are given in the major agro-ecological zones. **Table 3.5** shows distribution of fruits according to an altitude and river basin.

Table 3.5: Distribution of Fruits in the Alaknanda basin

Type	Altitude	Agro-ecological zone	Producing area
Apple, pear, peach, almond, apricot, and nut	1600-2200 m	Temperate cold	Dhouli Ganga, Vishnu Ganga, Upper reaches of Nandakini, Pindar, and Mandakini Rivers,
Citrus- lemon, orange, mandarin, and elephant	1000-1600 m	Sub-temperate to temperate	Mid-altitudinal regions of Nandakini, Pindar, and Mandakini, higher reaches of

citrus			lower Alaknanda basin
Guava, papaya, and mango	500-1000 m	Sub- tropical	Low-lying areas (river valleys) Nandakini, Pindar, Mandakini, and Alaknanda
Wild fruits- pear, peach, kafal (*Myrica esculenta*), ber (*Ziziphus Jujuba*), hinsul (*Rubus ellipticus*), and bhamore (*Benthamidia capitata*)	500-2200 m	Sub-tropical to temperate cold	In entire region of the Alaknanda River its tributaries

Source: Adopted and modified (Sati, 2004)

Table 3.5 shows distribution of fruits (including wild fruits) in the Alaknanda basin according to vertical and horizontal distribution. Agro-ecological zones vary from cold to sub-tropical (500 m-2200 m). The major types of fruits are (a) apple-pear, peach, almont, apricot, and nut (1600-2200 m) (b) citrus-lemon, orange, mandarin, and elephant citrus (1000-1600 m) (c) sub-tropical-guava, papaya, and mango (500-1000 m) and (d) wild fruits-pear, peach, kafal (*Myrica esculenta*), ber (*Ziziphus Jujuba*), hinsul (*Rubus ellipticus*), and bhamore (*Benthamidia capitata*) (500-2200 m). Wild fruits play a vital role in subsistence economy and livelihood of the Himalayan people. A variety of wild fruits with enormous economic potential can be seen grown in the valley regions, mid-slopes, and the highlands of the basin. These fruits used for food traditionally by native people. However, their economic valuation did not occur so far. The native people were able to brought value added products from some of these species during last three decades and so. These fruits have also been used as a medicine while curing many diseases through local health system.

Development of Fruit Cultivation: Current Status

Development of fruit cultivation has a long history in the basin. It has been practicing from centuries for domestic consumption. In the 1970's, the Government of Uttar Pradesh launched a programme for development of fruit cultivation in Uttarakhand (U. P. Hills). A proportion of land- uncultivated and forest was devoted and demarcated as 'fruit belts'. The area is characterized by temperate climate. A large number of fruit plants were planted in the demarcated area. However, in many proposed fruit belts, this scheme could not get success. The reason behind this was the joint venture of state government and state forest department. Many of the fruit belts were under reserved forest area. The state forest department refused to convert the reserved forest area into fruit belts. Therefore, a land which was under community land or uncultivated land of revenue department was put under fruit belts. Apple was largely grown in the fruit belts of Gwaldom-Lolti, Pothibasa-Duggal Bitta, Triyuginarain-Toshi, and Kalimati-Janglechatti. This was continued upto the 1980's. A large-scale production of apple was achieved and sold in the national market. A delicious apple variety got international market. The apple orchards are currently no more and they are converted into agricultural land or land under cash crops. An owner of about 5 ha apple orchard, now Shubhas Herbal Nursery (SHN) Mr. Jodh Singh Badiyari was interviewed. The owner had extensive apple cultivation before the 1990's where about 50 quintal apple were produced in a season. He informed that *due to disease in apple trees, the whole garden was destroyed*. Although, there is a horticulture training center at Gwaldom and the state government employed trainers to look after the orchards in the region yet according to the owner of SHN, *the trainers never visited his orchard*. He requested trainers several times to visit his orchard but they do not turn-up. There are various regions of failure of fruit

cultivation. Climate change is one of them. The author, during his field visits, observed that the orchards of apple and citrus are abandoned. Dwarika Prasad Sati, a forester in Forest Development Corporation remarked, *'due to tremendous changes in climate, cultivation of fruits has completely been vanished.* The areas where intensive cultivation of apple was carried out during the past are no more for cultivation. This belt has been sifted greatly in the higher elevation. This is also the case with citrus and nut-stone fruit belts. The extension workers of horticultural department and horticultural mobile teams could not do better for increasing production of fruits and helping to the poor farmers. Fruit orchard needs nourishment and high investment. It needs four to five years to grow. The farmers are marginal and poor. They are not able to run their livelihood for four to five years without growing subsistence crops. They need financial assistance. In this context, the government agencies can assist them financially.

Prospects of Fruit Cultivation

The whole basin is bestowed with suitable agro-ecological conditions, immense water resources, and cheap human labour. These factors together are feasible for cultivating fruits of various kinds. As the agro-ecological conditions vary from sub-tropical to alpine so that fruits of sub-tropical, sub-temperate, and temperate can be grown in a large scale with high quality and quantity. It is a common experience that the ecological conditions of the area are more suited to fruit cultivation rather than cereal farming (Atkinson 1889 a). Along with fruit cultivation, cultivation of tea and of off-season vegetables will boost up the regional economy (Sati and Kumar, 2004). From the valley regions to the north border, sub-tropical humid and bio-climatic conditions change step by step into temperate, sub-temperate, and alpine zones (Atkinson, 1889 b) depending upon different factors, such as altitude, direction of slope, and distance from snow-clad peaks. Out of these factors, altitude is most important one in determining broad features of climate of particular region, such as temperature, moisture, and rainfall. Fruit cultivation is even more overwhelming, owing to the presence of numerous mountains that transverse and tower above the surface and have relative relief ranging from 600 up to 7816 m. It is also varied from one altitude to another due to variation in the given factors.

Economy of the Alaknanda basin is based on cultivation of subsistence cereal crops. The production and productivity of these crops is considerably low. It does not meet even daily food requirement of the people. Therefore, the people of the region have out-migrated largely to the metropolitan city and plain region. This led a severe situation of over and under population. The whole region is ecologically fragile. Landslide and soil erosion is a common phenomenon. It reduces soil fertility and consequently low production of crops observed everywhere in the region. Cultivation of fruit on the hilly slopes of Garhwal region has duo impacts on economy and landscape. It is a cash crop. Tremendous production of fruit crops will lead a way for enhancing regional economy. Similarly, fruit trees conserve soil. The areas characterized by soil erosion should be demarcated and subsequently, plantation of fruit trees should be carried on.

Discussion and Conclusions

Development of fruit cultivation was greatly influenced by government policies and participation of community people. The movement for growing fruits in hill slopes of the Alaknanda basin could not get success due to two factors. Government decision to establish fruit belts in the temperate region was unsuccessful because of framing irrational planning and non-coordination with forest department. People's participation in the development process has a great role. There is a story of failure of individual efforts towards diversifying and enhancing livelihood options. The marginal agricultural land is fragmented. There are

various reasons of failure of individual efforts such as fear from wildlife, the other owners who are least interested for cultivating fruit crops will also create disturbances. This observed after interview of the farmers who grow fruits. Under such circumstances, what step is to be raised for development of fruit cultivation? There is a general consensus among the producers, researchers, and academicians about community participation with modern innovation in farming systems. If an innovative idea is implemented by the owners regarding initiating enterprises related fruit cultivation on community basis, sustainable development can be attended. Like self help group, community participation in development activities should be ensured. Though, there are various schemes launched for assisting farmers and organizing community groups for the development purposes, still major thrust is required to assist the community groups as a whole not as an individual basis. If a group of community people will participate together in cultivation of fruits, the entire scenario may be changed and development of the region may be ensured.

POTENTIALS OF DAIRY FARMING

Dairy farming in the Uttarakhand has a vast potential. Suitability in the environmental conditions for rearing lactating animals and suitable agro-ecological conditions for growing various types of grasses are largely found in entire mainland of Uttarakhand. In the past, outnumbered lactating animals were reared and milk was produced for self-consumption and as well as for supplying in the local market. This trend of producing milk has considerably been reduced in due coarse of time as the farmers have left this practice at a large scale. Keeping suitability in the environmental conditions, the Government of Uttarakhand and the Department of Animal Husbandry initiated Intensive Mini Dairy Project (IMDP) initially for five years in each district of Uttarakhand. This study aims to discuss the potential of dairy farming in the Alaknanda basin. An appraisal was made on Chamoli District Dairy Production Cooperative Union Limited (CDPCUL) Simli and a case study of Bhararisen Dairy Farm (BDF) was done.

Rearing livestock is a main occupation of the people of the study area. It consists mainly rearing of draught animals, used for getting manure and plow the agricultural fields. Domestic production of milk for self-consumption is also a characteristic feature of livestock rearing. In the past decades or so, when the population pressure on the land was comparatively less and the annual production from subsistence cereal crops was able to meet the average grain need, rearing of draught animals was relevant because they were the main source of manure and draught power. Subsistence production of milk and milk made products, mainly ghee, for household consumption and as well as its supply in the local market or within the villages was possible by rearing of lactating animals i.e., cows and *murrah* buffaloes. Currently, the major species of lactating animals are *Sahiwas*, *Red Sindhi*, *Jersey,* and *Halsteen Freejian* in caw and *Murrah* in buffalo. Each household had a pair of bullocks, a cow, and a buffalo as an average. Along with meeting the need of draught power, plowing agricultural fields and providing manure, the households were able to produce milk for daily consumption. A number of households sold milk in the nearby market to run their livelihood. Meanwhile, the trend of rearing draught and lactating animals has declined tremendously. Keeping declining trend and suitable geographical conditions for rearing improved lactating animals in view, the Government of Uttarakhand and the Department of Animal Husbandry initiated IMDP initially for five years from 2004-05 to 2008-09. There are 13 IMDP in Uttarakhand. CDPCUL Simli was case studied. Similarly, a case study of BDF was done.

IMDP in Uttarakhand (2004-05 to 2008-09)

The Government of Uttarakhand has taken initiatives to start IMDP in all thirteen districts of the state initially for five years from 2004-05 to 2008-09. The main purpose of this scheme is to augment employment and to enhance economy of the poor rural people in the main land of Uttarakhand. For successful implementation of this project, scientific training has been imparted to the beneficiaries to increase the milk production, income earning, and augmentation of employment so that the emigration of rural youth would be minimized. **Table 3.6** shows target under IMDP in Uttarakhand for 2004-05 to 2008-09.

Table 3.6: Target under IMDP in Uttarakhand (2004-05 to 2008-09)

	First year	Second year	Third year	Fourth year	Fifth year	Total
Establishment of mini dairy	1350	1450	1500	1550	1600	7450
Reserved for SC and ST	311	334	345	356	368	1714
Employment generation						
Direct	4590	4930	5100	5270	5440	25330
Indirect	505	542	561	580	598	2786

Source: Dairy development, Uttarakhand, UCDFL, Haldwani (Nainital)

NABAARD has recommended establishing a unit, which will ensure to provide two animals for each beneficiary. Loan up to Rs. 30, 000 will be provided by the bank to the beneficiary after the recommendation of the unit. Subsidies, in a form of transportation of animals (Rs. 2500), initially for fodder (Rs. 560), insurance of animal and beneficiary (Rs. 2520), and margin money (Rs. 3000) will be given to each beneficiary for establishing dairy unit. This department will provide the following services:

1. Providing technical investment facilities for beneficiaries having lactating animals.
2. Medicinal facilities by veterinary doctor at village level.
3. Solution of the problems related to animal insurance.
4. Imparting scientific training to beneficiaries for animal management and fodder development.
5. Imparting training to beneficiaries for using organic farming and biogas plants and reducing chemical fertilizers in agricultural fields.
6. Ensure women participation for their empowerment.
7. To assist the schemes run by NABAARD and cooperatives.
8. Benefiting landless labours, BPL families and the household fully depended on agriculture through this scheme.

Case Studies

Case studies of CDPCUL Simli and BDF have been carried out in the following manners:

(1) CDPCUL Simli

This unit was started in November 1989 at Simli in Chamoli district. Entire Chamoli district is its catchment but currently, this unit is working in mainly six development blocks (Deval, Tharali, Narainbagar, Gairsain, Karanprayag and Pokhari) and five main road sides (Simli-Gairsain, Simli-Deval and Gwaldom, Simli-Gaucher, Simli-Langasu and Simli-Kandara). Per day collection of milk is 720-liter. The main objectives for establishing of this plant are:

1. to provide milk market at village level,
2. to control over milk price,
3. development of self help group,
4. providing loan facilities for purchasing lactating animals,
5. empowering women through their active participation,
6. arrangement of grain and green fodders to animals, and
7. providing veterinary facilities for lactating herders.

Committees are set-up at village level, which include women and dairy herders and a chairperson, who will preside over all committees. The main function of the members of committees is to link between the cooperative society and the villagers. Furthermore, they also work for motivating the villagers to rear lactating animals and to become self-reliant. At Simli, seven employees are working with different capacities. A chairperson, three employees of state government, and three women workers in adhoc constitute the CDPCUL. Recently, the output from the CDPCUL is considerably low. As a result of this, the management has decided to drop three workers including two women from the working society. It means that the size of the society is reducing because of low output. While discussing with the personnel of the society, it was penetrated that the collection of milk from the different road heads is not feasible because of lacking in transportation and less production of milk. Meanwhile, the central location of CDPCUL Simli is ideal for collecting and distributing milk and milk based products.

(2) BDF Bhararisen

A case study of BDF **(Table 3.7)**, which is located at the water dividing of the Pindar and the Ramganga rivers about 30 km away from Karanprayag township and about five km away from Diwalikhal on the way to Karanprayag-Ranikhet, was done. During the 1980s, the government of Uttar Pradesh set-up this farm, at an altitude of 2000 m. The ideal conditions, such as climate, availability of fodder, and gentle slope favoured this dairy farm. In 1990, milk production per day was 3000 lt. (six lt./cow). Similarly, the total number of cows was 500. About 250 employees were working in this farm. In 2008, the entire scenario is changed. The area of the farm has reduced from 1 sq. km to 0.8 sq. km. Total number of cows is 300. Most of them are calves. Per day milk production has reduced and remained to 1500 lt. The milk consumption area is limited to CDPCUL Simli. When I raised the issue of declining milk production and number of employees from BDF with the employees, they ironically stated that the government withdrew its support and wants to close this unit. Interestingly, the entire regions, Bhararisen and its surroundings, have the potentials of rearing high yield variety animals and producing high quantity of milk. The agro-climatic conditions favour rearing of high yield variety lactating animals. An interesting point came into focus regarding dairy farming in this region. Farmers say that the joint efforts by the community people and the government can enhance milk production. The government has to support financially at the time of adverse circumstances prevail.

Table 3.7: Bhararisen Dairy Farm at a Glance

S. No.	Characteristic features	1990	2008
1.	Location	2000 m	2000 m
2.	Area cover	1 sq. km	0.8 sq. km
3.	Total number of cows	500	300
4.	Total number of employees	250	100
5.	Per day milk production	3000 lt.	1500 lt.

6.	Milk consumption area	Between Karanprayag and Dwarihat	CDPCUL Simli

Source: Primary collection

Table 3.8: Milk Yields and Fodder Requirement (Per Day)

Name of village (elevation)	Accessibility from road	Milk yield by cow (indigenous)	Milk yield by buffalo (indigenous)	Fodder used oak/other (Wint./Summ)	Crop residue (whole year)
Kimoli (1900 m)	10 km	80 kg	300 kg	800/900 kg	300 kg
Prethi (1600 m)	5 km	50 kg	150 kg	600/700 kg	400 kg
Ali (1200 m)	0.5 km	20 kg	25 kg	Nil/200 kg	400 kg

Source: Sati, 2004

Table 3.8 shows that the milk production and fodder requirement (per day) varies from one place to another according to the elevations. The production of milk is increased according to the increase in elevation. The milk obtained from buffaloes is much more than from cows. Similarly, altitude and oak fodder play a vital role in the production of milk. The fodder requirement is largely satisfied in the high altitudes. Forests provide the maximum fodder because there are large grassland and forestland surrounding the villages. The climatic conditions are feasible for the production of milk and the rearing of different animals. At least the accessible areas, which are connected by roads, may be used for introducing hybrid animals. This process will boost the economy of the villages.

Prospects of Dairy farming

Dairy farming is one of the economic activities upon which livestock-dependent farming communities in the mountain areas depend. It involves natural resources base-forest/ranglelands, croplands, livestock breeds, feeding, health management, marketing, and consumption of the product. Smallholder dairy farming has enormous potential. It can contribute to family income, generate gainful employment especially for women, elevate living standards of the producer, fight malnutrition especially amongst children, and enhance sustainable agriculture. Crop-livestock-forest integrity is a key factor in the sustainability of mountain livelihoods. Augmentation of dairy farming systems leads to enhanced performance of the overall production system.

Dairy farming is an integral part of the region's agriculture. Smallholders comprising most mountain farmers are accustomed to rearing some animals as an essential component of the farming system. Among the various basic needs the animals fulfill, milk is the most important as far as a family is concerned. Dairy animals are the best means to convert local vegetative biomass into useful products and work, and high value biodiversity into products of still higher value, such as dairy products fondly consumed by the masses (Singh, 1996). That is why dairy animals occupy the predominant places in the herds of the region. Here, smallholders who make up the overwhelming majority have evolved two major systems of livestock management in the mixed crop livestock farming system: sedentary and migratory. Cattle and buffaloes are the only dairy species throughout the state. The use of goats and sheep as dairy animals is extremely rare. Grasses have great significance in fodder supplied to animals. *Napier, guni, dolani guchhi, rai* and *brom* grasses are very suitable for fodder production in Uttarakhand. These grasses are found between 500 m and 2500 m. Cultivation of these grasses will be more beneficial to the herders of the region.

Uttarakhand Livestock Development Board (ULDB) is initiating to establish a 'Centre of Excellence for Fodder Grasses' in a selected ten ha Van Panchayat Land of eleven districts in first phase. In second phase, it will be extended in the other Van Panchayat areas of districts so that the problem of fodder could be reduced. ULDB has started to prepare compact field block of 5 and 2.5 kg to distribute to herders in a cheap rate.

Conclusions

Dairy farming may be a subsidiary economic activity after agriculture in Uttarakhand. Similarly, it may enhance livelihood of the populace. The agro-climatic conditions are very feasible for rearing lactating animals. Furthermore, the extensive presence of pasturelands, temperate and alpine, accelerates the possibility for intensive mini dairy farming in the main land of Uttarakhand. At present, there are 13 intensive mini dairy projects in Uttarakhand located in each district. A case study was done in CDPCUL Simli. The study reveals that this unit is not functioning well. Milk is collected from all directions (about six routs). The major problem is facing by the farm is distance between the collection areas and the unit and lacking in number of refrigerators. Milk is collected from about 50-60 km distanced areas in small-scale and often milk remains useless after traveling long distance. The dairy farming communities do not produce enough milk. Whatever they produce, it is for self-consumption or seldom for selling in the local market. For promoting intensive mini dairy farming the following suggestion are given:

1. Installation of refrigerators in each cluster of villages (10-12 in number) should be ensured to avoid wastage of milk.
2. Incentives should be given to the milk-producing farmers for encouraging them.
3. In each cluster of villages, a committee of milk farming community should be formed to look into all matters related milk production. This will ensure the people's participation and will be helpful for smooth functioning.
4. Involvement of local people in collection of milk and milk-based products should be ensured. This will augment employment to the poor rural youth.
5. Veterinary centres should be modernize and should be opened in each cluster of villages.

PROSPECTS OF TEA CULTIVATION

The Alaknanda basin has favourable agro-ecological conditions to cultivate tea mostly on the gentle mid-slopes. Keeping these conditions in view, the British East India Company started tea cultivation during the 1830s. Initially, the tea cultivating areas recognition and produced quality tea but later on, due to many problems related with tea cultivation, its production slowly got down till 1949. Currently, the Government of Uttarakhand established numbers of tea nurseries and gardens in Kumaon and Garhwal Hills where production has already been started.

The region is bestowed with suitable agro-ecological conditions, diverse forest resources, plenty of water resources, highly elevated snow-clad mountain peaks, and charming landscape. Cultivation of tea is done in Pauri and Chamoli districts, which falls in the Alaknanda basin. Case study of nine tea producing areas was carried out, which come under Nauti Sub-Projects (NSP) in Chamoli district. The other areas where tea is produced are Gwaldom in Chamoli district (oldest) and Gadoli-Mandalkhal in Pauri district. This study is mainly based upon interview of the extension workers, unskilled labours and local people who are engaged with this practice.

Tea Cultivation during British Regime

Commercial tea production in Uttarakhand was started during British period. In 1824, Mr. Bishop Heber investigated the potential tea cultivating areas in Kumaon region. It was supported by Mr. Ramley when he prepared a report on tea cultivation in Kumaon and sent it to the East India Company in 1827. Consequently, Lord Venting set up a committee in 1834 to complete this mission. In 1835, around 2000 plants of tea reached Uttarakhand from Kolkata. These tea plants were planted in Laxmeshwar in Almora and Bharatpur near Bhimtal. It spread in entire Uttarakhand slowly and in 1837-38, tea production started. It got recognition regarding its quality and British Government appreciated this efforts. Till 1880, there were 63 tea gardens in 10937 acre land. About 500 workers got employment in tea gardens. Due to severe impediments related to tea cultivation such as export, transport, lack of local markets, labour's problem, lack of tea processing factories at local level, less popularity of tea in the producing regions and minimum interest of the owners towards tea cultivation, it got slowly down in Uttarakhand till 1949.

Tea Cultivation after 1990s

In March 1994, Public Investment Board (PIB) of Uttar Pradesh Government sanctioned Rs. 21.77 crore for Tea Development Projects in Chheedapani (Champawat), Vijaypur-Kausani (Bageshwar), Bhimtal (Nainital), Gadoli-Mandakhal (Pauri) and Nauti (Chamoli) areas. PIB took a decision to establish tea gardens in 811 ha land with a tea processing factories in each sub project. Till now, around 380 ha land is under tea plantation. The land is classified as Van Panchayat, Gram Panchayat and the land of the farmers, which is taken in lease for 30 years. Rest of the plantation, which is scheduled to be done, will be done on the land of interested farmers, initially in lease for seven years and later it will be handed over to the owners (farmers). Table 1 shows proposed tea projects of Uttarakhand.

Table 3.9: Proposed Tea Projects of Uttarakhand

Name of sub project	Sanctioned target	Current situation
Kausani-Bhimtal sub-project	211 ha	210 ha
Nauti sub-project	200 ha	114 ha
Ghodakhal sub-project	200 ha	12 ha
Champawat sub-project	200 ha	44 ha
Total	**811 ha**	**380 ha**

Source: Uttarakhand Tea Development Board (UTDB), Almora

Small-Scale Tea Development Programmes

Keeping suitable agro-ecological conditions for cultivation of tea in view, the Government of Uttarakhand established a UTDB with its headquarter at Almora in 2004. The main objectives of establishing tea gardens in the state are (i) to harness the favourable agro-ecological conditions, (ii) to enhance the economy of the people inhabiting in the surrounding areas of these tea gardens (iii) to ensure the people's involvement so that augmentation of employment may be taken place, and (iv) to reduce the soil erosion after plantation of tea. A tea processing unit of private sector was also established in each area to facilitate the farmers to export their tea leaves. The land, other than Van Panchayat and community land will be under possession of the board for 7 years and then it will be returned to the owners. Training will also be imparted during this period to the owners and their family members. In between, the family members can work in the tea gardens as daily wages (per person per ha). There are some other plans to be implemented for tea cultivation such as National Sustainable Development Plan, Matching Grant Plan, and

Especial Component Plan (for Schedule Casts and Schedule Tribes people). Currently, the allotted area of 200 ha per garden has been reduced to 50-60 ha per garden with 10-15 km periphery.

The board has achieved the following success so far; (1) plantation of tea in 380 ha land, (2) establishment of multiplication plats, (3) establishment of lab for soil testing (Bhawali, Nainital), (4) establishment of nurseries, (5) imparted training for supervisors and labours (50 supervisors and 600 labours), (6) promotion for organic farming, (7) establishment of tea processing factories, (8) availability of global market as South Korea imported tea from Uttarakhand at the rate of Rs. 9700 per kg and it is known as Uttarakhand Tea, (9) employment for 10 permanent employees and 56 in ad hoc, 810 households benefited and 52% employment has been given to women so far, and (10) a research centre has been established at Kausani in 2003 by GBP University of Agriculture and Technology, Pantnagar.
A study of tea cultivating areas of Nauti sub-project in Chamoli District was carried out, which includes Khageli, Chulakot, Chondali, Jakh-Lwenta-Pudiyani, Nauti, Kanswan-Badet, Adi Badri, Janglechatti and Kalimati with its processing centre at Bhatoli. **Table 3.10** reveals details about tea cultivation in Nauti sub division.

Table 3.10: Tea Cultivation in Nauti Sub-Project

Name of tea garden	Classified land	Year of establishment	Area in ha	No. of Worker	No. of Supervisor
Khageli	Van Panchayat	1997	10	24	2
Chulakot	Land owned by farmers	2003	2	2	
Chondali	Land owned by farmers	1999-2000	7	13	1
Jakh-Lwenta-Pudiyani	Land owned by farmers	2004	5	7	1
Nauti	Van Panchayat/ Land owned by farmers	1995-continued	16	32	4
Kanswan-Badet	Land owned by farmers	2002	4	6	1
Adi-Badri	Land owned by farmers	2000	11	16	1
Janglechatti	Land owned by farmers	1999	7	11	1
Kalimati	Van Panchayat	1999	2	3	1
Total			**64**	**114**	**12**

Source: Primary collection

The above table reveals that the land under tea cultivation (64 ha) is mixed which includes Van Panchayat land and land of the local farmers. Total numbers of workers are 114 and supervisors are 12. Besides this, 3 field assistants are appointed. Out of them, one is permanent employee (on deputation) and other two are working in adhoc. The supervisors are appointed on adhoc bases with salary ranging from Rs. 2800 to Rs. 4000 pm. Field assistants, who are working as adhoc receive Rs. 6000 pm while the permanent field assistant receive Rs. 12000 per month. The workers who are engaged in collecting tea leaves receive Rs. 79 per day. Bhatoli is a service centre where a tea nursery is established. A private tea processing unit has also been established here. This unit buys the green leaves and processed it for selling. An ISI level is given by the Government of Uttarakhand to this tea processing unit. It is sold locally, regionally and globally. It has obtained global markets due to its quality.

Interview of workers, supervisors, and field assistants was taken place regarding potential of tea gardens for cost-benefit analyses. Currently, Rs. 64, 800 is paid to supervisors and field assistants as pm salary. Workers who are 114 in number receive Rs. 270180 salary pm. It is totaled as Rs. 334980 pm, excluding the cost of establishment of tea gardens (Rs. 4019760 annual). The output from tea cultivation is estimated. The off-season production of green tea leaves is 20 kg/ha/day, which is 1280 kg/month. During season (four months of monsoon), production increases and goes upto 100 kg/ha/day that is 6400 kg/month (25600 kg during monsoon period). An annual production therefore goes upto 35840 kg. Per kg cost of green tea leaves is Rs. 25. However, the annual output from tea cultivation is Rs. 896000. Cost-benefit assessment shows that tea cultivation in the study area is under severe loss (around five times less than input). When this situation was discussed with the officials who are working in tea gardens they seem optimistic and have a sense that in future, the output would be more. Because, the tea plants are small therefore the production is less. The tea gardens are mostly five to 10 years old and when they will be above ten years, the production will be high. If the production goes upto 100 kg or more from per ha land after 10 years as it is mostly assumed from all corners, the annual production from 64 ha tea garden would be 76800 kg and annual income would be Rs. 1920000. The area under tea gardens yet to be increased in future therefore, the prospect of cultivating tea is optimistic. The farmers who are involved with the practice of tea cultivation or those land is given in lease are though have similar optimistic perceptions but they differ with functioning of tea gardens. They argue that the tea gardens should be given in the hand of the community people than to the skilled labour, hired from the external sources. The conflict between skilled and non-skilled labour often creates severe impediments because of the supremacy of skilled labour. But this is not a big issue because after seven years, the tea gardens will be handed over to the owners of the land as policy has been framed alike. The cost-benefit assessment can not be done properly at this stage because many of the tea gardens are in their initial stage. Indeed, the production is low as the tea plants are small. Real output will be assessed after 10 years or so. Whatever the situation is, it favours the poor and marginal farmers because the benefit goes directly to them. The farmers are getting duo benefits as employment and earning money. Here, 114 local people are working in 64 ha land.

Tea cultivation may be a promising sector and may play a significant role in sustainable development of the basin. The areas, which have similar geo-ecological conditions, tea cultivation may be done in a wider perspective. This will enable the sustainable livelihood of the poor farmers. It needs gentle slope and moderate climate, which has abundance in the mid-slope regions of the study area.

For the enhancement of the society and economic development, the policies need to be reframed. Master trainers, extension workers and other governmental agencies need to be

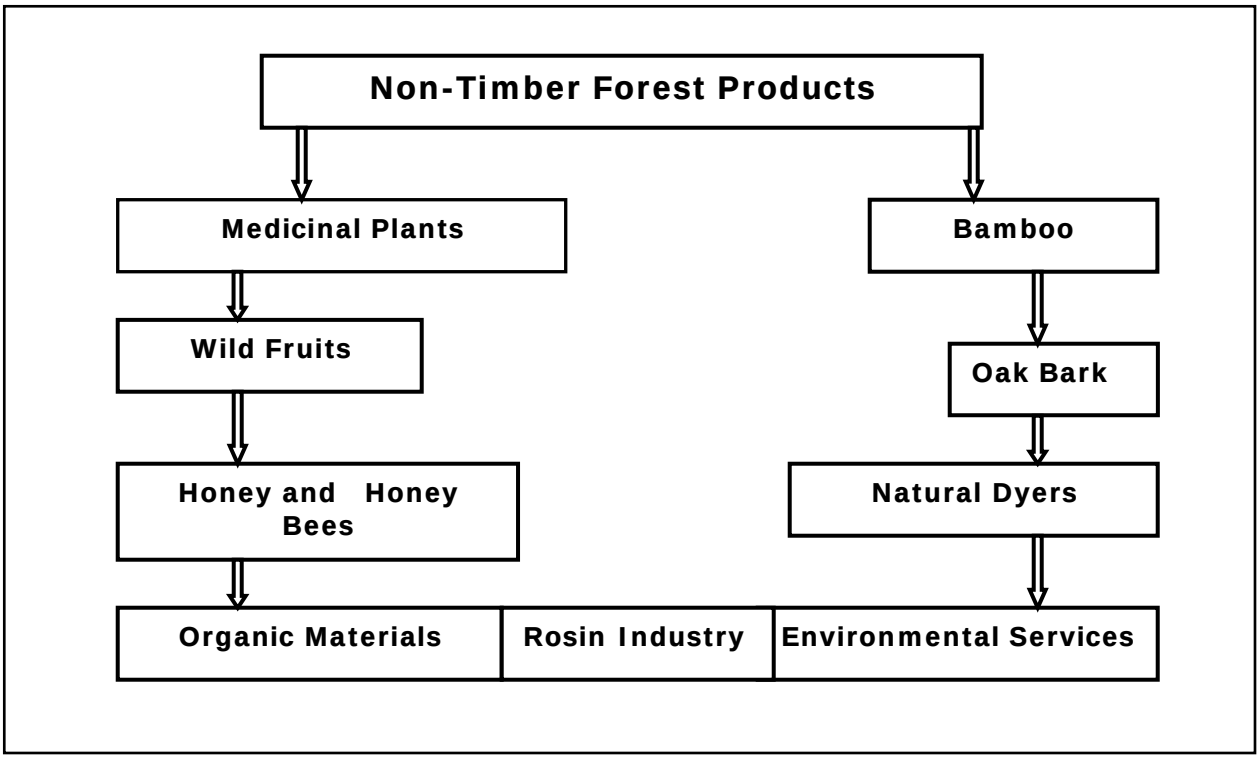
active with proper monitoring so that the policies imposed in any region really could do better. Without government support or intervention, it is difficult to achieve the target of any activities. Similarly, community participation in any developmental activities shows the worth and it is successful in many of the enterprises, which are owned and run by the community people. On the other, in many instances, where individual household or government agency is separately working means without involving the community participation, the schemes are also seam to be failure. Community participation therefore should be ensured as in many areas; active community participation can be noticed.

Worldwide researches for livelihood emphasized the need on diversification of agriculture. In mountain regions, where options for enhancing and diversifying livelihood are less, the cultivation of tea is one of the promising sectors subject to availability of favourable landscape and agro-ecological conditions. Uttarakhand State has an opportunity of having suitable agro-ecological conditions and best landscape for tea cultivation. Because of this, tea cultivation was started in nineteenth century by the Britishers. Though, the study reveals that the output from tea cultivation is tremendously low (five times less than input), yet the future prospects is considerably high. For sustainable tea cultivation in the study area; suitable areas should be sought out in a wider perspective and local people participation should be ensured from establishment of tea gardens to getting final products.

(B) NON TIMBER FOREST PRODUCTS (NTFP)

NTFP can be promoted in degraded land with the willingness of the Village Forest Committees (VFC's) through a participatory approach or the concept of User Group within the Village Forest Development Committee (VFDC) for gradual adoption of the short, as well as, long-term model. A clue can be taken from the centrally and State Government sponsored forestry and forest-based programmes. The Ministry of Environment and Forests, the Government of India is promoting conservation and development of NTFP including Medicinal Plants under National Afforestation Programme (NAP). The 100% Central Assistance Scheme and Projects sanctioned are being executed over a Five Year Period through Forest Development Agencies (FDA's), registered as societies under the State Societies Registration Act.

NTFP is defined as the forest products of biological origin other than wood as well as services from forests and allied land uses. FAO defines, "Non-Wood forest products consist of all goods of biological origin other than wood in all its form, as well as, services derived from forests or any land under similar use". Dr. M. P. Sniva defines: " All products obtained from plants of forest origin and host plant species yielding products in association with insects and animals, including their parts and, items of mineral origin except timber be defined as NTFP. The main non timber forest products are: medicinal plants, wild fruits, honey and honey bees, organic materials, bamboo, oak bark, natural dyers, and environmental services. Plantation of ringal at a large scale should be ensured. ONGC has recently initiated for plantation of ringal in Chamoli and Rudraprayag districts. Details of non-timber forest products are as follows:



ROSIN INDUSTRY

Rosin industry may have potential to enhance the regional economy. The raw materials and other favourable conditions are largely available in the Alaknanda Basin. Rosin locally known as 'Leesa' is extracted from the pine trees. It is collected in the big containers and supplied to the Depot. From there, it is supplied to the places where rosin industries located. It is processed for making different important items.

Definition of Rosin

Hard resin: a hard translucent resin ranging in color from amber to dark brown that is derived from the sap, stumps, or other parts of pine trees. It is used in making varnishes and other products and to increase friction, for example, between the bow and strings of some stringed instruments. **Oil from rosin:** a thick yellowish sticky liquid distilled from rosin and used in making varnishes, inks, and other products.

Distribution of Pine Trees

In the Alaknanda Basin, Forest covers about 67% of the geographical area. Out of it, 40% is covered by pine forest. It is densely found in the major sub-tributaries of the Alaknanda River. Dense pine forest can be seen in the Pindar, Nandakini, Mandakini, Alaknanda, and their sub tributaries between 800 m to 1600 m altitude. The extensive and dense pine forests in the basin provide a suitable base for rosin industry.

Case Study of Lastar Gad Sub-Watershed

A case study of Lastar Gad sub-watershed was carried out. It has around 50% land cover under pine forest. The detail description of rosin industry in Lastar Gad sub-watershed is as follows:

Table 3.11: Details of Rosin Industry in Lastar Gad

Name of area	North and South Jakholi Range
Collection point	Saral Van Parisar
Season of getting rosin	March to November
Production per day	17 kg
Production per season	20 thousand tin
Number of segments (blocks)	24
Number of Contractor	24 (one contractor in each segment)
Number of workers	5-7 worker in each segment
Non-skilled labour	Local and Nepali immigrants
Contractor	Local
Number of pine trees in each block	5000
Area of each block	200 ha
Location of rosin industry	Earlier at Tilwada now in Rishikesh
Products from rosin	Tarpin oil, Biroja, Koltar Paint, Oil for furniture and glass

Source: Primary collection

Table 3.11 shows general characteristics of rosin extraction in the Lastar Gad sub watershed. The area where rosin is extracted from pine trees is known as North and South Jakholi Range. Extracted rosin is collected in Saral Van Parisar which is located about 5 km down slope of Jakholi block headquarter. Rosin is extracted between March and November each year. Per day production of rosin is 17 kg with 20, 000 tin per season (a tin contains 15 kg rosin). The whole sub-watershed is divided into 24 segments (blocks) by the Forest Department. A contractor and 5-7 workers are engaged in each segment. The workers who are engaged in extraction of rosin are uneducated local people and Nepali immigrants. Contractors are locally appointed by the Forest Department. Number of pine trees in each segment is about 5000 while area under pine trees is about 200 ha. Rosin industry was earlier set up at Tilwada in Rudraprayag district now sifted to Rishikesh. While discussing with the employee of the Forest Department, contractors, and labours engaged with extraction of rosin, it was unanimously penetrated that rosin industry should be reinstated in Tilwada instead of Rishikesh. Arguing on this issue, the respondent stated that establishing rosin industry in Tilwada will pave a way for enhancement in regional economy and livelihood of the local people. It will give employment to the local people who should be the real beneficiaries from this industry. Involvement of local people from extraction of rosin to finished products will surely manifest a way for livelihood enhancement. The similar strategy should be adopted in other areas- the Pindar River Basin, Nandakini River Basin, Mandakini River Basin, and the areas located at mid-altitudes of the Alaknanda River basin. These are the areas where very dense pine forest is found. Rosin industry should be established at Narain Bagar for middle Pidar basin, Deval for upper Pindar basin, Ghat for Nandakini Basin, and Rudraprayag for Mandakini and Alaknanda Basins.

An effort was made to get cost-benefit from extraction of rosin. A container having 15 kg weight has a cost Rs. 1000-3000 depending upon distance between the area where rosin is extracted and a place where it is gathered. It is sold @ 3000-4000/container to the factory owner. The benefit goes to the Forest Department. It is obvious that if the whole work from extracting of rosin to the final products is given on the hand of the community people, benefits will go directly to them and they will be able to enhance their economy.

