CHANGING AGRICULTURAL ECONOMY OF LEH DISTRICT (LADAKH): ENVIRONMENT AND SOCIO-ECONOMIC DIMENSIONS

Thesis submitted to Jawaharlal Nehru University for the award of the degree of

DOCTOR OF PHILOSOPHY

JIGMAT NORBOO

CENTRE FOR THE STUDY OF REGIONAL DEVELOPMENT
SCHOOL OF SOCIAL SCIENCES

JAWAHARLAL NEHRU UNIVERSITY

NEW DELHI-110067

INDIA

2018

जवाहरलाल नेहरू विश्वविद्यालय
JAWAHARLAL NEHRU UNIVERSITY
Centre for the Study of Regional Development
School of Social Sciences
New Delhi-110067

Date: 20/07/18

DECLARATION

I do hereby declare that the Thesis entitled **"CHANGING AGRICULTURAL ECONOMY OF LEH DISTRICT (LADAKH): ENVIRONMNET AND SOCIO-ECONOMIC DIMENSIONS"** submitted by me is a bonafide work and has not been previously submitted, in part or full, for the award of any degree of this university or any other university.

JIGMAT NORBOO

FORWARDED BY

It is hereby recommended that the Thesis may be placed before the examiners for evaluation.

(PROF. HARJIT SINGH)

Supervisor

Centre for the Study of Reg
School of Social Sciences
Jawaharlal Nehru University
New Delhi -110067

(PROF. SACHIDANAND SINHA)

Chairperson

Chairperson
Centre for the Study of Reg. Dev.
School of Social Sciences
Jawaharlal Nehru University
New Delhi - 110067

(PROF. B.S. BUTOLA)

Supervisor

Dr. BALBIR SINGH BUTOLA
Professor
Centre for the Study of Regional Devt.
Jawaharlal Nehru University
New Delhi - 110067

Office Tel: 26704466 26704463 ..... Office E-mail: csrd.jnu@gmail.com

ACKNOWLEDGEMENT

In writing the thesis, I seek help and support of many people that I feel I will not be able to do justice them by saying a few words of thanks. Even acutely aware of this, I must extend my gratitude by acknowledging the assistance, support and encouragement of some very special people. The list is otherwise endless.

First and foremost, I would like to express my utmost regard and gratitude to my esteemed supervisor, Prof. Harjit Singh, Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi, for believing in me and blessing me with an opportunity to work under his able guidance. He has not only given me guidance in my work but also has been a source of inspiration and immense knowledge from which I have benefited immensely. He has not only provided me with the materials and advices but also taught me how comas and spelling mistake can make a difference. As a supervisor, he is an invaluable gift of ideas and information, a rich source of knowledge. I truly appreciate his patience and tolerance during my numerous mishaps. I can never thank him enough.

I am also grateful to my co-supervisor, Prof. B.S. Butola, Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi, for his unfailing assistance and incessant support throughout my thesis writing journey. I shall remain obliged to him for his valuable advices and encouraging help.

This work of mine would not have been the same had it not been for the help and encouragement of teachers and friends in the Centre for Study of Regional Development. I learnt a lot from department teachers while in their class and also during my papers presentations. My special thanks go to them. I also want to thank all my classmates and senior students for their ever encouraging help and support.

I take this opportunity to sincerely acknowledge the University Grant Commission (UGC), Government of India, New Delhi, for providing financial assistance in the form of Junior Research Fellowship which helped me to perform my work comfortably.

A very special gratitude goes out to all the administrative staff of Deputy Commissioner Office, Leh District and District Statistics & Evaluation Office, Leh for their help and support during procurement of the data. Besides, I'll be ungrateful

if I do not thank the staff members of the Central Library of Jawaharlal Nehru University. I'll always be grateful for their help, and look forward to avail same kind of help in the future too.

I owe gratitude to Chimat Ladol for her patience and support and above all helping me out in editing the work. I can never repay her back but may the good Lord bless her in every deeds of her life. I am also indebted to a number of friends who have provided me with advice and support at different stages of this work.

Most of all, this work would not have been possible without the confidence, endurance, love and support of my family. I am forever grateful to my father Sh. Tsewang Namgial and my beloved mother Smt. Sonam Spalzes who always have been the source of strength and inspiration behind my every endeavour. I am thankful to my loving brother Tashi Paldan for being the pillar of my strength. A lifetime of love and encouragement has no companion.

Finally, I thank Almighty God for the bountiful blessings, good health and wisdom that made possible to accomplish this venture.

Date: 20-07-2018 *Jigmat Norboo*

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Chapter One

Introduction

Agriculture has paramount importance in the economy of mountain regions in general and more particularly in the case of Himalayas. Nearly, all socio-cultural aspects of life are influenced by the predominance of agriculture in economy, which forms the main source of livelihood for mountain people. However, pursuit of agriculture is largely determined by various physical as well as socio-economic factors, which have tremendous impact on agricultural economy. These factors play significant role not only in shaping agriculture but also in its development. Therefore, it becomes essential to analyse environment and socio-economic dimensions of the same which have far reaching implications in the region.

India being a developing country, majority of its population still relies on agriculture for their food and livelihood security. It is known for providing employment, food and nutritional security for large section of population dependent on it. Historically, agriculture in India has encountered various structural and technological constraints, resulting in low productivity. Although attempts have been made to overcome these constraints through various agricultural reforms but many of such reforms have largely been ineffective because of several loopholes in the legislation and administration's indifference to them. As a result, "irrespective of radical objectives, the agrarian social structure in India has not changed radically, and structural impediments to higher productivity still persist over a large segment of Indian Agriculture"[1]. However, industrial revolution in Europe which led to technological developments ultimately paving the way for mechanised production also benefitted Indian agriculture. These technological developments have played significant role not only in overcoming various environmental impediments on agriculture but also in bringing further changes and development in existing ones. This has enabled farmers to bring diversification and increase in agricultural production and in greater economic returns, which, in turn, led to increase in the demand of inputs in agriculture. This was seen in Indian agriculture as a new stage of development in mid 1960s, which is often referred to as 'green revolution'. The

[1] A.Vinayak Reddy (1991), "*Modernisation of Indian Agriculture*", Mittal Publications, Mohan Garden, New Delhi

green revolution mainly comprised of the use of modern inputs, which enabled farmers to achieve higher farm production.

Though Indian agriculture saw a boom, it mainly benefitted large farmers in a few states like Punjab and Haryana and parts of western Uttar Pradesh and Tamil Nadu etc. Overall situation of agriculture in many parts of India still remained bleak due to various reasons. There are many villages in different parts of the country which are yet to experience the green revolution. Uncertain climatic conditions, immense population pressure, limited technological innovation or policy incentives, poverty, illiteracy, social structures have contributed to poor agricultural development in India with agriculture contributing only 13.9 per cent to GDP[2]. Agricultural conditions in mountain regions are not better though efforts are being made to harness mountain niches and comparative advantages of such regions.

Mountains cover 24 per cent of the land surface and provide support to 10 per cent of world's population. Their economy largely rest on agro-pastoral activities due to relative isolation, environmental constraints and socio-economic backwardness. As a result, agriculture in mountain regions is very different from that in plains in terms of crops and its other components. Small fragmented landholdings, fragile landscape, traditional technology and limited access to market are the main features of mountain agriculture. Most agricultural produce is for self consumption, playing significant role in ensuring household food security.

Nevertheless, mountain regions are also witnessing a shift in their agricultural economy with the advent of globalisation and modernisation. In many parts, it is changing from subsistence farming to commercial agriculture, thereby high-value crops such as fruits and vegetables becoming more important. This has enabled local farmers to improve farm income; reduce rural poverty and accelerate overall economic growth. However, many environmental scientists, government bodies and many studies have shown concern over sustainability of mountain agriculture due to growing commercialisation of agriculture.

[2] Indian Economic Survey 2013-14 – Key Highlights
http://www.kpmg.com/IN/en/services/Tax/FlashNews/India-Economic-Survey-2013-14%E2%80%93Key-Highlights.pdf

It, therefore, becomes important to understand response of people towards change in agricultural economy in such areas. Ladakh, located in Trans Himalayas has various physical and socio-economic factors influencing agriculture. Its environment is characterised by highly rugged topography and cold-arid climate. Its inhabitants have been trying to modify natural environment with available skills and knowledge, and in turn have adapted and adjusted to the prevailing conditions. This is reflected through various activities carried out for economic pursuits. Human response towards nature is generally region-specific depending on environmental conditions and resource base on one hand, and the level and nature of available technology on the other. Degree of nature's harness also varies within a region. Therefore, the response of people is not uniform. They respond either by becoming pastoral nomads in higher altitudes or by carrying out subsistence farming in relatively lower river valleys. Here, agro-pastoralism forms main economy activity of people.

Ladakh is a 'Cold Desert' characterized by low precipitation and low temperature which restricts growing season. In addition, the immature and stony soils act as major constraints on growing crops. Agricultural activities are performed within the limits imposed by rugged terrain and climatic constraints. Human beings have been trying to minimise these constraints with the help of technology, and have made efforts to extend the area of economic operation even under harsh conditions. These include developing irrigation with the help of narrow channels known as *kuls* to overcome moisture deficiency. Further, by modifying agricultural practices so that these correspond with environmental limits, such as by introducing quick maturing varieties of crops where temperature is very low over a longer period in a year or by cultivating crops which require less water in arid areas[3]. Lower parts of some river valleys are relatively warmer ensuring double cropping as against single cropping in most other areas of Ladakh.

People living in Ladakh with harsh environment have developed socio-cultural and economic institutions in response to compulsions of the environment, and hence they have organised their work in accordance with these factors. This can

[3] Harjit Singh (1981), "Ecological Set-up and Agrarian Structure of High Altitude Villages of Ladakh", *Recent Research on Ladakh, Proceeding of the 4th and 5th International Colloquia on Ladakh,* (eds., Henry Osmaston and Philip Denwood) Motilal Banarsidas Publishers, Delhi, pp. 196

be seen in agricultural activities of the region. From size of agricultural land holdings to dates of sowing and harvesting are determined by social institutions like monasteries, community structures of *phaspun*, polyandry and through many other social norms and cultural beliefs.

Traditional techniques of employing family labour, low infrastructural development, poor accessibility, lack of market facilities etc. have resulted in farmers adopting subsistence farming in Ladakh. However, the region has witnessed rapid changes in its demographic structure, occupational possibilities, land-use and urbanization in recent decades. These changes came after the Sino-Indian border dispute of 1962. Ladakh forms international border with both China and Pakistan. Its strategic significance was realised after 1962. Its significant got further enhanced with Indo-Pak conflicts of 1965 and 1971. This resulted in movement of unprecedented number of troops into Ladakh. Military is not only been seen as security provider but also as an economic factor with its emergence as a major job sector and as a market for farm produce as farmers in areas close to military locations have been growing vegetables etc. mostly for the consumption of army. Further, opening up of Ladakh for tourism in 1974 resulted in more agricultural development especially with horticulture which started booming. These factors along with series of other developments brought massive rush of forces of modernization and resulted in fast expansion of road linkages, which ultimately facilitated rapid urbanization, growth of rural areas and increased access to markets.

These changes have affected cropping choices and land-use strategies, resulting in changing agricultural economy. Agricultural inputs have also undergone change. Influx of agricultural labourers has coincided with increased literacy rate among locals, use of chemical fertilizers, pesticides and modern agricultural implements. All these helped in shift in cropping pattern from traditional food grains to commercial cash crops such as potatoes, beans and other vegetables and more recent horticultural crops especially apricot and apple. Such innovations have registered a considerable progress in agricultural economy in terms of per capita income and standards of living in recent decades. But the shift towards commercialization and progressive intensification of agricultural activities in such fragile environmental conditions have not only sought the attention of government bodies, developmental agencies, environmentalists and academicians but have also

raised concerns about sustainability of agriculture and vulnerability of natural base of the region.

Generally, agricultural development in plains is more as compared to mountains. There is a feeling that agricultural research community has neglected mountain regions and has given more importance to plains. Furthermore, mountain areas have received less public assistance, and are "often neglected by development planners except the state of Himachal Pradesh and a few pockets in other mountain states"[4]. As discussed by a large section of scholars, environmental constraints and certain socio-cultural aspects of mountain communities demand development planning in mountains to be radically different from that in plain areas. Since there are only a few empirical studies focusing of issues related to agricultural economy of Ladakh, it becomes important to understand various changes in the nature of agricultural economy in the context of this high altitude region.

1.1 Review of Literature

A review of available literature is very important as it provides an idea about work already done on the subject. Literature on Ladakh, however, is very scanty and mainly found in the form of travelogues. Recent decades have seen scholars showing interest in studying Ladakh and their studies are largely restricted to religious, social and historical aspects. Here, an attempt has been made to review available literature to have an idea about work already done on agricultural aspects. This will provide us an insight, valuable information and guidelines for the current study. It will also make us aware of various dimensions of the theme under study.

Some information does exist on various aspects of environment and development but most of it is isolated and scattered in published and unpublished records and is not easily available. However, the available literature has been organised under following heads;

1.1.1 Mountain Agriculture

Agriculture is predominant activity of mountain communities and serves as a focal point for sustainable interventions in these areas. However, mountain environment

[4] Narpat S. Jodha (2009), "Mountain Agriculture: Development Policies and Perspectives", *Indian Journal of Agricultural Economics*, Vol. 64, No. 1, Jan-March 2009. pp.3

provides different set of constraints, resources and specificities for agricultural development. Mountain people harness these specificities and resources in terms of adaptations and adjustments, which form distinctive characteristic of mountain farming systems.