WILD FRUITS

Wild fruits play a vital role in the subsistence economy and livelihood of the Himalayan people. A variety of wild fruits with enormous economic potential can be seen grown in the valley regions, mid-slopes, and the highlands of the Garhwal Himalaya. These fruits used for food traditionally by native people. However, their economic valuation did not occur so far. The native people were able to brought value added products from some of these species during last three decades and so. These fruits have also been used as a medicine while curing many diseases through local health system.

Table 3.12: Potential Wild Edibles in the Alaknanda Valley

Local name	Botanical name	Location (height in m)	Harvesting period	Potential use
Bel	Aegle marmelos	Up to 1200	July-August	Ripen fruit is eaten fresh and used for making juice and squash. Sacred in Hindu religion. Medicinal use: astringent, digestive and stomachic
Guriyal	Bauhinia purpurea	Up to 1300	Feb-March	Flower buds are cooked into vegetable and also pickled. Used in dysentery, piles, diarrhea, and ulcer. Leaves are used as fodder.
Semal	Bombax cieba	Up to 1200	Feb-March	Flower buds are used for making pickle and cooked into vegetable. Leaves are used as fodder.
Kingore	Berberis asiatica	600-2700	June-July	The berries are edible, sweet/sour in taste and used for making juice and squash. Roots form a reputed drug in Ayurvedic medicine.
Bhamore	Benthamidia capitata	1500-2500	Nov-Dec	Fruits are edible and used for making jam.
Lingra	Diplazium polypodies	1000-2000	June-Nov	Fronds of the plant are used for making pickle and also cooked into vegetable. It is Useful for the patient suffering from cough, asthma, fever, stomachache, dysenteric, dyspepsia, and diarrhea.
Gweain	Eleagnus latiifolia	1200 to 3000	Sept-Oct	Fruits are edible and used for making juice and squash. Good in cough and bronchitis. Ability to fix atmospheric nitrogen.
Anwala	Emblica officinalis	500-1500	Dec-Feb	Fruits are edible and used for making pickle, murabba, squash, and juice. Medicinal and nutritious used for curing of cough, anemia, peptic ulcer, diabetic, asthma and bacillary dysentery. Rich source of vitamin 'C'
Timla	Ficus	1000-1200	July-August	Fruits are eaten, making pickle and

	auriculata			cooked into vegetable.
Gular	Ficus glomerata	900-1500	Feb	Ripen fruits are eaten; unripe fruits are used for making pickle and cooked into vegetable. Leaves are used for fodder.
Bedu	Ficus palmata	500-1800	May-June	Fruits are edible, used for making pickle and cooked into vegetables. Medicinally used for digestive disorder. Leaves are used for fodder.
Khaina	Ficus semicordata	900-1400	Oct-Nov	Fruits are used for making pickle. Leaves are used for fodder.
Ames	Hippophae rhamnoides	2000-3000	Nov-Dec	Food, medicinal and cosmetic uses. Curing cold and cough.
Sahtut	Morus serrata	1200-2600	July-Sept	Leaves used for rearing silkworms. Fruits are used for making juice and squash.
Kaphal	Myrica esculenta	1400-2000	May-June	Fruits are eaten and used for making juice and squash.
Ghinga ru	Pyracantha crenulata	800-1800	June-July	Fruits are edible and used for making jam, sauce, juice and squash. Curing cough and cold.
Burans	Rododendren arboretum	1200-2400	March-April	Flowers are used for preparation of juice and squash.
Hinsul	Rubus ellipticus	1000-2000	May-June	Fruits are edible and used for making jam.
Amara	Spondias pinnata	700-1500	Dec-Feb	Ripen fruits are eaten and processed into juice, sauce and squash. Curing dysentery and diarrhea.
Bhatmo liya	Viburnum mullaha	1500-2800	Nov-Dec	Fruits are edible and used for making juice and squash.
Ber	Ziziphus Jujuba	Up to 1500	Nov-Feb	Edible and used for making juice, murabba and squash.

Source: Compiled by author

MEDICINAL PLANTS AND HERBS

India is endowed with a wide spectrum of bio-diversity in plants genetic resources and is to be recognized as one of the world's top 12 mega diversity nations. It possesses rich flora that include about 45, 000 species and many are accredited with medicinal value. Over 15, 000 species are used in different systems of health care in Asia (7, 000 in China and 8, 000 in India). However, available information shows that 1,700 species are used in Classical Indian systems of medicines. Ayurveda uses 1, 200, Siddha 900, Unani 700, Amchi 600, and Tibetan 450 medicines. These raw materials are obtained from the forests only, where a few plants are under cultivation. Despite, the close relationship between the forest and pharmaceuticals, very little effort has been made to maintain, manage, and develop technology for conservation of these medicinal plant resources of the Indian forests. The estimated 95% of medicinal plants collected in India are from the wild and process of collection is said to be destructive because of the use of parts, like roots, barks, wood, and whole plants. An estimate of the parts used by Ayurvedic industries are: roots – 29.6%, leaves – 25.8%, bark – 13.5%, wood – 2.8%, whole plant – 16.3%, and rhizome – 4% and

rest: seeds, flowers etc. A major part of the high range Himalayan plants are wild harvested and many of these are close to extinction due to over-harvesting or unskilled harvesting, e.g., nardostachys jatamansi, and aconitum species.

The state of Uttarakhand is declared as an *"Herbal State"* by the Government in 2003. It is blessed with thousands of species, however; about 320 species have been identified in terms of their medicinal value. The Forest Department claims to have knowledge of about 175 species, which are being commercially extracted and traded. But the district-wise inventorization has yet to be completed. The experts, however, estimate that in terms of value, the state is well positioned to generate revenue of about Rs. 1, 000 crores per annum through Herbs and Medicinal Plants (H and MP) alone in raw form. Management of H and MP has always been a question mark in Uttarakhand. Most of the species (about 95%) are found wild in the forests. The forest management has traditionally been timber oriented, and, tree centric. Hence H and MP sector has been deprived of the similar attention like shrubs and herbs vis-à-vis trees. However, due to ease of collection, the tree species of medicinal plants got an earlier attention, compared to their counterparts i.e. herbs and shrubs. Traditionally, the native people and *Bhotia* tribe of Uttarakhand has been developing for H and MP with their livelihood. This resource not only provides those primary herbal medicines but also nutrition to cattle population in particular and also contributes substantially to their income. Even today majority of the population derive their income from H and MP. Besides, there has been a significant shift globally towards H and MP for medicines and Medicare materials with a concretion. This is more patient friendly and environmentally agreeable. Declaration as "*Herbal State"* has necessitated to defining the operational, functional mechanisms formulating action plan for sustainable development of H and MP Sector in the State. Recently, cultivation of herbs mainly kutki and kut has been largely done in Ghaise village of Tharali taluk. This has been carried out with the help of HAPPRC, Srinagar Garhwal. About 25 HHs have been benefited with a cash of Rs. 87, 000 during last two years. Initially 32 HHs were involved with this practice but 7 HHs withdrawals because of delay in payment. With the interference of HAPPRC, the payment was made.

Most of the H and MP grow in the wild as natural component of vegetation. But this traditional base is shrinking due to informal supply chain, over exploitation, population pressure, unsustainable practices, and biodegradation. There are restrictions on extractions and procurement from wild, yet the trade is going on secretively and resulting on over exploitation of resource areas thus leading to unsustainable practices. In the absence of scientific system of collection and fostering regeneration of such plants, several species have been completely lost, have become endangered or on the verge of extinction with varying degrees. This is serious genetic erosion and causing loss of biodiversity of resource areas. Research in H and MP have focused on their biologically active compounds and evaluating their remedial properties, but little attention has been paid to the sustainable management of these plants in the State. Uttarakhand Government has yet to take effective measures in providing a sustainable management for marketing system and appropriate policies for conservation and protection of H and MP. Notwithstanding, the measures of propagation and cultivation of H and MP initiated extraction; rather collection from the wild sources through un-official trading systems is still going on unabatedly at a large scale. There is a great extent of the illegal trade and, majority of gatherers are unidentified and, posing a great threat to conservation through unscientific/destructive harvesting, because they are keen on earning fast buck of profits.

Major Systems for Utilization of H and MP

Ayurvedic system: The traditional health care systems (such as ayurveda, siddha, yoga, and unani) have been recognized as the original health care systems of India, which have deserver respect from countries abroad. The name ayurveda comes from two Sanskrit words: ayur meaning 'life' and veda meaning 'knowledge'. According to ayurvedic teaching, everyone and everything in the universe consists of three basic forces or elements. In Sanskrit they are called vata, pitta, and kapha. They together control all physical and mental processes and are compared to the workings of the wind, the sun, and the moon: Vata is linked to the wind, which is constantly on the move, and controls the central nervous system; Pitta is like the sun, a source of energy. It controls the digestive system and all biochemical processes; Kapha governs the balance of tissue fluid, controlling cell growth and the firmness of the body - rather as the moon governs the tides.

Table 3.13: List of Medicinal plants used in Ayurvedic medicines

Vernacular Name	Botanical Name
Kalonji	*Nigella letiva*
Neem	*Azadirachta indica*
Dhatura	*Dhatura fastuosa*
Tulsi	*Ocimum sanctum*
Anar	*Punica granatum*
Khajoor	*Phoenix dectylifera*
Methi	*Trigonella foenum*
Paiya	*Prunus cerasoides*

Source: Adopted from Anthwal et al (2006)

Unani system: Arabs and Persians coming from Greece evolved the Unani system of medicine in India. It is a modified system that had originated during 460 BC – 377 BC, perhaps. The body has four humours namely Blood (Dam), Phlegm (Balgam), Yellow bile (Safra), and Black bile that keep the equilibrium.

Siddha and Yoga system: Siddha means achievement of a process of perfection. Siddhas, saintly figures who achieve excellence in such process through the practice of yoga, promoted the system in Tamil Nadu. The manuscripts are in Tamil. It is believed that there are eighteen Siddhas, which contributed towards the development of Siddha medicine. It is largely therapeutic in nature.

Medicinal Plant Protected Areas (MPPA): Under this scheme, area having potential for production of H and MP can be selected and developed as MPPA with in the State, as has been successfully developed by the neighbouring hill State of Himachal Pradesh. The areas already included under Joint Forest Management (JFM) could also be included under this concept. In this pattern MPPA work allocated to a particular User Group within Valley Flower Development Corporation (VFDC), can sign a written document or Memorandum of Understanding (MoU) for sharing the usufructs or other monetary benefits drawn and explained to all the stakeholders involved in the endeavour. This MoU could have the concurrence of State Dept of Forest and, VFDC.

Medicinal Plant Conservation Area (MPCA): MPCA already established within the protected areas or in the vicinity of protected areas more beneficial from ecological as well as economic point of view. It is reported that an area of 6,379 Sq km has been brought under protected area network in the State. This could be taken as a step towards the MPCA.

Medicinal Plants up in the Himalaya: The oldest record of the use of plants as medicines is mentioned in the **'Rigveda'** (4,500-1600 B.C.) which Contains many 'shlokas' and hymns written in the praise of plants. The Charka Samhita by Agnivesa; Charaka (1000-800 B.C.) and, Susruta (800-700 B.C.) describes Himalayas as the best habitat of medicinal Plants.

In-situ conservation is defined as conservation of ecological, species, and genetic diversity in their natural habitat so as to let the dynamic of eco-system takes its natural course. This natural process can go unhindered indefinitely. Fortunately there are a number of protected areas rather six parks and six sanctuaries in the Uttarakhand State, which include the first National Park e.g. Corbett National Park (formerly Hailey National Park) established in 1936. These are specifically delineated to conserves the biota along with natural ecological and eco-evolutionary processes.

Ex-situ conservation means efforts made by research wing of forest department and other institutions to conserve artificial shelters e.g. aquaria, arboreta, botanical gardens, fen houses, zoological parks etc.

Types of H and MP

Plants are used for medicinal purposes throughout the world are clubbed under the category of *Medicinal Plants*. According to WHO, "a medicinal plant is any plant which, in one or more of its organs, contains substances that can be used for therapeutic purposes, or which are precursors for chemo-pharmaceutical semi-synthesis". The supply of medicinal plants is from two sources: collected from wild and cultivated material. The bulk material is traded from wild harvesting and only few species from the cultivated areas. The wild harvesting includes the plant material as: herb (plant above ground), folia (leaves), lignum (wood), or radix (roots). Traditionally, medicinal plant collection was a subsidiary activity when people went away from their dwellings to graze livestock. This resource was used for local health care as well as to generate some income. The government granted permits to individuals/contractors during the 1980s and started earning some revenue through this practice. Contractors, by and large, employed outside labour rather than local people, as the latter were likely to place greater stress on the extraction regeneration balance than on maximization of profits. Local people strongly opposed this policy, partly they did not get any direct benefits and because of the threat to their livelihood due to unsustainable harvesting by the outside labour. In the face of strong opposition from the people, this practice was terminated in 1988. The State Forest Department has prioritized ten medicinal species in Uttarakhand viz. Atis, Chirata, Daruharidra, Jatamansi, Kala Jira, Kutki, Kuth, Shatavari, Sarpagandha, Van kakdi.

Aromatic Plants are essential oil yielding plants. They have volatile, adoriferous oils in special cells, glands or ducts located in different parts of a plant, such as, the leaves, barks, roots, flowers, and fruits and sometimes in just one or two parts. The oils are usually present in very small amounts and comprise only a tiny fraction of the entire plant material. The oils are produced during some metabolic processes of the plant and are secreted or excreted as adoriferous by-products. The fragrant oils may not necessarily be present as such in the living plants but may occur as odourless compounds termed as glycosides. When the plant tissues are macerated, an enzyme reaction occurs, these causes the glycosides to undergo a chemical change. This action in turn liberates the distinctive essential oil.

Sacred Grows: As mentioned above, India is one of the world's top 12 mega diversity countries with rich variety of biological community types that includes coral reefs and alpine meadows, rain forests and desert scrub (McNeely et al., 1990). Many traditional societies all

over the world value a large number of plant species from the wild for a variety of reasons, for food, fiber, shelter, or medicine. The practice of conservation of plant species by the traditional societies of Alaknanda basin dates back to millennia. The people of Alaknanda basin have a rich tradition of nature conservation through socio-religious constraints on profligate use of common property resources. The ancient ethics changed by rejection and replacement of traditional practices under the influence of western cultures and by the advent of modern industry. Sacred groves are one of the first instances of traditional conservation. Increasing threats to biodiversity loss, demands new conservation approaches enabling fair share of the wider values of conservation to the local communities and positive local attitudes towards conservation goals. Nature worship has been a key force of shaping the human attitudes towards conservation and sustainable utilization of natural resources. Such traditional practices have been invariably operating in different parts of India. Sacred groves are the repositories of rare and endemic species and can be regarded as the remnant of the primary forest left untouched by the local inhabitants and protected then due to the belief that the deities reside in these forests. Many people have described sacred groves in different ways. However, there is an evident fact that wherever sacred groves existed, indigenous traditional societies have spiritual relationships with the existing physical environment sustained them. All forms of vegetation in the sacred groves are supposed to be under the protection of the reigning deity of that grove, and the removal of even a small twig is taboo (Vartak and Gadgil, 1973). However, little information is available on sacred groves and conservation of the biodiversity in Alaknanda basin (Sinha and Maikhuri, 1998). People of Garhwal follow ancestral worship and animism in the form of deity worship, with the central focus of worship on forest patches, which signify sacred groves. Affection towards nature was a zoolatry (worshipping of animals), totem (considering plants and animals sacred), etc, which in turn led to a sort of prudent conservation. Religious beliefs, traditions, and customs of Indians bear an allegiance in restricting the exhaustive use of natural resources.

Table 3.14: List of Sacred Plant Species of Garhwal Himalaya

Scientific Name	Vernacular Name	Beliefs/Uses
Cynodon dactylon	Doob	Used in rituals
Ficus religiosa	Peepal	A sacred tree
Ficus benghalensis	Bargad	A sacred tree
Ocimum sanctum	Tulsi	A sacred herb
Artemisia sps.	Dhoop or Kunju	Used in rituals
Musa paradisica	Banana	Used in rituals
Desmostachya bipinnate		Used in rituals
Aegle marmelos	Bail	Sacred plant
Emblica officinalis	Amla	Sacred tree
Mangifera indica	Mango	Used in rituals
Pinus roxburghii	Pine	Used in rituals
Prunus cerasoides	Paiya	Used in rituals
Cedrus deodara	Deodar	Sacred tree
Xanthoxylum achanothopodum	Timroo	Sacred tree
Azadirachta indica	Neem	Sacred tree
Quercus spp	Oak	Sacred tree

Source: Adopted from Anthwal et al (2006)

Table 3.15: Religious Festivals Associated with Sacred Trees

Festivals	Month of festival	Species associated
Sheela Asthami	March	*Azadirachta indica*
Nimb Saptami	April	*Azadirachta indica*
Vat Savitri	May	*Ficus bengalensis*
Bilvamengal	May-June	*Aegle marmelos*
Sawan ke Somvaar	Mid July-Mid August	*Bail*
Kadii Vrat	September	*Musa paradisica*
Somvari Amavasya	15 of all months	*Ficus religiosa*

Source: Adopted from Anthwal et al (2006)

Initiatives for Sustainable Development and Management of H and MP

After declaration of Uttarakhand as Herbal State, the government has taken initiatives for sustainable management in a phased manner. The government has appointed Agriculture and Processed food products Development Authority (APEDA), as the nodal agency to promote setting up of Agri Export Zones (AEZ) in two phases. Under First Phase six Districts Chamoli, Dehradun, Haridwar, Pithoragarh, Udhamsingh Nagar and Uttarkashi, are being covered. In this phase, emphasis on 10 high value species as mentioned above will be cultivated on about 500 ha. In second phase, the area under cultivation would be increased and, additional districts brought under the aegis of AEZ and other medicinal plants will also be cultivated. This is being done with the support from Infrastructure Development Finance Company Ltd. to boost exports and enhance India's share in the world market. The State has established Herbal Research and Development Institute (HDRI) at Gopeshwar in district Chamoli as nodal agency in the State to monitor developmental issues and for inventorization of H and MP species in the state.

Present Cultivation Pattern

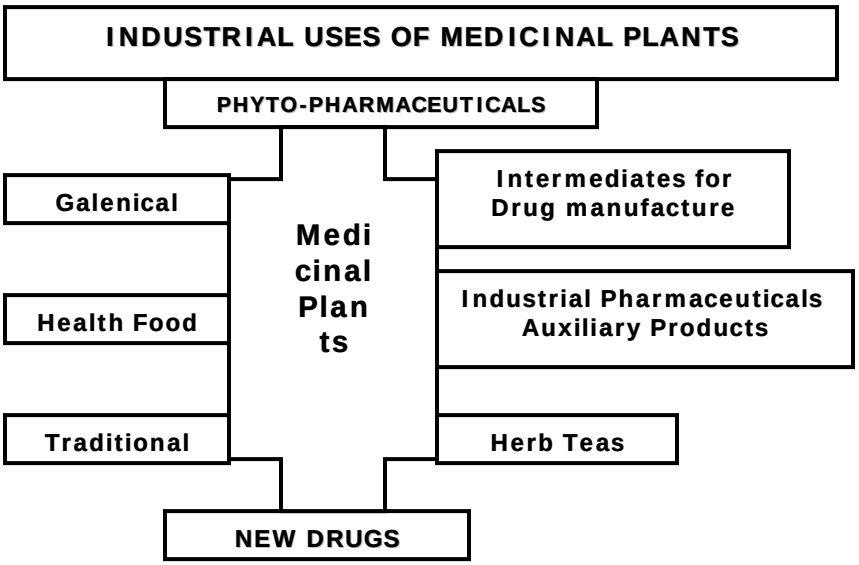
Medicinal plants are in great demand by the pharmaceutical industries based on the Indian medicine system. At present, medicines of vegetative origin are also prepared in the Homoeopathic system, which are in great demand in our country. The cultivation technology for some species have been perfected and employed in the field. Using seeds, stem, and root cutting does domestication of some species. Another initiative has been raising of seedlings of tropical, temperate, and alpine species such as: Aonla, Beheda, Harad, Bael, Amaltas and others. The year-wise summary of seedlings raised and made available to given in the **Table 3.16**.

Table 3.16: Year-wise Seedlings availability

S. No.	For Year	Seedlings Availability (No.)
1.	2001-2002	5,00,000
2.	2002-2003	14,00,000
3.	2003-2004	24,47,000
4.	2004-2005	42,89,968

Region-wise, circle-wise, division-wise, and species-wise seedlings include Harad, Baheda, Amla, Tejpata, Satavar, Timru, Sarpaganda, Stivia, Ashwwaganda, Kuth. Temperate and Alpine, viz.: Kutki, Salampanja, Atish, Doulu, Faran, Salammishri, Aatmesh, Jatamashi etc. Institutionalization and switching over of marketing of H and MP from Bhesaj Sangh has

been another initiative. Villages selected in different regions with vaying altitudes for participatory rural appraisal (PRA) in Garhwal region is given in **table 3.17**.



Source: FAO Bull. No. 11, 1997

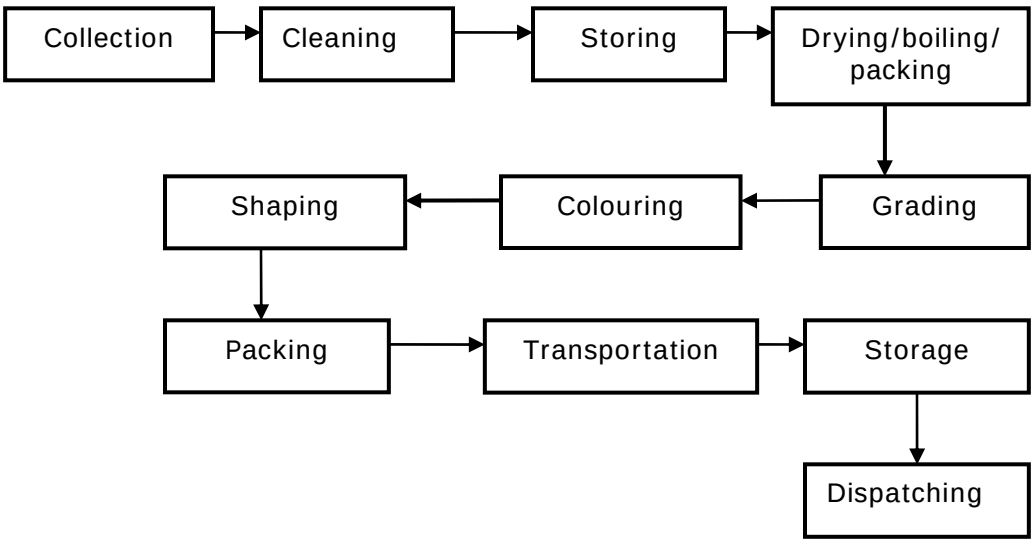
Table: 3.17 Species of MP and Number of Collectors

Regions	Village	Altitude(m)	PRA Participants included Cultivators/Collectors	No. of Species
Alaknanda	Sonala	900	58	61
Tharali	Gotinda	1,200	50	50
Chamoli	Lassi	1,500	40	69
Lohna	Diwali Khal	2,000	42	61
Badrinath	Mana	3,500	35	47
Total			**507**	

Table 3.18: The Distribution of Medicinal Plants by their Habit in Uttarakhand

Herbs	32%
Shrubs	20%
Trees	33%
Climbers	12%
Others	3%

Minimum Post-Harvest Steps Required for Marketing of H and MPs



The industries within the State are encouraged to establish R and D Centres as "Centres of Excellence". A Committee should work out the modalities and norms. Independent **certification agencies** could monitor the indicators and certify the system as sustainable. For example, institutions like the GBPIHED / GBPUAandT / HNBGU / ICFRE within the State could act as an impartial agency for such work. They could further extend training in certification issues with the help of WWF/ World Bank Alliance initiative. A number of NGOs (Including NRIF) and other autonomous institutions in the State or outside could be identified to undertake certification. The development of group certification schemes will help to lower the cost of certification (Extracted and synthesized from NRIF, 2004).

BEES AND BEE KEEPING

Bees contribute enormously to income generation through bee products and pollination services. It has been estimated that through pollination services to agriculture and surrounding flora, beekeeping helps communities to generate income equipment to 14 times the investment required (Free 1993). Bees keeping, especially for commercial purposes, may be an option for enhancing livelihood. It may substantially contribute livelihood for small and marginal farmers. In the upland of the Alaknanda River Basin (ARB), where feasible ecological conditions remain available throughout the year, the practice of apiculture can be done extensively. The upland has also privilege of having flowering season almost in the year. Already in many areas of the upland, people are involved with keeping of bees and producing a considerable quantity of it.

Bee keeping is a centuries old practice in the Uttarakhand Himalaya. In the mainland of Uttarakhand, it is carried out in traditional method. Bees make their artificial habitat mostly on the roof of the building, which is locally known as '*jala*'. Honey has multiple uses. It is used as a supplementary food, medicinal purposes, and pollination. It is also an eco-friendly practice and consumed domestically. As the economic viability of bee keeping is very high, and the ecological conditions for its sustainable practices are quite suitable, the region may lead in its production. It is noticed that there is a considerable decline in its practice during last three decades or so. The government has initiated several steps to set up stations for bee keeping both in Kumaon and Garhwal Himalayas.

'Jalikot' in Nainital District is a headquarter for bee keeping, which looks after imparting training programmes for the villagers and also assists them technically. Talwari in Chamoli district works parallel to assist the farmers of Chamoli district for bee keeping. Besides, the other centres are Pithoragarh, Almora, Nainital, Pauri, Kotdwar, Uttarkashi, and Chiniyalisaud. In Dehradun five centres; Rishikesh, Balawala, Nathuwala, Nakraunda, and Kunwawala are the major centres that involving in bee keeping. Three wooden boxes with ten frames are available in each centre. Five personnel from horticultural department are deputed in these centres for producing honey. They include development investigator, supervisor, sub-supervisor, field man, and peon.

The boxes are made of wood with various colours and stories for the safety of frames. Half kg sugar and one liter water is weekly required for each box during the winter and rainy seasons. During flowering seasons; autumn and spring, the bees collect their food from the flowers at daytime. Ten kg honey is produced from one frame in a year. The main species of bees is *Italian seeds of malifera*. The production of bees from this species is 15-20kg/frame/year. The reproduction period is flowering seasons, when about 200 to 300 eggs/day reproduced. Within a year, when the frame is overlapped, the group divided into two under a separate woman leadership. Development workers are required at this crucial time for their rehabilitation.

The major problems with the production of bees in this area are (i) the species are indigenous and consequently, the production is low, (ii) market is improper and inaccessible, therefore the bees producers do not get even the total cost of input (iii) although, there are training centres set up in each district and trainers are appointed, yet the producers do not get proper training for improving honey production, and (iv) traditionally practiced bees keeping is risky, while new introduced bees keeping in boxes is not available in the villages. In spite of these problems, bees keeping have many prospects; as (i) they are used as medicine (ii) it is widely used as food supplement, (iii) if market is available, it can increase the income level of the people involving with this, and (iv) because; it does not need much investment at all stages of its production, many people even marginal and small farmers can do this practice.

Conservation and Promotion of Indigenous Honeybees

Notwithstanding the achievements, there is much still to be done in terms of institutionalizing the successes of the programme and disseminating the results for wider impact across the region. Capacity building will continue to be an integral part of any future programme on honeybees. In addition, increasing honey production to meet the growing demand for organic honey in order to reduce poverty among the poor honey producing communities of the region and to counteract the reduction in the efficiency of pollination services requires new thinking and approaches to efficiently utilize and develop available honeybee resources. The impact of climate change is another important issue that requires attention. Indigenous approach included farmer-managed selection and multiplication of *Apis cerena*, which led to an increase in honey productivity from a mere two kilograms per hive per year to an average of six kilograms at project sides and a maximum of 13 kilograms at one site (Ahmad el al. 2008). The adoption of better management practices by farmers resulted in a reduction in absconding, greater resistance to disease and parasites, and an increase in colony numbers and colony strength. Capacity building efforts by the programme were focused on partnership development, networking, curriculum development, and training.

NATURAL DYES

In India, natural dyes provided by plants and animals have been in use for imparting different shades, generally to wool and cotton, from time immemorial. The various ethnic communities, including Bhotiyas of Chamoli District residing in the border regions of Garhwal Himalaya, are well known for their traditional expertise in making a range of woolen garments and materials, besides processing and colouring of wool. Before 1962, there was trans-border trade between India and former Tibet, and the import of wool was the major source of income for the Bhotiya's woolens-based, indigenous cottage industry. But after 1962, trade was stopped due to conflicts between China and India. However, due to the visit of a sizeable number of pilgrims and tourists to the Badrinath and Kedarnath shrines in Garhwal region, the Bhotiya community still has a market to sell the woolen products, so that this age-old tradition of preparing woolen products and processes to make them colourful through indigenous methods are alive in the remote areas of Garhwal.

Indigenous Approach of Wool Dyeing

The process of wool dyeing starts once the threading of wool is over. Normally, raw wool has two colours, black and white; only the white coloured wool is used for yeing purpose to give different shades of colours. The woolen material is dusted and ashed thoroughly before dyeing. The fruits of *Sapindus mukorosii* (Reetha) are used traditionally for washing the woolen threads. The roots or fruit covers of collected or stored plant species are washed thoroughly with tap water and then sun-dried. The dried plant material is powdered and mixed with water to prepare a solution. The solution is heated in a vessel until it begins to boil. The wool threads are then slowly immersed in the solution for dyeing. For dyeing one kg of wool, around 4 l of water is boiled with approximately 50–60 g of fresh root. The woolen threads are stirred thoroughly for a long time to ensure thorough and uniform soaking. Sometimes, a small quantity of ash is also poured in the prepared solution, for better colouring. Once the dyeing is over, the woolen threads are taken out from the boiling solution for drying. During drying, direct sunlight is avoided for retaining brightness of the colours.

Table 3.19: Plants and Their Parts used in Preparing Natural Dye

Plant species	Part used	Colour produced
Khukhuyinya, Rumex nepalensis	Root	Yellow
Dolu, Rheum australe	Root	Yellow
Akhrot, Juglans regia	Fruit cover	Camel
Kapasi, Corylus jacquamontii	Fruit cover	Camel
Kingod, Berberis spp.	Root	Yellow
Archa, Rheum moorcroftianum	Root	Yellow
Bajar Bhang	Root	Brown
Geranium nepalense	Root	Red

Source: Kala (2002)

Synthetic Dye as an Alternative to Natural Dye

The increasing influx of tourists and construction of road networks after 1962 has resulted in an augmented communication system, better education, and also invasion of modern supply systems and outside products. Correspondingly, knowledge of synthetic dyes was also brought in and slowly the indigenous natural dyes are being replaced by synthetic dyes. The choice of multiple colours, easy availability, and lesser time taken in preparing these dyes have made synthetic dyes more popular. For the past 25 years, the Bhotiya community in Chamoli district has been using the synthetic dyes purchased from Delhi, Ludhiana, Dehradun and also from local markets of Joshimath, Pipalkoti, Gopeshwar and Badrinath. Market survey indicates that the Bhotiya people purchase mainly eight colours such as black, maroon, yellow, pink, violet, green, sky blue, and navy blue. Black colour is commonly used, followed by maroon and green colours. The sheep in high altitude areas are white, and thus produce more white wool than black wool. Bhotiya women mainly wear a *Pakhi* or *Lawa*, which is always black in colour. Since the demand for black wool is more, they dye the white wool with black colour. There has been a substantial decline in purchase of synthetic dyes from the local market at Joshimath (a major service and supply centre in the high altitudes of Garhwal) since 1988, due to involvement of traders from outside who bring synthetic colours from Ludhiana, Amritsar, Delhi, and Dehradun along with wool and sell them door-to-door. Bhotiya people working in cities also bring these synthetic colours when coming home. In 1988, about 100 kg of black colour was sold at Joshimath market, whereas in 2001 it was reduced to only 30 kg. Similarly, there was a substantial decrease in the sale of other colours from 1988 to 2001 **(Table 3.20)**. The cost of black colour is lower (Rs 300 per kg) than the cost of the remaining colours (Rs 400 per kg). The total sale of synsynthetic colours in a single market at Joshimath accounted for about Rs 70,000 (US $ 1520) in 1988. However, it was reduced to about Rs 20,000 (US $ 435) in 2001, due to the availability of readymade coloured wool in the local market.

Table 3.20: Comparative Account of Various Colours Sold over the Years at the Local Market of Joshimath

Colours	Quantity sold (kg/year)		Rate (Rs/kg)	
	1988	2001	1988	2001
Black	100	30	200	300
Maroon	50	10	250	400
Yellow	25	5	250	400
Pink	25	5	250	400
Violet	25	5	250	400
Green	25	10	250	400
Sky blue	25	5	250	400
Navy blue	25	5	250	400

Source: Kala (2002)

Table 3.21: Average Income Generated through Sale of Woolen Products/Family/Year

	Chhinka		Saldhar	
Woolen items	**No. of pieces sold**	**Income generated (Rs)**	**No. of pieces sold**	**Income generated (Rs)**
Chutka	2		–	–
Pankhi	45	18,000	25	10,000
Pakhi (Lawa)	50	25,000	–	–
Dan	–	–	3	4,500
Ashan	–	–	15	2,200
Sweater	–	–	10	–
Cap	–	–	10	–
Total income		**43,000**		**16,700**

Source: Kala (2002)

The Bhotiya tribal economy and the indigenous practices, evolved to maintain this industry, were based on personnel interactions and keen observation of their environment. However, use of natural dyes started to decline gradually after the discovery of synthetic dyes in 1856. In view of the wide availability of colours through synthetic dyes, the traditional natural dyes, which offered only a limited range, suffered a severe setback. Besides, the decline in the woolen cottage industry is also due to lack of vision and ignorance of the traditional heritage and values attached to the indigenous system. Difficulties in getting raw material (desired plants) and preparation of natural dyes are among the many causes for the decline in use of this indigenous technique. However, extraction of natural dyes is low in cost and the natural dyes are user friendly products. It can also lead to employment generation at the village level. If serious efforts can be made, natural dyes can prove to be a boon to the textile industry, which markets its products to the European countries and USA. The abundant forest biomass can be used for manufacturing dyes on small-scale bases, especially in the villages. Unfortunately, this indigenous practice of using natural dyes has almost vanished even from the remote villages of Uttarakhand Himalaya (Extracted and synthesized from Kala, 2002).

References

Ahmad, F.; Joshi, S. R.; Gurung, M. B. 2003. The Himalayan cliff Bee Apis laboriosa and the Honey Hunters of Kaski. Kathmadu: ICIMOD

Anthwal et al 2006. Sacred Groves: Traditional Way of Conserving Plant Diversity in Garhwal Himalaya, Uttarakhand

Atkinson, E. T.: 1882: *The Himalayan Gazetteer*. Delhi, Cosmo Publication. **Vol. 2**. 369
Atkinson, E. T. (a&b): 1882: "The Himalayan Gazetteer" Cosmo Publication, Delhi, Vol. II, p. 369

Free, JB. 1993. Insect Pollination of Crops. London. Academic Press

Indian Council of Agricultural Research. 2002. Agricultural Research Data Book, ICAR, 2004.

Kala, Chandra Prakash. 2002. Indigenous knowledge of Bhotiya tribal community on wool dyeing and its present status in the Garhwal Himalaya, India. CURRENT SCIENCE, VOL. 83, NO. 7

Natural Resources India Foundation (NRIF). 2004. Mechanism for Sustainable Development & Promotion of Herbal and Medicinal Plants in the State of Uttaranchal. SER Division, Planning Commission. Government of India.

Ramakrishnan, P.S., Saxena, K.G., Swift, M.J. & Seward, P.D. (Eds.). 1993. Tropical Soil Biology and Fertility Research: South Asian Context. Oriental Enterprises, Dehra Dun.

Sati, V. P. & Rawat, MSS. 1993. Problems of Agriculture Ecology and their Management in the Alaknanda basin. *National Geographer* **Vol. XXVIII** No. 2 (Dec. 1993): 143~148

Sati, V. P. 1993. Cropping Pattern in the Hill Environment of the Alaknanda basin(A case study of a village). *National Geographer* **Vol. XXVIII.** No. 1, (June 1993): 31~37

Sati, V. P. and Kamlesh Kumar. 2004. *Uttarakhand Dilemma of Plenties and Scarsities*. New Delhi, Mittal Publications. 287

Sati,Vishwambhar Prasad. 2004. Resource Utilization Pattern and Development in Hills: A Case for the Alaknanda basin of Garhwal Himalaya. *Journal for Mountain Science* Vol 1, No. 2, pp 130-141 www.imde.ac.cn/journal

Sati, V. P. and Kumar, Kamlesh. 2004. Uttarakhand: Dilemma of Plenties and Scarcities. New Delhi. Mittal Publication.

Sati, V. P. 2004. Horticultural Development in Hills: A Case for the Alaknanda Basin. New Delhi. Mittal Publication. p. 123

Sati, Vishwambhar Prasad. 2005. "Vertical Zonation of Horticultural Farming in the Alaknanda Basin of Garhwal Himalaya, India" 'Journal of Mountain Science' Vol 2 No 4. http://www.imde.ac.cn/journal

Singh, Brahma, 1998. Vegetable production under protected conditions: Problems and Prospects. Indian Soc. Veg. Sci. Souvenir: Silver Jubilee, National Symposium Dec. 12-14, 1998, Varanasi, U.P. India pp. 90.

Singh, Narender; Diwedi, S.K. and Paljor, Elli, 1999. *Ladakh Mein Sabjion Kei Sanrakshit Kheti*. Regional Research Laboratory of DRDO, Leh. Pub. By D.R.D.O., Leh. Pub. By D.R.D.O. 56 A.P.O.

Sinha B. and Maikhuri R.K. 1998. Conservation through 'socio-cultural-religious practice' in Garhwal Himalaya: a case study of Hariyali sacred grove'. In: Ramakrishan P.S., Saxena K.G. and Chandrasekhar U. (eds), Conserving the Sacred: For Biodiversity Management. UNESCO and Oxford IBH Publishing Co. Pvt. Ltd, New Delhi, pp. 289–299.

Singh, V. 1996. *Draught Animal Power in Mountain Agriculture: a study of Perspectives and Issues in the Central Himalayas, India*. Discussion Paper. Series No. MFS 98/1. Kathmandu: ICIMOD. p. 74.