Ashish[5] (1979) has studied the issues associated with traditional agriculture in Kumaon Himalayas. He has dealt with the problems of deforestation, degradation and soil erosion due to traditional farming and grazing practices. He feels that if it was allowed to continue, the hill population would destroy the hill environment on which their livelihood depends and they would be forced to migrate to plains. Looking at the geographical formation of Kumaon hills which are extremely vulnerable to desiccation and erosion, the author says once subsoil rock is exposed, "vegetative cover is difficult, water retention is being lost, and the run-off is unchecked". The article underlines the policies that should be adopted to stop "uneconomic" and "unwise" extension of cultivable land and overgrazing. Moreover, he suggests total restructuring of hill economy including putting land to such uses requiring no ploughing, no further extension of agriculture, 100 per cent food grain import, surrendering land or renting land to government for afforestation and so on. The article reflects the limits that environment puts on mountain agriculture.

Jodha[6] (2009) in his article has discussed the agricultural development policies and programmes in mountains and hills in Himalayan Region. While working with the International Centre for Integrated Mountain Development (ICMOD), he studied agriculture in eight countries of Hind-Kush Himalayan Region namely Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. He says mountain agriculture is an intergraded system of resource usage linking various land-based activities. Mountain specificities and their imperatives which include inaccessibility, fragility, marginality, diversity, niche and their specific human adaptation mechanism have been dealt in detail. Further, he states that it is important to understand the mountain specificities and their imperatives

[5] Madhava Ashish (1979), "Agricultural Economy of Kumaon Hills: Threat of Ecological Disaster", *Economic and Political Weekly*, Vol. 14, No. 25, Jan. 23, 1997, pp. 1058-1064

[6] Narpat S. Jodha (2009), "Mountain Agriculture: Development Policies and Perspectives", *Indian Journal of Agricultural Economics*, Vol. 64, No. 1, Jan-March 2009

which help in identifying opportunities and constraints to guide development interventions. The article provides a detailed table of mountain specificities and the conditions of agricultural performance in the mountain regions. Strategic priorities on which the policy makers should focus have been highlighted. Measures to manage constraints and opportunities under traditional present day agriculture in mountain areas have been dealt through a detailed table. In the end, the policy challenges and approaches have also been included.

Kuniyal et al.[7] (2009) have studied the impact assessment of agricultural transformation on land-use pattern and traditional agro-ecosystem in high altitude region of the Lahaul Valley. They evaluated land use changes and have given current status of natural vegetation. The ways of appropriated land use pattern in order to balance village agro-ecosystem and land use development in a sustainable way have also been dealt with. For this, they conducted extensive and intensive field study in the region and specifically in four revenue villages namely Kuthar, Hinsa, Jahlma and Khoksar. In addition, more information was gathered through secondary sources such as relevant data from different departments, published and unpublished reports. Through this, they have found that dwindling forest ecosystem and traditional crop system have remarkably disrupted the existing land use pattern.

Pradeep[8] (2001) has given regional comparative analysis of mountain agriculture in Hind-Kush Himalaya. He studied mountain agriculture in three parts namely production of food grains, horticulture and livestock. Time series data published by national government agencies in five countries of Hind-Kush and Himalayas has been used in this regard. He has also discussed the trends in production of horticultural crops, cash crops and livestock population and composition in all these countries. The study shows that, although the area under food grain crops has not increased, their yields have not declined as much as is often perceived. In some cases, crop productivity has increased. This evidently implies

[7] Kuniyal et al. (2009), "Impact assessment of agricultural transformation on the land-use pattern and traditional agro-ecosystem in high altitude region of the Lahaul Valley, NW Himalaya". In:Rawat MSS, Pratap D (eds) Management strategies for the Indian Himalaya: development and conservation, vol. II. Transmedia Publication, Srinagar (Garhwal), pp.72-90

[8] Pradeep M. Tulachan (2001), "Mountain Agriculture in the Hind-Kush Himalaya: A Regional Comparative Analysis", *Mountain Research and Development*, Vol. 21, No. 3, August 2001, pp. 260-67

that mountain farmers are maintaining productivity of food grain crops for food security reasons. Increasing trends in crop diversification towards horticultural and cash crops have also been studied. He found that there is a general decline in cattle population across Hind-Kush Himalayas. Environmental constraints and problems of environmental degradation have not been discussed in the study.

Pratap[9] (2010) in his paper has attempted to identify and quantify sources of agricultural growth in India's north eastern mountain states. His paper is divided into five sections (i) introduction, (ii) data and analytical approach, (iii) overview of agriculture in the northeast region, (iv) sources of growth and (v) conclusions and implications. The article explains that agricultural growth as a cumulative and combined effect of changes in the gross cropped area, area under different crops and their yields, land reallocation among crops, and prices. He has given an overview of agricultural scenario in terms of cropping pattern, diversification of crop, crop yield etc. in north-eastern mountain states. Diversification of traditional crops towards high-value crops such as fruits, vegetables, condiments and spices has been analysed with the help of a detailed table. The study has been supported with many relevant tables. Author found that change in gross value of output is mainly due to change in total cropped area. Further, he found that the climate is favourable to grow a wide variety of crops, particularly fruits, vegetables and spices, though lack of system-specific technologies, poor infrastructure and underdeveloped markets restrict the realisation of true potential of agriculture.

Shroeder[10] (2014) has made an attempt to study agriculture in the hills and mountains of Nepal. In the beginning, he has given a brief account of demographic and cultural context of Nepal Himalayas. This is followed by discussion on characteristics of hill and mountain agriculture. Analysis takes place from a perspective that emphasizes environment, production, and the material conditions that most strongly influence agricultural systems in rural Nepal. Besides, land use,

[9] Pratap S. Birthal (2010), "Hill Agriculture in India: Problems and Prospects of Mountain Agriculture", *Indian Journal of Agricultural Economics,* Vol. 65, No. 3, July-Sept. 2010

[10] Robertt F. Schroeder (2014), "Himalayan Subsistence Systems: Indigenous Agriculture in Rural Nepal", *Mountain Research and Development*, Vol. 5, No. 1, Convergences and Differences in Mountain Economies and Societies: A Comparison of the Andes and Himalaya (Feb., 1985), pp.31-44

cropping pattern, labour, and diet characteristics of this form agricultural change have been described in detail. He found that rugged topography, combined with restricted transportation and communication are main problems for agricultural production, particularly in some seasons. In the end, he compares agricultural system of the Himalaya with Andes and noticed that agriculture continues to be strongly subsistence-oriented and relatively uninfluenced by market concerns in both regions.

1.1.2 Land use and Cropping Pattern

Since mountain agriculture includes all land based activities such as cropping, animal husbandry, horticulture and forestry, study of land-use and cropping pattern becomes important in order to understand the aspects of existing agricultural system. Changes in agricultural economy can be captured by analyzing changes in land-use and cropping pattern, which reveal the level of development and its interaction with other regions.

Osmaston[11] (1996) has studied the farming, nutrition and health in Ladakh, Tibet and Lowland China. He argues that nutrition and health conditions of farmers in these regions depend largely on subsistence food production from agriculture and livestock. Impact of imported subsidized food on sustainability of traditional agriculture has also been discussed in the study. Effective and efficient systems of nutrient conservation and recycling using livestock dung, human excreta and domestic waste have been discussed at length. To make the study more useful, yield of barley and wheat and their role in health and nutrition have been analysed. Detailed statistical evidence has been presented using variety of sources. He found traditional agricultural system to be effective, productive and sustainable. Further, he found that the total agricultural production is constrained by the existence of steep and rocky landscape and limited water for irrigation.

Dame and Mankelow[12] (2010) in their paper have examined land-use change in central Zanskar, Ladakh. Initially, they have discussed physical settings of the

[11] Henry Osmaston (1995), "Farming, Nutrition and Health in Ladakh, Tibet and Lowland China: A Review", *Recent Research on Ladakh 4 & 5, Proceeding of the Fourth and Fifth International Colloquia on Ladakh*, Ed. by Henry Osmaston and Philip Denwood, Motilal Banaridass Publishers Private Limited, New Delhi.

[12] Dame and Mankelow (2010), "Stongde Revisited: Land-Use Change in Central Zanskar", *Erdkunde*, Vol. 64, No.4, pp.355-370

region and climatic conditions, which are the prime determinants of agriculture in this area. This is followed by description of land-use and cropping pattern in Stongde village of Zanskar. Land-use change in Stongde has been examined from 1980 till 2008. In addition, they have highlighted as to how people have been deriving water from permanent and temporary snowfields in its tributary valleys, which shows the skills and knowledge of mountain communities in irrigating their fields. They argue that, in terms of agriculture, Zanskar region is considered backward and unproductive due to environmental constraints but government departments are supporting to "modernise" agriculture and raise its productivity. Further, they also found diversification of crops from traditional ones to modern cash crops such as vegetables. Cultivation of vegetables like radish, potato, cabbage, carrots, spinach, turnip, lettuce and cauliflower has become an important source of income for farmers over the last few decades. The study has been substantiated with maps and diagrams.

Chaudhuri[13] (2000) has studied the pastoral economy of Changthang region of Ladakh, where agricultural pursuits are not suitable due to its high altitude, extreme climate and remoteness. He has discussed the changes within the Changpa Community. Historical background of the community has been discussed in the beginning of the paper. Analysis of changes within the Changpa community and predictions regarding possible future directions of the community follow it. The differences between the annual migratory cycles followed by Samad Changpas before 1962, as compared to the cycle at the time of study have been studied effectively with the help of relevant data. Author found that the community at the time of study is making smaller number of moves and the people stayed together throughout the year. Attempt has also been made to highlight the effect of Indo-China War of 1962 that put an end to trade between Tibet and Changpa nomads. The study also deals with the introduction of Public Distribution System (PDS) which has changed communities' custom. Items which were earlier bartered with nearby regions like *Sham* and *Zanskar,* have now available through PDS. Finally, he has

[13] Ajit Chaudhuri (2000), "Change in Changthang: To Stay or To Leave?", *Economic and Political Weekly*, Vol. 35, No.1/2, Jan. 8-14, 2000, pp.52-58

discussed Polyandry system in Changthang which is being replaced by monogamous marriages due to education among younger people.

Sati and Singh[14] (2015) have analysed migration and agrarian change in Uttrakhand Himalaya. In the beginning, they have provided a section on previous research done in the study area in detail. An attempt has been made to understand the rate of out-migration and changes in agrarian system in Pindar Basin of Uttrakhand. They have further investigated potential of cultivation of off-season vegetables and geo-ecological conditions prevalent in that area. A survey of 15 villages was conducted by selecting 40 per cent of all households using random sampling method to generate primary data for the study. They found out that out-migration takes place in search of livelihood due to mounting pressure of population on the fragile land and limited scope for expansion and modernisation of agriculture.

Singh[15] (2009) has examined the need to conserve biological diversity especially in India after UN convention on biological diversity to protect local communities. Importance of local community in maintaining bio-diversity of a particular region has been dealt with. He argues that traditional culture, knowledge of farming have enabled people of Ladakh to survive physically and emotionally in an otherwise inhospitable climate irrespective of natural constraints on agriculture. Environmental constraints such as rugged topography, extreme climate and mountain skeletal soil and their impact on agriculture have also been discussed in the study. To make the study more relevant, cropping pattern and diversification of crops have been analysed in detail with the help of tables and graphs. Besides, the study also includes discussion on various plant species both endemic and endangered ones. He has given a brief account of tribes and culture. The study considers agriculture and pastoral life equally important as it ensures constant food

[14]Vishambhar Prasad Sati and R.B. Singh (2015), "Migration and Agrarian Changes in Mountain Regions: A Case Study of the Pindar Basin of Uttarakhand Himalaya, India", Published in Research Gate, 20 February 2015,URL:https://www.researchgate.net/profile/Vishwambhar_Sati/publication/272497972_Migration_and_Agrarian_Changes_in_Mountain_Regions/links/54e71a480cf2b1990609590f/Migration-and-Agrarian-Changes-in-Mountain-Regions.pdf

[15] Anurudh K. Singh (2009), "Probable Agricultural Biodiversity Heritage Sites in India: The Cold Arid Regions of Ladakh and Adjacent Areas", *Asian Agriculture-History*, Vol. 13, No. 2, 2009, pp. 83-100

production. Implicitly the article also reflects on as to how environment affects culture, "culture with respect to nature has been extremely successful in supporting agriculture". Author states that it is difficult to understand whether culture is determined by environment.

Sharma and Chauhan[16] (2013) have studied changes in cropping pattern, adoption of new technology, sources of information about new technology and emerging threats to existing cropping pattern in Lahaul-Spiti district of Himachal Pradesh. The study is based on primary data, collected from 200 sample households selected randomly from ten villages through proportional allocation method. The data have been analysed using simple statistical tools like averages and percentages. Authors found significant changes in cropping pattern with traditional crops like barley and black pea being increasingly replaced by cash crops such as green peas and potatoes. The factors that have facilitated crop diversification in the region comprise of improved road connectivity, better means of transportation, decline in the demand of traditional crops due to changing food habits, availability of favourable micro climatic niches, and the availability of new inputs. They further found that large farmers, village panchayat pradhans, and households whose family members were employed in government or non-farm jobs were the initial adopters of crop/new technology. The most important sources of crop/new technology were the officials of the state departments of agriculture and horticulture, followed by relatives and friends. Increasing susceptibility of different crops to insects-pests and diseases, dwindling yields, erratic weather conditions, loss of fertility, and changes in climate have been reported the potential threats to cultivation of high value crops in hilly region of Himachal Pradesh.