UTDB.2004. *Leaflet*. Uttarakhand Tea Development Board, Almora

Vartak V.D. and Gadgil M. 1973. Dev Rahati: an ethnobotanical study of the forests preserved on grounds of religious beliefs. Abstract, Proc. Indian Sci. Cong. 60: 341.

CHAPTER 4

LIVELIHOOD ANALYSIS

A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (DfID, 1999, Scoones, 1998, and Carney, 1998). The author attempted to elaborate the changes in the lifestyles of the rural communities in the Alaknanda Basin from the past to present. The prime focus is on the traditional livelihood and its current pattern. As observed in many cases the livelihood is in transition. To understand the traditional pattern and modern situation of livelihood in the study region, the primary data were gathered and reviewed. Subsequently, a study carries about the current livelihood patterns of the communities in clusters of villages of Chamoli and Pauri districts through a detailed field survey. Meanwhile, the focus of the field survey was to get a detailed data from primary sources knowing about the earning pattern of rural communities from different livelihood sources and expenditure for meeting their daily requirement.

Traditional Livelihood Pattern

The traditional lifestyle of the people living here, like that of most highland communities in all over the world, had four very distinctive characteristics: (a) A combination of activities including agriculture, pastoralism, and seasonal processing of forest produce to sustain the family economy. (b) Seasonal transhumance involving pastoralism, with several combinations- using the favourable conditions provided by the seasons at different altitudes to optimize resource availability for the family economy. Here, pastoralism was characterized by a nomadic lifestyle with summer and monsoon spent in the '*bugyals*' (alpine grasslands), and the winter in the '*Bhabar*' region at the foot of the outer mountain range. Families engaged in agriculture would split up and the more able- bodied spend the summer and monsoon in seasonal shelters called *'chhappers'* (Sati, 2008) used for large ruminants like cattle and buffaloes, farming fertile land on the forest margins referred to as '*danda*' with crops like potatoes and amaranth, and more recently herbs. Both were located near a ridgeline high above the village. During this period, the rest of the family would remain in the village and farm the 'sera' – broad, irrigated terraces in the valleys for paddy, and the '*ukhar*' or '*upraon'* – un-irrigated marginal lands around the village, for coarse grains like millets, and pulses. (c) Complete dependence on forests (oak and temperate grasslands): for all elements of life, e.g., firewood, fodder, fibre, medicines, supplementary foods, water, and soil conservation. Leaf fodder for cattle, and leaf litter for cattle bedding provide the inputs for agriculture. Both are further processed to make air-dried compost, the only fertilizer used for subsistence agriculture, and the major reason why yields of traditional crops have remained stable for centuries until recently.

The rural economy of the Alaknanda Valley has traditionally consisted of a combination or basket of activities, in which agriculture and animal husbandry have provided the base of the subsistence economy- putting food on the table for the family primarily. Processing of non-timber forest products (NTFPs) provided the base for the market economy, with marketable products in demand locally. The major trend to emerge was an ongoing diversification of livelihoods towards sources of income over and beyond the traditional lifestyle of farming, pastoralism, and collection and processing of NTFPs. This diversification clearly shows a steady rise in the importance of off-farm income in contributing to the family economy as compared to farm income, and a corresponding rise in household

expenditure on food. Interviewees identified this diversification as being the key to the continued economic viability of the village and family economy. It is clear that the rural population are realizing that just glorifying traditions can no longer sustain a growing population, where carrying capacity of the "jal, jungle aur jameen" (water, forest and cropland resources) to sustain the present population has been exceeded.

Livelihood Analysis

Family income, expenditure, and the proportion of families dependent on different livelihood was analyzed as case studies of 12 villages of Khanda Gad sub-watershed in Pauri District and 17 villages of Kewer Gadhera sub-watershed in Chamoli District. The objective was to identify the major trends in livelihoods. The analysis was based on interviews with farming families, artisans where possible, families belonging to the Scheduled Castes, and women. Data were gathered about levels of annual family income from various sources, family expenditure on household needs and other categories, and the interviewees' perceptions of the proportion of the population dependent on various livelihoods in the village. General observations about the overall standard of living in the villages were also cross- checked with interviewees, and incorporated into the findings. Livelihood analysis of case studied cluster of villages was carried out. A formula for livelihood sustainability index was prepared by the author to know the sustainability in livelihood of the people.

Livelihood Sustainability Index (LSI) = In (Fa+Bu+Gs+La) - Ex (Fo+Sh+Cl+Ed+Ot) = Sa

Where 'In' stands for Income, Fa for farming, Bu for Business, Gs for Government Service, La for labour, Ex for Expenditure, Fo for Food, Sh for Shelter, Cl for Cloth, Ed for Education and Sa for Saving. The objective of formulation of this index was to understand the level of sustainability in livelihood. Based upon this, LSI at village level and household level was prepared. It was penetrated from the study that the trend of saving money is high even among low income group people.

Household Incomes and Sources of Income

The major categories of livelihoods comprise agriculture, daily wage labour, jobs, artisanry, pensions, animal husbandry, and NTFP collection. Levels of total annual family income were calculated by taking the weighted average of the annual family income of the respondents. Similarly, the proportion of income from each livelihood category was also calculated by the same method. However, agriculture is primarily subsistence in nature, in order to fulfill the household requirements of food grains, and that in subsequent analysis the income from agriculture represents only the cash income and not the subsistence value. Similarly, for other categories of livelihoods also only the cash incomes are being considered.

Table 4.1: Valley-Wise Average Income

Village	Household Income				
Khanda Gad sub-watershed	Farming (Fa)	Business (Bu)	Govt. Service (Gs)	Labour (La)	Total
Margaon	14, 000	Nil	46, 000	2, 000	62, 000
Shrikot Khanda	12, 000	15, 000	50, 000	1, 000	76, 000
Margadna	10, 000	Nil	52, 000	1, 000	63, 000
Bhitai Malla	18, 000	Nil	32, 000	3, 000	53, 000

Kaldung	13, 000	Nil	42, 000	2, 000	57, 000
Dhanak	22, 000	Nil	28, 000	4, 000	54, 000
Gaduwa Gad	11, 000	10, 000	44, 000	2, 000	57, 000
Kamand	25, 000	Nil	25, 000	5, 000	55, 000
Dov	24, 000	Nil	26, 000	5, 000	45, 000
Shiyar Malla	20, 000	Nil	30, 000	4, 000	54, 000
Rawat Gaon	12, 000	Nil	48, 000	1, 000	61, 000
Bhitai Talla	14, 000	Nil	40, 000	1, 000	55, 000
Kewer Gadhera sub-watershed					
Kewer Talla	10, 000	20, 000	52, 000	1, 000	83, 000
Kewer Malla	15, 000	2, 000	40, 000	2, 000	59, 000
Bhagoti	8, 000	25, 000	60, 000	-	93, 000
Ratni	6, 000	Nil	38, 000	1, 000	45, 000
Keshwan	6, 000	Nil	42, 000	-	48, 000
Gadseer	12, 000	Nil	40, 000	2, 000	54, 000
Bunga	13, 000	Nil	32, 000	3, 000	48, 000
Jhijodi	10, 000	Nil	30, 000	4, 000	44, 000
Ali	4, 000	3, 000	46, 000	-	53, 000
Leguna	8, 000	Nil	40, 000	1, 000	49, 000
Bedula	8, 000	Nil	40, 000	1, 000	49, 000
Chirona	6, 000	Nil	50, 000	-	56, 000
Kaub	15, 000	8, 000	60, 000	2, 000	85, 000
Naini	6, 000	8, 000	58, 000	-	72, 000
Swan Malla	15, 000	Nil	28, 000	4, 000	47, 000
Swan Talla	12, 000	Nil	34, 000	3, 000	49, 000
Kimoli	16, 000	Nil	32, 000	5, 000	53, 000

Source: Primary collection

The households in each village have categorized into four categories according to their work type and income, the income of each village seems similar with minor variations. It is because that the income level in each village depends on the earning from remittances (money order based) as the **table 4.1** shows. The households with working only on the agricultural fields have very poor income and this group constitutes a considerable portion of the society. Similarly, a group of people emigrated to the metropolitan cities/the plains of Ganges, have left their agricultural land abandoned. **Table 4.1** shows the village wise proportion of total income contributed by the various sources of livelihoods. Income from farming, business, Government services, and labour were found to be the most important constituents of household income. Agriculture constitutes one of the major sources of household income. In many villages, mostly located in the highlands, major source of income is from farming of subsistence crops. Income from remittances has the higher proportion in household level. The people of the region are out-migrated for search of better livelihood. They are working in different institutions and earning money to run their livelihood sustainable. Few people are doing business. Uneducated people seasonally work in the agricultural fields as landless labour. They work in the small service center nearby the villages. However their proportion is considerably less.

Household Expenditure

If we look closely at the expenditure patterns in the study villages, it finds that in almost all villages, nearly a quarter of the income is spent on the purchase of food-grains. Household supplies in the forms of sugar, spices, edible oil, salt, and cooking gas ranks second for

household expenditure. These figures are reflective of a trend that there is an increasing dependence upon the outside markets for supply of food-grains and that the villages are no longer self-sufficient in terms of food-grains. This may have wide-ranging implications in terms of food security. This also reflects a general trend that there is a growing emphasis on the cultivation of cash crops and hence a decline in the availability of the food-grains for self-consumption. This trend is also symbolic of the increasing consumeristic nature in the villages, wherein people no longer consume the traditional food-grains.

Table 4.2: Village-Wise Average Expenditure

Village	Household Expenditure					
Khanda Gad sub-watershed	**Food (Fo)**	**Shelter (Sh)**	**Cloth (Cl)**	**Education (Ed)**	**Other (Ot)**	**Total**
Margaon	18, 000	12, 000	16, 000	14, 000	Nil	60, 000
Shrikot Khanda	20, 000	13, 000	20, 000	16, 000	2, 000	71, 000
Margadna	15, 000	10, 000	15, 000	14, 000	2, 000	56, 000
Bhitai Malla	12, 000	10, 000	12, 000	11, 000	1, 000	46, 000
Kaldung	14, 000	15, 000	12, 000	10, 000	Nil	51, 000
Dhanak	12, 000	10, 000	11, 000	13, 000	1, 000	47, 000
Gaduwa Gad	12, 000	10, 000	12, 000	11, 000	1, 000	46, 000
Kamand	13, 000	12, 000	10, 000	10, 000	Nil	45, 000
Dov	11, 000	7, 000	6, 000	10, 000	Nil	34, 000
Shiyar Malla	13, 000	12, 000	10, 000	10, 000	Nil	45, 000
Rawat Gaon	15, 000	10, 000	15, 000	14, 000	2, 000	56, 000
Bhitai Talla	10, 000	11, 000	9, 000	9, 000	Nil	49, 000
Kewer Gadhera sub-watershed						
Kewer Talla	20, 000	10, 000	14, 000	19, 000	2, 000	69, 000
Kewer Malla	10, 000	11, 000	9, 000	9, 000	Nil	49, 000
Bhagoti	20, 000	15, 000	16, 000	27, 000	3, 000	81, 000
Ratni	11, 000	7, 000	6, 000	10, 000	Nil	34, 000
Keshwan	11, 000	7, 000	6, 000	10, 000	Nil	34, 000
Gadseer	13, 000	12, 000	10, 000	10, 000	Nil	45, 000
Bunga	11, 000	7, 000	8, 000	12, 000	Nil	38, 000
Jhijodi	11, 000	7, 000	6, 000	10, 000	Nil	34, 000
Ali	12, 000	10, 000	12, 000	11, 000	1, 000	46, 000
Leguna	12, 000	10, 000	10, 000	11, 000	Nil	43, 000
Bedula	12, 000	10, 000	10, 000	11, 000	Nil	43, 000
Chirona	13, 000	12, 000	10, 000	10, 000	Nil	45, 000
Kaub	20, 000	13, 000	20, 000	16, 000	2, 000	71, 000
Naini	20, 000	10, 000	14, 000	19, 000	2, 000	69, 000
Swan Malla	11, 000	7, 000	6, 000	10, 000	Nil	34, 000
Swan Talla	11, 000	7, 000	8, 000	12, 000	Nil	38, 000
Kimoli	10, 000	11, 000	9, 000	9, 000	Nil	49, 000

Source: Primary collection

Table 4.2 represents village wise average expenditure. The major portion of earned money is spent for food, shelter, cloth, and education. Rate of expenditure varies from village to village. Villages located in the low-lying areas, expenditure on education is considerably

high than the villages located in the highlands. In other commodities such as cloth, shelter, and food, expenditure is more or less similar.

Table 4.3: Income, Expenditure, and Saving

Khanda Gad sub-watershed	Total Income	Total Expenditure	Saving
Margaon	62, 000	60, 000	2, 000
Shrikot Khanda	76, 000	71, 000	5, 000
Margadna	63, 000	56, 000	7, 000
Bhitai Malla	53, 000	46, 000	7, 000
Kaldung	57, 000	51, 000	6, 000
Dhanak	54, 000	47, 000	7, 000
Gaduwa Gad	57, 000	46, 000	7, 000
Kamand	55, 000	45, 000	10, 000
Dov	45, 000	34, 000	11, 000
Shiyar Malla	54, 000	45, 000	10, 000
Rawat Gaon	61, 000	56, 000	5, 000
Bhitai Talla	55, 000	49, 000	6, 000
Kewer Gadhera sub-watershed			
Kewer Talla	83, 000	69, 000	14, 000
Kewer Malla	59, 000	49, 000	10, 000
Bhagoti	93, 000	81, 000	12, 000
Ratni	45, 000	34, 000	11, 000
Keshwan	48, 000	34, 000	14, 000
Gadseer	54, 000	45, 000	9, 000
Bunga	48, 000	38, 000	10, 000
Jhijodi	44, 000	34, 000	10, 000
Ali	53, 000	46, 000	7, 000
Leguna	49, 000	43, 000	4, 000
Bedula	49, 000	43, 000	4, 000
Chirona	56, 000	45, 000	11, 000
Kaub	85, 000	71, 000	14, 000
Naini	72, 000	69, 000	3, 000
Swan Malla	47, 000	34, 000	13, 000
Swan Talla	49, 000	38, 000	11, 000
Kimoli	53, 000	49, 000	4, 000

Source: Primary collection

Emerging Trends

The economic analysis of the 29 study villages strongly suggest that an increase in the rural household incomes would not necessarily lead to an increase in the rural household savings. In fact, with an increase in incomes, the expenditure levels also seem to increase with the result that the monetary savings remain more or less static. More exposure with the outside world has meant that people have inculcated the same Consumeristic trends as prevalent in the cities and towns in the plains with the overall result that the quality of life of the village communities may not improve significantly with the increase in rural incomes. Attributable to jobs people tend to spend a greater proportion of their spending on providing quality education of their young ones. This is a clear indication that people are not greatly satisfied with their traditional agrarian economy and rural lifestyles. Given an opportunity, they want themselves as well as their children to secure good jobs and perhaps even leave their

homelands so that they could enjoy the urban lifestyles. However, in the case of the more remote villages such as Jhijoni and Kimoli people are more content with what they have and there is lesser desire to go outside and hence less focus on education. As traditional lifestyles have been gradually replaced by consumeristic values, a preoccupation with jobs as the ultimate security has resulted. Faith in traditional spirituality has eroded tremendously with the growing influence of the cash economy. The steady ingress of roads into remote areas has certainly brought convenience and ease of access. At the same time, they have trucked in modern, globalization- influenced values, eroded local culture, and many positive traditions.

Village Wise Comparison of Income and Expenditure

As we see that income coming from agricultural, its allied practices, and from remittances are not enough to smooth running of livelihood. The rural educated youth, who are not getting employment according to their choice, are unemployed. Meanwhile, they do not want to go back to work in the agricultural fields and rearing animals. This is a chronic situations in the villages studied. Education sector is renowned as an industry because in employment scenario, getting employment in teaching, primary as well as secondary is a current trend. From every village, teaching occupation goes nick and nick with the employment in army. In the valley regions, the unemployed youth are able to work in the quaternary sector as they started their businesses in the small service centers mostly located on the road heads. The ratio of income and expenditure is equal as the households have high income have high expenditure also and it is vice-versa with the households of low income earning. In terms of saving, it is almost very less in both income earning group i.e. high income and low-income groups. Small amount of saving is done for religious purposes but recently, the saving is also being done for educational purposes.

Food Security

The World Bank (1986) has defined food security as the, “access by all people at all times to enough food for an active and healthy life.” According to this definition, food security comprises of three aspects, namely: food availability, access and consumption. Prof. M.S. Swaminathan ( ), while defining food security has further elaborated upon these three elements of food security. He says, "Food security has three components, the first is food availability, which depends on food production and imports. The second is food access, which depends on purchasing power. The third, food absorption, is a function of safe drinking water, environmental hygiene, primary health care and education." It is important to understand through the above definitions that food availability is the first criterion towards food security. However, food availability is not an absolute measure of food security unless everyone has access to the available food. In fact, access to food is directly linked with the distribution of food. It is not the production, but the distribution and access to food for healthy and active life, which is the critical challenge (IFAD 1993). Food security is linked to food intake at the individual level, and to food availability at a higher level. Food security will be achieved when poor and vulnerable households living in the marginal areas, have physical and economic access to food, and will be achieved when they have sustainable livelihood (Sah 2002). It is important to understand that food security is not merely dependent upon agriculture. Diverse factors such as deforestation, seasonal variations in food supply, availability of fodder and other forest foods, shifts from subsistence to the cash economy etc, all have a bearing upon the food security (Falconer and Arnold, 1991).

Food Security and Forest

'Food security policies and investments focus primarily on production and trade of major staple grains, the crucial roles of forests in enhancing and sustaining food security are often overlooked or ignored' (FAO 1999). In general, forest foods are not, nor can they become, dietary staples. However, the contributions of forest resources to household food security are important (Falconer and Arnold, 1991). Forests play an important role in ensuring food security by providing multifarious products, generating livelihoods and also performing a number of ecological functions. 'They provide critical support to agricultural production, they provide food and fuel, and they provide cash income - particularly for the poor, and they provide insurance against drought and crop failure' (Falconer and Arnold, 1991). Forests are a source of fruits, vegetables, oils, medicinal plants, waxes, starches, gums, dyes, bamboo, cane, fibers, grasses, honey and lac (Swarup, 1993). The importance of forests for food security is particularly pronounced in the hills where the local populace derives a number of benefits from the forests. The local communities consume forests products for food such as fruits, vegetables, gums and honey. They add diversity to the diet increasing palatability. (Quoted in Ayalew, Melaku: What are food security, famine, and hunger? Addis Ababa, Ethiopia). (Quoted from MS Foundation website Quoted in SA H 2002 - IFAD, 1993: Providing Food Security for All, IFAD, Rome, Italy). Cases increasing overall quantities of food consumed (Falconer and Arnold, 1991). Forest foods are highly nutritious thereby adding to the overall nutrition levels of the communities. The high altitude medicinal plants in the Himalayas are not only useful for their medicinal properties but also as supplementary food. Seeds, mushrooms and animal proteins are also derived from the forests (Chauhan et. all 2001). Forests foods add diversity to the diet and also provide proteins, energy, starch, vitamins, and essential minerals (Falconer and Arnold, 1991). Forests are the main source of fodder for the livestock especially in the winter months when broad-leaved trees are extensively lopped for fodder throughout the entire region. Tree fodder consists of leaves, small branches, seeds and fruits. Many studies have pointed out the correlation between increasing deforestation and the decline in livestock numbers in the hills. By virtue of providing fodder especially during the months of fodder scarcity, forests contribute in sustaining the livestock population in the hills. The livestock in turn is a prime source of milk and meat, key constituents of the typical hill diet. Therefore, the role of forests in providing fodder and thereby ensuring food security cannot be undermined. Wood is important to food security in many ways. In developing countries of Asia and the Pacific, it is not uncommon for at least 75 percent of the population to depend on firewood for cooking (FAO, 1999). Most hill communities, particularly those living in remote villages, are also dependent upon the forests for firewood for cooking and heating purposes. According to Falconer and Arnold (1991) firewood shortages influence the amount of food supplied or cooked, affect the quality of foods consumed and the quality and supply of processed foods. Forests also generate incomes and employment for a large number of people, thus enabling them to purchase food (FAO 1999). According to estimates by FAO in 1994 forestry provides nearly 60 million work-years worldwide, of which about 80 percent is in developing countries (quoted in FAO 1999). Income earned from forest-based enterprises may supplement the household budget, which may be of particular importance to poorer households who must supplement food production with cash in order to meet their basic food needs. It is also worthwhile to mention that productive and protective functions performed by the forests are crucial for the sustainability of the farming system. Forests play an important role in farming by mitigating soil erosion and protecting watersheds (FAO 1999). However, the role that forest foods play in household nutrition has changed over the years. This is chiefly due to the reduction in the availability of forest products and changes in food habits due to the penetration of commercial markets and new products. In many regions forest foods are no longer consumed, and knowledge about their use is vanishing, although this trend is not universal (Falconer and Arnold, 1991).

Food Security in the Indian Context

The food security problem in India is currently one of access, as a sizable share of the population lacks economic and physical access to sufficient food (Persaud and Rosen 2003). 'In spite of huge buffer stocks, 8 percent of Indians do not get two square meals a day and there are pockets where severe under-nutrition takes its toll even today. Every third child born is under weight. In the last five decades, the mortality rate has come down by 50 percent and the fertility rate by 40 percent but the reduction in under nutrition is only 20 percent. Around half of the pre-school children suffer from under-nutrition. Micronutrient deficiencies are widespread; more than half the women and children are anemic; reduction in Vitamin-A deficiency and iodine deficiency disorders (IDD) is sub-optimal' (Planning Commission, 10th Plan Document). The government of India is constitutionally bound to ensure food security for the citizens. Article 47 of the Constitution of India states that the State shall regard raising the level of nutrition and standard of living of its people and improvement in public health among its primary duties. In this direction, the government has been making repeated efforts through the successive five-year plans but little progress has been made. The proportion of people living on less than $1 a day in India declined only marginally from 42% in 1993/94 to 35% in 2001 (World Bank, 2003: cited from Human Development Report, 2003).

Food Security in the Study Area

Traditionally, the hill villages were self-reliant, closed systems but over a period, there has been a general trend of increased dependence upon outside markets for fulfilling local requirements. Food security has become a major issue in the hills since, in the current scenario, farmers are not able to fulfill their year round requirements of food grains through their own fields and food grains are not being imported from outside. Koranne (1996) has observed that an average farmer produces only 4-5 months of sustenance food from his cultivated terraces and the rest has to be imported from outside. The village surveys, conducted under the present study, reveal that on an average, a family is able to meet only 3 to 4 months of food grain requirement through their own fields and for the rest of the months, food grains have to be imported from outside. It has also been found that only a limited number of families, having at least 1 to 2 acre land, are able to fulfill their year round requirements from their own fields. The most visible factors leading towards a scenario of food insecurity are:

1. Increase in population leading to fragmentation and sub-division of landholdings.
2. Change in food habits wherein people are consuming less and less of the traditional food grains.
3. Change in the cropping pattern as a result of which people are cultivating more cash crops for sale in outside markets and then purchasing food grains from the market for self-consumption.
4. Decline in forest cover.

References

Department for International Development (1999, 2000), *Sustainable Livelihoods Guidance Sheets.*

Carney, D. (ed.) (1998), *Sustainable Rural Livelihoods: What Contribution Can We Make?* (Department for International Development).

Scoones, I. (1998). 'Sustainable Rural Livelihoods: A Framework for Analysis', Working Paper 72, IDS, University of Sussex

CHAPTER 5

DEVELOPMENT OF TOURISM AND HYDROPOWER PROJECTS

Potential of tourism and small-scale hydropower projects is enormous in the Alaknanda Basin. Tourism has become a significant part of occupation and major source of income. This region has diversity in nature of tourism. Plenty of natural places, places for adventure, and pilgrimages present a unique combination and provide opportunity of extensive tourism activity in the Alaknanda basin. It has opened new avenues for the local people to rise above the poverty. Establishment of accommodation and creating new infrastructural facilities generate employment to the local people at a large-scale. This is the one face of tourism which gave new assignments and avenues to generate money. The other face is deterioration of an environment. Degradation of forestland in and around the tourist places and garbage problems due to booming up of tea-stalls and shops and as well as mass tourism are the major environmental problems. A wide range of debate on development of tourism took place in the 1990's when awareness towards environment got a momentum. The concept of eco-tourism is the result of it.

Development of hydropower projects has the potential to enhance the livelihood of the people. The Alaknanda basin is endowed with abundance of water resources. It has five major tributaries and their numerous sub tributaries. These rivers and streams are glacial fed, thus are perennial. In this chapter details of tourism development and development of small-scale hydropower projects are discussed.

Tourism Types and Development

Tourism has emerged as a smog free industry and biggest source of revenue generation in worldwide. The economic development as establishment of the new avenues, employment generation and earnings of foreign currency is one of the major functions of tourism. The scenic and panoramic view of the area further accelerated the scope of tourism. Tourism in a broader sense has existed for a long time in the basin in the form of pilgrimages to Hindu sanctuaries that are located high up in the mountains. Mountaineering, trekking, river rafting, rock climbing, and skiing are being the major tourist attraction in this region. These forms of mass tourism have a huge impact on the environment and on the local social structure. Presently, the trend of tourism is transforming into adventurer tourism. Skiing is being developed in Auli (district Chamoli) as winter sports. Trekking in many natural places and river rafting in the Alaknanda River are attracting tourist at a large scale. Various types of tourism are practiced here. Major tourism types are natural tourism, adventurer tourism: mountaineering, trekking, and skiing, cultural, and pilgrimage tourism. These are separately discussed here.

Table 5.1: Characteristics of Tourism in the Alaknanda Basin

Origin of tourism in Badrinath (Tourism inflow in %)	
Places	**Incoming tourism**
Garhwal	11.3
Kumaon	17.5
Other State	71.2
Duration of stay in Badrinath Tourist Zone	
Stay Days	**% of tourism**
<1-1	18.6

1-2	59.0	
2-3	19.3	
3-4	3.1	
Tourist by purpose in Uttarakhand		
Purpose	**% of tourist**	
Pilgrimage	60%	
Pleasure	25%	
Business	10%	
Others	5.0%	
Tourist by physiographic zones		
Physiographic zones	**% of tourist**	
Siwaliks	67%	
Lesser Himalayas	22%	
Middle Himalayas	6%	
Higher Himalayas	5%	
Tourist by nature of destination		
Nature of destination	**% of tourism**	
Pilgrim centers	54%	
Administrative and nodal places	31%	
Hill stations	14%	
Wild life nature	1%	
Sources regions of Indian tourism		
Region of origin of tourism	**Uttarakhand**	
Western zone	10	
Eastern zone	20	
Northern zone	60	
Southern zone	10	
Income categories of tourism %		
Annual income (Rs)	**India**	**Uttarakhand**
Up to 25, 000	67	40
From 25001 to 50000	34	30
From 50001 to 1 lakh	4	25
More than 1 lakh	4	5

Source: Adapted from Sati (2004)

Natural Tourism

The Alaknanda basin comprises with highly elevated snow-clad mountain peaks, deep depressed river valleys, gorges, cascades, waterfall, lush green pasturelands (alpine meadows), dense vegetal cover ranging from sub-tropical to temperate with high biodiversity-floral and faunal, and many hill towns whose natural beauty attract the tourist-domestic and international. Natural tourism has developed here after establishment of hill towns. In the late 1830's, the hill stations became more attractive for the civilian residents of India (especially for the colonial middle and upper class), due to the fact that they were an opportunity to escape the hot pre-monsoon months and the summer monsoon, at the same offering a stay in a more pleasant region with a beautiful landscape (Grotzbach 1994 a,). Mussoorie (founded in 1827) became a major center of attraction. Modern mass tourism started in 1960s and the number of tourists visiting the hill stations increased by the huge numbers. In Mussoorie, the number of visitors increased from 720000 in 1981 to 847191 in 2000. Modern mass tourism in the Himalayan region started in the 1950s after Sir Edmund

Hillary and Tenzing Norgay climbed the Mt. Everest and made the region popular in other parts of the world that had until then more or less ignored the region (Walder 2000).

Table 5.2: Tourist Inflow in Major Places Chamoli and Rudraprayag

Year	Joshimath	Ukhimath	Gope-shwar	Karna-prayag	Gupt-kashi	Pipal-koti	Gauri-kund
1985	35995	4500	7445	18000	-	17200	56100
1986	62324	7000	8644	19996	-	60614	55187
1987	51958	3820	10008	24359	-	52817	13500
1988	66800	4000	8961	70110	27008	25150	67000
1989	87655	1255	10313	10350	-	-	150025
1990	65835	850	13050	11389	18347	31450	105297
1991	69655	982	10271	13552	20126	42532	115522
1992	66217	1500	13092	15200	23000	45040	110000
1993	45194	2014	13535	17350	24024	48800	115024
1994	30613	1178	7777	16245	12297	52000	80182
1995	91480	-	9681	-	-	-	-

Source: U.P. Tourism (Hills), Dehradun and Tourist offices at various locations

Adventurer Tourism

The basin offers the modern tourism in a widespread range of possibilities. The activities range from visiting the unique cultural attractions, hiking, skiing, to the more adventurous types of tourism. In the last years, the modern (western) trend sports have been established in the Himalayan region, which includes rafting, kayaking, canyoning, rock climbing, mountain biking, bungee jumping, paragliding etc (Nepal Tourism Board 2000). Adventurer tourism is getting enormous attraction in the Uttarakhand Himalaya as winter sports skiing is developing in Auli (Chamoli District), river rafting in the Bhagirathi and Alaknanda Rivers, trekking in various natural places and pilgrimages (Tungnath, Rudranath, Madhamaheshwar, Triyuginarayan, Rookumd, Gomukh, Purnagiri, seven lakes of Nainital district, national parks, wild life sanctuaries and mountaineering in many of the snow-clad peaks.

Wildlife Tourism

The Alaknanda Basin is famous for national parks, wildlife sanctuaries, bird sanctuaries and biosphere reserves. Its 67% geographical land is covered by forest. The national parks are Govind Ghat National Park and Valley of Flowers National Park. Nanda Devi Biosphere Reserve is declared as world heritage site and known for Kasturi mirg (dear). There are also many sites, where bird sanctuaries are found. These areas have altogether the potentials of promoting wildlife tourism.

Cultural Tourism

Apart from the above types of tourism, cultural tourism also plays an integral role. The basin is woven by the fabrics of rich cultural heritage in the forms of fairs and festivals,

which occur throughout the year. Recently, Nanda Devi Rajjat is getting a moment. Similarly, there are many other festivals celebrated.

Pilgrimage Tourism

Pilgrimage to the Himalaya has played an important role for a long time. The worshipping of holy rivers and nature deities has its roots in the Aryan culture and was later integrated into Hinduism. The whole Himalayan region has an important spiritual meaning for Hindus as a "sacral space" (Grotzbach 1994 b). This leads to a different Hindu point of view of the Himalaya, not only a collection of natural features or a beautiful landscape, but also a representation of the divine. The Alaknanda basin is renowned for highland secret pilgrimages for centuries. Four *dhams* (pilgrimage) tourism has been practiced in the basin for the centuries. Badrinath, Kedarnath, Yamnotri and Gangotri have the religious importance as well as they are known for their natural beauty. Besides, numbers of other religious places are located here. The Govind Ghat and Hemkund Shahib are the two pilgrimages of Sikh religion. Tourists not only from the Indian sub-continent but also from worldwide visit these *dhams* every year. The total number of pilgrims arriving in the pilgrimage places of the Garhwal Himalaya is increasing from year to year. The major pilgrimages sites are widely elaborated here.

Panch Prayags

There are numbers of places where the major rivers meet with the Alaknanda River. These places are known as 'Prayags'. It is interesting to note that these 'Prayags' are only found in the Alaknanda River. The first Prayag starts with the confluences of Sarswati and Vishnu Ganga (also known as Alaknanda River) at Mana village, 3 km away from the famous Hindu pilgrimage 'Badrinath'. This is known as 'Keshav Prayag', which does not come under the famous 'Panch Prayag' of Garhwal. According to the religious wisdom of Hindu, the first Prayag starts with 'Vishnu Prayag' where 'Dauli Ganga' confluences with the Alaknanda River near Joshimath town. Traveling from Joshimath to Karanprayag, Nandaprayag town is located where Nandakini River confluences with the Alaknanda River. Pindar River meets with the Alaknanda River at Karanprayag. There is a myth that the Karna, son of Kunti did penance here about 3200 B. C. A Karna Kunda is located at the meeting point of the two rivers on a huge stone where the pilgrims offer tributes to late Danbeer Karna. Rudraprayag is located at the confluence of Mandakini and the Alaknanda Rivers. Although, there is another 'Prayag' i.e. Sonprayag where Son Ganga meets with the Mandakini River, yet very few description is available in the Hindu religious wisdom about this Prayag. The last and famous Prayag among Panch Prayags is 'Devprayag', where Bhagirathi and Alaknanda Rivers meet. This place has a religious importance because it is called 'The Ganga' from here.

Panch Kedars

At 3200 m, Kedarnath temple is located in Okhimath tahsil of Rudra Prayag district. The Mandakini River originates from Kedar peak and flows from the right side of Kedarnath temple. It is not only the place of religious importance but it has also a picturesque landscape. For around six months, the Kedar temple and its surrounding areas remain covered in snow while snow fall occurs even during the summer, which is the main season for pilgrims. There is a small township which is summer camp for the people of the low-lying areas. Few people emigrate here with their animals mostly during rainy season, when they find extensive pastureland for grazing their animals. For around six months, the Pandas (religious Gurus) and the owners of small hotels or shops migrate here for running their establishments. According to a myth; the temple was established by the Pandawas before

departing to Swarga. This myth was supported by the idols of five Pandawas, Dropadi and Kunti, which are stalled inside the temple. The Adi Guru Shankara Charya was willing to visit the temple of Kedarnath but while on the way at Bhairav Jap, he died with his followers. In the Garva Giriha (pivotal area), a flat triangle Ligna of Lord Shiva lies where the people make prikarma at the time of Darshan. Panch Kedar includes Kedarnath, Tungnath, Madhyamaheshwar, Rudranath, and Kalpeshwar.

Kedarnath pilgrimage is one of the most important pilgrimages where about 14 km trekking is traveled by the pilgrims from Gauri Kund. It is toughest rout. According to a survey (Sati, 2009 a), about 45% people use to ride over pony or mule or use wooden palanquin or doli (made by ringal, a variety of bamboo) to reach Kedarnath temple. Rest of the people visit the temple by walk. The months of May and June are the peak time for the pilgrims to visit this temple. During the summer seasons, the students and school children gets holyday and they make their resort to the pilgrimages and natural places. For a day estimate, She counted the people with their mode of transportation. The visit starts from 4'0 clock morning and lasts around 6'0 clock at evening. While sitting about one km away from Gauri Kund towards Kedarnath, an hour estimation of number of pilgrims was counted. Around two hundred twenty wooden palanquins, two hundred twenty horses, fifty dolies and six hundred by walk passed from the place which is 1070 persons. In a day, 14 hours movement of the pilgrims has been seen. Therefore per pilgrims who visit Kedarnath temple are estimated about 14980 in a day. This number may be reduced during the other months of pilgrimage season. July and August are the months when the highest monsoon rainfall occurs. September and October are the best months to visit Kedarnath, because it is the main flowering season.

Panch Badris

Panch Badri includes Badrinath, Bhavishya Badri, Yagdhyan Badri, Adi Badri, and Adinath or Bridha Badri. Lying on the lap of Nar and Narain Parvat, Badrinath is located on the right bank of Vishnu Ganga (Alaknanda River) at 3100 m. It is one of the four pilgrimages of India. The others are Puri in Orissa, Rameshwaram in Tamilnadu and Dwarika in Gujarat. Adi Gugu Shankaracharya established this temple. It is a seat of Lord Vishnu. Mainly, the Hindu pilgrims visit Badrinath Temple. Badrinath temple opens in the second week of May and closed in mid October. Remaining the year, it is covered in snow. Highest number of pilgrims visit Badrinath temple every year. Sati (2009 b) surveyed the number of pilgrims visit Badrinath temple during May and June. From Joshimath, only the one way traffic is available. In a day gate open for five times. The average number of vehicles for one time was 220 including big buses and mini vehicles, which were about 4400. In a day, the average number of pilgrims visits Badrinath were 22000, which is outnumbered the pilgrims visit Kedarnath in a day.

Table 5.3: Tourist Traffic to the Shrines of Badrinath and Kedarnath

Year	Badrinath			Kedarnath		
	Domestic	Foreign	Total	Domestic	Foreign	Total
1985	2,75,000	N.A.	2,75,000	1,13,161	162	1,13,323
1986	2,48,565	N.A.	2,48,565	84,121	43	84,164
1987	2,72,950	N.A.	2,72,950	79,371	51	79,422
1988	3,76,819	N.A.	3,76,819	1,37,015	79	1,37,094

1989	3,72,772	N.A.	3,72,772	1,15,842	14	1,15,856
1990	3,61,292	N.A.	3,61,292	1,17,744	N.A.	1,17,744
1991	3,55,722	52	3,55,774	1,18,634	116	1,18,750
1992	4,12,557	40	4,12,597	1,41,784	N.A.	1,41,784
1993	4,76,526	34	4,76,560	1,18,635	24	1,18,659
1994	3,47,025	390	3,47,415	1,04,533	105	1,04,638
1995	4,82,900	N.A.	4,82,900	1,06,000	N.A.	1,06,000

Source: U.P. Tourism (Hills), Dehradun

The infrastructural facilities such as transportation, lodging, and boarding are considerably less in these two pilgrimages. Though, road transportation is available up to Badrinath temple, the condition of road is not good. From Helang to Badrinath, the condition of road is bad but it is worsened between Joshimath and Badrinath, where one way traffic system prevails because of the narrow road. The carrying capacity of lodging and boarding is low, the expenses in these pilgrimages are therefore high and the pilgrims of low income group do not afford it. Income from pilgrimage tourism is comparatively less than the places of natural tourism in the Garhwal regions, while the pilgrims are outnumbered.