1.1.3 Animal Husbandry and Horticulture

Animal husbandry is an integral part of agricultural pursuits in mountains. It provides income and employment opportunities to mountain people. Horticulture has become a profitable sub-sector within agricultural sector, which also has a scope of

[16] H.R. Sharma and S.K. Chauhan (2013), "Agricultural Transformation in Trans Himalayan Region of Himachal Pradesh: Cropping Pattern, Technology Adoption and Emerging Challenges", *Agricultural Economics Research Review*, Vol. 26, pp.173-179

augmenting income of farmers. Moreover, government policies emphasise development of horticulture in order to make mountain agriculture more remunerative.

Namgail and Bhatnagar et al.[17] (2007) have studied the pastoral nomads of Changthang region particularly of Hanle Valley and dynamics of their life style. Natural constraints such as aridity and high altitude on livestock production have been highlighted. The study also talks about socio-economic and land-use changes in detail by using tables and maps. Extensive surveys were carried out by them and data was collected through semi-structured interviews of people in six villages and in high pastures. They found that an attempt has been made to overcome natural constraints on agriculture through government's watershed schemes. It has resulted in limited cultivation in otherwise barren area; and small business enterprises are being looked at as alternate means of livelihood. The article, thus, reflects the changing life styles of Changpas from pastoral nomadism to alternate sources of livelihood though not completely giving up pastoral life. Finally, the authors argue that detailed understanding of rangeland dynamics of the region is necessary for developing conservation and developmental strategies that can achieve the goal of enhancing livestock production without harming the ecosystem.

Deepa and Sanjai[18] (2005) in their article have examined the production of oil from apricot bitter kernels by rural communities of Ladakh. The authors argue that since the "fragile economy" is based primarily on agriculture and horticulture, not only sweet apricot kernels are used but the bitter ones can also be used to extract oil which can be used for cooking, for prayer lamps, in cosmetics and also for medicinal use and the residue called "*bachcha*" is fed to animals. This short article shows as to how natural constrains have made cultivation impossible in the region during winter months but the community can finds alternate economic ways.

[17] Namgial. et. al. (2007), "Pastoral Nomads of the Indian Changthang: Production System, Land-use and Socio-economic changes", *Human Ecology*, Vol. 35, No. 4, August 2007, pp. 497-504

[18] Deepa and Sanjai (2007), "Traditional Methods of Chuli Oil Extraction in Ladakh", *Indian Journal of Traditional Knowledge*, Vol. 6, No. 3, pp. 403-05

Namgail, Wieren and Prins[19] (2010) have studied aspects of *pashmina* production and socio-economic changes in the Indian Changthang. They have divided the study into four parts namely the socio-economic structure and transformation of people of Changthang, livestock (*pashmina*) production system, wild life status and conservation and natural resource management system. Information on socio-economic structure, livestock production system, conflict of interests between wildlife and people, and traditional natural resource management system of villages was collected with the help of survey and interviews. They have also examined the changes in traditional pastoral economy in recent years due to socio-economic development. They found that *Changpas* are increasingly exposed to outside culture due to tourism and military associated infrastructural development. However, *pashmina* or cashmere wool is still the mainstay of economy of people of Changthang, as almost 55 per cent of income is generated through the production of this fibre. While concluding, the authors state that understanding and applying local people's knowledge is important for effective management of natural resources.

Malik[20] (2013) in his article has dealt with the assessment of apple production and marketing problems in Kashmir valley. He has examined the growth rate and production of apple in Jammu and Kashmir. Potential of apple production and its impact on standard of living of local have been assessed. Added to these, he has examined marketing system prevailing in apple trade and has provided possible solutions to the problems faced by this sector. Both primary and secondary data have been used. Primary data was collected with help of pilot survey involving interviews through a questionnaire. He has found that quantity as well as quality of apple has declined due to spread of apple diseases such as apple scab, alter aria, red might and powdery mildew. Other problems like low market accessibility due to poor communication/road links, absence of value addition and apple processing at local level, poor integration of domestic and national markets and lack of public private partnership have also been discussed in the study.

[19] Namgail, Wieren and Prins (2010), "Pashmina production and socio-economic changes in the Indian Changthang: Implications for natural resource management" , *Natural Resources Forum*, No. 34, pp. 222-230

[20] Malik (2013), "Assessment of Apple Production and Marketing Problems in Kashmir Valley", *Journal of Economics & Social Development*, Vol. IX, No. 1,

Sharma[21] (2005) has studied agricultural development and crop diversification in Himachal Pradesh. He has attempted to study the pattern, process and determinants of regional agricultural development and crop diversification. His paper is organised into seven sections (i) introduction, (ii) data and methods, (iii) the pace and pattern of agricultural development, (iv) the process of agricultural diversification, (v) crop diversification: costs and returns (vi) facilitating factors and (vii) conclusions and lessons. The study is based on both secondary and primary data. A range of statistical tools has been used by the author to analyse the data. Author found that horticulture sector registered significant increase in terms of area and production of fruits in recent years. He further found that state's agriculture has diversified towards fruits and off-season vegetables like peas, potato, cabbage, cauliflower, etc. over the last few decades. The net returns from these crops were found to be very high compared to traditional field crops. Factors such as explicit consideration of mountain specificities in formulating developmental strategies, availability of huge market in the neighbouring states, high level of market consciousness among the farmers and the emergence of self-help institutions have played an important role in facilitating the process of agricultural development and crop diversification. In the end, the author has discussed some important lessons from agricultural development and crop diversification experience of Himachal Pradesh.

Ali, Yadav, Stobdan and Singh[22] (2012) have studied traditional methods for storage of vegetable in cold-arid region of Ladakh, India. In the beginning, authors have made a brief description of study area. For this study, they have interviewed sixty elderly and experienced villagers from 12 villages adjoining Leh town in Leh district. Data pertaining to the study have been collected by combination of discussion with the villagers and on-spot observation of the method practiced by the villagers. The study highlights 3 indigenous methods of vegetable storage namely

[21] H.R. Sharma (2005), "Agricultural Development and Crop Diversification in Himachal Pradesh: Understanding the Patterns, Processes, Determinants and Lessons", *Indian Journal of Agricultural Economics*, Vol. 60, No. 1, Jan-March, 2005, pp. 71-93

[22] Ali Zulfikar et al. (2012), "Traditional Methods for Storage of Vegetables in Cold Arid Region of Ladakh, India", *Indian Journal of Traditional Knowledge*, Vol. 11, No. 2, April, 2012, pp. 351-353

Sadong, *Tsothbang* and *Charches* which are most commonly used for storing of vegetables like potato, carrot, radish, turnip, cabbage and onion in the region. All these three methods have been discussed with the help of relevant pictures in detail. Authors emphasised that the storage methods entirely based on the use of local natural resources are comparable with energy intensive modern methods of storage in terms of shelf life of stored vegetable. They found that the stored vegetables serve as an important source of nutritive food for local population during the snow covered period in the region.

1.1.4 Agriculture in Ladakh

Agriculture in Ladakh is the main occupation despite environmental constraints like rugged terrain, harsh cold arid climate, and short growing season. Available literatures on agriculture in the study area include the following:

Singh[23] (1981) has shown the extent and nature of environmental constraints on agricultural economy of Ladakh. Major environmental constraints like rugged topography, extreme climatic conditions and their influence on agriculture in a cold desert region have been effectively discussed. Each environmental constraint has been dealt with in detail and the study has been supported with maps and graphs. He found that because of the above mentioned constraints, agriculture is restricted to river valleys especially on valley floor, river terraces and alluvial fans. The study has been substantiated with relevant data.

Aima[24] (1986) in his paper on Leh district of Ladakh region has discussed the dynamics of high altitude farming in cold desert region. Environmental constraints such as terrain, climate, and remoteness on agriculture have been effectively described. He has discussed land distribution, area under irrigation along with cropping pattern and farm income. Besides, the issue of under development of agriculture has also been examined. The study lacks in-depth analysis and is mainly descriptive. Environmental constraints have merely been described and no data on

[23] Harjit Singh (1981), "Environmental Constraints on Agriculture in a Cold Desert", *The Ecology of Agricultural System*, Ed. by Noor Mohammad, Concept Publishing Company, New Delhi. pp. 79-91

[24] A Aima (1986), "Farm Economy of Cold Desert Regions: A Case Study of Leh, Ladakh", *Indian Journal of Economics*, Vol. 65, Part – 3, No – 263, pp. 223-28

climatic parameters like precipitation, temperature, length of growing season have been provided, which would have made the extent of nature's control on agricultural development of the region more conspicuous.

Singh[25] (1995) has provided the process of interaction as reflected by land-use particularly in terms of agriculture and to comprehend the relationship that man evolved with nature by developing a certain type of agricultural system. He has discussed nature and natural constraints on land use in general and agriculture in particular, agricultural system, changes in traditional agricultural system. Three villages of Ladakh namely Stok, Rangdum, and Parkachik have been studied and Land use and cropping pattern have been analysed in detail to measure disparities in distribution of land holdings. Coefficient of Variation has been computed to measure inequalities in the distribution of land holdings. Gini-coefficient has been calculated and Lorenz Curves were drawn to support this. Cropping pattern has been discussed briefly and agricultural inputs have also been mentioned giving local nomenclature. Different agricultural practices have been discussed. He found that the intensity of land use is low due to harsh climatic conditions.

Bhasin[26] (1997) has made an attempt to explain the process of water sharing in cold desert region of Ladakh. She has explained the system of irrigation done through glacial-melt stream water in Ladakh, where rainfall is very scanty. Difficulties in irrigating fields with the help of channels due to rugged and uneven surface have been dealt with in detail. Author states that climatic and topographical conditions of Ladakh provide a model of human adaptation to extreme environment. The paper draws attention to the importance of rivers in cold desert mountainous regions like Ladakh where agriculture depends on irrigation. She has also highlighted difficulties in location of settlements due to environmental constraints and scarcity of water. Further, she mentioned three types of settlements in Ladakh:

[25] Harjit Singh (1995), "Ecological Set-up and Agrarian Structure of High Altitude Villages of Ladakh", *Recent Research on Ladakh, Proceeding of the 4th and 5th International Colloquia on Ladakh*, (eds., Henry Osmaston and Philip Denwood) Motilal Banarsidas Publishers, Delhi, pp.193-208

[26] Veena Bhasin (1997), "Water Sharing and Human Solidarity in Ladakh", *Journal of Human Ecology*, Vol. 8. No. 4, 1997, pp. 279-286

(1) the Gompas, forts and palaces, (2) grazing camps (Doksa) and (3) associated agricultural villages.

Angeles and Tarbotton[27] (2001), in their paper have studied subsistence traditional systems which are being replaced by modern market oriented, mechanized and chemical-intensive agricultural practices. They argue that women farmers in traditional farming are more vulnerable to this change because of their role in traditional farming. Besides, they have also studied the interaction and social learning between the Women Alliance of Ladakh (WAL) and Ladakh Farm Project (LFP) as a form for women's organising across and beyond local communities to enhance local sustainable agriculture. Shift in cropping pattern from traditional food grains to cash crops has been discussed.

Baba, Wani, Shaheen, Zargar and Kubrevi[28] (2011) in their paper have attempted to investigate the extent of agricultural labour shortage in the cold-arid region of Ladakh in Jammu and Kashmir. For this study, both primary and secondary data have been used. The study employed agricultural labour availability model to quantify the determinants of labour availability. In the beginning, structural changes in agricultural labour and gender have been discussed. Authors found that the availability of male labourers has gone down and of female labourers has increased over the years in the region. The determinants of labour availability reveal that the regression estimates of land productivity and average size of holding were positive and significant determinant of labour supply, whereas income from non-farm activities and extent of mechanization were found to be negatively contributed to the improvement of agricultural labour supply. Along with this, an attempt has also been made to discuss the causes of labour shortage and out-migration of rural labour to understand the extent of labour shortage. Implications of labour shortage and utilization of inexperienced members of family or migrated labours on cropping pattern and productivity level have been analysed in detail. In the end, the study

[27] Leonora C. Angeles and Rebecca Tarbotton (2011), "Local Transformation through Global Connection: Women 's Assets and Environmental Activism for Sustainable Agriculture in Ladakh, India", *Women's Studies Quarterly*, Vol. 29, No. ½, Earthwork: Women and Environments (Spring – Summer, 2001), pp. 99-115

[28] S.H. Baba et al. (2011), "Scarcity of Agricultural Labour in Cold-Arid Ladakh: Extent, Implications, Backward Bending and Coping Mechanism", *Agricultural Economics Research Review*, Vol. 24, 2011, pp. 391-400

provided some policy suggestions for sustainable farming in relation with agricultural labour scarcity.

As reflected from the above literature, one of the major problems with the region is the scarcity of literature. A very few studies, pertaining to different aspects of agricultural economy, has been carried out in the region. However, in the light of this fact, attempt of various authors should be regarded praiseworthy. Of all the articles surveyed, an article by Singh appeared to be the best because it dealt with nature and natural constraints on land use in general and agriculture in particular, agricultural system, changes in traditional agricultural system. Apart from this, the paper by Angeles and Tarbotton also discussed how subsistence traditional agriculture is being replaced by modern market oriented, mechanical and chemical intensive agricultural practices. Since the current trend of agriculture is shifting from traditional subsistence towards commercial agricultural, these studies gain significance and are of practical value.

1.2 Study Area

Leh District is situated between 32˚15'N to 36˚ N Latitude and 75˚15' E to 80˚E Longitude. It lies in high altitude, remote and inaccessible parts of India, covering an area of 45,110 square kilometres, which makes it second largest district of the country in terms of area. The district is one of the coldest and most elevated inhabited regions of the world having 112 inhabited villages and one uninhabited village at altitude ranging from 2,900 to 5,900 metres above mean sea level. It is one of the very sparsely populated districts in India with density of 3 persons per square kilometre in 2011. Located in eastern portion of Ladakh region of Jammu and Kashmir State, the district is bordered by Chinese Sinkiang in the north, Tibet in the East and Lahaul Spiti district of Himachal Pradesh in the south, along with the other district of Ladakh region namely Kargil. Leh district forms the northern tip of India.

Since the region lies in rain shadow zone, it is one of the driest places of India. Under these harsh conditions agriculture is difficult and a challenging task. Only 0.12 per cent of the total geographical area is under cultivation[29]. The district has three major physiographic divisions namely mountain ranges, river valleys and

[29] Statistical Handbook, Leh District, 2010-11

plateau. Because of its location to the north of Great Himalayan Range which acts as a climatic barrier, it receives very low precipitation of around 10 cm in a year. Not only it receives deficit amount of rainfall, it is also unevenly distributed.

Ladakh region can be divided into two parts on the basis of human response to severe environment:[30]

a) The pastoral areas situated in the higher parts of Ladakh (generally above 4,500 metres) especially in its eastern part known as Changthang. The main constraints, here, are excessive cold and arid climate and near absence of natural drainage. Almost the entire economy depends on natural pastures which are limited and scanty. Cultivation of crops is not possible under such conditions at the present level of technology.
b) Agricultural area which is confined to lower parts of river valleys of Ladakh. Farming is largely of subsistence type practised on areas situated below 4,500 metres above the mean sea level.

Ladakh experiences arid to semi-arid climate and it puts fairly strict limitations on activities in which scarcity of water is an important factor. Most decisive factor is low rainfall and its uneven distribution. However, scanty rainfall is a norm in the areas where agriculture is possible. There are marked difference in the valleys and uplands. Agriculture is mainly confined to valleys, which have shallow skeletal calcareous soils that are alkaline in nature and are low in organic matter. Rest of the region is a desert with sandy soils[31]. Barley is the main crop covering two third of cultivated land. Wheat and buckwheat are other important crops. Vegetables like peas, potatoes, tomato and cabbage are also grown in lower parts, which have relatively warmer climate. Villages in upper slopes depend largely on livestock where sheep, goats, yaks, cows, dzos, donkeys and horses are reared. These play important role in providing manure, fuel, transport, labour, wool, milk, meat and hides.

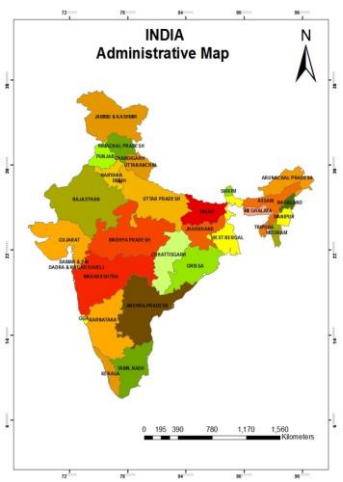
[30] Harjit Singh (1981), "Environmental Constraints on Agriculture in a Cold Desert", *The Ecology of Agricultural System*, Ed. by Noor Mohammad, Concept Publishing Company, New Delhi. pp. 79

[31] Anurudh K. Singh (2009), "Probable Agricultural Biodiversity Heritage Sites in India: The Cold Arid Regions of Ladakh and Adjacent Areas*", Asian Agri-History*, Vol. 13, No. 2, pp. 83-100

Due to inhospitable climate and rugged topography, the region is quite isolated. At present, the region remains cut off from the rest of the world during winter months. Air links is the only method of reaching Ladakh during winter. An effective effort by people has led to the development of very specific agricultural adaptation despite the harsh environmental conditions. The present study is an attempt to understand environment and socio-economic dimensions of changing agricultural economy of Leh District. (Table 1.1)

Map 1.1

LOCATION OF LADAKH IN INDIA
(STUDY AREA)



LEH DISTRICT

1.3 Objectives

Main purpose of this study is to look at the changing agricultural economy of Leh District and to comprehend its environment and socio-economic dimensions. Therefore, the following are the objectives:

1. To examine major elements of physical environment in Ladakh in order to comprehend the constraints imposed by these on agricultural economy and the measures adopted by farmers to overcome these constraints.

2. To understand changing role and importance of various socio-economic parameters with special reference to the monasticism, community structures, norms and beliefs which play role in agricultural practices.

3. To study the spatial variations in cropping-pattern and changes therein, which occurred during 1996-2014.

4. To assess the socio-economic factors responsible for diversification of crops and its contribution in agricultural economy across villages.

5. To evaluate the significance of horticulture as an emerging sub-sector and identify ecological zones with higher potentials/advantages for horticultural activities.

1.4 Research Questions

Natural environment plays an important role in agricultural pursuits in any region particularly in high altitude mountain areas. Recent socio-economic changes have also resulted in significant changes in agriculture of Ladakh. Therefore, an attempt has been made to answer the following research questions:

1. What is the level and nature of harsh physical environment in restricting agricultural activities in Ladakh? What are the measures adopted by the farmers in overcoming various environmental constraints in agriculture? How does adverse role of environment vary within Leh District?

2. How has the integration of villages with market forces contributed to the decline in the role of traditional social institutions, community structure and norms on agricultural activities across villages?

3. What are the different socio-economic parameters affecting cropping pattern and the variations in it across different zones in Ladakh?

4. What are the spatial variations and temporal changes in cropping-pattern and the causes of these?

5. How does horticulture affect the levels of crop diversification and commercialization? What are the relative advantages of some areas in the emergence of horticulture sector?

1.5 Database

Data for the present study have been obtained from both primary as well as secondary sources. Information about household composition, livestock numbers and agricultural conditions has been collected through primary survey by taking 30 households each from twelve sample villages.

To support the primary data, secondary data has also been obtained from Government publications and unpublished data from various institutions. Following are the major sources of secondary data:

1. Meteorological Tables, Defence Research and Development Organization (DRDO), Leh, Ladakh. 2004-09. Climatic data has been used to understand the role of environmental constraints on agriculture across altitudinal zones.

2. SRTM Digital data (SRTM is an international project spearheaded by the National Geospatial-Intelligence Agency (NGA) and the National Aeronautics and Space Administration (NASA, 2000). This has been used to construct the elevation

ranges, altitudinal zones and slope map etc. of Leh district to depict physiographic constraints on agriculture.

3. Government of Jammu & Kashmir, Ladakh Autonomous Hill Development Council (LAHDC), Block-wise Village Amenity Directory, 2010-11. It has been used to get information on the amenities available to the people of Leh District. Distance of sample village from market centres has also been obtained from this source.

4. Government of Jammu & Kashmir, Ladakh Autonomous Hill Development Council (LAHDC), Statistical Hand Book, Leh District for 2004-05, 2009-10 and 2010-11. This data has been used to analyse land holdings, land use, cropping pattern, seeds used and other agricultural inputs such as fertilizers, pesticides, and agricultural implements.

5. Agricultural Census, Department of Agriculture Cooperation & Farmers Welfare, India for 1995, 2001, 2005 and 2010. It has been used to get data on Ownership and Distribution of Landholdings.

6. Census of India, District Census Handbooks, Leh district for 1971, 1981, 2001 and 2011[32]. This data source has been used to analyse workforce in agriculture and changes therein.

7. Patwari Records. Land records of surveyed villages, land-use and cropping pattern have been collected from patwari records of each sample village.

8. Primary survey at village and household levels was carried out during September-October 2016 to collect statistical information pertaining to farm size, livestock numbers,

[32] 1991 census could not held in J&K due to political disturbances.

educational level, income status, family size and type and agricultural conditions. A village level questionnaire was prepared to procure the information pertaining to pursuits of agriculture.

In addition, an extensive tour to the district was undertaken to visit a large number of inhabited villages as well as pasture and grazing lands to make the general observations. Documentary evidences have been generated through photographs undertaken during field survey. A wide ranging discussion was carried out with cultivators and various governmental officials dealing with each and every aspects of agricultural economy in Leh district.

1.6 Methodology

The present study is an analysis of changing agricultural economy of Ladakh, its environment and socio-economic dimensions. Methods used for the study can be divided into two parts;

1. Methods of Data Collection
2. Methods of Analysis

1. Data Collection Methods

Since interviewing the entire population is a difficult task and time consuming, a representative sample needs to be drawn to get true picture of changing agricultural economy. For this, primary data was collected through structured questionnaires covering twelve villages and 30 households from each surveyed villages. The villages have been selected by keeping in view the altitude and their varying proximity to market centers. The entire region has been divided into three different altitudinal zones. These are lower zone with villages situated below 3,200 meters, the middle zone between 3,200 meters and 3,900 meters; and upper zone where villages are located above 3,900 meters above the mean sea level. Three villages each from lower and upper each zone and six villages from middle have been selected for detailed investigation and comparison among these.

This has been done in order to highlight the differences so that villages from both highland and low terraces and their distance and closeness to economic centers are represented in the sample. Altitudinal variations and distance from market centers formed the main basis for the selection of surveyed villages (Table 1.1).

As per the 2011 census, there were 113 villages in Leh District. Out of these, 112 were inhabited and 1 village was uninhabited. Therefore, this had to be omitted as data pertaining to chosen variables was not available.

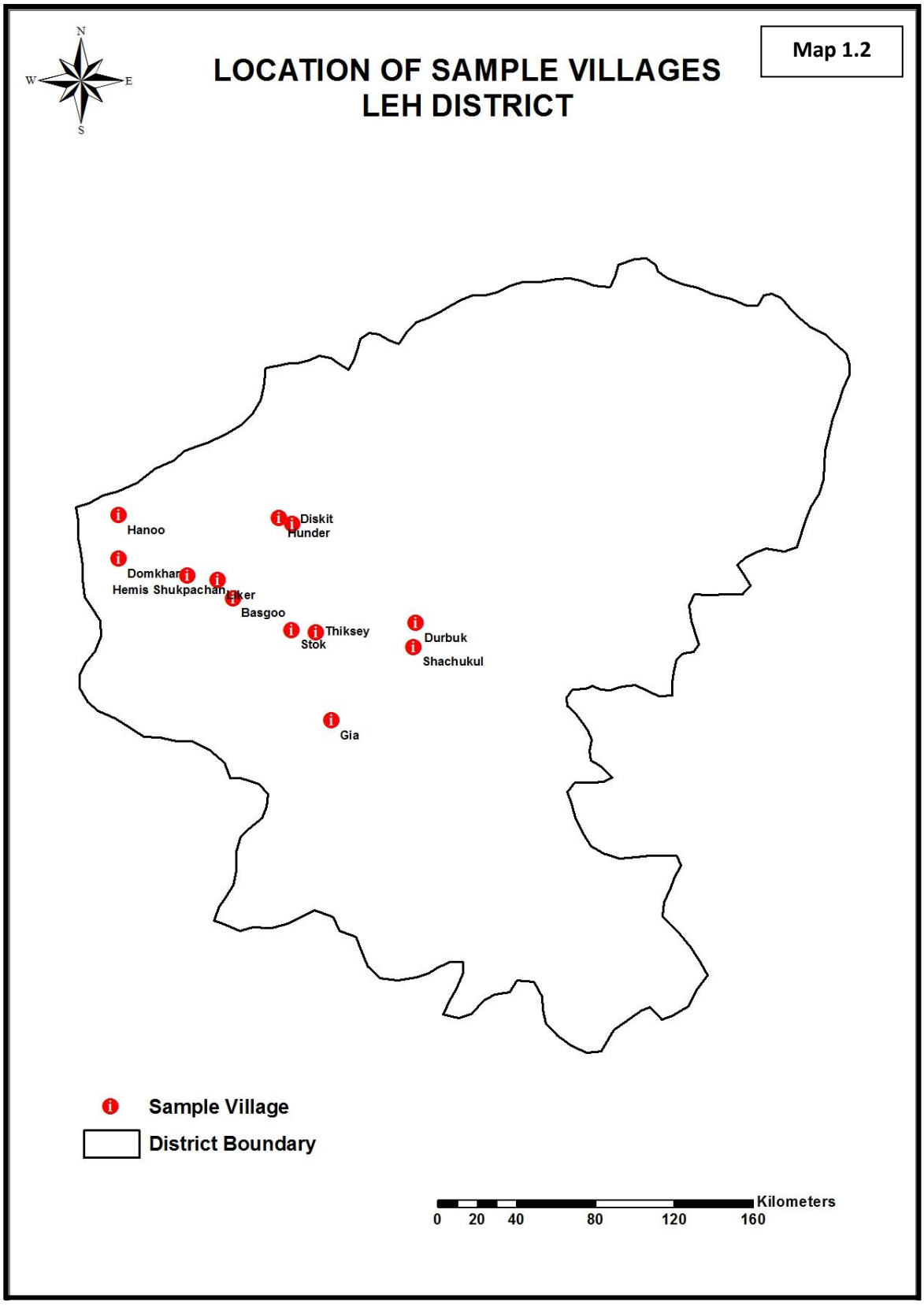
Table 1.1

DETAILS OF VILLAGES SURVEYED

Sr. No.	Altitudinal Zones (heights in *metres*)	Total Inhabited Villages	Number of villages surveyed	Distance from Market Centres in *kilometers* (Name of villages)
1	Higher Above 3900	36 (32.14%)	3 (25%)	Less than 15 (Durbuk) 15-45 (Shachukul) More than 45 (Gia)
2	Middle 3900-3200	51 (45.54%)	6 (50%)	Less than 15 (Stok), (Diskit) 15-45 (Thiksey), (Basgoo) More than 45 (Likir), (Hemis Shukpachan)
3	Lower Below 3200	25 (22.32%)	3 (25%)	Less than 15 (Hunder), 15-45 (Domkhar), More than 45 (Hanoo)
Total	All Zones	112 (100%)	12 (100%)	Thirty households from each village have been selected i.e. 360 households