Tourism has multiplier impacts on economy, as it helps for augmentation of employment, increasing living standard of the local people and as well as increasing national income (Sati 2004). The dawn of the mass tourism era in the Himalaya had an enormous influence on the local economy. With the number of visitors increasing dramatically, the total amount of money spent by them increased in the same way. In fact, it is a major source of income as Rangan (2000) reported that Garhwal earned between 10-15% of its revenue from taxes and levies imposed on pilgrims each year. In India, tourism is the second-largest source of foreign currency behind the gem and jewelry business (TED N/A). The money spent by the tourists has diverse effects on the local economy. It stimulates the economy and induces the so-called “multiplier-effect” – jobs are created, capital is accumulated and local workers that used to be dependent on subsistence farming start their own businesses that serve the tourists, selling or renting supplies, providing guides or selling souvenirs to the tourists. Those businesses, in turn, employ people as guides or workers, which thereby benefit indirectly of the tourist money. But a part of the money can also be used to improve the local living standards through better health care, education and building structure. With the scarcity of jobs, tourism offers a lucrative and interesting avenue for income. The economic impact of tourism can be noticed along the roadsides from Rishikesh to Badrinath and Kedarnath, where mushrooming of small tea-stalls, dhabas, and other shops are earning a noticeable amount of wealth from the tourist everyday. A study reveals, the villages lie on the major routs to the pilgrimages are now fully dependent on the income coming from the tourist by providing them accommodation and other basic facilities at their stay.

While tourism in the study area is an important source of livelihood for the people and revenue for the State, the environmental implications are many. Land degradation is the most common effect of tourism, particularly in hill resorts. The demand for fuel wood the primary fuel for restaurants and dhabas, is much higher during tourist season, especially in the higher locations of the basin, leading to further pressures on the forests (UEPPCB 2004). In addition expansion of tourist areas causes degradation of adjoining green belt, as most of the tourist centres are located in places with good natural vegetation.

Hydropower Projects

The Himalaya is bestowed with rich bio-diversity and provides wide varieties of natural resources including the life sustaining water to the Indian sub-continent. In the last few years significant increase in the number of proposed hydroelectric projects has been witnessed in various river basins. The enormous hydroelectric potential of Uttarakhand has made it synonymous with URGA-ANCHAL (Power State). During the 1980's there were 22 proposals of hydroelectric projects and many of them have got commenced. These macro hydroelectric projects are mostly commencing in these areas where human settlements and productive agricultural patches are densely located. There are total 220 power project proposed in Uttarakhand. Out of which 52 are of large size, 36 messo, and 132 small scale projects. From each macro project, 100 MW power productions are targeted. Similarly from messo project, 25 to 100 MW productions are proposed and 25 MW productions are proposed from small-scale projects. There are seven dams, which have more than 200 m height. The state has 20 to 30 thousand MW hydroelectric generation capacities. At present 8 thousand capacity powerhouses are under construction. The major projects where generation of power has started are Dhauli Ganga hydroelectric project, Maneri bhali, and Tehri. The project under construction are Vishnu Prayag hydropower project, Tehri dam second phase (1000 MW), Koteshwar dam, Lakhwad-Vyasi, Loharinag-Pala, Pala Maneri, Arakot Tyuni, Tyuni-Plau, Khartoli-Lumti, Jakhol-Sankari, Bowala-Nanda Prayag, Nand Prayag Langasu, Bhairavghati, Tamak-Lata, Sela-Urthig, Karmali, Pala-Tiloth, Hanol-Tyuni, Bhilangana, Vishnigad-Pipalkoti, Garba-Tavaghat, Jad Ganga etc.

The macro hydroelectric projects in the region are not sustainable because of fragility and instability of mountain terrain. There are conflict between the dam commencing agencies and the local people and social workers regarding this issue. Meeting with energy need for development processes, and harnessing water resource potential optimally, micro hydroelectricity projects are the need of the hours. This will reduce the environmental degradation and rehabilitation problems. There are numerous places, where these small projects can be commenced.

Table 5.4: Details of selected hydropower projects in Garhwal region

Hydropower projects	River valley	Capacity in MW (Construction company)	Number of affected villages and impact on them due to construction	Current situation
Vishnuprayag	Alaknanda	400 (JP)	5 villages, Perennial sources of water are dried up and cracks are placed in the villages. 30 houses damaged in Chai village	16 km tunnel constructed, connecting Lambagar and Chai village
Tapovan-Vishnuprayag	Dhauli Ganga	520 (JP)	5 villages, agricultural land, forestland and grazing land affected	Construction work has been started
Lata-Tapovan	Dhauli Ganga	162 (JP)	5 villages, agricultural land, forestland and grazing land affected	Construction work has been started

Singoli-Bhatwadi	Mandakini	90 (L and T)	16 villages, agricultural, grazing and forestlands affected	Construction work has been started
Srinagar	Alaknanda	330 (JBK)	20 villages and Dhari Devi temple, Individual and community land affected	Construction work is in peak
Danawa-Churena	Balganga	5 (Gunsaula)	6 villages, irrigated agricultural land, grazing land, community land affected	Power house has been constructed
Bhilangana	Bhilangana	22 (Gunsaula)	4 villages, irrigated land and forestland	Powerhouse has been constructed and tunnel is under construction
Devlang (Ghuttu)	Bhilangana	24 (Gunsaula)	10 villages, forestland, community land and grazing land affected	Tunnel is being constructed
Maneri-Bhali Phase 2	Bhagirathi	304 (NHPC)	22 villages. Natural perennial water resources are dried up. Cracks are appeared in the houses.	Under construction. Tunnel is likely to be completed.
Pala-Maneri	Bhagirathi	480 (NHPC)	2 villages, fertile cultivable land and 6.8 ha forestland	Work started in 2007 but in 2008 the work is rigorously stopped due to people's agitation
Lohari-Nag-Pala	Bhagirathi	600 (NHPC)	6 villages, 112 ha fertile land	-Do-
Jakhol-Sankari	Tons	33 (NHPC)	5 villages	Proposed, Peoples' agitation continued
Netwad-Mori	Yamuna	33 (NHPC)	5 villages	-Do-
Total 13	**8 River valleys**	**3003 MW (5 companies)**	**101 villages**	**2 projects are proposed and 11 are under construction**

Source: Compiled by author

Some hydropower projects of Garhwal region were case studied and a separate discussion was carried out on each project to look into the overall scenario. **Table 5.4** reveals that 13 hydropower projects of 3003 MW capacity are proposed or under construction in 8 river valleys in Garhwal region affecting total 101 villages directly or indirectly.

Water Mills (*pan chakki/gharat*)

Community participation in production of hydroelectricity through installation of water mills with financial assistance from government agencies is vital in this hilly region to meet the energy need and reduce firewood burden from the forest. The water mills are successfully commencing in many areas where the governmental agencies have provided financial assistance to the rural villagers to run this entrepreneur. This option of sustainable livelihood is renewable and need financial assistance at the beginning stage.

On the way to field visit of Khanda Gad sub-watershed, I saw an improved *gharat* (water mill) on the right bank of Khanda Gad, a perennial stream (gad is synonymous to stream). I met with the owner Mr. Achala Nand Nautiyal, a 74 years old inhabitant of Khanda village. He has two sons and four grand sons. Up to December 2007, he had a traditional Gharat and income from the Gharat was not enough even to meet the two times meal. He has also 0.25 acre agricultural land, which is irrigated. In January, a team of government officials visited his house and invested seven hundred thousand rupees to improve his traditional water mill. Now, he is able to run his family's livelihood enormously. Currently, he has three mills for grinding wheat, oilseeds, and paddy. Not only this, the electricity generated by this improved water mill is sufficient for lighting house, cooking, and running water mill. Except the initial investment, which was born by the government, nothing was invested till now. This water mill is able in grinding more than 2 quintal wheat per day and also fulfilling the need of the villagers of about nine villages. The villages, which are dependent for grinding wheat from this water mill, are Sirkot, Khanda, Asnauli, Pipalkoti, Girgaon, Baheli, Teruli, Amdar, and Perauli. Mr. Nautiyal is now physically not fit so that his wife Shakuntala Devi, 60 years old runs the water mill. This can be seen as women empowerment. The 10 member family is currently self-reliant. The agricultural land (0.25 acre), which was earlier part of their livelihood, is currently in lease given to a neighbour since all family members are engaged with running water mill. This is not only a case in the region but there are many instances, where the people individually and collectively practicing this.

Potentials of Micro-Hydroelectric Plants

The feasibility of micro-hydroelectric plants in mountain regions, which are ecologically fragile and geologically unstable, is very high. This basin is highly sensitive in terms of instability and fragility. Macro-hydroelectric projects are not only unsuitable from stability point of view but economic point of view also as it is seen during the construction of Asia's highest Tehri high dam, which took nearly three and half decades to get its present form. The expenditure for its construction was double during the construction phase. A group of local people agitated against its construction and this agitation also took nearly two decades. The economic viability and feasibility of micro-hydroelectric projects is considerably high even a capacity of 2x2.5 MW power projects are quite suitable. The Government of Uttarakhand has already constructed the power projects with this capacity. Such capacity power plant is constructed near confluence of the Pindar (from right side) and Kail Ganga on Kail River. This project is able to provide electricity for around twenty-five villages of its command area. While discussing with the villagers, they are found fully satisfied with electricity supply, and even in better position.

Reference

Grotzbach, E. 1994, Hindu-Heiligtümer als Pilgerziele im Hochhimalaya. – In: Erdkunde 48(3). Pp. 48

Nepal Tourism Board. 2000. Welcome to Nepal. Pp. 45-51
http://www.welcomenepal.com/Brochure.asp , 03/03/03.

Rangan Haripriya. 2000. *Of Myths and Movements: Rewriting Chipko in Himalayan History.* London: Verso. : 70 Pp. 72-74

Sati, Vishwambhar Prasad. 2004. 'Tourism Development in Uttarakhand: The Emerging Vistas' Nigan and Ranga (ed.). *'New Approaches in Tourism Management'* Abhijeet Publication, Delhi. Pp. 315-317.

Sati, Nirmala. 2009. Development of Pilgrimage Tourism: A Case of the Chaar Dham Tourism in Uttarakhand. Paper presented at a National Seminar, held at Bilaspur, Chhattisgarh. 16-17 Jan 2009.

Trade and Environment Database (TED). YEAR N/A. Himalaya Case Issue. Pp. 8 http://www.american.edu/TED/HIMALAY.HTM , 11/02/03.

Walder, G. 2000. Tourism Development and Environmental Management in Nepal: A study of Sagarmatha National Park and the Annapurna Conservation Area Project, with special reference to Upper Mustang. MSc Thesis, the International Centre for Tourism and Hospitality Management, Bournemouth University. Pp. 9

CHAPTER 6

CASE STUDIES

Case studies of two micro-watershed regions of the Alaknanda Basin were carried out. These micro-watershed regions are; Khanda Gad, sub-watershed of the lower Alaknanda River and Kewer Gadhera, sub-watershed of the Middle Pindar River. Villages are the unit and household level study was conducted to know about socio-economy and options for enhancing and diversifying livelihood of the people. Village wise data on population profile and land use pattern was gathered from secondary sources, mainly from censuses of 1971, 2001, and Patwari circles (a revenue unit). Data on farming systems and earning of farmers from different sources were collected through structured questionnaire and personal interviewed of the households. Here, the details of the case studies are given separately on each micro-watershed region.

Khanda Gad Sub-Watershed

Khanda Gad, sub-watershed of the lower Alaknanda River is located in the South part of the Alaknanda Basin. This is a perennial stream. It outlets from the 'Danda of Khirsu' in Khirsu block of Pauri District, inlets into the Alaknanda River at opposite of Kirtinagar town. It is extended between 30° 9' N and 30° 12' N latitude and between 78° 45' and 78° 48' E Longitude. It has dense forest cover mainly pine in the lower elevation and oak in the higher reaches of the watershed. Besides, small bushes and shrubs are also found mostly in the lower elevations. Agricultural land is available in the valley regions and mid-slopes where subsistence cereal crops are grown. Pauri town is district headquarter located on the top of in this watershed. The other small service centres are Khanda, Khirsu, and Chaubatiya. The valley regions are hot during the summer while highland areas have feasible climatic conditions. However, during winters, valley regions get severe cold and remained under fog for around three months. Meanwhile, higher reaches receive snowfall. The chilled winds from the mighty Himalayan ranges reduce the temperature.

Many studies on the farming system of Himalaya reveal that traditional cereal crops, which dominate the cropping pattern in the region, do not support the livelihood system at sustainable level. Although these crops have rich crop diversity and are fit in the ecosystem of the region yet they do not able to produce crops in enough quantity. During field visits, I interviewed the residents of Khanda Gad about their livelihood. A resident of Khanda Gad Mr. Kathait has about 2 ha agricultural land, where he grows wheat, mustered, and masure (lantil) during the rabi season and paddy, mandua (finger millet), gahat, bhatt (two varieties) during rainy season. The crops he grows is very insufficient even do not meet the food requirement annually. It is available only for few months. The interviewed person has a shop in the village, which he runs for the livelihood of entire family. This is the case for many of the villagers who are engaged in business parallel to agriculture. The agricultural land is fragmented and steep sloped which depend on the rainfall during the rainy and winter seasons. Khanda village is a small service centre. Small patches of agricultural fields are available along both sides of Khanda Gad. It is around two km long and 500 m wide patch of fertile land with irrigation facilities. The local people grow the traditional crops including wheat, rice, pulses, oilseeds, and millets and normally, the crops production is low.

Tremendous changes have been taken place in the cropping pattern in Khanda village with the arrival of five Nepali immigrant families. They started the cultivation of case generating crops (off-season vegetables) particularly tomato, potato, onion, cauliflower, green

vegetables and beans. Due to availability of water through this perennial stream and manure (as they reared animals), the productivity of these crops are considerably high and able enough to substitute their livelihood. They have about 2 ha land. Commercially, tomato, potato, onion, cauliflower, green vegetables and beans are grown extensively. While discussing with these Nepali Families, they informed that about 100 boxes of tomato is grown in a season. Each box has 18 kg capacity. Market is easily available even the products are sold out from the fields. Easy accessibility through road transportation further enhances the marketing opportunity. Similar case is applied with the production of pees. In a season, the growers are able to earn about 50, 000 rupees ($ 1000). The land fertility does not make any change in terms of growing cash generating and subsistence crops. On the other hand, land fertility is equal for growing subsistence crops and off-season vegetables.

It is interesting to note that even the potential of off-season vegetable is tremendously high in the area; the local people do not grow it. They are still growing subsistence crops in the adjacent area. Off-season vegetables are grown by the Nepali immigrants along both sides of khanda Gad. One important point I noted that the cultivation of cash generating crops require high labour input than to cultivation of subsistence crops. The Nepalese immigrants are strong and hard worker and able to grow these vegetables. Twelve villages were case studied in the Khanda Gad sub-watershed. These villages are Margaon, Khanda Srikot, Margadna, Bhitai Malli, Kaldung, Dhanak, Gaduwa Gad, Kamand, Dov, Shiyar Malla, Rawat Gaon, and Bhitai Talli. A detail study of population profile, land use, and cropping pattern was carried out.

Population Profile 1991-2001

Population study was carried out in the 12 villages along both sides of the Khanda Gad of Pauri district. **Table 6.1** shows area in ha, number of households, and change in percentage. In the last decades 14.3% increase in HHs registered in these 12 villages. Margaon, Margadna, Gaduwa Gad, and Dov have registered negative increase in HHs while other eight villages registered positive increase.

Table 6.1: Number of Households and Change in Percentage

Village Name	Area (ha)	HHs		
		1991	2001	Change in %
Margaon	9.3	35	31	-11.4
Shrikot Khanda	122.0	67	109	62.7
Margadna	32.7	18	8	-55.5
Bhitai Malli	73.4	71	76	7.04
Kaldung	80.9	31	32	3.2
Dhanak	26.1	19	27	42.1
Gaduwa Gad	44.7	11	10	-9.1
Kamand	25.5	17	23	35.3
Dov	53.7	26	24	-7.7
Shiyar Malla	33.8	0	-	0
Rawat Gaon	46.6	7	7	0
Bhitai Talli	71.9	20	21	5
Total	**620.6**	**322**	**368**	**14.3**

Source: Census hand books of 1991 and 2001

Table 6.2 reveals population under 0-6 age group, total population, density of population, literacy rate, SC population, and Sex ratio. Data from two censuses were gathered (1991-2001). In 1991, total population under 0-6 age group was 269 which reduced 172 in 2001. During this decade, 97 persons decreased. This was -36% decreases. Increase in female population was registered higher than male population (-34% and -38% respectively). 2.4 % increase in total population was registered during 1991-2001. There was no change in female population while it was about 5.1% increase in male population. Density of population was 3 persons per ha area (2 male and 1 female). Literacy rate increases from 62.5% in 1991 to 75.9% in 2001. It was highest in male (89.8%) than female (63.2%). This shows higher than national and state average. Sex ratio was tremendously increased from 956 to 1010 women per thousand men. Increase in literacy rate and sex ratio shows that these cluster of villages have numbers of school from primary to university.

Table 6.2: Population Structure

	Total	**Population**	**Male**		**Female**	
Population Structure	1991	2001	1991	2001	1991	2001
Population (0-6)	269	172 (-36%)	138	86 (-38%)	131	86 (-34%)
Total Population	1580	1618 (2.4%)	736	774 (5.1%)	844	844 (No change)
Population Density (Person per ha)	3	3	2	2	1	1
Literacy	987(62.5)	1228(75.9)	567(77)	695 (89.8)	420 (49.7)	533 (63.2)
SC Population	399	392 (-1.7%)	204	195 (-4.4%)	195	197 (1.0%)
Sex Ratio	956	1010				

Source: Census hand books of 1991 and 2001

Changes in Land Use Pattern

Land use data of twelve villages of Khanda Gad sub-watershed were gathered from census handbook of 1971 and Patwari circle, Srinagar and Pauri of 2007. Three categories of land use such as forest cover, irrigated land and un-irrigated land including total area of the villages were gathered and changes in land use from 1971 to 2007 were calculated. **Table 6.3** shows changes in land use (ha).

Table 6.3: Changes in Land Use (ha) 1971*-2007**

Village name	Total Area	Forest land	Irrigated land	Un irrigated land
Margaon	-22.7	3.6	1.9	-12.3
Shrikot Khanda	-10.4	12.8	5.0	2.9
Margadna	5.9	-	0.4	6.7
Bhitai Malli	-0.6	5.2	3.7	28.5
Kaldung	-11.9	4.9	-0.1	35.2
Dhanak	0.5	3.0	0.2	6.9

Gaduwa Gad	-2.9	-	-0.5	17.1
Kamand	-0.3	5.5	-0.4	0.5
Dov	10.1	14.3	-	2.0
Shiyar Malla	20.6	-	1.3	-1.5
Rawat Gaon	-0.2	-	0.4	14.8
Bhitai Talli	-94.5	7.1	-0.7	-55.2
Total	**-105.8**	**56.4**	**8.8**	**45.6**

Source: * Census handbook 1971, ** Patwari circles, Srinagar and Pauri.

For the last three decades or so, the total land area of the villages decreased. It was 726 ha in 1971 and in 2007 it recedes 620.2 ha (-105.8 ha). Contrary, forestland increased from 2.4 ha in 1971 to 58.8 ha in 2007 (56.4 ha). Irrigated land also increased from 14.4 to 261.6 ha (8.8 ha) and similarly un-irrigated land increased from 23.2 to 307.2 (45.6 ha). The increase in forestland was mainly due to Forest Act of India 1982, establishment of *van panchayat* to ensure peoples' participation and because of the uprising awareness among the villagers towards conservation of forest. Increase in sown area was due to high growth in population. Although, the rate of increase is considerably less as compare to increase in population. It was due to large-scale emigration and land abandonment. The other categories of land such as wasteland and cultivable wasteland have decreased simultaneously.

About 10 years ago, some Nepali inhabitants of Rolpa District of Nepal visited the villages of Khanda Gad. Initially, they immigrated here for search of Job. Meanwhile, they met with the villagers of Khanda Gad (Margaon, Shrikot Khanda, Margadna, Bhitai Malli, Kaldung, Dhanak, Gaduwa Gad, Kamand, Dov, Shiyar Malla, Rawat Gaon, Bhitai Talli) mostly those who were permanent emigrants. From them, they got small patches of land, along the Khanda Gad in lease (Rs. 4000 (Indian) per family per crop season), which were mostly abandoned. Since, the Khanda Gad is a perennial stream therefore it provides ample irrigation facility. Largely, the households (elders) are illiterate but recently their children have joined primary school. The Literacy rate is 31.3% (among children, it is 90%) with 45.3% girl's literacy. Male and female are equally working on the farmlands. **Table 6.4** shows demographic profile of Nepali immigrants. Total number of households is 65 and total population is 409. Sex ratio is high as 1034 women are against of 1000 men.

Table 6.4: Demographic Profile of Nepali Immigrants

Village name	Total Nepali HHs	Total population	Male	Female	Sex Ratio	Literacy	
Margaon (Khanda)	10	64	33	31	939	22	34.3
Koti	10	65	32	33	1031	18	27.6
Dhamkeshwar	10	63	32	31	968	20	31.7
Khanda Shrikot	2	11	6	5	833	5	45.4
Margadana	2	13	7	6	857	4	30.7
Mitai	1	7	4	3	750	3	42.8
Kaldung	1	10	6	4	666	4	40
Dhanak	4	26	12	14	1166	10	38.4
Gadowa Gad	2	14	7	7	1000	5	35.7
Kamand	4	20	11	9	818	6	30
Dob Shrikot	4	22	12	10	833	7	31.8
Malli Sera	5	36	12	24	2000	6	16.6

Rawat Gaon	4	24	11	13	1181	7	29.1
Gadoli (tea state)	6	34	16	18	1125	11	32.3
Total	**65**	**409**	**201**	**208**	1034	**128**	**31.2**

Source: Surveyed by the author

The Nepali immigrants started cultivating cash generating crops such as potato, tomato, onion, cauliflower, capsicum, spinach, cucumber, pumpkin, and beans commercially. They use both chemical fertilizer (Rs.1400/ha) and manure (Rs.500/ha). Manure is easily available from the nearby villages. Every cluster of HHs has a pair of oxen, which they use to plow fields and get manure. Responding for a question, a head of Nepali immigrants in Dhanak village informed that there is no negative change in the production of off-season vegetables even they are using chemical fertilizers for high production of vegetable crops. However, still subsistence agriculture is done on the middle patches of agricultural fields by the native farmers but the production and per ha yields of the crops are considerably low. **Table 6.5** shows production of off-season vegetables in twelve villages of Khanda Gad in 2007-08. Highest production among off-season vegetables is obtained from cauliflower (727 quintal) followed by tomato (1790 boxes). Potato ranks third. Capsicum (118 quintal), beans (144 quintal) and cucumber (310 quintal) obtain lowest rank in production respectively.

Table 6.5: Production of Off-Season Vegetables in Khanda Gad 2007-08

Village name	Area ha*	Production (quintal/boxes)					
		Cauliflower	Cucumber	Tomato (boxes)	Capsicum	Beans	Potato
Margaon (Khanda)	5	70	30	350	12	15	Nil
Koti	5	70	30	350	12	15	100
Dhamkeshwar	5	70	30	350	12	15	200
Khanda Shrikot	2	30	12	140	4	4	100
Margadana	2	30	12	140	4	4	
Mitai	1	12	06	60	2	2	
Kaldung	1.5	15	08	170	2	3	Nil
Dhanak	5	70	30	350	12	15	Nil
Gadowa Gad	2	30	12	140	4	4	
Kamand	5	70	30	350	12	15	Nil
Dob Shrikot	5	70	30	350	12	15	Nil
Malli Sera	4	60	25	300	09	11	Nil
Rawat Gaon	4	60	25	300	09	11	Nil
Gadoli (tea state)	5	70	30	350	12	15	Nil
Total	**51.5**	**727**	**310**	**1790**	**118**	**144**	**400**

Source: Primary collection ***** Patwari circles Srinagar and Pauri

Table 6.6 shows area and annual income of off-season vegetables and cereals in 2007-2008. The total area under off-season vegetables is 51.5 ha and annual income is Rs. 133, 8100 (Rs. 25, 982 per ha) while under cereal crops, it is 330.4 ha land and Rs. 502, 1600 annual income, which is Rs. 15, 198 per ha. Similarly, the numbers of households working

for producing off-season vegetables are 65 while, 368 households are involving with cultivation of cereal crops.

Table 6.6: Area and Annual Income of Off-Season Vegetables and Cereal Crops 2007-2008

Off-season vegetables	Area (ha)	Annual income (Rs.)	Cereal crops	Area (ha)	Annual income (Rs.)
Cauliflower	15	5, 08900	Wheat	100	1472000
Cucumber	3	2, 17000	Rice	100	2520000
Tomato	20	1, 79000	Barley	50	760000
Capsicum	3	1, 18000	Millets	50	121600
Beans	3	1, 15200	Pulses	20	70000
Potato	7.5	2, 00000	Oilseed	10.4	78000
Total	**51.5**	**13, 38100**	**Total**	**330.4**	**50, 21600**

Source: Primary collection

Table 6.7: Production and per ha Yield from Off-Season Vegetables and Subsistence Crops 2007-08

Off-season vegetables	Area (ha)*	Production (in quintal)	Per ha yield	Subsistence crops	Area (ha)*	Production (in quintal)	Per ha yield
Cauliflower	15	727	48.5	Wheat	100	1520	15.2
Cucumber	3	310	103.3	Rice	100	3680	36.8
Tomato	20	1790	89.5	Barley	50	1840	36.8
Capsicum	3	118	39.3	Millets	50	1472	29.4
Beans	3	144	48.0	Pulses	20	368	18.4
Potato	7.5	400	53.3	Oilseeds	10.4	368	35.4
Total	**51.5**	**3489**	**67.7**	**Total**	**330.4**	**9248**	**28.0**

Source: Primary collection * Patwari circles Srinagar and Pauri

Table 6.7 shows production and per ha yields from off-season vegetables and subsistence crops in 2007-08 in twelve villages of Khanda Gad sub watershed. Main off-season vegetables grown are cauliflower, cucumber, tomato, capsicum, beans, and potato. Among cereals, the main crops are wheat, rice, barley, millets, pulses, and oilseeds. Land under off-season vegetables is 51.5 ha while under subsistence, it is 330.4 ha. Highest per ha production is of cucumber (103.3) followed by tomato (89.5) and potato (53.3). Under cereal crops, rice and barley (36.8 each) have highest productivity followed by oilseeds (35.4). Concisely, per ha yield of off-season vegetables is 67.7 in comparison of cereals (28.0). This reveals the high potentials of off-season vegetables. If a sizeable proportion of cultivable land is devoted for cultivating cash generating crops, food security can be obtained.

Kewer Gadhera Sub-Watershed

Kewer Gadhera is a sub-watershed of the Pindar River. It originates from the root of Kanpurgarhi top (a highest point of the watershed) and confluences into the Pindar River at Narain Bagar. It is extended between 30° 5' N and 30° 8' N latitude and between 79° 20' and 79° 23' E Longitude. Flows in the middle watershed of the Pindar River, it is a perennial stream. It has four sub-perennial tributaries. The stream makes steep to gentle slopes. During monsoon, it flows above denser marks due to heavy downpour. It flows below average during winter season. Through out it course, water of the stream is not used for any purposes; drinking as well as for irrigation. It is due to rough, rugged, and precipitous landscape on the course of the stream. Only in few places, small agricultural land is irrigated. The whole watershed of the Kewer Gadhera is prone to soil erosion. Largely, during the monsoon season, when entire watershed receives heavy downpour (mostly the wind blowing from the south-east direction) landslides and debris flow is very common. There are many instances when the entire villages along with agricultural lands washed away with heavy losses to life and property. Musudiar landslide is an example, which took place in Aug 1993.

Until now, about 80% villages are not connected by road network. Recently, road are being constructed and some of villages are networked, but the frequency of vehicles is low. The condition of road is worst. Though, there is a plan to connect most of the villages by road transport yet the pace of making this plan truth is very slow. The people have to walk miles to do their daily works. A small service centre Narainbagar is located on the bank of the Pindar River and on road head connects Karanprayag and Gwaldom. This service centre fulfills the subsidiary needs of the villagers.

Subsistence cereal farming is the main occupation of the people inhabited in this area. The main crops are known as *'Barah Naja'* (twelve grains), which include millets, pulses, and oilseeds. Farming is mostly done on the narrow patches of terraced fields in the middle and upper reaches of the watershed. Few places on the valley regions are farmed. The considerable loss of soil due to large scale erosion is resulted in low production and per ha yields. Further, the modes of agricultural practices are traditional. Crops are grown in two different seasons. First season is *rabi* which starts from Nov-Dec and lasts to May-June. In this season, wheat is main crop followed by barley and mustered. Earlier, barley was the prime crop. Second season is kharif. Rice, millets, maize, pulses, and oilseeds are the main crops. This season begins from April and lasts in Oct. Changes in farming systems have been noticed during last two decades. This was started with changes from subsistence crops into cultivation of paddy and wheat. Still in the highland villages such as Kimoli, Swan, and Jhijodi, subsistence crops are grown. In the villages of middle slopes and valley regions, rice and wheat along with millets are largely grown.

Case study of 17 villages of Kewer Gadhera sub-watershed was carried out. The villages are Kerer Tall and Malla, Bhagoti, Ratni, Keshwan, Gadsseer, Bunga, Jhijodi, Ali, Leguna, Bedula, Chirona, Kaub (cluster of four villages), Naini, Swam Malla and Talla, and Kimoli. Village wise study of land use and population profile was done.

Table 6.8: Changes in Area and Number of HHs (1971-2001)

Villages	Area			HHs		
	1971 (ha)	2001	Change	1971	2001	Change
Kewer Talla	32	31.1	-0.9	68	247	179
Kewer Malla	47.5	45.4	-2.1	13	26	13
Bhagoti	100.04	104.5	4.4	67	88	21
Ratni	37.6	37.8	0.2	15	27	12
Keshwan	50	25.5	-24.5	19	21	2
Gadseer	156	171.6	15.6	73	103	30
Bunga	112	129.4	17.4	60	70	10
Jhijodi	204	162	-42	116	150	24
Ali	11.5	11.1	-0.4	7	15	8
Leguna	14	19	5	9	20	11
Bedula	71.6	71	-0.4	20	36	16
Chirona	26.8	27	0.2	4	11	7
Kaub	231.6	228.6	-3	144	242	-2
Naini	22.8	22.6	-0.2	14	20	6
Swan Malla	2	28.2	26.2	13	16	13
Swan Talla	56.4	58.3	1.9		43	43
Kimoli	242	247.9	5.9	111	168	57
Total	**1417.84**	**1421**	**3.3**	**753**	**1303**	**450**

Source: Calculated from censuses of 1971-2001

Table 6.8 shows that geographical area of the case study villages was more or less unchanged. It also varies from one village to another. In Jhijodi, village area reduced tremendously. Between 1971 and 2001, -42 ha land reduced. This was followed by Keshwan (-24.5 ha). Swan Malla registered increase in land (26.2 ha) followed by Bunga (17.4 ha) and Gadseer (15.6 ha). It is interesting to note that during 1971-2001, numbers of households do not increase at a large scale. On the other hand, rate in population growth is very less. Highest increase in number of HHs was registered in Kewer Talla (179 HHs). Decrease in number of HHs was registered in Kaub, cluster of five villages. During last three decades, -2 HHs decreased. The major cause of decrease in HHs is large scale emigration. The HHs out-migrated to the plain areas of the state for search of job. The trend of out-migration can be noticed everywhere in the study villages.

Table 6.9: Population Structure (1971-2001)

	Total Population		Male		Female	
Population Structure	1971	2001	1971	2001	1971	2001
Population	3521	6613 (87.8%)	1622	3171 (95.5%)	1899	3442 (81.3%)
Population Density (Person per ha)	2	5 (3 person)	1	2 (1 person)	1	2 (1 person)
Literacy %	27.8	61.0	48.0	73.6	10.5	49.3
SC Population	900	1797 (99.6%)	431	843 (95.6%)	469	954 (103.4%)
Sex Ratio	1170	1085				

Source: Calculated from censuses of 1971-2001

Table 6.9 shows population structure in the cluster of villages of Kewer Gadhera sub-watershed. Total population increased during the last three decades was 87.8%. Out of it, 95.5% increased in male population and 81.3% increased in female population. Density of population also increased from 2 people/ha to 5 people/ha. Changes in literacy rate during the period increased double fold. It was 27.8% in 1971 and 61% in 2001. Male literacy was higher (73.6%) than female literacy (49.3%). Increase in SC population also registered during this period. This increase was greater than total population.

Table 6.10 Land Use/Cover Changes in Cluster of Villages in Kewer Gadhera Sub-Watershed between 1971* and 2007**

Village name	Total Area	Forest Area	Irrigated	Un-Irrigated
Kewer Talla	-0.9	-1.2	-0.8	0.5
Kewer Malla	-2.1	-1.2	-	-0.1
Bhagoti	4.5	1.2	-	24.8
Ratni	0.2	1.7	-	0.4
Keshwan	24.5	-	-	16.8
Gadseer	15.6	3.5	-	1.3
Bunga	17.4	56.6	-	4.2
Jhijodi	-42	-29.3	-	26.3
Ali	-0.4	5.4	-	-0.1
Leguna	5	5	-	-1.9
Bedula	-0.4	18.1	-	-0.3
Chirona	0.2	6.7	-	0.1
Kaub	3	29.7	-	2.9
Naini	-0.2	-0.1	-	-0.8
Swan Malla	26.2	-0.8	-	3.7
Swan Talla	1.9	5.8	-	1.4
Kimoli	5.9	6.4	-	13.9
Total	**58.4**	**107.5**	**-0.8**	**93.1**

Source: * Census handbook 1971, ** Patwari circle, Narainbagar

Table 6.10 shows land cover changes during 1971-2001. Tremendous change occurs during this period. In many villages total land area decreased. Jhijodi village registered -42 ha decreased in land area followed by Kewer Malla -2.1 ha. It shows increase in forest cover. Highest increase in forest cover (56.6 ha) noticed in Bunga village followed by Kaub (29.3 ha). Bedula registered 18.1 ha land increased under forest cover. There are the villages where forest cover decreased. Jhijodi village received highest decreased in forest cover (-29.3 ha). Total 68.91% increase observed in the Kewer Gadhera sub-watershed in terms of forest cover. Irrigated area is negligible. Only in Kewer Talla, a small portion of cultivable land is irrigated. Changes in un-irrigated land are similar as it is with the total geographical area. Sown area is decreased. Land abandonment is being common recently. The villages- Kaub, Naini, Ali, Kewer Talla, and Kewer Malla, emigration took place at a large-scale. This has led land abandonment on the one hand and on the other, forest land increased. During the same period, Uttarakhand State as a whole, registered 1.3% increase in forest land. In Dehradun District alone, 10.6% forest land increased.

Other Case Study Areas

Besides these above given case studies cluster of villages, case studies were also conduction in a village of Gwaldom (Shubhas Herbal Nersery), Diwalikhal (Jangle Chatti Village), and Takori Gad catchment to understand the livelihood pattern of the villagers. Details of the study are as follows:

Shubhas Herbal Nursery (SHN)

SHN is located about 2 km away from Gwaldom towards Talwadi at the height of 1900 m. It is spread about 5 ha land. Shri Jodh Singh Badiyari is the owner of this farmland. The owner had extensive apple orchard before 1990's where about 50 quintal apple were produced in a season. While interviewing, the owner informed that due to disease in apple trees, the whole orchard was destroyed and then they decided to cultivate vegetables and herbs. A seven lakh herbal plant was established to cultivate herbs and processed them. Initially they were able to built poly houses to grow herbs. The main herb grows is geranium, which is used for making medicines, scents, and soaps. They processed it. A German made herbal processing plant was established by the owner. The herbal is grinded. One liter herbal oil has Rs. 4000 cost. The owner is able to get 25 liter oil in a season. For getting one liter oil of geranium ten quintal geranium is required. A unique variety of rose with white flower (*Nurjahan Gulab*) is also grown extensively in the farmland. The oil of this flower is very costly (Rupees 2, 50, 000 per liter). Except these herbal plants, seasonal vegetables such as pumpkin, cucumber, and potato are also cultivated. Even 250 quintal potato is grown in a season. Citrus fruits are also grown. All these crops are grown with using organic fertilizer. The owner is producing composite fertilizer. He bought 1 kg earthworm from a Narain Bagar based NGO and produced 50 kg earth worms. Vegetation leafs are available in surrounding of the farmland. Due to its location on the road head and nearness to service centre many government officials including top bureaucrats of the state government visited this nursery.

While discussing, the owner was utterly discontent with the government officials involving with horticulture department as expert and extension workers. He informed that the Government Herbal Research Centre Gopeshwar has deputed Master Trainers to impart training at village level; the trainers never visited the allotted areas. He is aware that everything is in black and white in the department documents, but nothing is being done on the ground. This is the case with many other people, who are involved with this practice.

A Case Study of Jungle Chatti Village

At the height between 1800 and 1900 m, this village is located about three km away from Diwalikhal on the way to Karanprayag in Chamoli District of Uttarakhand. It is a village assembly with 300 households. Out the total household only six HHs are emigrated. Rests are working on the agricultural fields as it is the prime occupation of the people. Total cultivable land is arround 100 hectare. Few people are seasonally emigrated to the urban areas. The agro-climatic conditions of the village are feasible for cultivating various grains, oilseeds, pulses, fruits, and vegetables including tea. Keeping its favourable climatic conditions in view, then the Government of Uttar Pradesh, demarcated this village as 'fruit belt' named Kalimati-Janglechatti fruit belts in 1972. The whole area was devoted for cultivating apple. A considerable proportion of land, which was otherwise not fit for the production of cereal crops, was devoted for this purpose. Tremendous success was gained by the farmers in growing apple and still today, the farmers are able to grow a considerable quantity of apple. As observed in many apple grown areas in Uttarakhand, even in Himachal Pradesh, a large-scale failure in apple production took place during the last decades, this village in still maintaining the production of apple. Apples are sold regionally. The advantage

of oak forest in and above the village provides cold climate, which is very useful for production of apple fruits.

Takori Sub-Watershed: Eleven villages such as Dang Chonra, Dugadda, Malu Pani, Semala, Takoli, Tolu, Tatyamandal, Maikhand, Jakhand, Amoli, and Kandikhal were case studies. All villages are located on the road head; Srinagar-New Tehri road. The agro-climatic conditions in these villages are feasible for production of paddy, wheat, turmeric, ginger, garlic, potato, and onion. Pulses and oilseeds are largely grown. Recently, cultivation of potato and ginger is getting attention and the people are encouraged to cultivate these crop.