Table 1.1 shows the location and other details of sample villages of present study. The villages have been chosen according to altitude (Higher, Middle and Lower) and their distance from market centres categorized as less than 15 kms, 15-45 kms and more than 45 kms. Further, the villages have been classified in order to ensure

proportionate distribution under each mentioned category. The higher zone reveals the concentration of 36 villages accounting for 32.14 per cent of the total inhabited villages. A sample of nearly 25 per cent was taken from this zone. There are 51 villages in the middle zone comprising 51 per cent of the total inhabited villages. Fifty per cent of the sample villages were selected from middle zone as it shows more concentration of human activities. The lower most zone has 25 villages accounting for 22.32 per cent of the total inhabited villages. Twenty five per cent of the sample villages were taken from this zone.An attempt has been made to draw equal proportion of sample villages from each zone in Leh District and location of village from market centre has been made main criterion. Therefore, in total twelve villages (Map 1.2) were selected for the primary data collection with the help of questionnaires.


Map 1.2
LOCATION OF SAMPLE VILLAGES
LEH DISTRICT
N
W
E
S
Hanoo
Diskit
Hunder
Domkhar
Hemis Shukpachan
Basgoo
Thiksey
Stok
Durbuk
Shachukul
Gia
Sample Village
District Boundary
Kilometers
0 20 40 80 120 160

2. Methods of Analysis

Both qualitative and quantitative methods have been used for the analysis. Both statistical and cartographic techniques have been primarily used in the analysis. Percentages, ratios and averages have been computed. Bar and pie diagrams have also been used to show data of land use and cropping pattern.

Diversification of crops has been measured with the help of Herfindahl Index (HI);

$$\text{HI} = \sum_{i=1}^{n} \text{p}_\text{i}\, 2$$

where, $p_i$is share of each crop defined as,

$$HI = \frac{A_1}{\sum_{i=1}^{n} A_1}$$

Here, A_1 is acreage area under each crop; $\sum_{i=1}^{n} A_1$ is total acreage area and the value of H ranges from 0 to 1. While, unity implies complete specialization, zero implies high diversification. Hence as value of Herfindahl decreases, diversification in a particular region increases and as HI increases, diversification in that region decreases.

Che-square (X^2) test has been used to determine variations between size of farms and ownership with the help of following formula:

$$X^2 = k \quad 1 \quad \frac{(\text{Oij} - \text{Eij2})}{\text{Eij}}$$
$$i = 1 \quad j = 1$$

k = total number of categories.

1 = total number of samples.

Oij = the observed frequency in category i of sample j.

Eij = the expected frequency in category i of sample j.

Lorenz curves have been drawn to show inequality in the distribution of land holdings. Gini-coefficient (G) was calculated with the help of following formula:

$$G = \frac{1}{100 \times 100} (\sum XiYi + 1) - (\sum Xi + 1Yi)$$

where,

X_i = cumulative % of number of households (land holdings) up to 'i' th class households;

Y_i = cumulative % of area of land holdings up to 'i' th class of land holdings**.**

Maps have been prepared by using proportionate circles placed on settlements with the help of Arc-GIS Map tool.

Most of the primary as well as secondary data has been presented in tabular form. Cross-tabulation has been attempted to represent the relationship between relevant variables. A number of maps have also been prepared to show the spatial variations as well as co-relationships among various aspects of agricultural development.

1.7 Organization of the Material

The present study related to changing agricultural economy of Leh District needs to be arranged in a rational and meaningful sequence. Therefore, the entire research material has been divided into six chapters, each representing the analysis of a certain facet of changing agricultural economy of Leh district.

The introductory chapter essentially provides detailed analysis of the importance of agriculture in the study area. It also includes as to how physical and socio-economic characteristics of the district influence level of technological development. Description of the study area, objectives of the study and some research questions have been discussed in this chapter. The chapter also includes review of available literature on agriculture in the region. Finally, the data source, methodology and presentation of research have been discussed.

Natural environment plays a vital role in agriculture in high altitude areas like Leh District. Therefore, second chapter deals with the role of natural environment on agriculture. Different elements of natural environment have been analysed with a view to comprehending their impact on economic activities, particularly agriculture. It contains different aspects of natural environment, further divided under the sub-heads of physiography, natural drainage, climate, soil and vegetation.

Land-use and cropping pattern of a region reflect different aspects of agricultural economy. Changes in agricultural economy that have taken place over the past decades have been captured by analysing land-use, distribution of land holdings, cropping pattern, cropping intensity and yield of major crops. Therefore, an attempt has been made in third chapter to analyse these aspects at the spatial and temporal level.

The emergence of horticulture has proved to be a harbinger of revolution in terms of increase in farm income. Thus, the fourth chapter deals with horticulture in terms of growth of horticulture, commercialization and diversification of crops. Changes in area, production and yield of various temperate fruits have been studied in this chapter. Furthermore, problems in the adoption of cash crops and analysis of shift towards horticultural crops and its role in commercialization of agriculture have also been analysed in this chapter.

The nature of numerous socio-economic aspects of agriculture plays a vital role in changing agricultural economy. Different socio-economic aspects such as land tenancy and system of ownership, size of land holdings, pressure of population, workforce in agriculture and labour use have been discussed at the spatial and temporal levels. Besides, effort has been made to understand the role played by *Gompas*, *Phaspun* and *Bes* in agricultural economy of Leh District.

All the major findings of the study have been summarised in the final chapter which presents summary and conclusions.

Chapter Two

Aspects of Natural Environment and its Constraints on Agriculture

Natural environment provides the basic necessary conditions required for human beings for their survival. Human beings interact with their natural environment through various activities. In the process of this interaction, nature imposes limitations on human activities and they, in turn, minimise restrictions imposed by nature with available technology. Moreover, human beings always try to modify the natural environment with available skill and knowledge according to their own needs wherever possible. This relationship between human beings and environment has undergone various changes over time with improvement in technology. Even though technology can minimise restrictions imposed by nature, but it cannot completely remove human dependence on physical environment. The same view was put forward by Griffith Taylor in his theory "Stop and Go determinism/Neo-determinism", where he stated, "in the short term, people might attempt whatever they wished with regard to their environment, but in the long term, nature's plan would ensure that the environment won the battle and forced a compromise out of its human occupants"[33]. Further, he compares human beings with a traffic controller in a large city who alters the rate but not the direction of the progress. Therefore, it can be inferred from the above statement that though human beings can alter natural environment according to their needs and requirements, but they cannot control it. They have to respond to the traffic controller and can proceed in their pursuit of development when nature permits the modification.

The response of human beings towards nature varies in space and is generally region specific depending on the resource base, level and the nature of natural constraints and that of available technology[34]. It may be different for different regions, considering the prevailing socio-economic conditions and physical

[33] http://www.yourarticlelibrary.com/geography/dichotomy-between-determinism-and-possibilism-of geography/24592

[34] Singh, Harjit (1981), "Environmental Constraints on Agriculture in a Cold Desert", *New Dimensions in Agricultural Geography: The Ecology of Agricultural System*, Ed. by Noor Mohammad, Concept Publishing Company, New Delhi. p. 79

set-up. For example, in mountainous region, with cold and arid climate combined with limited resources, people tend to get adapted to the dictates of nature by carrying out subsistence farming wherever it is possible. Leh district, often termed as 'cold desert' due to scarcity of water with very low precipitation, is one such mountainous area "where nature is hostile and human beings have adapted themselves by becoming a pastoral nomad in its eastern part, where farming is not possible due to very high altitude and cold climate, and by tilling land in relatively lower warmer valleys"[35]. Mountain ranges adorn it with numerous glaciers, high peaks and highly rugged terrain. The nature of mountains, cold-arid climate with very low temperature and precipitation exert a strong impact on human activities, particularly agriculture.

Since agriculture is directly related to physical environment, variations in the latter are bound to affect agricultural land use and cropping pattern in its different parts. Thus, any comprehensive study of agriculture requires in-depth investigation of various elements of physical environment such as topography, natural drainage, climate and soil. These factors play a vital role in affecting the growth and distribution of crops in a particular region. The analysis of these factors, therefore, helps in understanding of their constraining role on agriculture on one hand, and relative advantages offered to agricultural development on the other. Thus, in the context of this, a detailed geographical enquiry of elements of natural environment becomes imperative for studying changing agricultural economy of Leh district.

2.1 Relief

Relief features of an area determine the value of terrain for arable farming, particularly through elevation, ruggedness and slope. "These three factors determine the pace of cultivation and farm mechanisation and the degree of accessibility"[36]. The utilisation of land for cultivation is largely influenced by both altitude and slope. The effects of altitude are experienced directly i.e. through climate by limiting agricultural land utilisation; whereas slope constraints agricultural land use partly directly, as with limitation of cultivation by steepness and partly indirectly i.e. through climate and soil. Degree of accessibility, regional variations in land use and

[35] Singh, Harjit (1981), *op.cit*., p.79.
[36] Singh, J. and Dhillon, S.S. (2006), Agricultural Geography, Tata McGraw-Hill Publishing Company Limited, New Delhi. p. 47

cropping pattern, sources of irrigation, level of farm mechanisation, diffusion of agricultural innovation, etc. are also determined by slope. It becomes clear that while flat areas with moderate slopes are fit for cultivation as against uneven and dissected topography with steep slope restricting it. Leh district can be divided into following zones based on relief:

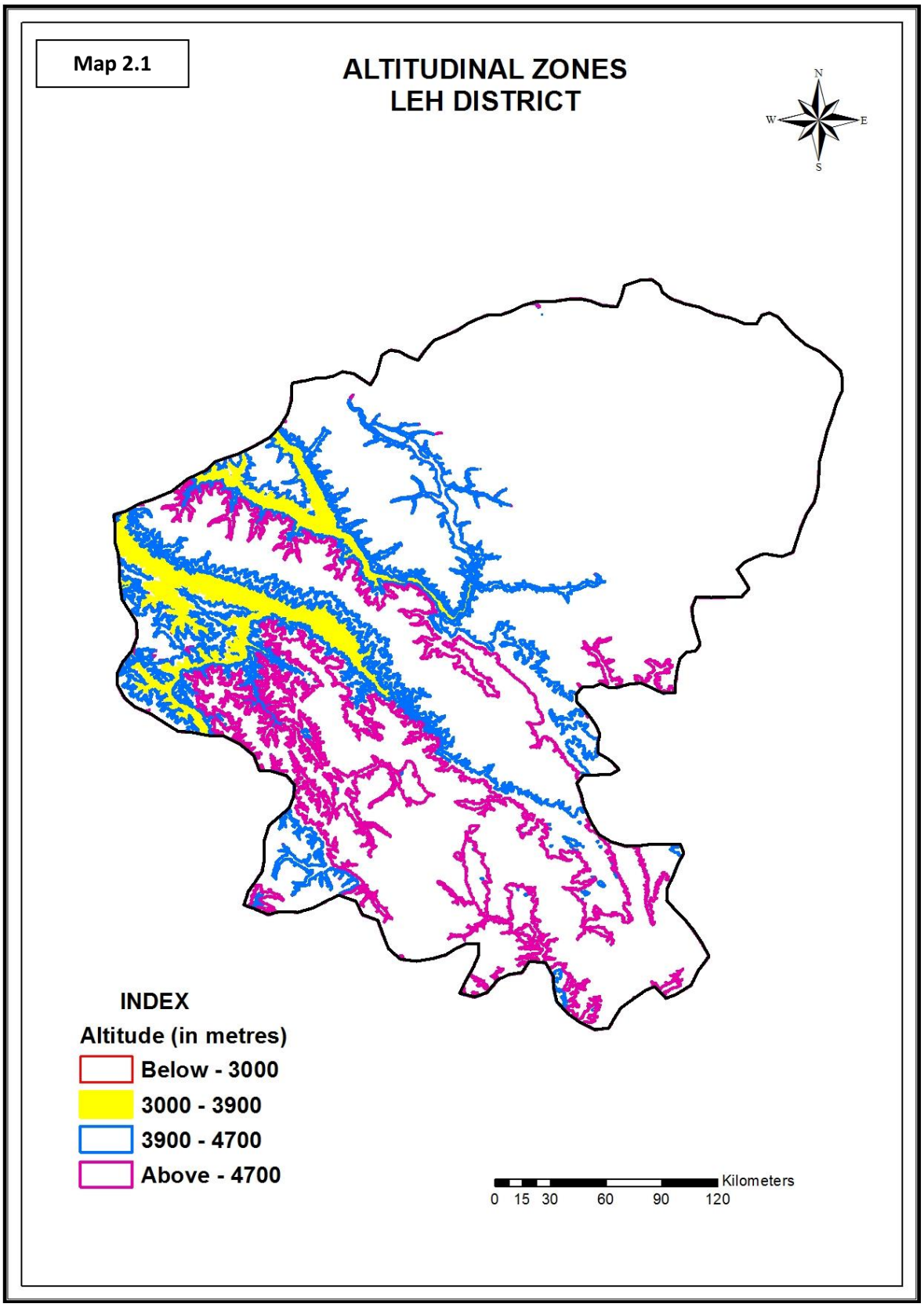
Altitudinal Zones

Map 2.1 and Table 2.1 reveal that the entire area of the district is highly elevated depicting a maze of alternating valleys and mountain ranges. Most of the land lies above an altitude of 4700 metres. The whole area can be divided into four main altitudinal zones.