Lastar Gad Watershed: The landscape of Lastar Gad watershed is very much feasible for development of land-based resources. This includes intensive agriculture, horticulture, herb culture, apiculture, non-timber based forest products, and dairy farming. Eco-tourism and construction of micro-hydropower plants has the high potential. High fertility of soil, dense temperate and pine forest, feasible environmental conditions, extensive agricultural fields with gentle slopes, and availability of workforce characterize this watershed. Laster Gad has the potential for construction of hydropower projects with medium scale. Similarly, high potential of eco-tourism enhances the possibility for food security.

Table 6.11: Employment Status, Farming Community, and Emigration

Village	Employment status				Farming community		Emigration		Total
	Teaching	%	Others	%	No.	%	No.	%	
Kaparniya	13	10	40	30	65	50	12	9	130
Bachwar	02	2	25	33	40	54	7	9	74
Jakholi	15	25	20	34	20	34	03	5	58
Bazeera	04	1	85	38	120	55	09	4	218
Dhankurali	00	0	20	429	25	53	02	4	47
Mayali	25	20	55	44	30	24	15	12	125
Baman Gaon	22	26	30	35	12	14	20	23	84
Barsir	09	5	60	39	70	46	12	7	151
Jainti	21	16	45	34	50	38	15	11	131
Serain	01	2	15	44	10	29	08	23	34
Total	**112**	**10**	**395**	**37**	**442**	**42**	**103**	**9**	**1052**

Source: Primary collection

Table 6.11 shows employment status, farming community, and emigration in the Lastar Gad sub-watershed of Mandakini basin. Teaching is performed by 10% population. The people engaged with other services are 37%. 42% people are engaged with farming community and 9% people are emigrated.

Conclusions

Cultivation of subsistence cereal crops in the Alaknanda basin do not meet with the food requirement of the people. Increase in population on limited terraced agricultural fields further accelerated food scarcity. This has led a way for transformation of subsistence crops into cash generating crops to achieve food security. Similarly, large-scale emigration

towards the metropolitan cities and the plains of Ganges for search of livelihood took place. The change in cultivation does not take shape for large-scale transformation while it was limited on the certain valley regions where ample water supply was available and the uplands. Fruit cultivation was also started during the 1980s but remained failure due to various reasons. The case study villages (Khanda Gad sub-watershed) present a unique example of food security through cultivation of cash generating crops but this is mainly being done by the Nepali immigrants not by the native people even they overlooked the success of Nepali immigrants. The Alaknanda basin has suitable agro-ecological conditions for cultivation of various crops subsistence as well as cash generating. Here, emphasizes have been given for land-based development. Industrial development could not take place because of landscape and lacking in infrastructural facilities. The following suggestions may do better for sustainable livelihood and may achieve food security: (1) Keeping suitability of agro-ecological conditions in view, a large proportion of land should be transformed into cultivation of cash generating crops such as off-season vegetables, fruits, medicinal plants and tealeaves (2) Subsistence cereal farming should go parallel because it maintains ecology and diversity in the cropping pattern (3) Rearing livestock for milk and milk products may achieve food security as the study area has extensive alpine grasslands and feasible climatic conditions for rearing of high yield variety indigenous livestock (4) Community participation collectively with government assistance should be insured for cultivating cash generating crops so that the populace can attend food security in due coarse of time.

CHAPTER 7

CONCLUSIONS: PROBLEMS AND PROSPECTS

The Alaknanda basin has immense potential for developing land base resources especially for extensive agriculture and horticulture. The agro-ecological conditions such as temperature, rainfall, humidity, soil fertility, water, and landscape is suitable for cultivating agricultural and horticultural crops. Meanwhile, there are number of drawbacks, which are adversely affecting these practices. Here problems with developing land base resources, policy intervention for meeting out these problems, and approaches for sustainable development have been discussed thoroughly.

Major Problems

Lacking in Infrastructural Facilities: Lacking in infrastructural facilities such as cold storages and proper marketing system, the produced items do not receive full returns. Often they are unsold and consumed locally. Establishment of cold storages according to the production and distances between the producing areas will promote the production of cash crops and motivate the producers. Furthermore, it will ensure proper marketing of products. Many producers of case crops in Janglechatti village had an urge to the government for construction of cold storage. Similarly, small-scale industries and food processing centres should be established and local people involvement should be insured. *'We do not receive the return of the products we produce even often we are unable to have two times meal. We do not have work other than farming of grains and vegetables'*. A villager of Janglechatti village remarked.

Lacking in Government Initiatives Holistically: Institution involvement in terms of encouraging farmers to cultivate certain cash generating crops such as herbs and providing them financial assistance, insurance of their crops at the time of crop failure, and prepaid cash of their crops is lagging behind in the basin. High Altitude Plant Physiology Research Centre of HNB Garhwal University initiated such practice in a very high altitude village of Ghais where farmers are growing medicinal plants and HAPPRC works as mediator between the villages and the company, which purchased the product of the villagers. Government initiatives for any development programmes have the multiple impacts in the area particularly at the time, when the government has to control over entire affairs of the state. The impacts may be negative or positive depending upon the degree of involvement and rationale of planning. Political instability (untimely change in government) and lacking in involvement towards development planning further deteriorates the aspect of livelihood. In the Alaknanda basin, it has a tremendous effect on the development. This part of the land was under the rule of Uttar Pradesh State till 2000. Due to its remoteness, very less impact of policies towards development could reach in the region and consequently, it remained untouched from the waves of modernization and industrialization. Further, instability in the tenure of political parties (ruling) over the state created lacuna in the development process.

Lacking in Proper Marketing: Lacking in proper marketing remains a major hurdle for the growers of various cash generating products in the region. The products of high quality and quantity do not get proper market for a long time and consequently the growers do not get their returns. Infrastructural facilities as transportation and cold storages are slackened. Many of the occasions, the crops after taking a year to get a form of product do not sell out. While discussing with the growers of medicinal plants, fruits, and vegetables regarding their products and economic viability, the growers do not find themselves easy to grow the given cash generating crops instead of traditional cereal crops. The main cause which they

strongly observe is market unavailability. The villages, where the agro-climatic conditions are suitable for growing cash crops and the farmers also intend to grow them extensively, are very inaccessible from transportation point of view. A good marketing system (from regional to national) will be the base for exporting these products. The upland areas are lagging behind in good marketing system therefore the products do not get sold timely and properly. The intention of growing subsistence cereal crops is increasing as these crops are the main source of livelihood and they are self reliant, do not require any services from outsides. In many instances, the farmers argued, '*why we should grow cash generating crops for which we have to wait even for more than two years to receive the returns while from subsistence cereal crops we are getting returns within six months'*.

Lacking in Training Programmes: Diversities in the government programmes for enhancing and diversifying livelihood options can be noticed in the basin. Some of them are decades old. In the 1970's, then the Government of Uttar Pradesh launched a programme, which aimed to demarcate the boundaries of middle and high hills of UP (now Uttarakhand) as fruit belts keeping the suitability of agro-climatic conditions in view. This programme was also initiated due to the impressive progress achieved by Jammu and Kashmir State and Himachal Pradesh in this regard. However, this scheme could not get success as the Department of Forest did not support it. Meanwhile, in some areas of middle and high altitudes, the local farmers initiated cultivating fruits. Transformation of cereal cropped land into fruit crops took place. Almost for a decade, apple and citrus dominated in the cropping pattern in these areas. Now the situation is changed. The land which was under fruit crops are either abandoned or replaced by other crops. This was due to improper nourishment of fruit trees. It is surprising to note that even the State Government and the Department of Horticulture appointed master trainers to impart training to the growers; the trainers did not do this. The farmers do not know the technical aspects because they are not well trained, the situation becomes sternly serious.

Climate Change: The reality of climate change, particularly in the mountain regions, is required an appraisal of climate data for a century or more. Currently, the perception of all groups of society towards the impact of climate change in mountain regions is parallel. As discussed in the previous paragraphs, the land which was largely cultivated by fruit crops earlier is currently abandoned. The growers have also the perceptions that the unproductiveness of fruits plants is due to climate change. Dwarika Prasad Sati, a forester in Forest Development Corporation left his agricultural land abandoned. While discussing he said, *'due to tremendous changes in climate, cultivation of fruits has complete been destroyed'*. The areas where intensive cultivation of apple fruit was carried out during the past are no more for its cultivation. This belt has been sifted greatly in the higher elevation. This is also with the case of citrus and nut-stone fruits.

During my extensive field visit of Gwaldom-Lolti apple fruit belts, I was noticed that the apple orchards are no more existed. This belt was producing large-scale apple even exporting it. Now, the orchards have been disappeared. It was observed in Gwaldom region that pine forest invaded oak forest at a large-scale. Pine trees can be seen in and above oak forest. The invasion of pine forest over temperate or coniferous forest resulted in warming in the region. Not only this, it has also impacted on cropping pattern. The differences noticed in apple cultivation in different locations are presence and absence of oak forest. Disappearance of oak forest was due to over exploitation because the oak trees have multiple uses from fodder to fuel and cooling environment. A large-scale oak forest depletion was noticed during the 1980s resulted in increase in temperature.

There is a story of failure of individual efforts towards diversifying and enhancing livelihood options. The agriculture land is largely fragmented. If innovative ideas are implemented by the farmers for changing in farming systems they are not able to cultivate these ideas. There are various regions such as fear from wildlife and from the farmers. Under such circumstances, what step is to be raised for enhancing and diversifying the options for better livelihood? There is a general consensus among the producers, researchers, and academicians about community participation. Like self help group, community participation in development activities should be ensured. Though, there are various schemes launched for assisting farmers and organizing community groups for the development purposes, still major thrust is required to assist the community groups as a whole not as an individual farmer. If a group of community people will participate together in any development activities, the entire scenario may be changed and development of the region may be insured.

Land abandonment can be observed in many locations. It is generally found in the villages, which are located in the lower elevation or along the roads. One of the most important factors of land abandonment along the road is commercial uses of land or for constructing settlements. The region is best known for tourism especially for pilgrimage tourism. The farmlands along the roads are converting into accommodation avenues; lodging and boarding. Along the valley of Alaknanda River, from Devprayag to Karanprayag or in other river valleys, around 80% percent land is abandoned and mushrooming hotels, motels, lodges, and *dhawas* can be seen. In the villages of lower elevation, land abandonment is due to large-scale emigration of the populace to the urban centres of India. They are permanent migrants and settled in the urban centres. Their cultivable land is abandoned. It is also noticed that the households, who are earning money through remittances, also leave their agriculture land uncultivated. There are the cases in the villages, where about 60% people have migrated and their land is abandoned. A common trend was observed in the villages that only the households, who are fully dependent on the output from agricultural land for their livelihoods are cultivating cereals and they also cultivate the farmlands of the migrants.

Policies Interventions

Developmental intervention through government agencies needs a considerable policy framework. Crops diversity needs conserved but at the same time a considerable proportion of cultivable land to be devoted for case generating crops. Both situations are favourable for sustainable livelihood. For the centuries, the local people are practicing different systems of cultivation in this hilly region as trial and error. No doubt, sustainability in livelihood had been achieved to a certain extend but the hardship, particularly of women did not reduce and in many areas, especially in the highlands where development of the infrastructural facilities is mirage and still the populace is struggling for basic needs of food, cloth, and shelter, which can not be easily accessible. Many studies have been carried out by the researchers and academicians so far for enhancing and diversifying livelihood options. The government has also initiated people's supportive programmes for speedy development and welfare of the local people. Earlier, all segments of the society have the perceptions that due to the uniqueness of the region and its ruling from a large state, development formulas could not be fitted and then struggle was started for a separate state and finally in 2000 a part of the hilly region as Uttarakhand State was carve out. Eight years have been gone and government has been changed in three times after its statehood, no tremendous changes has bee noticed so far. Under the overall process of development, things have been changed, but when we look upon the hardships and livelihood of the people, we do not find major changes in many cases. For getting sustainable livelihood, following suggestions are given:

(1) To develop the techniques and regulatory structures to ensure that the needed infrastructure for electricity, roads, hotels, and housing does minimal damage to the ecology. If these measures cost money, the nation as a whole must provide it.

(2) To restore the rights of management of the forests to mountain people. Not to deny the science of forestry, but to ensure that the science is applied by and for them. Forest departments must accept partnership with hill people, not seek to control them for all time.

(3) To realize the actual, material benefit of the genetic pool in the mountains, and the borrowing by others of the genes and traditional knowledge of these resources. A global treaty on access and benefit sharing is essential. In its turn, the governments must ensure that these benefits, in full measure, flow to mountain people.

(4) To give fair value for the produce of the mountains. For the native grains and fruit, full of taste and wholesomeness; for the splendour of the experience of the landscapes, biospheres, and sanctuaries; for the hosting of dams and the electricity and irrigation services they provide; for the timber and medicinal plants; and for keeping under lock huge stores of carbon in the forests.

(5) Education for better livelihoods through the capacity to absorb new technology and innovate.

Approaches for Sustainable Livelihood

Diversification in Cultivating Crops: It has doe impacts: first it sustains soil fertility and second it enhances livelihood options. This is already practiced in the study area particularly in the uplands. The villages located in highlands (above 1600 m) have the capacity to store the grains for adverse time. Even the market collapses, these villages are quite able to sustain their livelihood. Global changes can be noticed everywhere in mountain regions. Population increased manifolds. The changes in farming systems have been observed apparently. The cereal crops farming was not enough to meet the increasing food demands resulted in changes in cultivation from millets to paddy and wheat. During the past, paddy and wheat crops were rarely sown but now it is very common food. I personally do not agree with Rao and Saxena's (1993) statement, '*food insecurity was due to change in food habits of paddy and wheat instead of millets*'. It was observed that cultivation of wheat and paddy has increased production and food security as the people became self-reliant. Even today, a large proportion of sown area is devoted for paddy and wheat crops. During the 1980s and 90s, a large-scale cultivation of fruits and out-of- season vegetables was carried out. The production of potato and onion tremendously got a momentum but it was reduced considerably and currently more land is devoted to paddy and wheat. The increasing trend of cultivating paddy and wheat shows its importance in cropping pattern. It does not need market because it grows for self-reliant. The other crops like case crops need market and other necessary facilities, which is seldom available in the region.

Use of Forest Based Non Timber Products: Forest products such and bee keeping, collection of herbs, oak bark, natural dyes, rosin, and better use of environmental conditions may enhance the livelihood. It will have trio impact on the villagers, e.g. poising economy, augmenting employment, and control over emigration.

As it is discussed in earlier that the people of hill areas are still doing agricultural practices as trial and error they did not come to a final conclusion about cultivation of a suitable crops. Cereal crops are failed to secure livelihood as population is increasing and production of cereals is remained constant or decreasing. The farmers of the region tried to squeeze

out from food insecurity and they opted various farming systems and grown various crops during the past from subsistence cereals to cash crops i.e. fruit, herbs, and vegetables. Most of the practice was carried out individually which was resulted in to complete failure. As at the global level, community participation in development activities gained outstanding result. The community participation has seen negligible in development process in the study area therefore any trail for enhancing livelihood could not receive expected level and there was 'U' turn in terms of practicing agriculture. Eco-tourism, pilgrimage tourism, adventurer tourism, and natural tourism can be developed. The Alaknanda basin is endowed with beautiful landscape and plenty of pilgrimages. Micro hydropower plants may enhance economy and augment employment for the local poor people.

Figure 1: Indian Himalayan Region showing Uttarakhand Himalaya

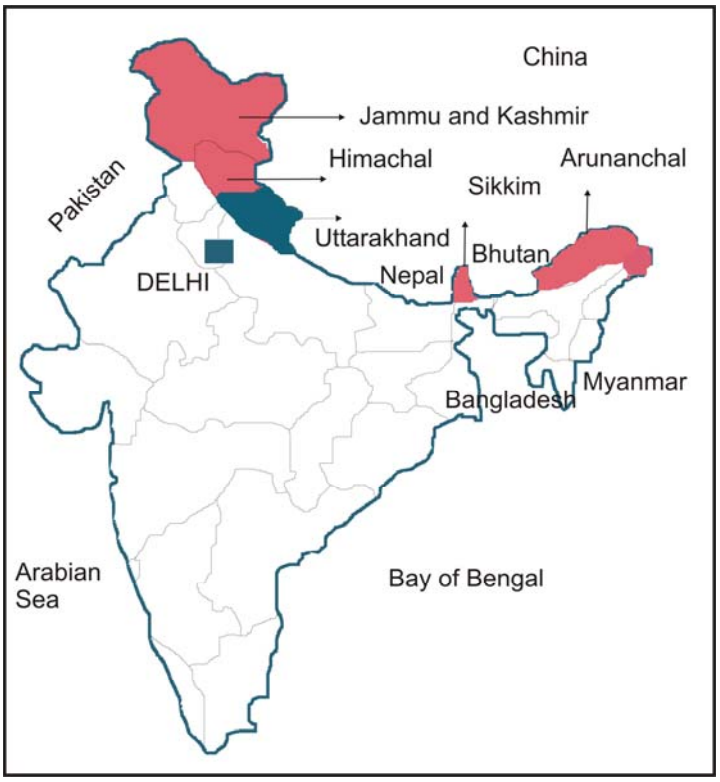


Figure 2: Indian Himalayan Region and map of states of India

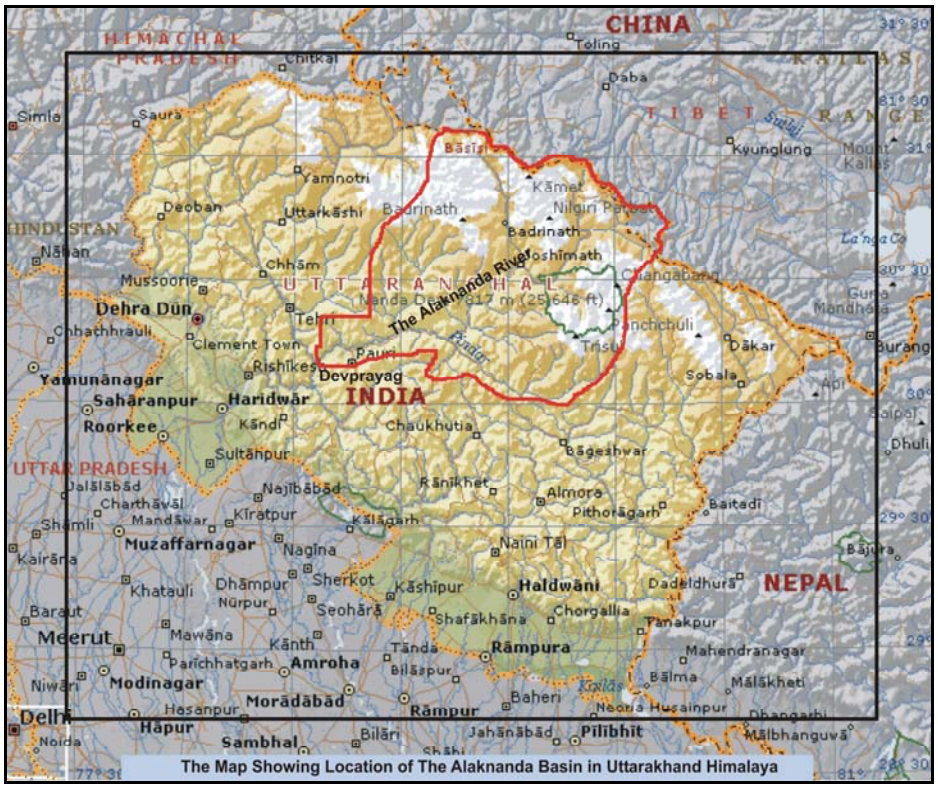


Figure 3: The Alaknanda Basin in Uttarakhand Himalaya

Figure 4: The Alaknanda Basin and its tributaries

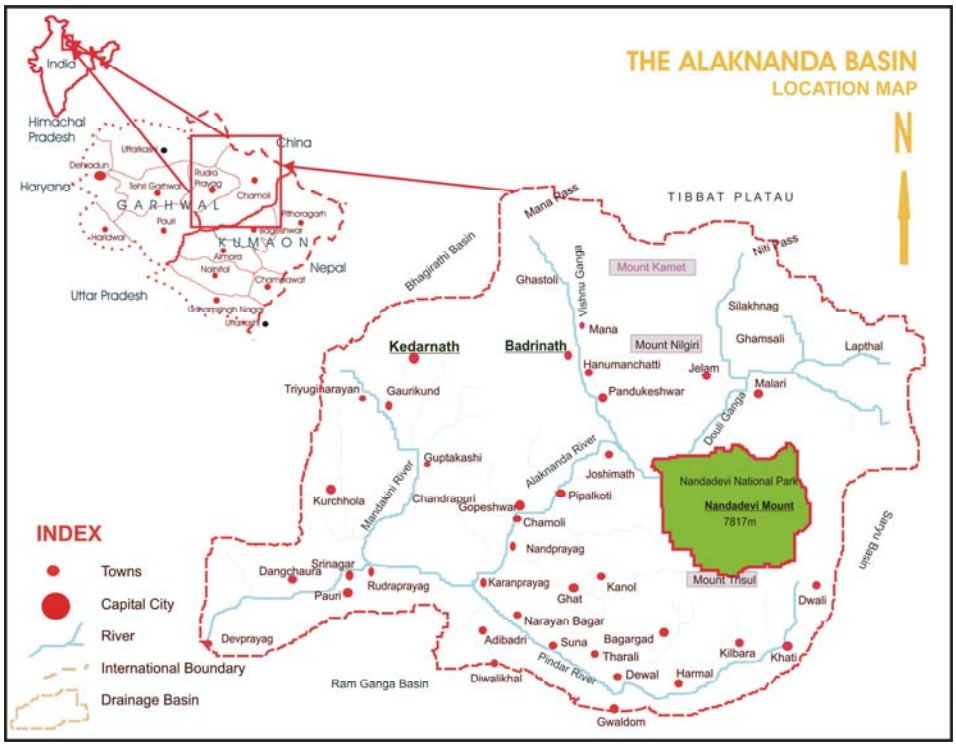


Figure 5: Location Map of the Alaknanda Basin

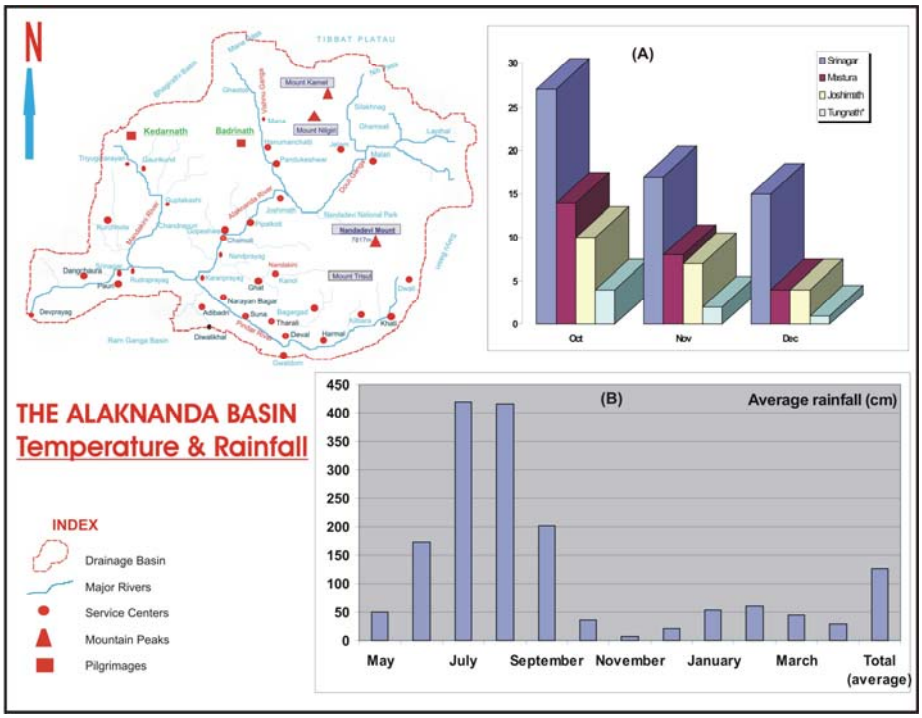


Figure 6: Temperature and Rainfall in the Alaknanda Basin

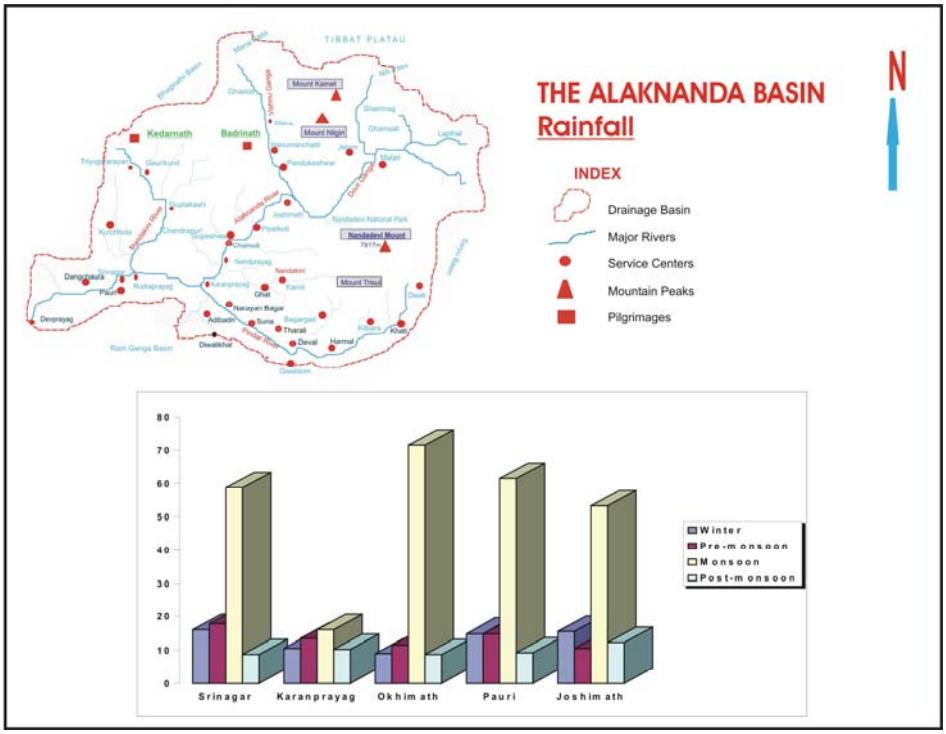


Figure 7: Rainfall in Five Towns of the Alaknanda Basin

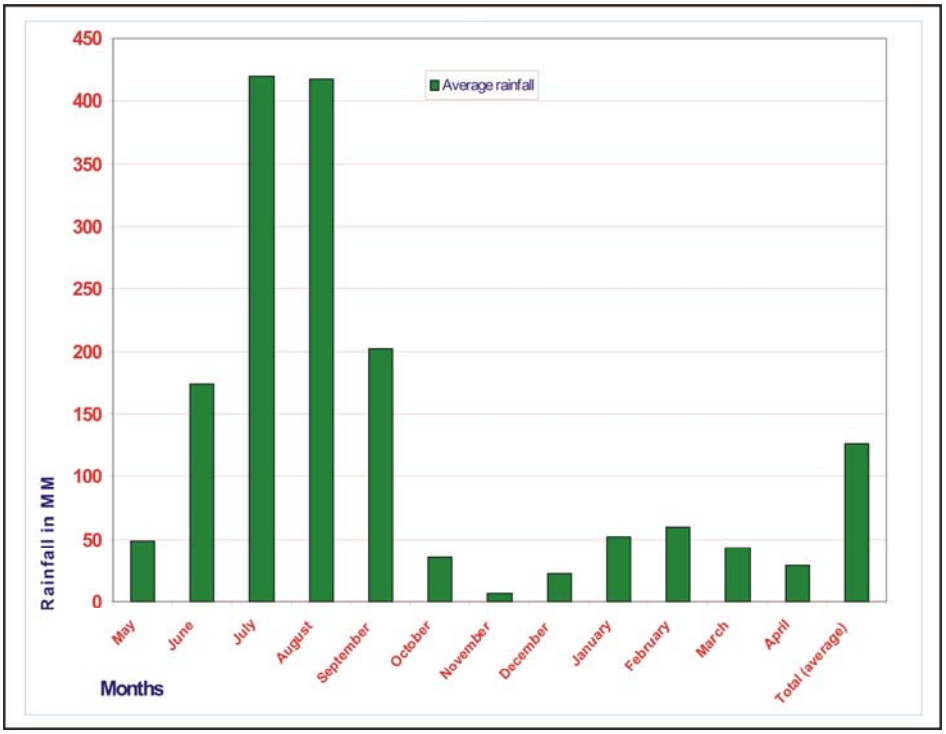


Figure 8: Monthly average rainfall in the Alaknanda Basin

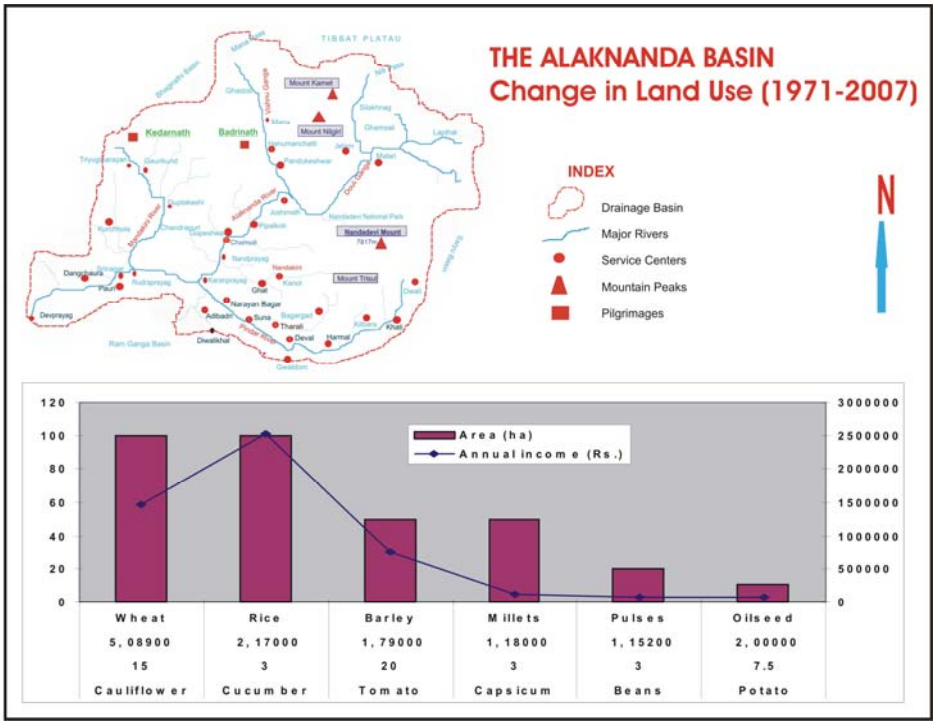


Figure 9: Land Use Change in the Alaknanda Basin

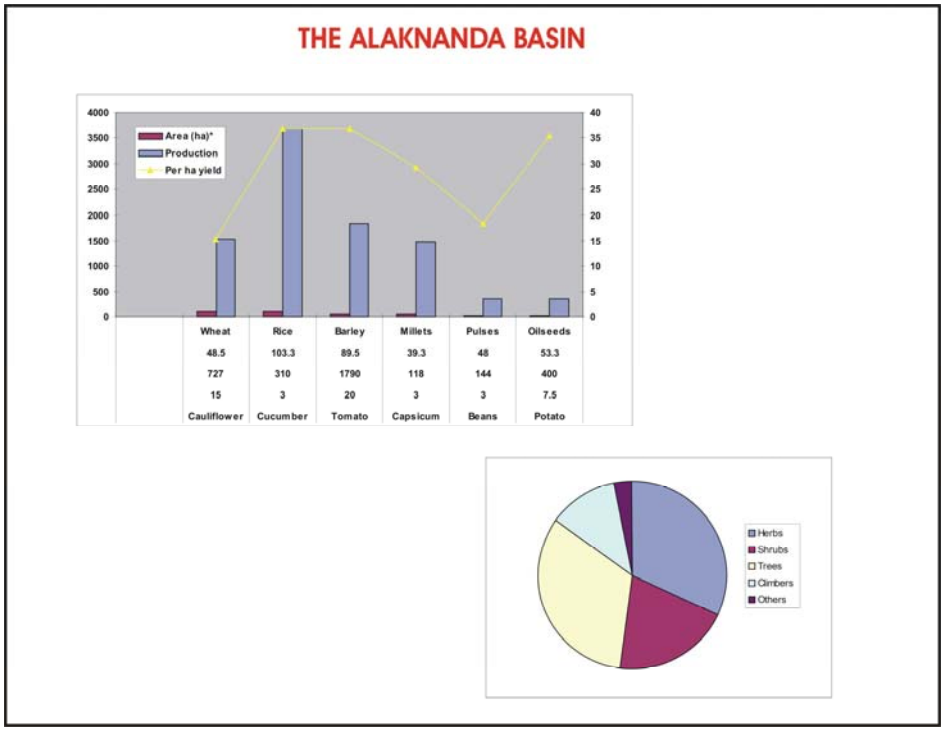


Figure 10: Area, Production, and Productivity of Various Crops

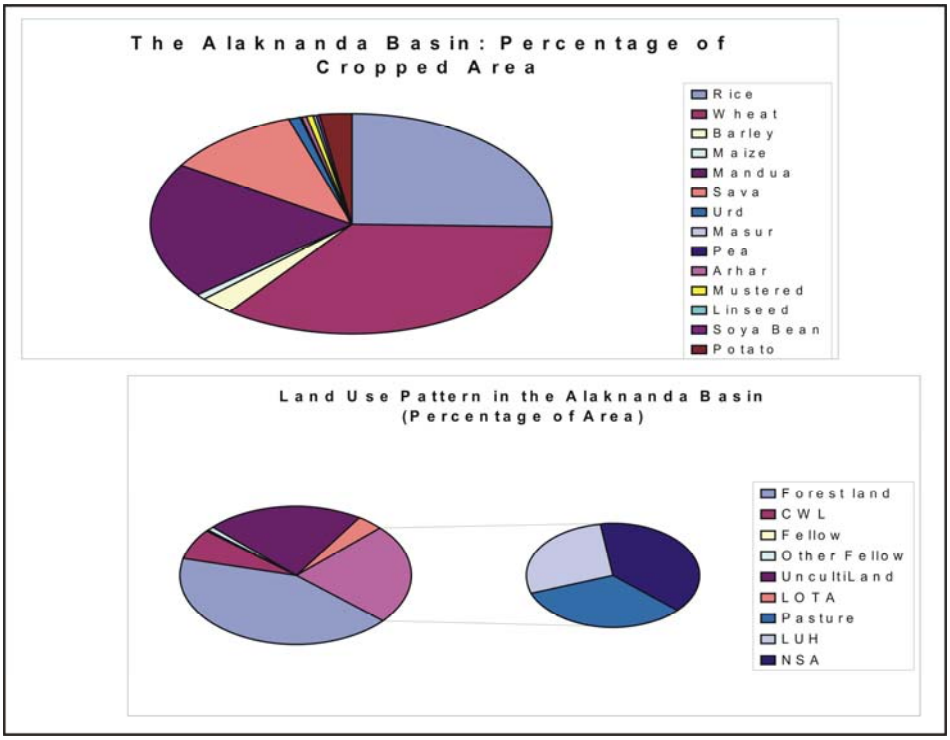


Figure 11: Land Use and Cropping Pattern (Percentage of Cropped Area)