1. Above 4700 metres: This zone is mainly represented by the area excluding prominent river valleys accounting for 78.38 per cent of the total geographical area. It can be observed from the map that area of this zone is widely distributed in Leh district. It is mostly glaciated and highly rugged area and is virtually unfit for crop cultivation on account of extensive rocky surface and inhospitable climate. However, some portion of this zone supports pastoral activity of a rudimentary kind along with grazing and collection of fodder from high altitude alpine pastures during summers.

2. 3900-4700 metres: This zone contains most of the upper parts of prominent river valleys of Leh district and associated tributary valleys. It has the second largest coverage of across zones comprising 16.74 per cent of the total geographical area. Characterised by barren, steep and rugged undulating sloppy terrains and scarcity of moisture, this zone restricts the availability of agricultural land. In turn, it makes the crop growing a challenging task under such harsh conditions. Less than 1/4th of the total villages are located in this zone.

3. 3000-3900 metres: This is the middle zone accounting for 4.81 per cent of the total geographical area. Most of the settlements are located in this zone largely confined to the river valleys of Indus, Shyok and Nubra. This zone has significant amount of fertile land under cultivation.


Map 2.1
ALTITUDINAL ZONES
LEH DISTRICT
N
W
E
S
INDEX
Altitude (in metres)
Below - 3000
3000 - 3900
3900 - 4700
Above - 4700
Kilometers
0 15 30 60 90 120

4. Below 3000 metres: The lowermost zone has the least proportion of area i.e. 0.07 per cent of the total geographical area. A small tract of land in lower Indus and Shyok valleys comes under this category. This zone is characterised by moderate climatic and physiographic conditions which, in turn, makes the farming comparatively easier compared to higher zones.

Table 2.1

PROPORTION OF AREA UNDER VARIOUS ALTITUDINAL GRADIENT

Elevation Zones (in *metres*)	Area (km^2)	Percentages (%)
Above 4700	60028.31	78.38
3900 – 4700	12820.27	16.74
3000 – 3900	3681.53	4.81
Below 3000	50.25	0.07
Total Area	76580.36	100.00

The above analysis clearly shows that the most inhabited and cultivated area falls in lower zones i.e. below 3900 metres. Thus, it is clear that the adverse effects of high altitude in the form of various environmental constraints make the areas lying above 4700 metres virtually unfit for cultivation. Altitudinal zones are also indicative of availability of alpine pastures, which are very significant for the farming communities as they depend on these for fodder especially during summer months. Therefore, it is apparent that altitude shows inter and intra-zonal variations in the mountain crop production systems. Topographical configuration is the major factor in making the region arid, rugged and barren interspersed with deep and narrow valleys. Therefore, it becomes important to analyse the slope characteristics in order to have an idea about the land available for cultivation.

Slope is another important physiographic aspect influencing agricultural land of an area. Accessibility and cultivation of particular area is determined to a large extend by slope characteristics. Slope influences agriculture directly as well as indirectly. Most obvious direct influence of slope is in the form of the restrain on

crop cultivation. "The indirect effect of slope manifests itself in pedological and climatic modifications including the position of water table, development of soils, air drainage and the relative freedom from frost"[37]. Besides, steeper slope may also influence livestock rearing in terms of grazing and fodder collection.

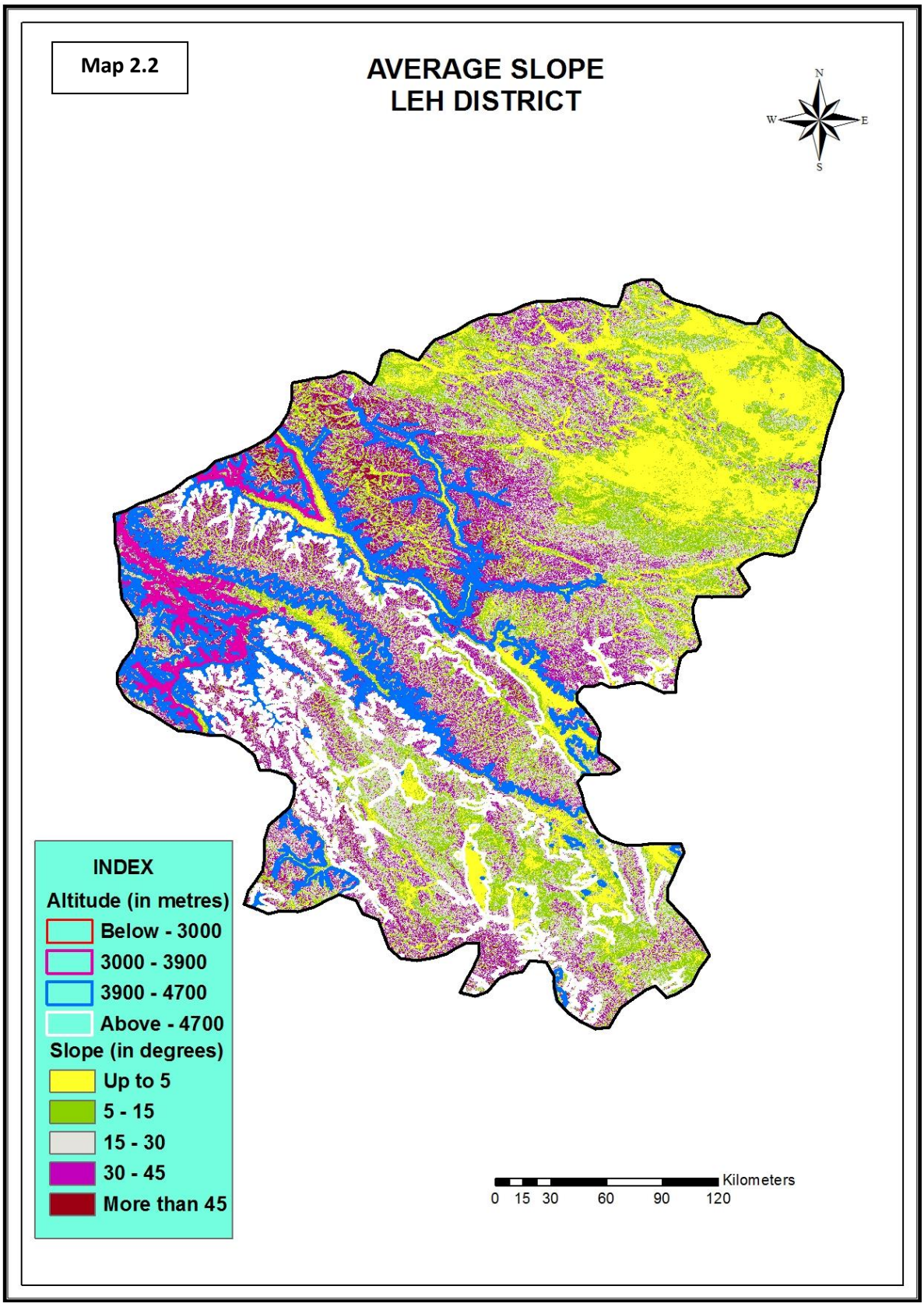
Table 2.2

PERCENATGE OF AREA UNDER AVERAGE SLOPES

Average Slope (in *degrees*)	Area (km^2)	Area (in *hectares*)	Percentage of total Area (%)
More than 45	3072	307200	4.02
30 – 45	18710	1871000	24.43
15 – 30	25497	2549700	33.29
5 – 15	16318	1631800	21.31
Up to 5	12983	1298300	16.95
Total Area	76580	7658000	100.00

Map 2.2 and Table 2.2 show that land is largely rolling in nature and rugged in most parts Leh district. A small proportion i.e. 16.95 per cent land covering an area of 12983 square kilometres has slope of up to 5 degrees. Its considerable portion is in western and eastern parts of Indus valley in Leh district. It is well spread throughout the district. A large proportion is situated above an altitude of 4700 metres across the region covered under pastures and snowfields. The next largest proportion i.e. 21.31 per cent covering an area of 16318 square kilometres have slope of the land between 5 to 15 degrees. Some portion is located in the eastern parts of Indus valley and north parts of the district. A large portion is also scattered above 4700 metres which is not suitable for agriculture. The next largest proportion i.e. 33.29 per cent covering an area of 25497 square kilometres have slope of the land between 15 to 30 degrees. It is evenly distributed in the river valleys at an altitude of 3000 to 4700 metres. Some portion is also situated above an altitude of 4700 metres. Largest proportion i.e. 24.43 per cent comprising of an area of 18710 square kilometres have slope of the land more that 30 degrees. All such land is well spread in the entire Leh district. Small portion of this land has been brought under cultivation by making

[37] Singh, J. and Dhillon, S.S. (2006), *op.cit*., p.52


Map 2.2
AVERAGE SLOPE
LEH DISTRICT
N
W
E
S
INDEX
Altitude (in metres)
Below - 3000
3000 - 3900
3900 - 4700
Above - 4700
Slope (in degrees)
Up to 5
5 - 15
15 - 30
30 - 45
More than 45
Kilometers
0 15 30 60 90 120

narrow terraced fields cut closely along contours. Thus, a larger part of this land cannot be brought under cultivation due to undulating topography.

It can be inferred from the above that very large portion of land falls under steep sloping surface which is devoid of soil and hence, unfit for cultivation. Most of the parts are covered either under ice and snowfields or rock out-crops produced by rock falls and glaciers moving down the slope. It is only on some patches, where relatively thicker soil cover formed over a period of time, one can find glacio-fluvial fans, river terraces and talus cones. Some of these have been and can be brought under plough.

2.2 Physiographic Divisions

Leh District shows significant physiographic diversity with many mountain ranges alternating with river valleys in central and western part. Its eastern part is formed by a high altitude plateau region. In general, the terrain is mountainous in character with barren and uneven topography except in its eastern part. With steep slopes, the topography considerably restricts the extent of areas suitable for human activities, particularly agriculture due to extremely cold climate, absence of soil cover and acute scarcity of water. It is only on the valley floors one finds relatively thicker soil cover which can provide suitable land for agricultural activities. Therefore, human settlement and agriculture is confined to river valleys with an altitude varying between 2,500 meters and 4,500 meters above mean sea level.

Leh district can be broadly divided into following physiographic divisions on the basis of physiographic characteristics: - Mountain ranges, Plateau region and River valleys.

1. Mountain ranges

The mountain ranges and hills found in Leh district of Jammu and Kashmir are part of the Trans Himalayan Ranges. According to Cunningham, most striking thing about physical features of Ladakh comprises “parallelism of its mountain ranges which stretch through the country from south-east to north-west”[38]. These ranges exhibit striking intra-area variations from north to south and east to west. These are

[38] Cunningham, A. (1970) “Ladak: Physical, Statistical and Historical”, Sagar Publishers, New Delhi

generally east-west running ridges, interspersed with some of world's highest mountains and enormous glaciers with river valleys cutting through them. The mountains contain of some of the highest mountain peaks in the world with altitude ranging from 5,000 to 7,000 meters above the mean sea level. Characterised by barren and uneven terrain devoid of natural vegetation, such areas are considered negative from agricultural point of view. However, the higher parts remain covered with snow throughout the year which helps in getting much needed snow-melt water for irrigating agricultural fields. Some of the important mountain ranges that lie in the district are as follows:-

I. Saltora Ranges and Southern face of Karakoram Range.
I. Ladakh Range
II. Zanskar Range

I. Saltora Range and Southern face of Karakoram Range

Karakoram range forms the northern most range of Trans Himalayas. It lies almost parallel to Ladakh range to its north and "intervene between the line of Shyok Valley and upper part of Yarkand river"[39]. The southern slope of this range falls within the boundary of Ladakh region. The range is a source of many important rivers and streams flowing in the region, which provides farmers with water for irrigating their agricultural fields. One such river is Shyok which originates in the higher part of this range, descends and flows along the southern piedmont, separating it from Ladakh range. Besides, the entire crest line of Karakoram range is covered with perpetual snow with a number of large glaciers. These are mainly found along the southern face of Karakoram range. Some of these glaciers are among the largest in the world outside Polar Regions. Important glaciers of Karakoram range in this region are Hispar (58km) and Batura (64km), discharging into Indus, Biafo (64km) and Baltora (62km) which discharge into Shigar, a tributary of Indus, Siachen (72km), discharge its melt-water into Nubra river. Various U-Shaped valleys have been curved by glaciers.