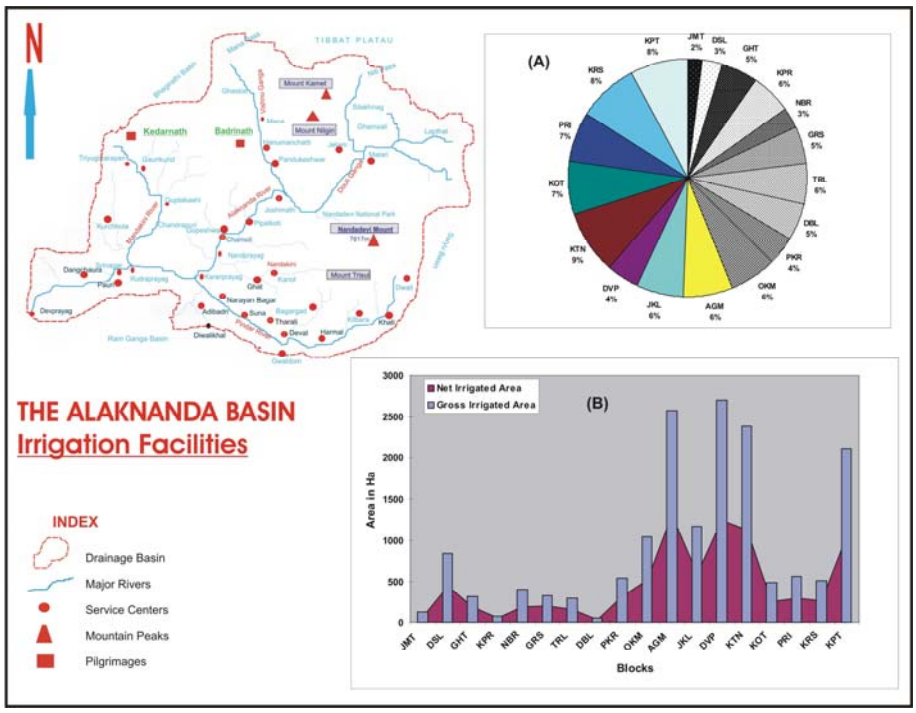


Figure 12: Block-Wise Irrigation Facilities in the Alaknanda Basin

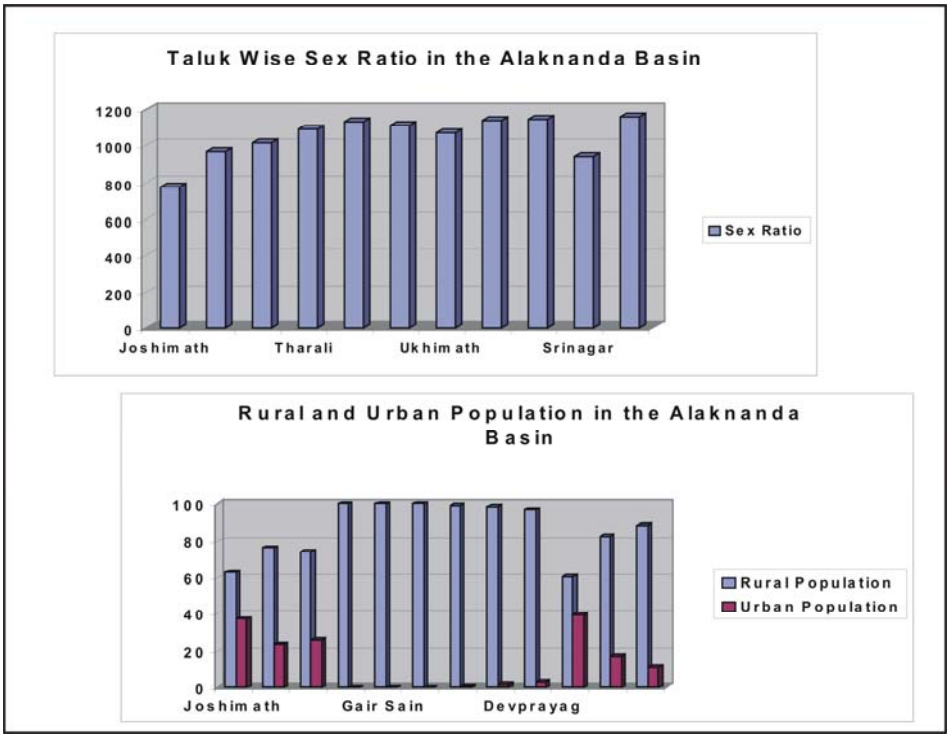


Figure 13: Taluk Wise Sex Ratio and Rural and Urban Population

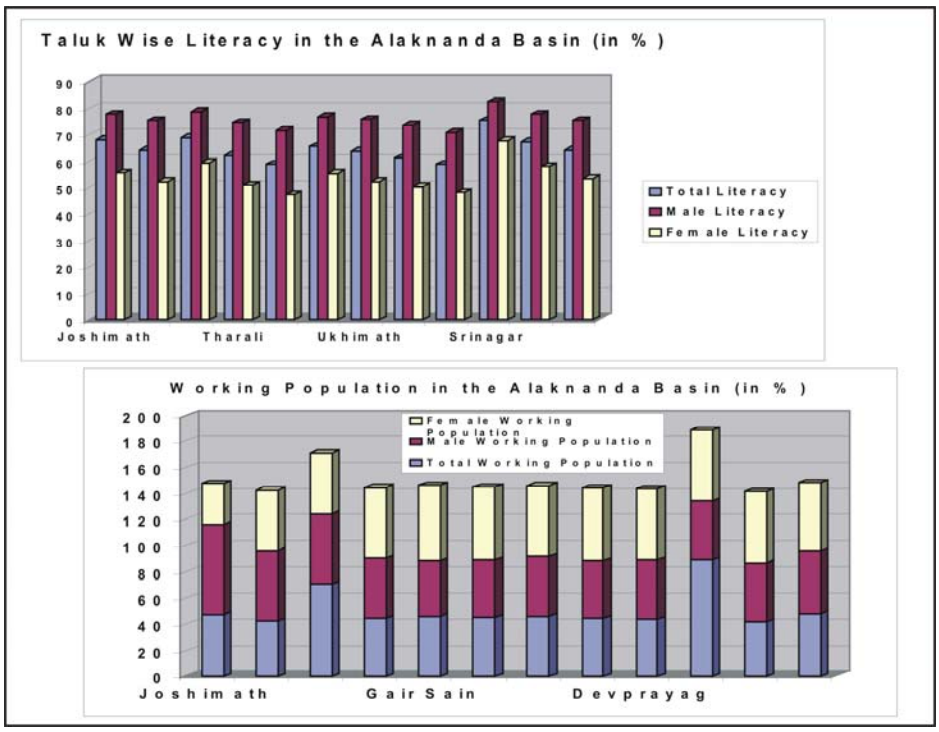


Figure 14: Literacy and Working Population in the Alaknanda Basin

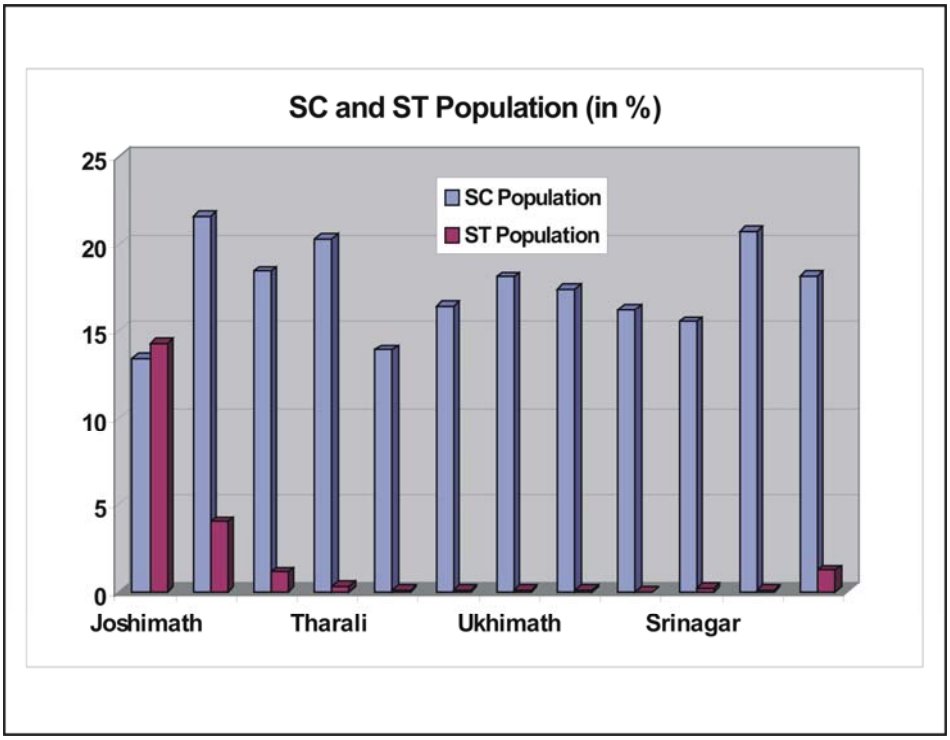


Figure 15: SC and ST Population

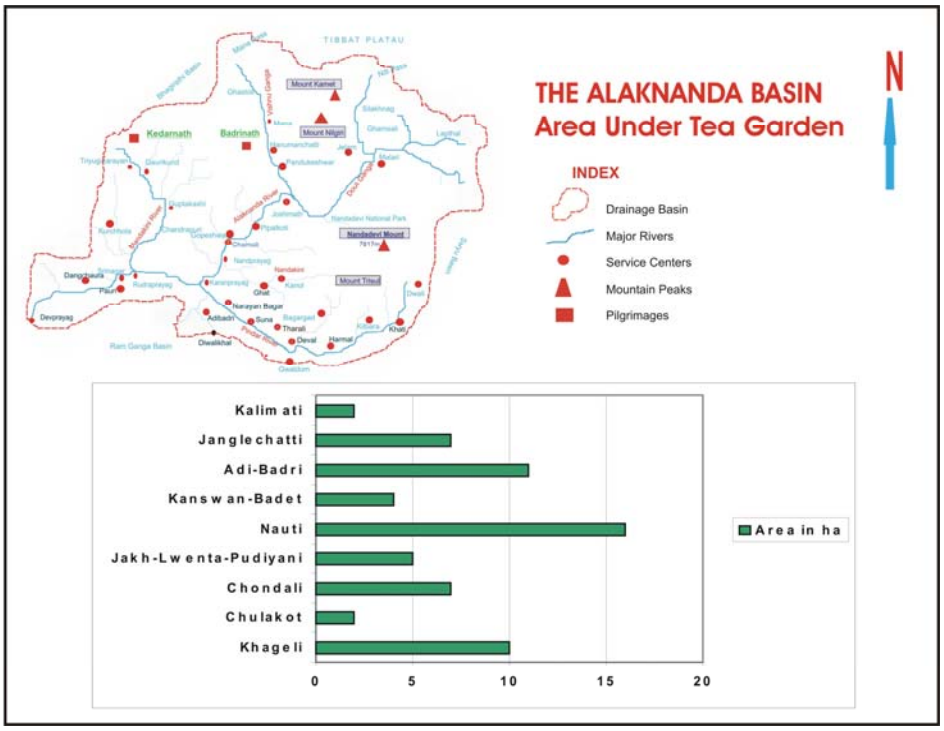


Figure 16: Area under Tea Gardens

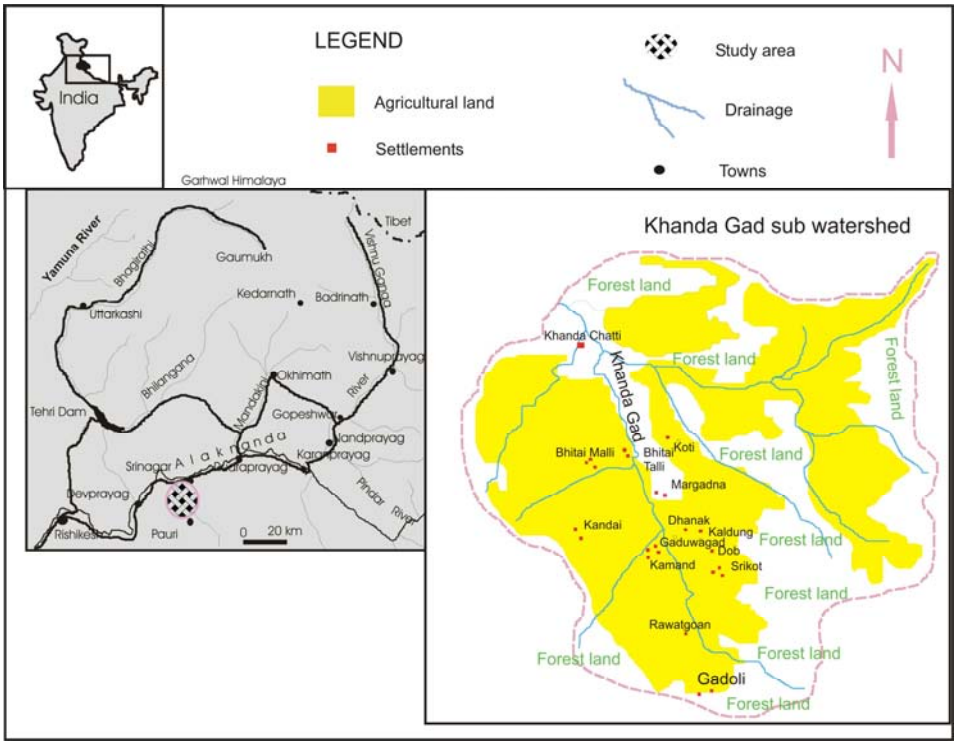


Figure 17: Land Use Pattern of Khanda Gad Sub-Watershed

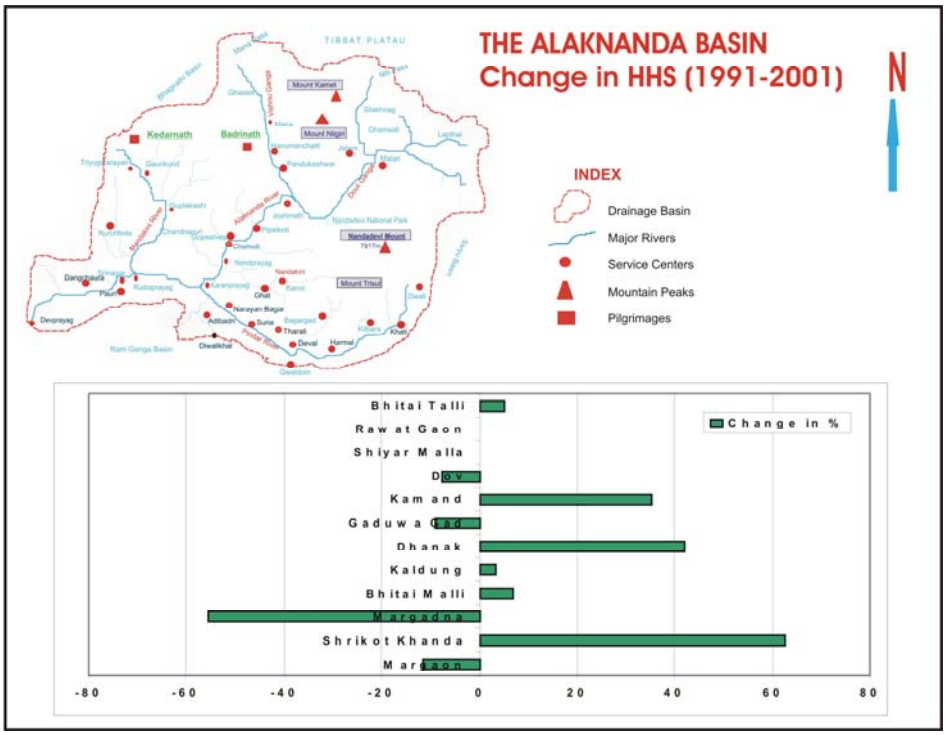


Figure 18: Change in Households (1991-2001) in the Khanda Gad Sub-Watershed

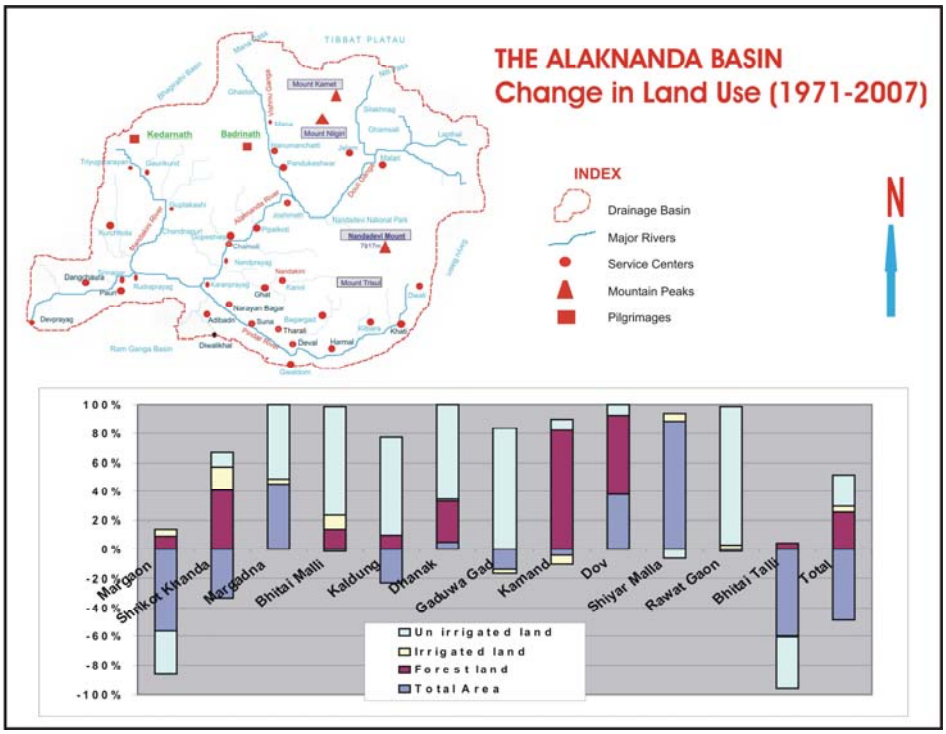


Figure 19: Land Use Changes in Khanda Gad Sub-Watershed

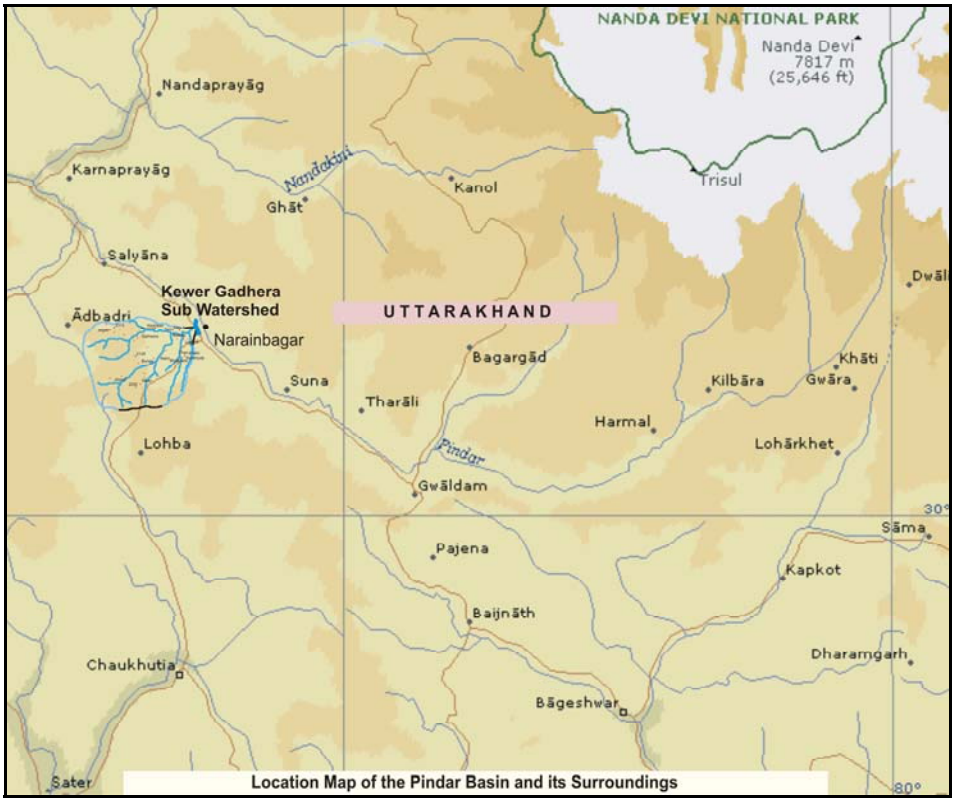


Figure 20: Kewer Gadhera Sub-Watershed in the Pindar Basin

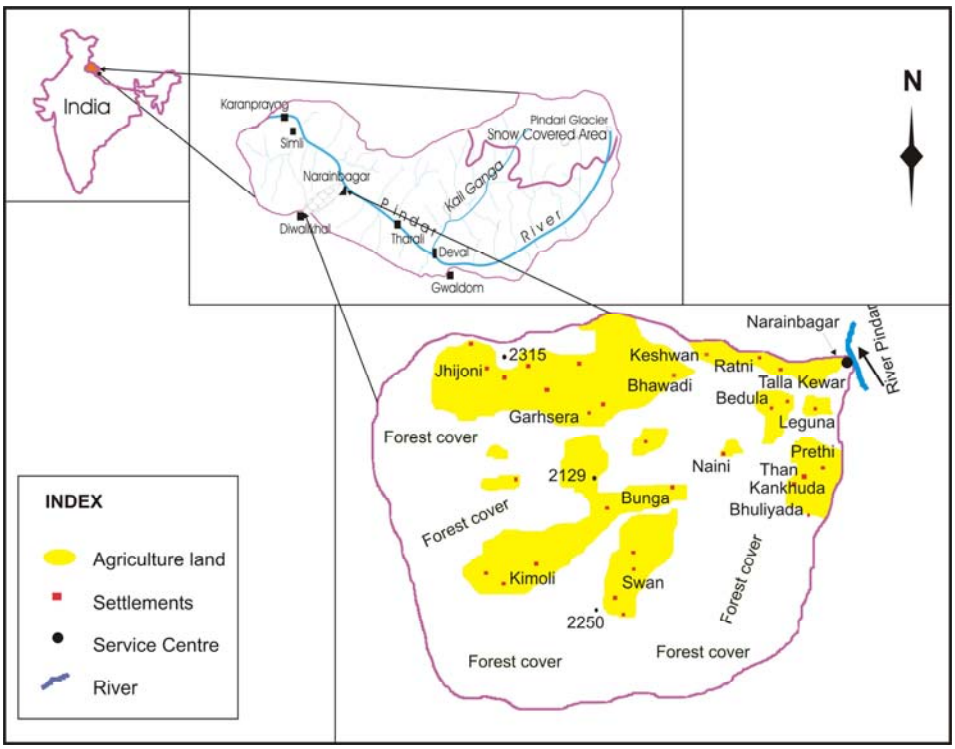


Figure 21: Land Use Pattern of Kewer Gadhera Sub-Watershed

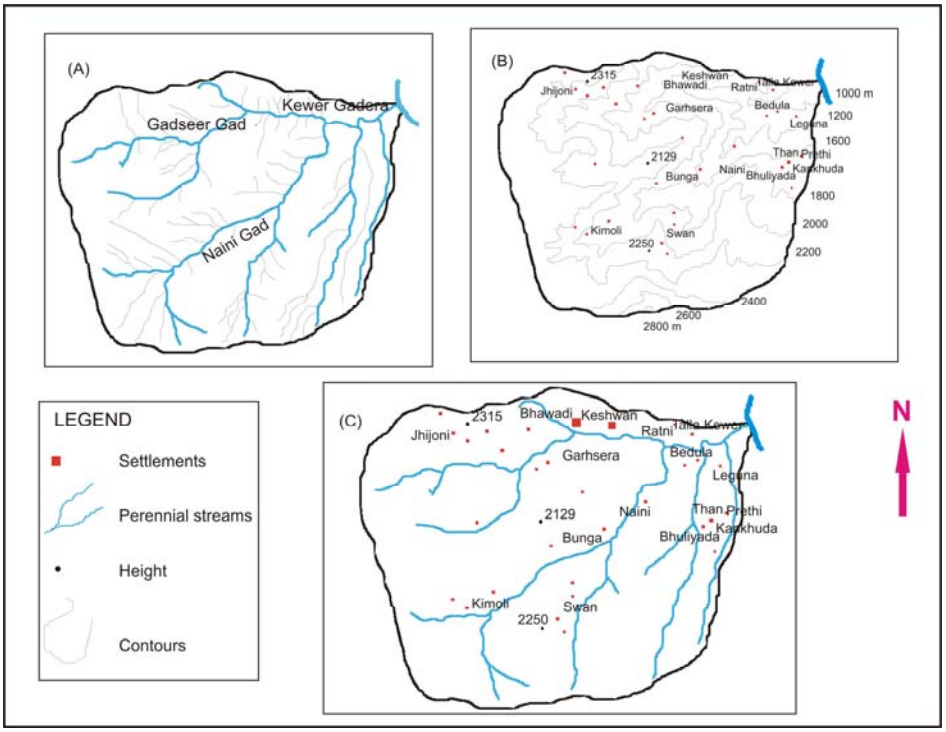


Figure 22: (A) Drainage Pattern **(B)** Contour Map and **(C)** Settlements of Kewer Gadhera Sub-Watershed

Photo 1: A panoramic view of middle watershed of the Pindar Basin

Photo 2: Dense pine forest in upper watershed of the Pindar River

Photo 3: The Great Himalayan Range, dense oak forest, agriculture land, and settlement in the Lastar Gad sub-watershed

Photo 4: Mount Chaukhamba of the Great Himalayan Range facing and the panoramic view of middle watershed of the Pindar River with wheat crop grown in village Kaub (1600 m)

Photo 5: A village situated at 1800 m near Gwaldom town surrounded by dense vegetal cover with agricultural fields in gentle slope

Photo 6: A view of terraced fields with human settlements in centre in the Ata Garh sub-watershed

Photo 7: Alaknanda River flowing in Srinagar town making meander

Photo 8: Villages under vulnerable; a large landslide occurs in Mandal region in Chamoli District

Photo 9: Women carrying fodder (green leaves of oak) near Gairsain town

Photo 10: Children carrying water. Water scarcity is found everywhere while this region has abundance of water resource

Photo 11: A woman cleaning mustered seeds

Photo 12: Women carrying green leaves (*kandali*) in baskets. This is widely used as fodder for animals and as green vegetables.

Photo 13: A perennial well, major source of drinking water mostly during summer season

Photo 14: Children carrying firewood. This is used for cooking food.

Photo 15: Keshav Prayag, confluences of the Saraswati River with the Vishnu Ganga (Alaknanda River)

Photo 16: The Alaknanda River meets with the Bhagirathi and called 'Ganga'

Photo 17: One of the *barahnajas jhangora* grown extensively in the uplands

Photo 18: Traditional crop diversity. Twelve grains (*barahnaja*) grown in a single cropped land

Photo 19: Extensive banana plants in the Takori Gad sub-watershed

Photo 20: Paddy crop extensively grown in the low-lying areas

Photo 21: Terraced paddy field on the bank of Alaknanda River

Photo 22: High yield variety calves in Bhararisen Dairy Farm

Photo 23: Pulses and red chilli, getting dryer

Photo 24: A good variety of Amla grown extensively in the Indian Himalayan Region. This is the product of the Pindar Valley used for various purposes such as making Murabba, pickles, squash, and medicinal uses.

Photo 25: Edible wild fruit (*Timli*) used for pickles and eat raw and ripened and found extensively between 800-1500 m

Photo 26: A bunch of sweet peach used domestically and has wider prospects to enhance livelihood if grown commercially

Photo 27: A bunch of orange. Orange is grown in the mid-altitude of the basin

Photo 28: Mixed cropping; apple grown in the field of wheat crop

Photo 29: Cultivating off-season vegetables in Khanda Gad sub-watershed

Photo 30: A Nepali immigrant cutting cauliflower leaves. Recently, Nepali immigrants are growing off-season vegetables in entire Garhwal Himalaya

Photo 31: Garlic crop field at Janglechatti village

Photo 32: The boys are selling seasonal vegetables locally known as *lankuda*

Photo 33: A local man selling Kafal at Srinagar town. Kafal is edible wild fruits ripened during May and June over water dividing areas of the Alaknanda River and its tributaries

Photo 34: A boy selling strawberry in Saharanpur Chauk at Dehradun. Strawberry is extensively grown in the Garhwal region

Photo 35: Bottle packed Orange and Buransh juice is processed through small-scale entrepreneur with local people participation

Photo 36: Geranium, an herbal grown in poly house in a bio-village near Gwaldom town

Photo 37: A newly established tea garden in Kalimati village

Photo 38: A highland natural pond using for fisheries in Gwaldom town

Photo 39: Women are being empowered slowly but steady after involving with various enterprises. This woman of Khanda Gad village is fully involved in enhancing livelihood.

Photo 40: A small-hydropower project with 2x2.5 mw capacity in the Kail Ganga near Deval

APPENDICES

1. Land Use Pattern in the Alaknanda Basin (ha)

Name of DB	Total Area	Forest land	Cultivable waste land	Fallow land	Other fellow	Uncultivable land	Land other than agriculture	Pasture land	Land under horticulture	Net sown area
JMT	245877	39774	30532	106	292	133132	4068	17849	17842	2282
DSL	28504	6213	563	43	103	7729	435	4838	3338	5242
GHT	40997	16794	4717	93	193	2878	358	6811	3736	5417
KPR	13366	5932	1657	67	84	701	123	2212	802	1788
NBR	18750	4143	478	38	100	1787	611	3959	2732	4902
GRS	37672	12867	5638	93	329	3529	240	7184	2742	5050
TRL	15333	6537	993	40	84	1068	78	1565	1260	3708
DBL	24592	9970	2156	146	93	3791	129	1923	4514	1870
PKR	27150	8225	1210	133	139	3933	2004	3356	4032	4118
OKM	52778	27577	2527	7	122	12499	1371	1654	2897	4124
AGM	131419	68668	6293	17	305	31122	3415	4119	7212	10268
JKL	59511	31095	2850	8	138	14094	1546	1865	3266	4649
DVP	37398	13506	650	1190	1218	477	10566	59	11	9721
KTN	57704	40039	288	541	1110	344	6763	30	11	8578
KOT	41633	24061	1950	575	1262	4266	1440	1323	2059	5213
PRI	41584	22320	1912	575	1435	1987	1373	1964	5271	4955
KRS	40023	27176	1516	575	804	1770	1353	1189	1899	3735
KPT	106865	65885	7598	341	886	1424	951	16082	5883	7815
ANB	**1021156**	**430782**	**73528**	**4588**	**8697**	**226531**	**36824**	**77982**	**69507**	**93435**

2. Cropping Pattern

Name	Rice		Wheat		Barley		Maize		Mandua		Sava	
	NI	I	NI	I	NI	I	NI	I	NI	I	NI	I
JMT	414	74	675	58	15	--	8	--	366	--	31	--
DSL	2033	486	2617	464	157	--	25	--	1794	--	298	--
GHT	2011	190	1549	172	147	--	13	--	1775	--	280	--
KPR	302	47	1298	39	95	--	7	--	265	--	182	--
NBR	1471	234	1620	224	177	--	17	--	1299	--	338	--
GRS	1639	194	2993	177	208	--	62	--	1445	--	398	--
TRL	1440	189	730	147	58	1	20	--	1271	--	108	--
DBL	517	23	730	25	60	--	8	--	455	--	113	--
PKR	2514	327	3099	283	301	--	34	--	2218	--	579	--
OKM	1998	415	2230	285	290	--	53	--	1399	--	871	--
AGM	4329	1243	4159	988	159	14	71	--	3029	--	476	--
JKL	1876	743	3381	1048	532	27	34	--	1561	--	646	--
DVP	1249	570	4343	355	575	13	206	--	2968	--	3832	11
KTN	1553	975	4345	820	131	6	163	--	2435	--	3070	5
KOT	1389	287	1928	285	429	--	143	--	1182		1280	
PRI	1167	233	1655	197	225	--	146	1	1392		1047	
KRS	928	156	1905	223	174	3	80	3	1263		893	
ANB	**26830**	**6386**	**39257**	**5790**	**3733**	**64**	**1090**	**4**	**26117**		**14442**	**16**

3. Cropping Pattern (Remaining)

Name	Urd	Masur	Pea	Arhar	Mustered		Linseed	Soya bean	Potato	
JMT	29	7	2	7	49	--	9	26	823	10
DSL	15	7	--	18	33	--	6	20	288	--
GHT	74	7	--	10	57	3	3	13	337	6
KPR	41	2	--	4	98	--	--	10	288	--
NBR	81	10	3	25	60	3	--	6	100	--
GRS	26	10	--	19	49	--	14	10	167	--
TRL	76	5	4	8	63	2	4	11	146	--
DBL	11	5	--	12	24	--	3	11	466	--
PKR	66	9	--	14	109	3	5	13	465	--

OKM		53			67		67		55	
AGM		65			73		73		22	
JKL		24			39		39		40	
DVP	146	107	16	117	101	14	61	108	114	
KTN	138	92	14	54	82	13	52	71	108	
KOT	78	31	1		4		17		12	
PRI	220	27			2		14		15	
KRS	40	37	1		2		22		14	
ANB	**1041**	**498**	**41**	**288**	**912**	**38**	**389**	**299**	**3460**	**16**

4. Taluk Wise Distribution of Population 2001

Taluk	No. of HHs			Population			Male			Female		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Joshimath	8751	5297	3454	39919	25033	14886	22503	13284	9219	17416	11749	5667
Chamoli	19239	13992	5247	91993	70456	21537	46826	34625	12201	45167	35831	9336
Karnaprayag	11860	8679	3181	55170	40890	14280	27405	19277	8128	27765	21613	6152
Tharali	17491	17491	0	88432	88432	0	42336	42336	0	46096	46096	0
Gair Sain	11197	11197	0	59383	59383	0	27890	27890	0	31493	31493	0
Pokhari	7583	7583	0	35462	35462	0	16785	16785	0	18677	18677	0
Ukhimath	16409	16275	134	80185	79703	482	38718	38249	469	41467	41454	13
Rudraprayag	31130	30576	554	147254	145004	2250	68817	67394	1423	78437	77610	827
Devprayag	21462	20743	719	100824	97609	3215	47037	45299	1738	53787	52310	1477
Srinagar	11134	7051	4083	49800	30142	19658	25699	14501	11198	24101	15641	8460
Pauri	33396	27714	5682	146074	120737	25337	67731	54171	13560	78343	66566	11777
Total ARB	**189652**	**166598**	**23054**	**894496**	**792851**	**101645**	**431747**	**373811**	**57936**	**462749**	**419040**	**43709**

5. Taluk Wise Working Wopulation 2001

Taluk	Total working population			Male working population			Female working population		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Joshimath	18974	12106	6868	13041	7254	5787	5933	4852	1081
Chamoli	39142	32272	6870	20910	15561	5349	18232	16711	1521
Karnaprayag	39142	32272	6870	20910	15561	5349	18232	16711	1521
Tharali	39427	39427	0	17992	17992	0	21435	21435	0
Gair Sain	27423	27423	0	11618	11618	0	15805	15805	0
Pokhari	15955	15955	0	7007	7007	0	8948	8948	0

Ukhimath	36917	36449	468	16847	16387	460	20070	20062	8
Rudraprayag	65116	64171	945	28657	27771	886	36459	36400	59
Devprayag	44251	43271	980	20002	19144	858	24249	24127	122
Srinagar	44251	43271	980	20002	19144	858	24249	24127	122
Pauri	60746	53564	7182	27350	21507	5843	33396	32057	1339
Total ARB	**431344**	**400181**	**31163**	**204336**	**178946**	**25390**	**227008**	**221235**	**5773**

6. Taluk Wise Working Population 2001 Continues……

Taluk	Total main worker			Male main worker			Female main worker		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Joshimath	13807	7557	6250	10295	4868	5427	3512	2689	823
Chamoli	23724	17909	5815	13940	9392	4548	9784	8517	1267
Karnaprayag	13294	8989	4305	8039	4764	3275	5255	4225	1030
Tharali	26201	26201	0	12581	12581	0	13620	13620	0
Gair Sain	12316	12316	0	5940	5940	0	6376	6376	0
Pokhari	7558	7558	0	3945	3945	0	3613	3613	0
Ukhimath	29304	28884	420	13702	13289	413	15602	15595	7
Rudraprayag	29304	28884	420	13702	13289	413	15602	15595	7
Devprayag	31371	30456	915	15313	14520	793	16058	15936	122
Srinagar	12708	8199	4509	8203	4208	3995	4505	3991	514
Pauri	43591	36979	6612	20516	15116	5400	23075	21863	1212
Total ARB	**243178**	**213932**	**29246**	**126176**	**101912**	**24264**	**117002**	**112020**	**4982**

7. Taluk Wise Working Population 2001 Continues……

Taluk	Total marginal worker			Male marginal worker			Female marginal worker		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Joshimath	5167	4549	618	2746	2386	360	2421	2163	258
Chamoli	15418	14363	1055	6970	6169	801	8448	8194	254
Karnaprayag	10514	9675	839	3902	3324	578	6612	6351	261
Tharali	13226	13226	0	5411	5411	0	7815	7815	0
Gair Sain	15107	15107	0	5678	5678	0	9429	9429	0
Pokhari	8397	8397	0	3062	3062	0	5335	5335	0
Ukhimath	7613	7565	48	3145	3098	47	4468	4467	1
Rudraprayag	18352	18316	36	6305	6271	34	12047	12045	2
Devprayag	12880	12815	65	4689	4624	65	8191	8191	0
Srinagar	3792	3498	294	1806	1556	250	1986	1942	44
Pauri	17155	16585	570	6834	6391	443	10321	10194	127
Total ARB	**127621**	**124096**	**3525**	**50548**	**47970**	**2578**	**77073**	**76126**	**947**

8. Population Distribution Below 06 Year 2001

Taluk	Population below 06 year (T)			Population below 06 year (M)			Population below 06 year (F)		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Joshimath	5362	3615	1747	2744	1823	921	2618	1792	826
Chamoli	13374	11058	2316	7030	5782	1248	6344	5276	1068
Karnaprayag	7506	5726	1780	3895	2919	976	3611	2807	804
Tharali	14050	14050	0	7195	7195	0	6855	6855	0

Gair Sain	10168	10168	0	5219	5219	0	4949	4949	0
Pokhari	5250	5250	0	2711	2711	0	2539	2539	0
Ukhimath	12759	12759	0	6519	6519	0	6240	6240	0
Rudraprayag	23117	22826	291	11849	11693	156	11268	11133	135
Devprayag	15914	15516	398	8215	8016	199	7699	7500	199
Srinagar	5805	3859	1946	3120	2056	1064	2685	1803	882
Pauri	20659	17710	2949	10656	9095	1561	10003	8615	1388
Total ARB	**133964**	**122537**	**11427**	**69153**	**63028**	**6125**	**64811**	**59509**	**5302**

9. Population Distribution SC 2001

Taluk	Population SC (T)			Population SC (M)			Population SC (F)		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Joshimath	5389	3701	1688	2832	1901	931	2557	1800	757
Chamoli	19886	15999	3887	10244	8092	2152	9642	7907	1735
Karnaprayag	10166	7217	2949	5071	3501	1570	5095	3716	1379
Tharali	17971	17971	0	8920	8920	0	9051	9051	0
Gair Sain	8305	8305	0	3998	3998	0	4307	4307	0
Pokhari	5822	5822	0	2926	2926	0	2896	2896	0
Ukhimath	14543	14521	22	7204	7182	22	7339	7339	0
Rudraprayag	25768	25494	274	12763	12596	167	13005	12898	107
Devprayag	16337	15858	479	8079	7850	229	8258	8008	250
Srinagar	7735	5487	2248	3924	2677	1247	3811	2810	1001
Pauri	30348	27052	3296	14736	12968	1768	15612	14084	1528
Total ARB	**162270**	**147427**	**14843**	**80697**	**72611**	**8086**	**81573**	**74816**	**6757**

10. Population Distribution ST 2001

Taluk	Population ST (T)			Population ST (M)			Population ST(F)		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Joshimath	5710	4431	1279	2766	2127	639	2944	2304	640
Chamoli	3691	2389	1302	1756	1104	652	1935	1285	650
Karnaprayag	646	473	173	324	220	104	322	253	69
Tharali	285	285	0	156	156	0	129	129	0
Gair Sain	98	98	0	47	47	0	51	51	0
Pokhari	54	54	0	34	34	0	20	20	0
Ukhimath	90	81	9	58	49	9	32	32	0
Rudraprayag	96	76	20	48	38	10	48	38	10
Devprayag	3	1	2	2	0	2	1	1	0
Srinagar	101	11	90	50	4	46	51	7	44
Pauri	135	11	124	83	7	76	52	4	48
Total ARB	**10909**	**7910**	**2999**	**5324**	**3786**	**1538**	**5585**	**4124**	**1461**

11. Literacy 2001

Taluk	Total Literacy			Male literacy			Female literacy		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Joshimath	27217	15832	11385	17550	9950	7600	9667	5882	3785
Chamoli	58995	42020	16975	35392	25187	10205	23603	16833	6770
Karnaprayag	38046	27117	10929	21572	15012	6560	16474	12105	4369
Tharali	54978	54978	0	31549	31549	0	23429	23429	0