[39] Drew, F. (1971), "The Jammu and Kashmir", Oriental Publishers, (eds.1971), pp.261 quoted in Singh, Hargit (1978), "Ladakh: Problems of Regional Development in the Context of Growth Point Strategy", Unpublished Ph.D. Thesis, New Delhi: Jawaharlal Nehru University, pp.26

The entire range is negative from agricultural point of view due to its high altitude and rough terrain. In fact, the higher slopes being very steep in gradient are devoid of soil or vegetation. Average altitude of this range varies between 5,128 meters and 7,000 meters above mean sea level. Some peaks of this range exceed 7,500 meters above mean sea level. The highest peak of the Karakoram range in Leh district is Saser Kangri (7,672m). Some important passes of this range are Mustagh pass (5,700m), Saser la (5411m), Hispar pass (5,128m), and Karakoram pass (4,693m). As a result, such areas cannot be used even for grazing on any significant scale. Geologically, the range is mainly composed of granite and limestone, which falls in the Trans Himalaya subdivision of the Himalayas.

II. The Ladakh Range

Lying parallel to the Zanskar range, Ladakh range stretches between Indus and Shyok valleys. It is flanked by Indus and Shyok rivers from the south and the north respectively. Average elevation of this range varies from 5,800 meters to 6,100 meters above mean sea level. The range has no major peaks but its northern subsidiary, Pangong range, runs parallel with it along the southern shore of Pangong Lake. It is actually more imposing with its highest peak rising to 6,700 meters above mean sea level.

The range is largely composed of crystalline granite rocks. A few minor tributaries of Indus and Shyok rivers incise deep gorges in the barren rocks and form eroded flat valleys. Important mountain passes in this region are Khardung La (5,602m), Chang La (5,599m), Digar La (5,400m), Chorbatt pass (5,090m) and Tsak La (4,724m). Khardung La, which provides a segment of the historical Ladakh-Central Asia route, joins Indus and Nubra valleys.

III. The Zanskar Range

This range runs parallel to Ladakh range which is situated to its north and encloses Dras, Suru, Wakha and Zanskar valleys. It consists of bare rocky surface with irregular cliffs, scree slopes, loose rocks and accumulated debris found at its foot. Its upper rocky slopes are devoid of any vegetation, while lower slopes, with some scanty vegetation, can be used for grazing purposes.

Plate 2.1: River Shyok with Saltaro/Kararkoram Range in background. (3500 meters)

Plate 2.2: Leh town with Zanskar range in background. (3500 meters)

The only access to inhabited valleys of Zanskar tehsil of Kargil district is through high passes located in the Zanskar range. Some important mountain passes are Purifi La (3,950m), Namtse La (4,350m), Charcha La (5648m), and Pensi La (3950m). While the first three passes connect Leh district with the Kargil distcrict, whereas the last one connects the Kargil tehsil with Zanskar tehsil situated to its south. Average altitude of the range varies from 5,000 meters to 6,000 meters above mean sea level. Highest peaks of Zanskar range are Yan Kangri (6,265m), Stok Kangri (6,153m), and Meru (5,748m).

All these ranges provide barren rocky surfaces largely devoid of soil and vegetation cover. The average altitude varies from 5,000 meters to 7,000 meters above mean sea level. Owing to these characteristics, all these mountain ranges are not suitable for human settlements in general and agriculture in particular. Therefore, settled agriculture is confined to areas below 4,500 meters above mean sea level which comprises mainly of river valleys.

2. The Plateau Region

The eastern part of Leh district presents typical plateau and is commonly referred to as Changthang. The plateau is less rugged compared to the mountains, yet it is of little use for agriculture owing to very high altitude causing extremely cold conditions, high aridity and extensive rocky surfaces. However, land lying between 4,500 meters and 5,000 meters, constituting approximately 5 per cent of the total area, permits some pastoral activities. The people of this area are nomads called '*Changpas'*, who live in tents called '*rebo'* and keep on wandering in search of grazing land for their herds of cattle, sheep and goats. While moving from pasture to pasture, they exchange goods like butter, cheese, wool, meat and hides, which provide them with livelihood security.

The following are the sub-divisions of Changthang:

I. Rupshu Plain

Rupshu plain is situated in the south-eastern part of Leh district, lying to the south of Indus river. It is "one of the loftiest regions of the world"[40], having altitude ranges

[40] Cunningham, A. (1970), *op.cit.*, p.22.

from 4,600 meters to 5,000 meters above mean sea level. Despite high altitude, the plain is inhabited by *Changpas* nomads who keep on wandering with their herds of sheep, goats and yak. Their population is extremely low and is mainly concentrated in Hanle valley and near Tso Morari Lake. A few hamlets are also located near the springs and other small lakes.

II. Lingzithang Plain

Lying between Chang-Chenmo valley and Kunlun ranges, this plain is located at an elevation 4,500 meters above mean sea level. It is wonderfully even as compared to other parts of the plateau, which is dotted with small lakes and has little or no vegetation. These wide plains, which are bare in character and dry in nature, get exposed at noon to sunrays uninterrupted and the air produces mirage.

The plateau is relatively less rugged as compared to mountains and is "wonderfully even", yet it is of little use for human settlements mainly because of the followings:[41]

a) High altitude generally above 4,500 metres which makes the climate inhospitable;
b) Aridity of land with an inland drainage that provides limited and highly uncertain water supply; and
c) Extensive rocky surfaces either with very thin or no soil cover.

Animal rearing used to be the main economic activity of Changthang. However, with the advent of tourism industry in recent years, a shift in the economy is seen and nomads from Rupshu, Kharnak etc. have started migrating to areas around Leh town to work in tourism as guides, cooks, drivers, or to join the army. Area near Tsomoriri lakes has also become a tourist destination resulting in many families running restaurants and slowly giving up their traditional occupation.

Agricultural activities in Changthang region are almost negligible and are mainly practised in river valleys as discussed above. Even in the river valleys, cultivation is a difficult task because of harsh terrain and severely cold climate.

[41] Singh, Harjit. (1981), *op.cit*. p. 81

Fields are irrigated with the help of *khuls* which are narrow channels carrying water from rivulets and streams to agricultural fields.

Since the entire area is elevated, there is a strong correlation between altitude and environment inhospitality, and areas lying above 4,500 meters appear to be unfit for human settlement and agricultural activities. This is because of unbearable cold climate above 4,500 meters and extremely short growing season. The initial requirements, which confront the society and their agricultural activity to survive and overcome the vigour of natural environment, are suitable land for agricultural activities and availability of water for irrigation. These characteristics are found in the river valleys due to located lower elevation. Therefore, it becomes important to study the river valleys in order to have an idea about the land available for cultivation.

3. The River Valleys

The river valleys occupy lower parts of Leh district at an elevation ranging from 2,500 meters to 3,700 meters above mean sea level. Forming narrow and relatively flat parts of the region, these play a significant role in settlements of the area as these provide suitable land for agricultural activities. Being situated at lower elevation, these experience relatively milder climate, thus support most of the population. It is because of this that majority of villages are situated along the banks of rivers. These provide flat river terraces and alluvial fans suitable for agriculture, proximity to water for irrigation and relatively less severe climate.

Though the river valleys occupy a very small proportion of Leh district in terms of areal extend these have great significance in human geography and agricultural geography of Ladakh. The important river valleys of the region are as follows:

I. Indus Valley
II. Shyok and Nubra Valleys
III. Hanle Valley

I. Indus Valley

Indus valley lies in-between Ladakh range and Zanskar range situated to its north and south respectively. The valley has large stretches of undulating land around it

interspersed by high mountains which have many passes. With an area of 10,360 square kilometres and width ranging from 4km to 6km, this valley is longest and broadest valley of Leh district. General direction of the valley is from south-east to north-west covering more than eight per cent of area of Leh district. Its upper course is barren and rocky, and is devoid of natural vegetation except for patches of grass found in immediate vicinity of the river channel. As a result, the valley is sparsely populated in the upper section. It becomes flatter and wider at its junction with other small tributary valleys. Hence, majority of settlements are concentrated in and around the central and lower course of the valley, which offer habitable conditions in terms of wider and flatter stretches of land.

Most of the villages are situated close to the rivers while some villages are also on adjacent glacio-fluvial fans and talus cones depending on suitability of land for agriculture. Important villages found in this section are Gia, Hemis, Stakna, Thiksey, Shey, Chushot, Choglamsar, Spituk, Phey, Nimoo, Saspol, Basgo, Nurla, Khaltse, Takmachik, Domkhar, Skurbuchan and Dah. Leh town, the district headquarter is also situated in this valley close to the right bank of Indus river at an elevation of 3,500 meters above mean sea level.

The Indus valley is known as the Orchard house of Leh district. Here a variety of cash crops such as fruits like apples, apricots, walnuts and vegetables such as cauliflower, potatoes, onion, and cabbage etc. are grown. Apart from these, main food crops grown here are barley, wheat, buckwheat, and green peas. Generally, two crops are annually grown in the lower reaches of the valley. Important villages of this part are Khaltse, Takmachik, Domkhar, Skurbuchan and Dah etc.

II. Shyok and Nubra Valley

Shyok and Nubra valleys are formed by both the rivers flowing down southern slope of Karakoram range carving deep valleys which are approximately 500 meters wide. Nubra river joins Shyok river at the foot of Karakoram range, and the combined water body is henceforth known as Shyok. From here on, it flows between Karakoram range and Ladakh range situated to the north and south of it respectively.

Upper part of Shyok valley has rocky surface and is therefore, devoid of vegetation cover and human settlement. Middle and lower sections are, however,

suitable for agriculture and horticulture due to favourable climate and availability of flat area. “The river provides a strip of level land having a width of 6 kilometres in its lower section which is consequently more suitable for agriculture and for the growth of grass and short trees compared to its upper section”[42]. It can be compared with that of the Indus valley in terms of width, availability of land and suitability of climate.

Nubra valley originates when the river flows down from Siachen glacier. It runs parallel to upper Shyok and joins the latter in its middle section near Diskit. Though the main river of the area is Shyok but the area is popularly called Nubra Valley. With an area of 23,869 square kilometres, it lies directly to the north of Leh across Ladakh range. Its average elevation is about 3,048 meters above mean sea level. The valley bottom is composed of alluvial sand and stones over which the river flows in a broad bed with braided channel. The valley is flanked by high barren mountains on both sides forming walls of solid rock broken only by narrow side gorges, dividing the wall into numerous sections. The gorges have formed symmetrical “fans” radiating out broadly from the narrow openings and extend to middle of the valley. Villages are situated on these “fans” scattered throughout the valley as fertile spots. Availability of irrigation facilities and gentler slope supports concentration of population. The main villages are Diskit, Khalsar, Summor, Hundar, Thois and Partapur.

This valley is also luxuriant and fertile like the Indus valley. Its climate is quite conducive for growing variety of fruit crops such as apples, apricots, pears, grapes and vegetables like potatoes, cabbage, cauliflower and radish. The main food crops grown here are barley, wheat and green peas. The valley is also endowed with vast patches of various trees like poplar and willows. Its gentle slopes are covered with thick grass and flowers during summer months, giving it the name of Nubra, which means the ‘valley of flowers’ and it is an open valley[43]. Double humped Bactrian camels of Central Asia are also found here.

Nubra valley has Shyok river which is major tributary of Indus in Leh district along with sub-tributary of Nubra river, both originating in Karakoram range, while

[42] Singh, Harjit (1978), “Ladakh: Problems of Regional Development in the Context of Growth Point Strategy”, Unpublished Ph.D. Thesis submitted to Jawaharlal Nehru University. p. 33
[43] Singh, Harjit (1978), *op.cit*. p. 41

Nubra river rises from Siachen glacier on the southern slopes of the range and Shyok river emerges from the mountain southeast of famous treacherous Karakoram pass, which connects Leh through ancient trade routes with Yarkand[44]. The two rivers form a giant arch and meet just above Diskit village, the largest 'town' of Nubra valley.

III. Hanle Valley

Situated in the eastern part of Leh district, this valley forms core of traditional territory known as Rupsho plain. This valley is more rugged and desolate compared to other valleys. Its average elevation is about 4,500 meters above mean sea level and has severe climate with extremely low temperature and acute aridity. Population living here is extremely sparse owing to very high altitude and harsh climate. It is inhabited by mainly by *Changpa* nomads, whose herds depend on limited vegetation found near springs and lakes. The valley has a vast expanse of sedge-meadows which act as pastures for domestic and wild animals.

It is clear from the above that river valleys form the most important physiographic unit of the region as these provide bulk of cultivable and habitable land in an otherwise negative environment. Along with river valleys, mountain ranges, and plateaus mark the topography of Leh District. Of all the valleys, only lower part of Indus and Nubra valleys permit cultivation of two crops in a year. Arid climate, highly rugged relief and high altitude make the region difficult for habitation, and cultivation is possible only during short summer season.

2.3 Natural Drainage and Water Resources

Study of natural drainage network provides an overview about the topography, climate, geology, and hydrological features of a region. Natural drainage is formed by streams, rivers, and lakes in a particular region, and is an important natural agent in sculpturing landform. Drainage pattern and basin characteristics of a region greatly influence location of human activities especially in mountainous regions. Human activities generally tend to occur in the vicinity of water bodies such as rivers and streams. These water bodies provide flat land with agricultural potential in terms of river terraces, alluvial fans and talus cones. With relatively thicker soil

[44] Cunningham, A. (1970), *op.cit.* p.21

cover and availability of water for irrigation, such areas are easily put under plough. Therefore, it becomes important to analyse drainage in order to assess the role of natural environment and its impact on socio-cultural and economic aspects.