Gair Sain	34887	34887	0	19971	19971	0	14916	14916	0
Pokhari	23231	23231	0	12900	12900	0	10331	10331	0
Ukhimath	51091	50771	320	29415	29102	313	21676	21669	7
Rudraprayag	89987	88296	1691	50665	49538	1127	39322	38758	564
Devprayag	59132	56681	2451	33346	31945	1401	25786	24736	1050
Srinagar	37577	21518	16059	21249	11769	9480	16328	9749	6579
Pauri	98261	78035	20226	52782	41379	11403	45479	36656	8823
Total ARB	**573402**	**493366**	**80036**	**326391**	**278302**	**48089**	**247011**	**215064**	**31947**

12. Illiteracy 2001

Taluk	Total illiteracy			Male illiteracy			Female illiteracy		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Joshimath	12702	9201	3501	4953	3334	1619	7749	5867	1882
Chamoli	32998	28436	4562	11434	9438	1996	21564	18998	2566
Karnaprayag	17124	13773	3351	5833	4265	1568	11291	9508	1783
Tharali	33454	33454	0	10787	10787	0	22667	22667	0
Gair Sain	24496	24496	0	7919	7919	0	16577	16577	0
Pokhari	12231	12231	0	3885	3885	0	8346	8346	0
Ukhimath	29094	28932	162	9303	9147	156	19791	19785	6
Rudraprayag	57267	56708	559	18152	17856	296	39115	38852	263
Devprayag	41692	40928	764	13691	13354	337	28001	27574	427
Srinagar	12223	8624	3599	4450	2732	1718	7773	5892	1881
Pauri	47813	42702	5111	14949	12792	2157	32864	29910	2954
Total ARB	**321094**	**299485**	**21609**	**105356**	**95509**	**9847**	**215738**	**203976**	**11762**

13. Land Use (ha) in the Villages of Khanda Gad 1971*-2007**

Village name	Area			Forest (Van Panchayat)		
	1971	2007	Change	1971	2007	Change
Margaon	32	9.3	-22.7	-	3.6 (1952)	3.6
Shrikot Khanda	132.4	122.0	-10.4	0.8	13.6	12.8
Margadna	26.8	32.7	5.9	-	-	-
Bhitai Malla	74	73.4	-0.6	-	5.2 (2000)	5.2
Kaldung	92.8	80.9	-11.9	1.2	6.1 (2001)	4.9
Dhanak	25.6	26.1	0.5	-	3.0 (1985)	3.0
Gaduwa Gad	47.6	44.7	-2.9	-	-	-
Kamand	25.2	25.5	-0.3	-	5.5 (2000)	5.5
Dov	43.6	53.7	10.1	0.4	14.7 (2001)	14.3
Shiyar Malla	13.2	33.8	20.6	-	-	-
Rawat Gaon	46.4	46.6	-0.2	-	-	-
Bhitai Talla	166.4	71.9	-94.5	-	7.1 (2000)	7.1
Total	**726**	**620.2**	**-105.8**	**2.4**	**58.8**	**56.4**

Source: * Census handbook 1971, ** Patwari circle, Srinagar and Pauri

14. Land Use (ha) in the Villages of Khanda Gad 1971*-2007 Continue….**

Village name	Irrigated			Un-irrigated		
	1971	2007	Change	1971	2007	Change
Margaon	-	1.9	1.9	13.2	0.9	-12.3
Shrikot Khanda	-	5.0	5.0	33.2	36.1	2.9
Margadna	0.8	1.2	0.4	21.6	28.3	6.7
Bhitai Malla	-	3.7	3.7	17.6	46.1	28.5
Kaldung	0.8	0.7	-0.1	22.8	58.0	35.2
Dhanak	2.4	2.6	0.2	6.4	13.3	6.9
Gaduwa Gad	2.4	1.9	-0.5	15.2	32.3	17.1
Kamand	1.6	1.2	-0.4	14	14.5	0.5
Dov	-	-	-	23.2	25.2	2.0
Shiyar Malla	-	1.3	1.3	2.8	1.3	-1.5
Rawat Gaon		0.4	0.4	17.6	32.4	14.8
Bhitai Talla	4.0	3.3	-0.7	74.0	18.8	-55.2
Total	**14.4**	**23.2**	**8.8**	**261.6**	**307.2**	**45.6**

15. Table Population Under 0-6

Village Name	Population (0-6)					
	Total		Male		Female	
	1991	2001	1991	2001	1991	2001
Margaon	23	23	10	15	13	8
Shrikot Khanda	59	41	30	18	29	23
Margadna	17	3	9	2	8	1
Bhitai Malla	59	38	29	20	30	18
Kaldung	42	17	23	7	19	10
Dhanak	17	18	12	7	5	11
Gaduwa Gad	6	0	2	0	4	0
Kamand	13	7	7	3	6	4
Dov	10	8	7	6	3	2
Shiyar Malla	0	-	0	0	0	-
Rawat Gaon	0	8	0	5	0	3
Bhitai Talla	23	9	9	3	14	6
Total	**269**	**172**	**138**	**86**	**131**	**86**

Source: Census hand books of 1991 and 2001

16. Total Population

Village Name	Population					
	Total		Male		Female	
	1991	2001	1991	2001	1991	2001
Margaon	163	130	69	54	94	76
Shrikot Khanda	310	435	153	214	157	221
Margadna	86	34	44	15	42	19
Bhitai Malla	392	389	177	174	215	215
Kaldung	178	169	89	87	89	82

Dhanak	91	115	45	52	46	63
Gaduwa Gad	54	41	22	26	32	15
Kamand	74	93	33	43	41	50
Dov	104	92	51	51	53	41
Shiyar Malla	0	0	0	0	0	0
Rawat Gaon	28	33	13	18	15	15
Bhitai Talla	100	87	40	40	60	47
Total	**1580**	**1618**	**736**	**774**	**844**	**844**

Source: Census hand books of 1991 and 2001

17. Literacy Rate

Village Name	Literacy								
	Total			Male			Female		
	1991	2001	Change	1991	2001	Ch	1991	2001	Change
Margaon	98	79	-19	52	32	-20	46	47	1
Shrikot Khanda	161	326	165	102	184	82	59	142	83
Margadna	37	67	37	24	40	16	13	27	14
Bhitai Malla	222	58	-164	127	34	-93	95	24	-71
Kaldung	88	26	-62	57	13	-44	31	13	-82
Dhanak	35	281	246	24	150	126	11	131	120
Gaduwa Gad	40	112	72	20	75	55	20	37	17
Kamand	38	63	25	22	37	15	16	26	10
Dov	69	64	-5	40	37	-3	29	27	-2
Shiyar Malla	0	0	0	0	0	0	0	0	0
Rawat Gaon	25	21	-4	13	12	-1	12	9	-3
Bhitai Talla	57	131	74	23	81	58	34	50	16
Total	**987**	**1228**	**241**	**567**	**695**	**128**	**420**	**533**	**133**

Source: Census hand books of 1991 and 2001

18. Scheduled Caste Population

Village Name	SC Population					
	Total		Male		Female	
	1991	2001	1991	2001	1991	2001
Margaon	0	0	0	0	0	0
Shrikot Khanda	87	104	43	52	44	52
Margadna	49	0	27	0	22	0
Bhitai Malla	70	64	33	32	37	32
Kaldung	120	136	64	70	56	66
Dhanak	27	75	14	34	13	41
Gaduwa Gad	8	10	3	5	5	5
Kamand	1	0	1	0	0	0

Dov	0	0	0	0	0	0
Shiyar Malla	0	0	0	0	0	0
Rawat Gaon	0	0	0	0	0	0
Bhitai Talla	3	3	2	2	1	1
Total	**399**	**392**	**204**	**195**	**195**	**197**

Source: Census hand books of 1991 and 2001

19. Case Studied Villages of Kewer Gadhera Sub Watershed

Villages	Area				HHs			
	1971 (ha)	1981	1991	2001	1971	1981	1991	2001
Kewer Talla	32	44.9	45.5	31.1	68	149	243	247
Kewer Malla	47.5	31.1	41.2	45.4	13	22	26	26
Bhagoti	100.04	104.8	105.2	104.5	67	65	78	88
Ratni	37.6	38	37.1	37.8	15	17	22	27
Keshwan	50	25.5	25.8	25.5	19	21	19	21
Gadseer	156	123.8	171.6	171.6	73	87	101	103
Bunga	112	131.1	124.1	129.4	60	55	58	70
Jhijodi	204	162.7	162.6	162	116	114	139	150
Ali	11.5	11.3	11.6	11.1	7	10	15	15
Leguna	14	12.1	12	19	9	14	12	20
Bedula	71.6	72.4	70.8	71	20	24	28	36
Chirona	26.8	27.1	26.9	27	4	8	9	11
Kaub	231.6	288.3	222.9	228.6	144	208	235	242
Naini	22.8	23.1	28.49	22.6	14	12	21	20
Swan Malla	2	26.3	28.2	28.2	13	8	8	16
Swan Talla	56.4	57.1	58.1	58.3		46	45	43
Kimoli	242	248.9	124.1	247.9	111	133	138	168
Total	**1417.84**	**1428.5**	**1296.19**	**1421**	**753**	**993**	**1197**	**1303**

20. Population Structure (Total Population)

Villages	Total Population											
	1971			1981			1991			2001		
	T	M	F	T	M	F	T	M	F	T	M	F
Kewer Talla	286	150	136	584	353	231	981	632	349	967	546	421
Kewer Malla	58	22	36	114	56	58	130	67	63	147	75	72
Bhagoti	200	100	100	315	128	187	363	161	202	430	194	236
Ratni	69	31	38	108	47	61	118	52	66	125	55	70
Keshwan	93	33	60	103	46	57	98	48	50	96	36	60
Gadseer	348	162	186	459	191	268	604	304	300	519	227	292
Bunga	239	108	131	288	136	152	344	163	181	446	204	242
Jhijodi	506	233	273	585	264	321	786	420	366	770	349	421
Ali	44	24	20	40	19	21	64	34	29	62	34	28
Leguna	49	24	25	68	36	32	71	36	35	106	60	46
Bedula	97	43	54	128	60	68	164	80	84	234	141	93

Chirona	28	13	15	42	16	26	45	19	26	53	28	25
Kaub	865	369	496	1011	434	577	1240	601	639	1257	559	698
Naini	50	17	33	58	24	34	109	57	52	103	42	61
Swan Malla	38	21	17	56	27	29	63	23	40	82	30	52
Swan Talla				213	100	113	126	105	121	225	103	122
Kimoli	551	272	279	636	304	332	884	492	392	991	488	503
Total	**3521**	**1622**	**1899**	**4808**	**2241**	**2567**	**6190**	**3294**	**2995**	**6613**	**3171**	**3442**

21. Literacy Rate

Villages	Literacy											
	1971			1981			1991			2001		
	T	M	F	T	M	F	T	M	F	T	M	F
Kewer Talla	132	104	28	378	270	108	715	519	196	743	455	288
Kewer Malla	23	16	7	35	23	12	73	42	31	101	53	48
Bhagoti	176	78	98	119	80	39	175	95	80	282	145	137
Ratni	21	20	1	39	29	10	62	35	27	84	43	41
Keshwan	32	21	11	54	33	21	61	41	20	61	28	33
Gadseer	104	98	6	161	114	47	332	227	105	336	174	162
Bunga	18	18	-	67	59	8	92	85	7	249	153	96
Jhijodi	65	62	3	132	123	-	234	210	24	338	208	130
Ali	21	16	5	26	15	11	41	25	16	47	30	17
Leguna	11	10	1	22	13	9	37	25	12	75	48	27
Bedula	28	27	1	42	35	7	62	47	15	160	106	54
Chirona	9	8	1	17	8	9	21	10	11	33	17	16
Kaub	228	193	35	395	285	110	599	388	211	711	392	319
Naini	13	11	2	24	13	11	85	32	26	67	33	34
Swan Malla	16	16	-	21	18	3	31	15	16	58	21	37
Swan Talla	-	-	-	53	44	9	72	52	20	136	77	59
Kimoli	81	81	-	136	129	7	279	257	22	553	352	201
Total	**978**	**779**	**199**	**1721**	**1291**	**421**	**2971**	**2105**	**839**	**4034**	**2335**	**1699**

22. S C Population

Villages	S C Population											
	1971			1981			1991			2001		
	T	M	F	T	M	F	T	M	F	T	M	F
Kewer Talla	127	63	64	181	90	91	242	132	110	344	160	184
Kewer Malla	-	-	-	3	1	2	7	4	3	21	13	8
Bhagoti	22	7	15	19	8	11	21	9	12	20	9	11
Ratni	4	2	2	-	-	-	9	4	5	12	5	7
Keshwan	-	-	-	-	-	-	-	-	-	0	0	0
Gadseer	4	3	1	6	4	2	10	7	3	20	9	11
Bunga	110	48	62	134	60	74	155	71	84	223	103	120
Jhijodi	116	55	61	117	59	58	179	92	87	218	110	108
Ali	16	9	7	12	8	4	19	9	10	19	10	9
Leguna	-	-	-	-	-	-	-	-	-	0	0	0

Bedula	13	8	5	24	11	13	27	11	16	25	15	10
Chirona	-	-	-	-	-	-	-	-	-	0	0	0
Kaub	286	133	153	351	168	183	247	206	241	547	236	311
Naini	-	-	-	-	-	-	-	-	-	0	0	0
Swan Malla	-	-	-	1	1	-	-	-	-	0	0	0
Swan Talla	-	-	-	-	-	-	-	-	-	0	0	0
Kimoli	202	103	99	232	110	122	310	168	142	348	173	175
Total	**900**	**431**	**469**	**1080**	**520**	**560**	**1226**	**713**	**713**	**1797**	**843**	**954**

23. Population Structure (Population Below 6 Year)

Villages	**1991**			**2001**		
	Total	**M**	**F**	**Total**	**M**	**F**
Kewer Talla	127	70	57	140	76	64
Kewer Malla	20	10	10	25	18	7
Bhagoti	76	41	35	68	34	34
Ratni	20	9	11	16	10	6
Keshwan	13	6	7	17	7	10
Gadseer	113	55	58	70	31	39
Bunga	67	32	35	83	34	49
Jhijodi	149	84	65	165	87	78
Ali	12	9	3	7	4	3
Leguna	10	5	5	12	6	6
Bedula	44	23	21	32	17	15
Chirona	13	6	7	8	7	1
Kaub	244	131	113	245	126	119
Naini	22	10	12	15	6	9
Swan Malla	16	7	9	15	9	6
Swan Talla	58	30	28	34	15	19
Kimoli	168	103	85	164	91	73
Total	**1172**	**631**	**561**	**1116**	**578**	**538**

24. Land Use Land Cover Changes in Cluster of Villages in Kewer Gadhera Sub-Watershed Between 1971* and 2007**

Village name	**Area (ha)**			**Forest**		
	1971	**2007**	**Change**	**1971**	**2007**	**Change**
Kewer Talla	32	31.1	-0.9	1.2	-	-1.2
Kewer Malla	47.5	45.4	-2.1	1.2	-	-1.2
Bhagoti	100	104.5	4.5	1.4	2.6	1.2
Ratni	37.6	37.8	0.2	-	1.7	1.7
Keshwan	50	25.5	24.5	-	-	-
Gadseer	156	171.6	15.6	4	7.5	3.5
Bunga	112	129.4	17.4	12	68.6	56.6
Jhijodi	204	162	-42	40	10.7	-29.3

Ali	11.5	11.1	-0.4	0.4	5.8	5.4
Leguna	14	19	5	2	7	5
Bedula	71.6	71	-0.4	4.3	22.4	18.1
Chirona	26.8	27	0.2	13	19.7	6.7
Kaub	231.6	228.6	3	20.2	49.7	29.7
Naini	22.8	22.6	-0.2	5.8	5.7	-0.1
Swan Malla	2	28.2	26.2	6	5.2	-0.8
Swan Talla	56.4	58.3	1.9	4	9.8	5.8
Kimoli	242	247.9	5.9	40.2	46.6	6.4
Total	**1417.8**	**1421**	**58.4**	**155.7**	**263**	**107.5**

Source: * Census hand book 1971, ** Patwari circle, Narainbagar.

25. Land Use Land Cover Changes in Cluster of Villages in Kewer Gadhera Sub-Watershed between 1971* and 2007**

Village name	Irrigated			Un-irrigated		
	1971	2007	Change	1971	2007	Change
Kewer Talla	0.8	-	-0.8	17.4	17.9	0.5
Kewer Malla	-	-	-	18.4	18.3	-0.1
Bhagoti	-	-	-	40	64.8	24.8
Ratni	-	-	-	18.8	19.2	0.4
Keshwan	-	-	-	24	7.2	16.8
Gadseer	-	-	-	64	65.3	1.3
Bunga	-	-	-	40	44.2	4.2
Jhijodi	-	-	-	46	72.3	26.3
Ali	-	0.1	-	4.4	4.3	-0.1
Leguna	-	0.8	-	8	6.1	-1.9
Bedula	-	0.7	-	24.8	24.5	-0.3
Chirona	-	-	-	5	5.1	0.1
Kaub	-	-	-	93	95.9	2.9
Naini	-	-	-	9.2	8.4	-0.8
Swan Malla	-	-	-	6	9.7	3.7
Swan Talla	-	-	-	30	31.4	1.4
Kimoli	148	-	-	74	87.9	13.9
Total	**148.8**	**1.6**	**-0.8**	**523**	**582.5**	**93.1**

Source: * Census handbook 1971, ** Patwari circle, Narainbagar

26. NTFPs (Including H and MPs) Information Collected from the Forests in Selected Districts viz. Chamoli (Garhwal Region) and Pithoragarh (Kumaon Region) (UTTARAKHAND STATE)

S.	Botanical Names (Families)	Local Names	Habits	Parts Used	Season of Collection	Uses
1.	Aconitum atrox Stapf. (Ranunculaceae)	Vatsnam/ Meetha Vish	Herb	Roots/ Rhizome	Sep. – Oct.	Whooping cough and asthma. Ayurvedic and

2.	A. falconeri Stapf. (Ranunculaceae)	Meetha Vish/ Vatsnam	Herb	Roots/ Rhizome	Sep. – Oct.	Whooping cough and asthma. Ayurvedic and Yunani medicines; roots used for nervous and digestive diseases; also for rheumatism and fevers
3.	heterophyllum Wall. ex Royle (Ranunculaceae)	Atis Ativisha	Herbs	Roots/ Rhizome	Sep. – Oct.	For cough, strength and as tonic, astringent, stoma chic. Used in powder form aphrodisiac roots considered a valuable febrifuge and bitter tonic. Also used for hysteria, throat infection and diabetes.
4.	A. laciniatum Stapf. (Ranunculaceae)	Murilla	Herb	Roots	Sep. – Oct.	Root extract used in cure of ailment locally.
5.	Acorus calamus L. (Araceae)	Bach/ Vacha/ Safed bach	Herb	Roots, root-stem transition	Sep. – Oct.	Stimulant, carminative, tonic and stoma chic, useful in dyspepsia, flatulence, loss of appetite, hysteria, epilepsy and insanity. Also used for glandular and abdominal tumors; alcoholic extract of the rhizome has sedative and analgesic properties.
6.	Adiantum venustum G. Don (Adiantaceae)	Hansraj	Herb	Leaves and whole plant	Oct. – Mar.	Skin diseases and treatment of bronchitis. Also used against tumors, biliousness, inflammatory diseases of the chest and ophthalmic.
7.	Aesculus indica Colebr. ex Camb. (Hippocastanaceae)	Pangan / Pangar/ Bankhor/ Pangla	Tree	Fruit and seeds	Jul. – Aug.	In stomach disorder of horses, arthritis. In allopathic medicines, cure for skin diseases;

						roots used in leucorrhoea; bark made into a paste and applied to dislocated joints.
8.	Allium stracheyi L. (Liliaceae)	Jambu	Herb	Leaves and flowers	Sep. – Oct.	Used as spice for flavoring and spluttering food items.
9.	Angelica glauca Edgew. (Apiaceae)	Gandrayan / Chora	Herb	Roots / Seeds	Sep. – Oct.	As spice and root oil has demand in international market for scenting the food items. Also used as a cardio active, carmi-native, expectorant, diaphoretic.
10.	Artemesia maritima L. (Asteraceae)	Pati / Chamur/ Kirmala / Afsanthin	Shrub	Leaves flowers	Sep. – Oct.	Leaves scented. In preparation of Ayurvedic medicine Naglona. Possesses antihelmi-nitic, antiseptic properties. Also used for asthma and psychological diseases and is recommend-ed for chronic fever and swellings; yields an essential oil called wormwood oil which has a tonic effect on digestive organs; also used externally for rheumatism.
11.	Asparagus racemosus Willd. (Liliaceae)	Satawar/ Shatawar/ Satmata / Phusar	Herb	Roots and leaves	Throughout the year	Gives cooling effect. Roots demulcent, diuretic, aphrodisiac, antispasmodic and alterative tonic. Leaves used for treatment of boils, smallpox. Fresh root juice is mixed with honey and given for dyspepsia; these also form a constituent of medicinal oils used

						for nervous and rheumatic complaints; roots also used as demulcent, aphrodisiac, diuretic, anti-dysenteric, and in veterinary medicines.
12	Berberis asiatica DC (Berberidaceae)	Kilmoda, Rasaut, Daru-haldi	Bush	Roots and bark	Oct. – Mar.	Recommended in excess urethral discharge, eye diseases, jaundice, and fevers. Root bark used for skin diseases, eye ailments and malaria. Roots useful in healing of wounds.
13.	Berberis aristata DC. (Beberidaceae)	Dar-haldi	Shrub	All parts especially root bark / stem	Jul. Aug.	Malaria, jaundice, eye disease, skin and stomach diseases. In Ayurvedic and Yunani system it is used for preparation of Berberis hydrochloride;
14	Berginia ciliata Sternb (Saxifragaceae)	Pashanabheda/ Shailagarbhaja / Silphori	Herb	Rhizome	Sep. – Mar.	The drug Pashanabheda is extracted from dried rhizomes. It possesses astringent, tonic, antiscor-butic and laxative prop-erties. Useful in pulmo-nary infection, dysentery, ulcers, spleen enlarge-ment, cough and fever.
15.	Cannabis sativa L. (Cannabinaceae)	Bhang / Ganja	Shrub	Seeds, dried leaves	Sep. – Oct.	As intoxicant, stomachic, analgesic, narcotic, sedative, pain killer, and anodyne.
16.	Centella asiatica (L.) Urban (Hydrocotylaceae)	Mandukparni	Herb	Leaves/ Stem	Sep. – Oct.	Treatment of cold and useful for improving brainpower also. Used in Ayruvedic and Yunani

						systems of medicines as diuretic, alterative and tonic and has demand in International market also. A decoction of the whole plant is used in treatment of leprosy.
17.	Chenopoduim album L. (Chenopodiaceae)	Bathua	Herb	Leaves	Jun. – Sept.	Appetizer and laxative
18.	Cinnamomum tamala (Buch.-Ham.) T. Nees and Eberm. (Lauraceae)	Tejpat	Tree	Leaves	Oct. – onward	Leaves used as Tejpat or Tejpatta leaf. Useful in scabies, disease of the anus and rectum such as piles (in Ayruveda), colic and diarrhea.
19.	C. zeylanicum Blume (Lauraceae)	Dalchini	Tree	Inner bark	Sep. – Nov.	Bark used as Dalchini (a spice). It has a sharp hot taste, tonic; used as alexiteric, stimulant, car-minative, expectorant, aphrodisiac and for headache, etc. Used in Ayurvedic and Yunani systems of medicines.
20.	Citrullus colcocynthis (L.) Kuntze (Cucurbitaceae)	Indrayan	A pere-nnial herb	Fruits, roots	June – July	Ayurvedic and Yunani medicines for blood pressure, stomachache, jaundice, urinary diseases and rheumatism. Fruit and roots antidote to snake poison, extract from fruit pulp is highly effective against bacteria.
21.	Coleus forskohlii (Willd.) Briq. (Lamiaceae)	Coleus	Herb	Roots	Sep.-Oct.	Blood pressure and glaucoma, in allopathic medicines.

22.	Corydaylis govaniana Wall. (Fumariaceae)	Bhutkeshi/ Jatamansh	Herb	Root	Sep.-Oct.	Insecticide, strength, blood purifier. Roots locally used as incense; also recommended against syphilis and coetaneous affections.
23.	Datura stramonium L. (Solanaceae)	Dhatura	Herb	Flower, leaves, fruit, seeds	Oct.-Nov.	Sleepiness, intoxicant, skin diseases, fever leprosy and asthma. In Ayurvedic, allopathic and Yunani medicines; alkaloid atropine used as stimulant for the central nervous system and as sulphate for dilating pupil.
24.	Delphinium denudatum Wall. (Ranunculaceae)	Nirbishi	Herb	Root	Sep.-Nov.	The root is bitter and considered as stimulant, alternative and tonic. Also useful as tonic for toothache and an adulterant for aconite.
25.	Didymocorpus pedicellata R. Br. (Gesneriaceae)	Patthar Phori	Herb	Leaves and bud		As scent and in Ayurvedic medicines as remedy for kidney and bladder.
26.	Dioscorea bulbifera L. (Dioscorcaceae)	Vangenthi/ Gainthi / Ratalu	Herb (Climb-er)	Tuber	Oct. – Jan.	For strength and nutrition in Ayrvedic medicine e.g. Chyvanparash. Tuber used in piles, syphilis and applie to ulcers.
27	D. deltoidea Wall. ex Kunth. (Dioscoreaceae)	Kathparun / Kithi	Climb-er	Tuber (stem)	Oct. – Jan.	In cortisone hormones and Allopathic medicines, tubers yield steroidal sapogenins, which are sources of oral contraceptives.
28.	Diploknema butyracea (Roxb.) H.J. Lam. (Sapotaceae)	Chyura(Indian Butter Tree)	Tree	Fruit	Jun.-Jul.	Edible oil used as butter and in preparation of chocolate and hair pomade.

29.	Emblica officinalis Gaertn. (Euphorbiaceae)	Amla / Aonla	Tree	Flower, Fruits, roots	Oct. – Nov.	Fruits used as diuretic, laxative and for treatment of jaundice, cough stomach disorders, anemia and eye ailments; rich source of vitamin c; fruits have anti-biotic activity against a variety of micro-organisms.
30.	Ephedra gerardiana Wall. (Ephedraceae)	Soam	Shrub	Twigs	August	Cure of syphilis (genital diseases), asthma, cold, hay fever and rashes of allergic origin; nasal spray is used against inflammation of mucous membrane.
31.	Fritillaria roylei Hook. (Liliaceae)	Kakoli	Herb	Root tuber	Oct.-Nov.	In Ayrvedic and Yunani medicines roots used for healing of wounds, corms are used for asthma and bronchitis.
32.	Hebenaria comme-linifolia Wall. ex Lindl. (Orchidaceae)	Vridhi	Herb	Roots	Jun.-Oct.	Used in Ayrvedic preparation as chyavanprash and for strength as a source of salep.
33.	Hedychium spicatum Buch.-Ham. ex. Smith (Zingiberaceae)	Kapur kachari/ Kapoor kesri/ Ban Haldi	Herb	Rhizomes	Oct. – Dec.	Stomachic, carminative, tonic, stimulant, Useful in liver complaints, vomiting, diarrhea, inflammations and pain as well as snakebite.
34.	Indigofera pulchella Roxb. (Fabaceae)	Sakina / Hakna	Shrub	Roots	May-June	Used for treatment of cough and chest pain .
35.	Juglans regia L. (Juglandaceae)	Akhrot	Tree	Fruit, bark and leaves; roots	Nov.-Jan.	Bark possesses insecti-cidal properties, toothpaste making, fruit edible; leaves astringent, tonic and anathematic.
36.	Juniperus communis L. (Cupressaceae)	Haubera/ Aaraar	Shrub or small tree	Leaves and fruit	Sep.-Oct.	Yields essences, scent and havan material. Fruit used as Hauber in Ayruvedic, also used for flavouring

						gin.
37.	Adhatoela vaxiea Nees (Acanthaceae)	Adulasa/ Arusa	Peren-nial herb	Leaves	Jun.-Sep.	In cough as expectorant bronchitis and other respiratory ailments. In allopathic, Ayurvedic and Yunani medicines; leaves also possess anthelmintic properties.
38	Lyonia ovalifolia Wall.) Drude (Ericaceae)	Ayar	Tree	Leaves and buds	Jan.-Feb.	Insecticidal used in skin ailments. Also in folklore medicine in Kumaon and Garwal, traditional treatment of diseases.
39.	Macrotomia benthami A. DC. (Boraginaceae)	Ratanyot or Laljadhi Kashimiri Goozaban	Herb	Root and root bark	Sep.-Oct.	Roots paste mixed with milk used for healing of internal wounds and soars. Good for vomiting and digestion. As colour-ing agent in spices; aqueous extract of flowering shoots is used in making sherbet and jams that are recommended for troubles of tongue and throat and for cardiac disorders.
40.	Mallotus philippensis (Lamk.) Muell. – Arg. (Euphorbiaceae)	Rohini/ Kamala/ roli/ Sindhuri	Tree	Fruit (oil glands and hair on fruits) seeds	Mar.-May	Bitter, possesses wormicidial and insecticidal properties, fruits yield a red dye used as an anathematic and for coetaneous affections; seed oil is used for making hair fixers and ointments.
41.	Mentha longifolia (L.) Huds. (Lamiaceae)	Jungli Pudina	Perre-nial herb	Leaves/ flowers	Sep.-Oct.	Carminative, stimulant and cooling medicines.

42.	Myrica esculenla Buch.-Ham. ex D. Don (Myricaceae)	Kafal, Katfal	Tree	Bark	Sep.-Oct.	Bark carminative Ayur-vedic and Yunani system of medicine for cough, dysentery and dieresis; chewed for toothache.
43.	Nardostachys jatamansi (D. Don) Dc. (Valerianaceae)	Jatamansi/ Balchhar	Herb	Rhizome	Sep.-Oct.	Stimulant, strength as antiseptic, epilepsy and intestinal pain, source of an essential oil supposed to improve hair growth and black colour; its tincture is use for epilepsy and hysteria; also used as a laxative for improving urination, menstruation and digestion.
44.	Orchis latifolia L. (Orchidaceae)	Hathandi/ Salammishri/ Salap	Herb	Stem, root	Sep.-Oct.	Tonic for digestive system, Cough, heart ailment and healing agent of wound in Ayurvedic and Yunani System of medicine.
45	Paris polyphylla Sm. (Liliaceae)	Satua	Herb	Root and tuber	Oct.-Mar.	Used in Ayurvedic medicine. The rhizome is possessing antithelmintic properties and also used as tonic.
46	Picrorhiza kurrooa Royal ex Benth. (Scrophulariaceae)	Kutki, Katki	Herb	Root	Sep.-Oct. and May.-Jun.	Roots are used for treatment of fever, dysentery scorpion bite, eczema, catharic, stoma chic, purgative.
47.	Pinus roxburghii Sarg. (Pinaceae)	Chir	Tree	Stem	Throughout the year	Resin extract is used in manufacture of turpentine oil, varnish and paints industry. Also mixed in artificial essences, camphor and scent preparations.

48	Podophyllum hexandrum Royle (Podophyllaceae)	Bankakri/ Papda	Herb	Roots	Sep.-Oct.	Liver ailment, digestive and purgative; the drug also checks growth of cancerous cells.
49.	Polygonatum multiflorum (L.) All. (Liliaceae)	Mahameda	Herb	Rhizomes	Sep.-Oct.	Ayrvedic medicine especially in Chavanprash; also used for treatment of piles and discolouration of skin resulting from blows.
50.	P. verticillatum All. (Liliaceae)	Meda/ Mitha dudhia	Herb	Roots	Sep.-Oct.	Ayrvedic medicine especially in Chavanprash
51.	Potentilla fulgens Hook. (Rosaceae)	Vajradanti	Peren-nial herb	Root	Sep.-Mar.	Liver related diseases; roots used in diarrhoea
52.	Prunus cerasoides D. Don (Rosaceae)	Padam	Tree	Bark and fruit	Nov.-Jan.	Bark in Ayurvedic medicine and fruit for colouring the medicines. The stem is bitter, acrid, antipyretic, refrigerant, causes flatulence, cures leprosy, hallucinations, burning of the body, etc.
53.	Rheum emodi Wall. ex Meissn. (Polygonaceae)	Dolu/uvan tantora	Herb	Root, root-stem transition zone	Sep.-Nov.	For strength and also ingredient in digestive medicines; powdered roots also used in healing ulcers.
54.	Rhododendron arboreum Sm. (Ericaceae)	Burans	Tree	Flower	Mar.-Jun.	Flowers yields juice used in making squash for cold drinks; also used in diarrhea and dysentery.
55.	Rhus succedanea L. (Anacardiaceae)	Kakrasingi	Shrub	Insect galls	Sep.-Oct.	As tonic, expectorant, cough, phthisis, asthma, fever, want of appetite and irritability of stomach; galls are astringent and expectorant.
56.	Rubia cordifolia L. (Rubiaceae)	Manjishtha, Manjit	Herb (climb-er)	Roots/ fruit		Used in Ayurvedic medicines for rheumatism; roots yield a red dye.

						Fruit, useful in hepatic obstruction.
57.	Schima laureola(DC.) Choisy(Theaceae)	Nettpati/ Kasturpatti	Herb	Leaves	Sep.-Oct.	Incense and as scent.
58	Stephania glabra (Roxb.) Miers (Menispermaceae)	Gindaru	Climbi-ng shrub	Roots / tubers	Sep.-Jan.	Burn and blood pressure; tubers are used in pulmonary tuberculosis, asthma and dysentery.
59.	Swertia chirayita (Roxb. ex. Flem.) Karst. (Gentianaceae)	Chirayita	Herb	Whole plant	Sep.-Oct.	Ingredient in medicines of chronic fever and stomach ailments; tonic in bronchial asthma, anemia, liver disorders and also laxative.
60.	Symplocos paniculata Miq. (Symplocaceae)	Lodh	A large shurb or tree	Bark	Feb.-Mar.	Eye ailment, coolant gum ailments. Useful in bowel complaints, diarrhea and ulcers, etc.
61.	Syzygium cuminii (L.) Skeels (Myrtaceae)	Jamun, Jambu	Tree	Bark, fruit, seeds	Apr.-June.	Bark bitter, used in bleeding asthma and healing of wounds, fruits edible; seeds recommended for diabetic patients.
62.	Taxus baccata L. ssp. wallichiana (Zucc.) Pilger (Taxaceae)	Thuner, Birumi, Dhurai, Talishpatra	Tree	Leaves and bark	May.-Nov.	Asthma, epilepsy, insanity. Bark is used for Ayurvedic and Yunani medicines against headache, giddiness, diarrhea and biliousness.
63.	Thalictrum foliolosum DC. (Ranunculaceae)	Pinjari, Mamira	A tall herb	Roots	Sep.-Oct.	Used as a purgative, diuretic, febrifuge and dyspepsia in Ayurvedic medicines and ophthalmic as well as for making kajal sticks.
64.	Thymus serpyllum L. (Lamiaceae)	Banajwain	Herb	Whole plant seeds especially	Jul.-Aug.	Poor eyesight, liver and stomach ailments, urinary problem, Seeds have insecticidal

						properties. Oil used in toothache and as a spice.
65.	Valeriana jatamansi Jones (Valerianaceae)	Samoy/ Samau/ Mushkbala	Herb	Roots and fruits	Sep.-Oct.	As stimulant and antiseptic; also used in making ince-nse sticks and scents; for hair oils and perfumes and medicines for hysteria and nervous problems.
66.	Viburnum cotinofolium D. Don (Caprifoliaceae)	Karra/ Ghinwa	Shrub	Bark	Oct.-Nov.	Ayurvedic medicines used as Viburnum bark for menorrhagia and metrorrhagia.
67	Viola odorata L. (Violaceae)	Banfsha/ Vanafsa	Herb	Roots flower and fruit	Mar.-May	Roots antihelmintic, antipyretic, febrifuge. Flowers emollient, demulcent, used in biliousness and lung troubles; flowers used in Ayurvedic and Unani systems for several skin, eye and ear diseases; also used as blood purifier.
68.	Woodfordia fruticosa (L.) Kurz.	Santha / Dawi	Bush	Tuber	Jan.-Mar.	In Ayurvedic and Yunani medicines, solutions / liquids, bark extract is used as a colouring agent and for tanning.
69.	Zanthoxylum armatum DC. (Rutaceae)	Timur / Tejphal/ Darmar	Tree	Stem bark and seeds	Nov.-Jan.	Teeth and gum ailment including pyorrhea; Treatment of scabies seeds used as a tonic; bark, fruits and seeds are extremely used in medicines as carminative, stoma chic and anathematic; essential oil from seeds used for making tooth powders.
70.	Tanacetum nubigenum Wall.	Dhup/ Gugal	Herb	Roots	Sep.-Oct.	In pain and fever, as an insecticide;

	ex DC. (Asteraceae)					gum resin is used as incense.

Source: Natural Resources India Foundation: Pilot Study on Mechanism for sustainable development and promotion of herbal and medicinal plants in the state of Uttarakhand, SER division planning commission, Govt. of India.

27. Inventory of Medicinal by HABITS Occurring in Uttarakhand

Botanical Names	Vernacular names	Families	Habit	Part used	Status
Acacia concinna DC.	Shikakai	Mimosaceae	Tree	Pods / leaves	Endangered
Cassia fistula Linn.	Amaltas	Caesalpianaceae	Tree	Fruit pulp	Cultivated
Cedrus deodara (Roxb. ex Lamb.) G. Don	Deodar	Pinaceae	Tree	Wood oil	Common
Hydnocarpus laurifolia (Dennst.) Sleumer	Rowti / Taurella	Flacourtiaceae	Tree	Seeds	Rare
Mesua ferrea L.	Nagkesar	Clusiaceae (Guttiferae)	Tree	Flowers	Cultivated
Pistacia integerrima Stewart ex Brandis	Kakarasinghi	Pistaciaceae	Tree	Leaf galls / wood	Scarce
Prunus cerasoides D. Don	Padam	Rosaceae	Tree	Heartwood/ Fruit / endocrp	Common
Rhododendron arbore -um Sm.	Burans	Ericaceae	Tree	Flowers/bark./ tender leaves	Common
Strychnos nux-vomica L.	Karaskara / Kuchla	Strychnaceae	Tree	Seeds	Scarce
Symplocos racemosa Roxb.	Lodhra	Symplocaceae	Tree	Bark	Scarce
Taxus baccata Linn. sp wallichiana (Zucc.) Pilger	Thuner / Talishpatra	Taxaceae	Tree	Leaves / Bark	Scarce
Zanthoxylum armatum DC.	Tejphal/Darmar	Rutaceae	Tree	Wood / seeds	Scarce
Aconitum atrox Stapf	Mithavish	Ranunculaceae	Herb	Roots	Threatened
A. heterophyllum Wall. Ex Royle	Ativish	Ranunculaceae	Herb	Roots	Threatened
A. violaceum Jacq.	Patish/ Dudhia vish	Ranunculaceae	Herb	Roots	Endangered
Acorus calamus L.	Vacha/vach	Araceae	Herb	Rhizomes	Common
Anacyclus pyrethrum DC.	Akarkara	Apiaceae	Herb	Roots	Scarce
Angelica archangelica L.	Chora	Apiaceae	Herb	Roots / seeds	Scarce
A. glauca Edgew.	Gandrayani	Apiaceae	Herb	Roots/fruits	Endangered
Apium graveolens	Ajmada / Solari	Apiaceae	Herb	Roots	Cultivated
Artemisia maritima	Kirmala	Asteracea	Herb	Whole plant	Common

L.					
Asparagus adscendens Roxb.	Shatavar	Liliaceae	Herb	Roots	Cultivated
Bacopa monnieri (Linn.) Pennell	Brahmi	Scrophulariaceae	Herb	Whole plant	Common
Berginia ciliata Sternb	Pashanbhed/ Silphori	Saxifragaceae	Herb	Roots	Rare
Cannabis sativa Linn.	Bhang	Cannabinaceae	Herb	Leaves	Abundant
Centella asiatica (L.) Urban	Mandukparni	Hydrocotylaceae	Herb	Whole plant	Common
Citrullus colocynthis (L.) Kuntze	Indrayan	Cucurbitaceae	Herb	Whole plant	Cultivated
Colchicum luteum Baker	Hirantutiya	Liliaceae	Herb	Whole plant	Cultivated
Coptis teeta Wall.	Mamira/Mishmi	Ranunculaeae	Herb	Rhizomes	Rare
Curculigo orchiodes Gaertn.	Kalimusli	Hypoxidaceae	Herb	Roots	Scarce
Curcuma amada Roxb.	Amahaldi	Zingiberaceae	Herb	Roots/ rhizomes	Common
Cyperus rotundus Linn.	Motha	Cyperaceae	Herb	Rhizomes	Common
Dactylorhiza hatagirea (Don.) Soo	Hathjari	Orchidaceae	Herb	Roots	Rare, now cultivated
Delphinium denudatum Wall.	Nirbishi	Ranunculaceae	Herb	Roots	Rare
Didymorarpus pedicellata R.	Pathar laung/	Gentianaceae	Herb	Leaves	Rare
Br. Dioscorea deltoidea Wall. ex Kunth	Patthar Phori Gainthie	Dioscoreaceae	Herb	Tubers	Cultivated
Eulophia campestris Wall.	Salibmisri	Orchidaceae	Herb	Roots/ tubers	Endangered
Fumaria officinalis L.	Pitt Papara	Fumariaceae	Herb	Whole plant	Common
Gentiana kurroo Royle	Nilkanthi, Kurn/ Kutki	Gentianaceae	Herb	Whole plant	Common
Gloriosa superba Royle	Kalihari	Liliaceae	Herb	Tubers/ leaves	Rare
Hedychium spicatum Buch.– Ham. Smith	Kapur kachri/ Sitruti	Zingiberaceae	Herb	Rhizomes	Scarce
Hyoscyamus niger L.	Khurasani ajvayan	Solanaceae	Herb	Leaves	Cultivated
Mucuna pruriens (L.) DC.	Konch / Kawnch	Fabaceae	Herb	Seeds/ fruits	Common
Nardostachys jatamansi (D. Don) DC	Jatamasi/ Balchhar	Valerianaceae	Herb	Rhizomes	Endangered
Nelumbo nucifera Gaertn.	Kamal	Nelumbonaceae	Herb	Stem/ Seeds	Common
Orchis latifolia L.	Salammisri / Salap	Orchidaceae	Herb	Leaves	Rare
Papaver somniferum L.	Aphim	Papaveraceae	Herb	Capsules	Cultivated

Plantago ovata Forsk	Isabgol	Plantaginaceae	Herb	Seed husk	Common
Podophyllum hexandrum Royle	Bankakri/ Vankakri	Podophyllaceae	Herb	Roots	Endangered
Polygala chnensis Ham.	Miragu	Polygalaceae	Herb	Roots	Common
Rheum emodi Wall. ex Miers.	Archu/ Revandchini	Polygonaceae	Herb	Roots	Endangered
Rubia cordifolia Linn.	Manjeeth/Manjeet	Rubiaceae	Herb	Roots	Common
Saussurea costus (Falc.) Lipsch	Kuth	Asteraceae	Herb	Roots	Common/ Cultivated
S. obvallata Wall. ex C.B. Clarke	Brahmakamal	Asteraceae	Herb	Roots	Common
S. lappa C.B. Clarke	Kuth	Asteraceae	Herb	Roots	Common
Swertia chirayita (Roxb. ex Flem.) Karst	Chirayita	Gentianaceae	Herb	Whole plant	Roadside plantation
Tephrosia purpurea (L) Pers.	Sharepunkha	Fabaceae	Herb	Leaves	Common/ Cultivated
Tinospora cordifolia Miers ex Hook F. and Thoms.	Giloi/ Gurach	Menispermaceae	Climbing - shrub	Whole plant	Common
Urginea indica (Roxb.) Kunth.	Jangli piyaz/ Banpiaj	Liliaceae	Herb	Whole plant	Common
Valeriana hardwickii Wall.	Sugandhbala/ Tagger	Valerianaceae	Herb	Roots	Scarce
V. jatamansi Jones	Tagar/ Sameva	Valerianaceae	Herb	Rhizomes	Rare
Viola odorata L.	Vanafsa/ Banafola/ Banafsa	Violaceae	Herb	Flower/ fruit	Common/ Cultivated
Berberis aristata DC.	Daruharidra	Berberidaceae	Shrub	Roots/ bark	Rare
B. asiatica Roxb.	Kilmora/ kingora	Berberidaceae	Shrub	Roots/ bark	Rare
Calotropis giganteum Linn.	Madder/ Madar	Asclepiadaceae	Shrub	Whole plant	Common
Cephaelis ipecacuanha (Brot.) A. Rich.	Ipecac	Rubiaceae	Shrub	Whole plant	Rare
Ephedra gangetica Wall.	Som	Ephedraceae	Shrub	Stem	Scarce
E. gerardiana Wall.	Som/Asmania	Ephedraceae	Shrub	Whole plant	Rare
Glycyrrhiza glabra Linn.	Mulethi	Fabaceae	Shrub	Roots/ stems	Cultivated
Juniperus communis Linn.	Dhup lakri	Cupressaceae	Shrub	Whole plant	Common
Plumbago indica L.	Lal Chitra	Plumbaginaceae	Shrub	Roots	Grown in gardens
P. zeylanica L.	Chitter/ Chitrak	Plumbaginaceae	Shrub	Roots	Rare, now Cultivated
Pueraria tuberosa (Roxb. ex	Vadarikand, Siari	Fabaceae	Shrub	Tuber/	Scarce
Willd.) DC.				leaves	
Tylophora indica	Anantmool	Asclepiadaceae	Climbers	Leaves/	Endangered

(Burm. F.) Merr.				roots	
Uncaria gambier (Hunt.) Roxb.	Math-kuntha, Kath-Kuntha	Rubiaceae	Climbing , Shrub	Leaves/ branches	Rare
Withania somnifera (L.) Dunal	Ashagandgha/ Asgandha	Solanaceae	Shrub	Roots	Rare
Dioscorea bulbifera L.	Ratalu/ Gainthie	Dioscoreaceae	Climbing	Aerial tubers	Common
Entada phaseoloides (L.) Merr.	Gadbigh/Gadbich Birabi/Chian	Mimosaceae	Huge climbing shrub	Seeds/stem/ bark	Common
Smilax glabra Roxb.	Bari Chobcheeni	Smilacaceae	Climber	Roots/bulb	Common
Trichosanthes dioica Roxb.	Potala/ Parwal	Cucurbitaceae	Climber	Fruits	Cultivated

Source: Natural Resources India Foundation: Pilot Study on Mechanism for sustainable development and promotion of herbal and medicinal plants in the state of Uttarakhand, SER division planning commission, Govt. of India.

28. Main Socio-Economic Factors Behind Responsible for Traditional Crops/Landraces/Germplasm (After Bisht et al., 2006)

S.No.	Important factors responsiblefor agrobiodiversity loss	Process of change and implication
1	Change in cropping patternsdue to economicconsiderations	The farmers in the region are involved in diverse livelihood options as cultivation of crops, livestock, forestry, etc. Many of the traditional crops are grown under marginal conditions and often provide low yield and extremely low income, forcing the farmers to undertake other activities, for example, replacement of mixed cropping to monocropping, cultivation of improved strains bringing about more uniformity in crop species and switching over to cash crops. Mono-cropping and uniformity results in increased vulnerability to pest epidemics and consequent loss of biodiversity. Besides, a significant proportion of the traditional agricultural land has been brought under cash crops or o .-season vegetables. This has adverse implications on traditional agro-ecosystemsand traditional agro-biodiversity of the region has shrunk over the time.

2	Population growth and landfragmentation	The human population has increased over time. The land fragmentation and insufficient crop yield due to high land: man ratio and low output: input ratio of traditional crops compelled farmers to consider other options for livelihood.
3	Lack of traditional knowledge	Since there is no systematic documentation of ethno-medicinal uses of traditional landraces and the traditional underutilized crops, the younger generation is unaware about the distinctive properties of the landrace diversity. Lack of this knowledge often leads to discontinuation of cultivation of some of these landraces which are of high nutritional value to them. This kind of knowledge is, however, very much essential for value addition to local landrace diversity and also in IPR protection.
4	Out-migration	Migration of people to plain areas for o .-farm jobs and reduced interest in traditional agriculture.
5	Change in food habits	Yield potential of most of the traditional crops has been stable for the last 2 -3 decades. The food shortage problem is because of population growth, change in food habits (increasing preference for wheat and rice as staples), reduction in crop diversity and net sown area.
6	Social values	Local socio-cultural integration has decreased. Social institutions such as community participation in natural resource management for agriculture, and seed and labour exchange systems are disappearing fast leading to weakening of agricultural management.

29. Changes in Faming System

Crops/ cropping season Summer season crop	Replacement crop	% decline in traditional crops
Panicum miliaceum (Cheena)	High Yielding rice varieties	65.5
Oryza sativa (Traditional	High Yielding rice varieties	100

land races)		
Avena sativa (Jai)	Potato	78.5
Fagopyrum tataricum (Phaphar)	Potato and rajma	82.5
F. esculentum (Oggal)	Rajma	92.7
Parilla frutescense (Bhangjeera)	Soyabean	100
Setaria italica (Kauni)	Soyabean	65.2
Eleusince coracana (Koda)	Soyabean and amaranth	36.5
Echinochloa frumentacea (Jhangora)	Pigeon Pea	72
Macrotyloma uniflorum (Gahat)	Soyabean and amaranth	70
Vigna sp. (Mass)	Pigeon pea and amaranth	100
Winter season crops		
Triticum aesativum (traditional landraces of wheat) + Brassica (sarson)	High yielding wheat varieties	100
Hordeum himalayens (Owa)	Potato, amaranth and rajma	95
Hordeum vulgare (Jau)	Improved mustard varieties	84.3

Source: The Role of Cultural Values in Agrobiodiversity Conservation: A Case Study from Uttarakhand, Himalaya 2008 Sunil Nautiyal, Vimla Bisht*, K.S. Rao! and R.K. Maikhuri

30. Traditional Commercial Crops

English name	Vernacular name	English name	Vernacular name
Amaranth	Chaulai	Soybean	Bhatt
Amaranth	Chuwa/Marcha/Ramdana	Soybean	Kala Bhatt
Pigeon pea	Tor	Soybean	Soybean
Pig-weed	Bethu	Naked barley	O-wa-jau
Taro	Pindalu/Kuchain	Horesgram	Gahat
Buckwheat	Oggal	Potato	Alu
Buckwheat	Phaphar	Mat bean	Bhirnga
Maize	Mungri	Adjuki bean	Rains
Rice bean	Bhotia	Black gram	Urd
Zinger	Adrak	Cow pea	Sonta
Poppy	Post	Hog-millet	Cheena Jakhiya

31. Threatened Medicinal Plants of Uttarakhand

Name of the plant	Family	Local/trade name	Status	General distribution	Distribution in Uttarakhand
Part I *Nardostachys grandiflora* DC.	Valerianceae	Jatamansi	Vulnerable	India (Garhwal to Sikkim) Bhutan, Nepal & W. Tibet	Garhwal & Kumaon 3300-4500 m
Fritillaria toylei Hook.	Liliaceae	Kashir kokoli	Critically rare	India (Kashmir to Kumaon) China (W. Tibet)	Garhwal & Kumaon 2600-4000 m
Onosma bracteatum Wall.	Boraginaceae	Gojhiva	Rare	India (Garhwal to Kumaon) Nepal	Garhwal & Kumaon 3300-4500 m
Podophyllum hexandrum Royle.	Podophyllaceae	Ban kakri	Endangered	India (Kashmir to E. Himalaya) Nepal	Garhwal & Kumaon 3000-4000 m
Rheum australe D Don =(*Rheum emodi* Wall).	Polygonaceae	Revan Chini	Vulnerable	India (H.P. to Sikkim) Nepal, Bhutan, S.W.	Garhwal & Kumaon 3300-4000 m
Picrorhiza kurrooa Royle	Crophulariaceae	Kutki	Endangered	India (Garhwal and Kumaon) Nepal, Bhutan, China and Mayanmar	Garhwal & Kumaon 3300-4000 m
Swerita chirayita (Roxb. Ex Flem). Karsten	Gentianceae	Chirayita	Critically Rare	India (Kashmir to Sikkim and Assam), Nepal and Bhutan	Garhwal & Kumaon 1800-2500 m
Dactylorhiza hatagirea (D. Don) Soo = (*Orchis latifloia* L.)	Orchidaceae	Salam panja	Endangered	India (Kashmir to Sikkim), Nepal, Bhutan, China,	Alpine region of Garhwal & Kumaon 3000-4000m

				Pakistan	
Angelica glauca Edgew	Apiaceae	Choraka, Choru	Vulnerable	India (Kashmir to Garhwal & Kumaon	Garhwal 2700-3600 m
Selinum elatum (Edges) Hiroe = (*Selinum tenuifolium* Wall. Ex Cl.)	Apiaceae	Murva		India (Kashmir to Sikkim & Assam) Nepal and China	Garhwal & Kumaon 3000-4300 m
Gentiana kurroo Royle	Gentianaceae	Karua/True Kutki	Rare, Endangered	India (Kashmir to Kumaon)	Garhwal & Kumaon
Part II					
Aconitum heterophyllum wall.	Ranunculaceae	Ativisha/ Ateesh	Vulnerable	India (Kashmir to Sikkin), Nepal	Garhwal & Kumaon 3600-4500 m
Lilium polyphyllum D. Don	Litiaceae	Kakoli	Rare	India (Kashmir to Kumaon), Afganistan & Nepal	Garhwal and Kumaon 2200-3500 m
Malaxis muscifera (Lindl.) Kuntze = *Microstylis muscifera* (Lindl.) Rdl.	Orchidaceae	Jivak	Rare	India (Kashmir to Sikkim), Nepal, Bhutan, Myanmar, and W. China	Garhwal and Kumaon 2600-4000 m
Celastrus paniculatus Wild.	Celastraceae	Jyotismati	Vulnerable	India (H. P. to Assam UP to 750 m from plains, Nepal)	Outer Himalaya tropical forest of Uttaranchal
Curculigo orchioides Gaertn.	Hypoxidaceae	Talmulika	Vulnerable	India (Jammu to Assam & South India), Nepal, Sri Lanka, Japan, Malaysia & Australia	Tropical forests up to 500 m
Taxus wallichiana	Taxaceae	Talish/Thuner	Critically Rare	India (Western to	Garhwal & Kumaon

Zucc. (=*taxus baccata* L.)				Eastern Himalaya), Nepal, Bhutan, Myanmar, Malaysia and Indo China	2600-3800 m
Abies pindrow Royle	Pinaceae			India (Kashmir to Kumaon), East Afganistan & Nepal	Garhwal & Kumaon 2300-2700 m
Abies spectabilis (D. Don) Mirb = (*Abies webbiana* Lindl.)	Pinaceae	Aitalish		India (Kashmir to Kumaon) E. Afghanistan and Nepal	Garhwal & Kumaon 3000-4000 m

32. State Government Initiatives for Enhancing Livelihood

Objectiv	Scheme	Direct Outlay/Time period/no. of beneficiaries	Indirect Outlay/period	Indirect Outlay/Period (2)/Period
To alleviate poverty	Livelihood assistance/ training & skill up gradation/ Revolving Fund to SHGs	Self Employment (Annual) 1) Nos. of Swarozgaris of SHGs under SGSY --- 1500 2) Namada Woollen Acivity Training --- 200 3) Off season vegetable cultivation by polyhouses --- 556 4) Fisheries ---10 5) Training to unemployed youth in ITI --- 170 6) Employment oriented books to unemployed youth --- 1000	Rs. 2000/- pm after 3 yrs. Rs. 1200/- pm after 6 months Rs. 1000/- pm after 6 months Rs. 2500/- pm after 6 months Rs. 1000/- pm after 6 months Rs. 5000/- pm after 2 Yrs.	Reduction of poverty in %age -- 8.25%
To increase agricultur productivi	1) Minor Irrigation 2) Major Irrigation 3) Agriculture	Irrigated Area - 75.38 Hect. Irrigated Area - 75.38 Hect. Improve seed distribution Checking landslides	Increase in production due to improved seed supply & irrigation.	Per hectare income of Rs. 2850 in Kharifcrops & Rs. 3675 in Rabi crops

	4) Check Dams/ Land Mgmt.			
School Enrolment & in literacy	1) Provision of books 2) Prov. of Lab Eqpts. 3) Provision of sports goods	In 244 Schools In 210 Schools In 60 Schools	Increase in Enrolment	Increase in Attendance
ent	Road & Bridges construction 1) Strengthening of Primary Health Centres 2) Development of health facilities 3) Strengthening of Anganwari Centres	1st Yr. --- 2.00 kms/ 1 bridge 2nd Yr. --- 15.00 kms/ 3 bridges 3rd Yr. --- 16.55 kms/ 2 bridges 1st year --- 9 2nd year --- 9 3rd year --- 9 1st year --- 3 2nd year --- 2 1st year --- 3 2nd year --- 3 3rd year --- 3	To connect rural areas with Health Centres, Block HQs & Inter Colleges Health Care Dev. & population control.	Increase in marketing & income
Transformers & HT/LT lines for improvement in Low Voltage supply	Sub Station 79x25 sq mt HT lines --- 29.8 kms LT lines --- 34.2 kms	To address problems of increased power demand & low voltage supply	Establishment of powerbased small scale industry & generation of income by augmentation of employment.	
Tourism Development	Development of rural tourism, trekking & ancient routes.	Developing tourism to generate alternate means of livelihood and thus augment earnings.	To attract both national & international tourists for generating employment & increased income.	

Jatropha plantation	Van Panchayat, degraded land through SHGs	Seeds will be purchased by Uttaranchal Forest Development corporation	Provide additional employment & income to SHGs

Table 33: Changing Approaches to Forest Conservation

Approaches	Main features
Sustainable timber harvest.	Timber harvest in amount equal to increment, thus capital remaining intact; replete with failures suggesting that ecosystems do not behave like banks.
Harvest of non-timber forest products (NTFPs) and development of economic enterprises based on them.	Expected to be more sustainable because trees are cut, only their parts such as resin, leaves, fruits, bark and organisms like mushrooms, lichens, and medicinal herbs collected. However, sustainable harvest practices are poorly developed and hardly practiced. Market is also poorly understood.
Carbon sequestration in response to the global warming, an easily measurable ecosystem service.	A part of Clean Development Mechanism of Kyoto protocol; but trade is still in infancy, at least in developing countries. Easy to trade because carbon is not required to be transported and quality of good invariant.
Other ecosystem services, e.g., soil formation, pollination of crops hydrologic regulation, and regulation of biogeochemical cycle.	Science of ecosystem services still in infancy; payment mechanism scarcely in place.

Source: S. P. Singh. 2007. Selling of Ecosystem Services. Samaj Vigyan Shodh Patrika. Special Issue (Uttarakhand-1). Pp. 3-10

Table 34: A summary of Ecosystem Attributes and Services of Major Forest Types in Central Himalaya and of *Lantana camara* that follows after Deforestation

Forest	Attributes	Supply of ecosystem services
Banj Oak	• Large biomass (about 400-500 t ha^{-1} • Fine roots and carbon deposition up to 1.50 m or more • High investment of photosynthate in ectomycorrhizae, massive yearly nutrient return to soil through litter fall	• Deep soil formation • High soil fertility • Effective carbon sequestration (also in deep soil) • Considerable nutrient and water retention
Chir pine (*Pinus roxburghil*)	• Small biomass (about 200 t ha^{-1}	• Supply of ecosystem services from steep

	• High productivity (12-20 t ha^{-1} yr^{-1}) • High nutrient use efficiency, great ability to tolerate stress • Effective colonization of mountain scopes and control over soil nutrients	slopes with little soil • Retention of nutrient on step and rocky slopes, associative nitrogen fixation (at least in some pines)
Alder (*Alnus nepalensis*)	• Small biomass (about 100 t ha^{-1}) • Very high productivity (20-30 t ha^{-1} yr^{-1}) • High effective colonization of landslips: High rate of N-fixation (up to 200 kg ha^{-1} yr^{-1})	• Development of tree cover (a sort of raining plantation by nature) without any cost • Facilitation of other species • Nutrient supply to other ecosystems.
Lantana Bush land (*Lantana camara*)	• Low biodiversity • Flammable by cool fire • Productivity similar to forests but low biomass, very shallow rooted	• Low soil C storage • Hydrologic cycle adversely affected • Persistent but light fire regime • Loss of biodiversity

Source: S. P. Singh. 2007. Selling of Ecosystem Services. Samaj Vigyan Shodh Patrika. Special Issue (Uttarakhand-1). Pp. 3-12

Table 35: Altitudinal Variations in Natural Vegetation

Type	Height	Species
Sub-tropical	< 1400	Aonla, Semal, Jamun, Reetha, Mango, Malu, Tun, Buransh, Anyaar,
Sub-temperate	1400-2000	Pine, Oak, Buransh, Anyaar, Kafal, Payan, Bhimal
Temperate	2000-3300	Oak, Mawa, Pangar, Korak, Silver, Fur, Uttis, Thuner, Devrigaal, Ransal, Devdar, Thamrigal, Jumura
Alpine	> 3300	Grassland, Alpine meadows, Terang, Deodar, Bhojpatra, herbs

Source: Compiled by the author

BIBLIOGRAPHY

Anita. 1989. Population Geography of District Chamoli. Unpublished thesis submitted for Ph.D. degree to HNB Garhwal University, Srinagar, Uttaranchal.

Arimoro, A.O. M. A. Fagbeja, and W. Eedy. 2002. The Need and Use of Geographic Information Systems (GIS) for Environmental Impact Assessment (EIA) in Africa: With Example from Ten Years Experience in Nigeria. *African Journal of Environmental Assessment and Management.* Vol. 4. No.2 Pp. 16-27.

Ashish Madhav. 1979. Agricultural Economy of Kumaon Hills, Threat of Ecological Disaster. Economic and Political Weekly. June 24.

Ahmad, F.; Joshi, S. R.; Gurung, M. B. 2003. The Himalayan cliff Bee Apis laboriosa and the Honey Hunters of Kaski. Kathmadu: ICIMOD

Anthwal et al 2006. Sacred Groves: Traditional Way of Conserving Plant Diversity in Garhwal Himalaya, Uttarakhand

Atkinson, E. T.: 1882: *The Himalayan Gazetteer*. Delhi, Cosmo Publication. **Vol. 2**. 369
Atkinson, E. T. (a&b): 1882: "The Himalayan Gazetteer" Cosmo Publication, Delhi, Vol. II, p. 369

Atkinson, E. T. a&b. 1882. *The Himalayan Gazetteer*. Cosmo Publication, Delhi, Vol. II, p. 369

Azad, Swarup and Sikka. 1989. *Horticultural Development in Hills*. Gyanodaya Publishing House, Nainital.

Banskota, K. and Sharma, B.1995. Economic and Natural Resources Conditions in the Districts of Bagmati Zone and Their Implications for the Environment: An Adaptive Simulation Model. ICIMOD discussion paper MEI series no. 95/9

Bhatt, HP and Bhatt S. 1992. Environmental Degradation in Garhwal Himalaya: Can We Stop It? *Environmental Management: Socio-Economic Facts* **Vol II** (ed) R. K. Rai, A. C. Mohapatra and Goel N. P.,): 117~121

Binswanger, H.P., Khandker, S.R., Rosenzweig, M.R., 1993, 'How infrastructure and financial institutions affect agricultural output and investment in India', Journal of Development Economics, Vol 41 No 2: 337-366

Bryceson, D.F. (1999) 'African Rural Labour, Income Diversification and Livelihood Approaches: A Long-term Development Perspective'. *Review of African Political Economy* 26 (80): 171–89.

Chadha GK. 1993. Non-Farm Employment for Rural Households in India: Evidence and Prognosis. Indian Journal of Labour Economics. Vol. 36.

Chadha, GK. 1994. Employment, Earning and Poverty: A Study of Rural India and Indonesia. Sage Publications, New Delhi.

Chadha, GK. 1994. Himalayas: Environmental Problems. Ashish Publication Co. New Delhi.

Conelly, W. T., 1994, 'Population pressure, labor availability and agricultural disintensification: the decline of farming on Rusinga Island, Kenya' Human Ecology 222: 145-70

Dabral, S. P. *Uttarakhand Ka Itihas. (in Hindi),* Garhwal publishing house, Doggada Kotdwar, Uttaranchal.

Datt, G. and Ravallion, M. (2002) 'Is India's Economic Growth Leaving the Poor Behind?' *Journal of Economic Perspectives* 16 (3): 89–108.

Davies, S. (1996) *Adaptable Livelihoods: Coping with Food Insecurity in the Malian Sahel*. London: Macmillan.

Diagana, Bocar, and Kelly, Valerie, 1996, Will the CFA Franc devaluation enhance sustainable agricultural intensification in the Senegalese peanut basin? USAID and Michigan State University

Eapen, M. 1992. Rural Non-agricultural Employment in Kerala: Inter-District Variations. Economic and Political Weekly. March 25.

Eckholm, E. 1979. Planting for the Future: Forestry for Human Needs. World Watch Paper 26, World Watch Institute, Washington, DC.

Eder, J. F., 1991, 'Agricultural intensification and labor productivity in a Philippine vegetable gardening community: a longitudinal study', Human Organization, Vol 50 No 3: 245-55

Free, JB. 1993. Insect Pollination of Crops. London. Academic Press

Grotzbach, E. (1994), Hindu-Heiligtümer als Pilgerziele im Hochhimalaya. – In: Erdkunde 48(3). Pp. 48

Guyer, J.I. and Lambin, E.F., 1993, 'Land-use in an urban hinterland - ethnography and remote-sensing in the study of African intensification', American Anthropologist 95, no. 4: 839-859

Haripriya,(2000), *Of Myths and Movements: Rewriting Chipko in Himalayan History.* London: Verso. : 70 Pp. 72-74

ICIMOD. 1996. Background Note for Regional Meeting of Experts on Development of Micro Enterprises in Mountain Area 25-26 July, Unpublished Text

Indian Council of Agricultural Research. 2002. Agricultural Research Data Book, ICAR, 2004.

ICRA, 1990, 'Intensification and differentiation in Agricultural and Livestock Production, Usagara Division, Tanzania'

Jodha, N.S. 1990. Mountain perspective and sustainability: a framework for development strategies. Paper presented at International Symposium on Strategies for Sustainable Mountain Agriculture, International Centre for Integrated Mountain Development, Kathmandu, Nepal.

Kelly, V., Diagana, B., Reardon, T., Gaye, M., Crawford, E., 1995, Cash Crop and Foodgrain

Khanka, S. S. 1984. Migration from Kumaon Region: some Findings Based on Sample Study of Pithoragarh district. I*ndian Journal of Labour Economics* **Vol. XXVI** No. 4 (January): 302~12

Kulkarni, GA and others. 1982. A Note on Identification of Economically Backward Regions in India. Sarvekshan. Vol. VI No. 1-2, July-Oct.

Kumar, K. 1974. Garhwal Himalaya: A Study on Population Geography. Unpublished thesis submitted for Ph. D. in Meerut University, Meerut.

Maikhuri, R.K., Saxena, K.G. & Rao, K.S. 1995. Experiences in developing a village agroforestry project in Garhwal Himalaya, India. *International Tree Crops Journal*. 8: 213-221.

Maithani, D. *Environment, Resources and Development.* (ed). New Delhi. Daya publishing house.

Murray Colin. 2001. Livelihoods research: some conceptual and methodological issues. Department of Sociology University of Manchester Background Paper 5 Chronic Poverty Research Centre ISBN Number: 1-904049-05-2

Meenakshi, J.V. and Ray, R. (forthcoming, 2002) 'How Have the Disadvantaged Fared in India? An Analysis of Poverty and Inequality in the 1990s' in Sharma, K. (ed.), *Trade Policy Regim,*

Mehta, G. S. 1990. Problems and Potentials of Horticulture Development. *Planning Strategies for a Development Region*. (ed) Singh, A. K Lucknow: Print House.

Mehta, GS. 1989. Economics of Apple Growing in India. Report Submitted to DRI, Tiburg, The Netherlands.

Mehta, GS. 1996. Uttarakhand: Prospects of Development. Indus Publishing Company, New Delhi.

Mehta, GS. 1997. Development Experiences and Options in a Hill Region: A Case of Uttarakhand, India. ICIMOD, Kathmandu, Nepal.

Mehta, GS. 1999. Development of Uttarakhand: Issues and Perspectives. APH Publishing Company, New Delhi.
Nand and Kumar. 1989. *The Holy Himalaya: A Geographical Interpretation of Garhwal Himalaya*. New Delhi. Daya publishing house.

Nepal Tourism Board (2000), Welcome to Nepal. Pp. 45-51
http://www.welcomenepal.com/Brochure.asp , 03/03/03.

Okali, D. U. U. 1985. The Nigerian Environmental; Ecological Limits of Abuse. Keynotes paper in the Nigerian Environment; Ecological Limits of Abuse. Proc. Annual Conf. And General Meeting of the Ecological Society of Nigeria (ECOSON) Held at the River state University of Science & Technology, Port Harcourt, 3rd -5th May, 1985, S. Nokoe (ed) Pp. 1-16.

Papola, T. S. 1996 a&b. Planning for Environment and Economic Development in Mountain Areas: Concepts, Issues, and Approaches. Discussion Paper No. MEI 96/2. Kathmandu, Nepal: ICIMOD.

Purohit, K. C.1994. Chamoli District: Resource Utilization Pattern. Unpublished thesis for Ph. D. degree submitted to HNB Garhwal University, Srinagar, Uttaranchal.

Ramakrishnan, P.S., Saxena, K.G., Swift, M.J. & Seward, P.D. (Eds.). 1993. *Tropical Soil Biology and Fertility Research: South Asian Context*. Oriental Enterprises, Dehra Dun.

Rangan Haripriya,(2000), *Of Myths and Movements: Rewriting Chipko in Himalayan History.* London: Verso. : 70 Pp. 72-74

Rawat, M. S. 1993. "Environment, Resources and Development. (ed) New Delhi. Daya publication house.

Reardon T., Berdegué J. and Escobar G. (2001). Rural Nonfarm Employment nd Incomes in Latin America: Overview and Policy Implications. World Development Volume 29, No. 3. Elsevir Science Ltd, UK.

Roumasset, J.A., Boussard, J-M. and Singh, I., 1979, Risk and Uncertainty in Agricultural Development, New York: Agricultural Development Council.

Sati, Vishwambhar Prasad. (2004), 'Tourism Development in Uttaranchal: The Emerging Vistas' Nigan and Ranga (ed.). *'New Approaches in Tourism Management'* Abhijeet Publication, Delhi. Pp. 315-317.

Sati, V. P. & Rawat, MSS. 1993. Problems of Agriculture Ecology and their Management in the Pindar Basin. *National Geographer* **Vol. XXVIII** No. 2 (Dec. 1993): 143~148

Sati, V. P. 1993. Cropping Pattern in the Hill Environment of the Garhwal Himalaya (A case study of a village). *National Geographer* **Vol. XXVIII.** No. 1, (June 1993): 31~37

Sati, V. P. and Kamlesh Kumar. 2004. *Uttaranchal Dilemma of Plenties and Scarsities*. New Delhi, Mittal Publications. 287

Sati, Vishwambhar Prasad. 2004. Resource Utilization Pattern and Development in Hills: A Case for the Pindar Basin of Garhwal Himalaya. *Journal for Mountain Science* Vol 1, No. 2, pp 130-141 www.imde.ac.cn/journal

Sati, V. P. 2004. Horticultural Development in Hills: A Case for the Alaknanda Basin. New Delhi. Mittal Publication. p. 123

Sati, Vishwambhar Prasad. 2005. Vertical Zonation of Horticultural Farming in the Alaknanda Basin of Garhwal Himalaya, India, 'Journal of Mountain Science' Vol 2 No 4. http://www.imde.ac.cn/journal

Sati, V. P. 2004. Systems of Agricultural Farming in the Uttaranchal Himalaya. '*Journal for Mountain Science*' Vol. 2, No. 1 www.imde.ac.cn/journal

Sati, Vishwambhar Prasad. 2005. Natural Resource Conditions and Economic Development in the Uttaranchal Himalaya, India. *Journal of Mountain Science,* Vol 2, No 4, 336-350 www.imde.ac.cn/journal

Sati, Vishwambhar Prasad. 2006. Forest Resource Management in Mountain Regions: A Case for the Pindar Basin of Uttaranchal Himalaya'. L*yonia: A Journal of Ecology and Application,* Vol 11 (1) Pp. 75-84. www.lyonia.org/journal

Sati, V. P. 2004. *Horticultural Development in Hills: A Case for the Alaknanda Basin of Garhwal Himalaya*. Mittal Publishers. New Delhi

Saxena, P. B. 1989. *The Alaknanda Basin: Modern Approaches in Geography.* New Delhi. Concept publication house.

Scoones I. 1998. *Sustainable Rural Livelihoods: A Framework for Analysis.* Working Paper 72, Institute for Development Studies, Brighton, UK.

Schelhas, J., 1996, 'Land use choice and change: Intensification and diversification in the Lowland Tropics of Costa Rica', Human Organization, Vol 55 No. 3: 198-306

Scott, C.A. & Walter, M.F. 1993. Local knowledge and conventional soil science approaches to erosional processes in the Shivalik Himalaya. *Mountain Research and Development.* 13: 61-72.

Singh, B. M. 1991. Land Capability Classification for Wasteland Management in the Himalayan Terrain. *Mountain Resource Management and Remote Sensing* (ed) Gupta, P. N. and Roy, A. K.), Surya Pub Dehradun 122~135

Singh, Brahma, 1998. Vegetable production under protected conditions: Problems and Prospects. Indian Soc. Veg. Sci. Souvenir: Silver Jubilee, National Symposium Dec. 12-14, 1998, Varanasi, U.P. India pp. 90.

Singh, Brahma, 1998. Vegetable production under protected conditions: Problems and Prospects. Indian Soc. Veg. Sci. Souvenir: Silver Jubilee, National Symposium Dec. 12-14, 1998, Varanasi, U.P. India pp. 90.

Singh, Narender; Diwedi, S.K. and Paljor, Elli, 1999. *Ladakh Mein Sabjion Kei Sanrakshit Kheti*. Regional Research Laboratory of DRDO, Leh. Pub. By D.R.D.O., Leh. Pub. By D.R.D.O. 56 A.P.O.

Singh, Narender; Diwedi, S.K. and Paljor, Elli, 1999. *Ladakh Mein Sabjion Kei Sanrakshit Kheti*. Regional Research Laboratory of DRDO, Leh. Pub. By D.R.D.O., Leh. Pub. By D.R.D.O. 56 A.P.O.

Singh, V. 1996. *Draught Animal Power in Mountain Agriculture: A study of Perspectives and Issues in the Central Himalayas, India*. Discussion Paper. Series No. MFS 98/1. Kathmandu: ICIMOD. p. 74.

Sinha B. and Maikhuri R.K. 1998. Conservation through 'socio-cultural-religious practice' in Garhwal Himalaya: a case study of Hariyali sacred grove'. In: Ramakrishan P.S., Saxena K.G. and Chandrasekhar U. (eds), Conserving the Sacred: For Biodiversity Management. UNESCO and Oxford IBH Publishing Co. Pvt. Ltd, New Delhi, pp. 289–299.

Trade and Environment Database (TED) (YEAR N/A): Himalaya Case Issue. Pp. 8 http://www.american.edu/TED/HIMALAY.HTM , 11/02/03.

UTDB.2004. *Leaflet*. Uttarakhand Tea Development Board, Almora

Vartak V.D. and Gadgil M. 1973. Dev Rahati: an ethnobotanical study of the forests preserved on grounds of religious beliefs. Abstract, Proc. Indian Sci. Cong. 60: 341.

Walder, G. (2000), Tourism Development and Environmental Management in Nepal: A study of Sagarmatha National Park and the Annapurna Conservation Area Project, with special reference to Upper Mustang. MSc Thesis, The International Centre for Tourism and Hospitality Management, Bournemouth University. Pp. 9

Waldia, K. S. 1964. *Geology of Garhwal Himalaya.*

Walker, T.S. and Ryan, J.G. (1990) *Village and Household Economies in India's Semi-arid Tropics.* Baltimore: Johns Hopkins University Press.

Walton. 1910. *Gazetteer of Western Himalaya.* Reprinted by Natraj publication, Dehradun.