I. Important Rivers

Leh District is drained by a number of mountain tributaries of Indus river except in north-eastern part of Lingzhitang and parts of Rupshu plains, which have drainage converging into a few brackish lakes. Most remarkable feature of rivers in Leh District is the general parallelism of their courses, which is due to the direction of principal mountain ranges. Common name for a river in Ladakh is *'chhu'* meaning water, generally, a river as *Singge-Chhu*, the Lion River or Indus, and *Zanskar-Chhu*, Zanskar river. Smaller streams are called *Dok-po* meaning "narrow water". Indus is the master river of Leh District and Shyok-Nubra, Zanskar and Hanle rivers are its prominent tributaries. Among its tributaries, Shyok-Nubra river is relatively more significant compared to Hanle river. These rivers and streams generally originate from glaciers. Following are the main rivers of Leh District:

a) Indus River

The name Indus originated from a Sanskrit word '*Sindhu'* meaning- river, stream or ocean. In Tibet, the river is known as Singge-Kha-babs i.e. the river that rises from lion's mouth. It originates from glaciers in western part of Tibetan plateau in the vicinity of Mount Kailash and Lake Manasarovar at an elevation of 5,180 meters above mean sea level. The river flows in a north-westerly direction and enters Leh District near Charding La close to Demchok village in Changthang area. After flowing through a barren mountain landscape and plunging down narrow gorges, it takes sharp turn south of Pangong Lake and cuts through Ladakh range, and then flows between Ladakh range and Zanskar range. It finally leaves Ladakh in the west near Gilgit and traverses down along the entire length of Pakistan to merge into Arabian Sea near the port city of Karachi in Sindh Province. Total length of Indus in Ladakh region is 430 kilometres. The river has a steep gradient and the valley is very narrow in its upper course. It becomes gentle in its central course and forms numerous alluvial fans, extensive flood plain and river terraces, which provide fertile and levelled land suitable for farming. Consequently, most of the settlements and cultivation are found in the central and lower course.

Indus river is joined by many rivers and mountain streams during its journey through Ladakh. The most important right bank tributaries are Shyok and its tributary Nubra, both originating in Karakoram range. Nubra joins Shyok near Diskit which subsequently joins Indus near Skardu. Zanskar river merges with Indus on its left bank at Nimoo and the confluence is known as *Nimoo-Ralpa.* Other tributaries of Indus are Suru, Wakha and Drass which flow in Kargil district.

b) Shyok River

Shyok river, an important mountain tributary of Indus river. It originates from Rimo glacier in southern slopes of Karakoram range at an elevation of 6,983 meters above mean sea level. After flowing westward in its initial stage, the river turns southeast and is joined by the Chang-Chenmo river, and finally makes a U-turn to flow towards the northwest and is joined by Nubra river near Diskit village. Shyok river joins Indus river at Keris situated to the east of Skardu town. It has a total length of about 489 kilometres in the region. Its upper course is turbulent and the surface is rocky, making it unsuitable for farming. At the point of confluence with Nubra, it forms wide valley with sides covered by series of alluvial fans and wide flood plain.

c) Nubra River

Nubra River is a right-bank tributary of Shyok river. Originating from Siachen glacier, it flows in the south-east direction and joins Shyok river near Diskit village. It has a total length of about 90 kilometres.

d) Hanle River

Hanle River is one of the important left-bank tributaries of Indus River. It originates in the snowy wastes on northern slopes of Zanskar range in eastern Ladakh. It flows towards north by north-west course and joins Indus near Loma. Total length of Hanle river is about 97 kilometres. It drains area to the east of Tsomoriri Lake in Rupshu plain The river is main source of fresh water in rocky and rugged terrains of Rupshu plain. It serves *Changpa* nomads who find relatively better pastures for their herds in vicinity of the river channel.

e) Zanskar River

Zanskar river is one of the principal left-bank tributaries of Indus river. It has two main branches, first branch; the Doda with its source near the Pensi-La (4,400 m) mountain pass and the second branch is formed by two main tributaries known as Kargyag river, with its source near the Shingo-La (5,091 m), and Tsarap river, with its source near the Baralacha-La. These two rivers unite below the village of Purne to form the Lungnak river, which flows north-westwards along a narrow gorge towards Zanskar's central valley, where it unites with Doda river to form Zanskar river. This river then takes a north-eastern course through narrow steep walled gorge and finally joins Indus near Nimoo village. The head-waters of the Zanskar river are Yunam, Serchu and Sherpa, all of which rise to the north of Great Himalayan range near Bara Lacha Pass[45]. It has a total length of about 370 kilometres. The river remains frozen or with meagre water during winter months from November to May.

One of the important characteristics of all these rivers is that these have compact channels with a few cases of braided channels at some place, e.g., Shayok near its confluence with Nubra and Indus between Shey and Thiksey. All rivers are perennial and even small streams are fed by glaciers situated in higher parts of mountain ranges. Volume of water in these rivers is determined by the amount of snowfall through-out the year and heat during summer months. Most of human activities are confined to the banks of these rivers and streams, which provide relatively fertile soil and water for irrigation which are necessities for crop cultivation.

Drainage pattern denotes the geometric arrangement of streams in a particular region. Different types of pattern of drainage can be seen in Leh district. Firstly, trellis pattern of drainage is formed by left bank tributaries of Indus such as Zanskar and Hanle at their points of confluence with Indus. Secondly, dendritic pattern of drainage is seen by many smaller tributaries. Thirdly, Rectangular pattern of drainage is noted mainly in the eastern part of Zanskar range. Streams of Lingzhitang and Rupshu Plains converge into brackish lakes forming centripetal pattern of drainage.

[45] ibid. p. 96

In high altitude regions agricultural land is mainly confined to river valleys. Thus, the length of rivers provides a rough idea about the extent of agriculturally suitable land associated with each. The length of the various rivers[46] flowing through Leh District is given below:

Table 2.3

LENGTH OF DIFFERENT RIVERS[47]

Name of the River	Length (Kms)
Shyok	489
Indus	430
Zanskar	116
Hanle	97
Nubra	90

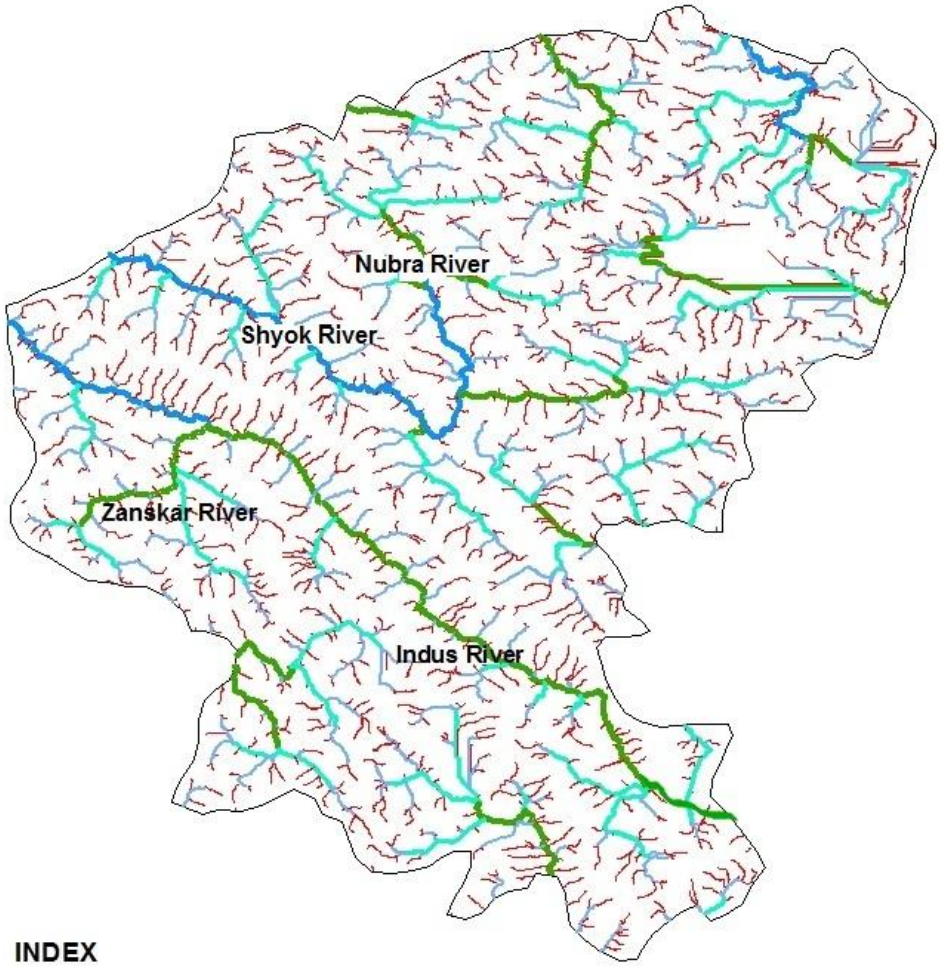
Table 2.3 shows that Shyok river, a tributary of the Indus river, has a total length of 489 kilometres. It is followed by Indus river with a total length of 430 kilometres, which is the main river of the district. Zanskar river, a north-flowing tributary of the Indus, comes next with a total length of 116 kilometres. The total length of Hanle and Nubra is 97 kilometres and 90 kilometres respectively. All these rivers, flowing through the district, provide a perennial source of irrigation to a large area.

[46] Singh, Harjit (1978), "Ladakh: Problems of Regional Development in the Context of Growth Point Strategy", Unpublished Ph.D. Thesis submitted to Jawaharlal Nehru University. pp.41

[47] It may be noted that the length of the rivers as given above is approximate. The length of the river has been measured from the point of its entrance into Ladakh up to its confluence with the Shyok river.

Map 2.3

STREAM ORDERING
LEH DISTRICT



INDEX

ORDER NUMBERS

1
2
3
4
5

Kilometers
0 15 30 60 90 120

II. Stream Ordering and Bifurcation Ratio

Stream ordering provides an idea regarding the dimension of basin of each tributary and extent of water discharge. There exists a positive correlation between water discharge and width of the valley with the stream order. In other words, higher the order of the stream, wider would be the valley and higher would be the water discharge. In terms of this relationship, valley of Indus is most important from the point of view of water availability and width of the valley followed by valleys of Shyok and Zanskar.

Map 2.3 and Table 2.4 show stream ordering and bifurcation ratio in Leh District. Among all the tributaries of Indus, Shyok has largest basin followed by Zanskar river. Shyok river attaints fifth order and appears to carry maximum water and sediment discharge. Zanskar is the only left bank tributary which attaints fourth order before its confluence with Indus. Bifurcation ratio is the ratio between the number of stream segments of a given order and number of streams of next higher order in drainage network. Table 2.4 shows the bifurcation ratio of basins of different tributaries of the Indus and that of the Indus itself.

Table 2.4

BIFURCATION RATIO OF RIVERS

Name of the River	Bifurcation of different orders of streams				
	I:II	II:III	III:IV	IV:V	V:VI
Zanskar	5	3.6	5	+	+
Shyok-Nubra	4.9	4.5	5	1	+
Hanle	5	3.6	5	+	+
Indus	4.8	5	5.2	1.6	3

Source: Singh, Harjit. (1978), *Ladakh – Problems of Regional Development in the Context of Growth Point Strategy*, Unpublished Thesis, New Delhi: Jawaharlal Nehru University.

It is evident from the above table that bifurcation ratio between the first and second order streams is five or close to it in case of all streams. Further, it shows that the ratio between the second and third and order streams varies from three to five. The ratios between the third and fourth order streams do not vary much in most of the basins. It may be inferred that higher the ratio of streams in the lower order, more would be the size of catchment area, which, in turn, is positively correlated

with volume of available water. Higher the volume of available water more is likely to be the extent of land suitable for cultivation and potential for irrigating agricultural fields. Indus river is the most important river of Leh district in terms of suitability of valley for agricultural purposes. Among its tributaries, Shyok and Nubra are relatively more significant compared to Zanskar and Hanle rivers.

Eastern part of Leh district comprising Lingzhitang and Rupshu plains, constitute an area of inland drainage. There is no large stream in the region. Small streams rising either from western Loqzung mountains or from southern slopes of western Kun Lun mountains, discharge their water into Aksai Chin, Tso Tang, Pangong Tso, Tso Moriri, Tso Kar and other small lakes situated in this region in Rupshu plain. The region as a whole faces acute water scarcity and therefore, the territory is largely a desert in character with only a few oases dotted over it either close to small streams or lakes.

III. Lakes

Lakes, a significant hydrological feature of Leh district, are generally formed when a bowl-shaped depression is filled with water. In the eastern part of Leh district, the undulating land of high altitude plateau has huge basins with no outlet, into which the snowmelt streams fall into great brackish lakes. Lakes in this region are generally called '*Tso'*. These lakes are situated at an elevation of about 4,300 metres above the mean sea level. Important among the lakes are;

a) Tso Moriri and Tso Kar Lake

Tso Moriri Lake is situated in eastern upland of Rupshu. It lies at an elevation of 4,450 metres above the mean level. It is about 20 km long with width varying from 5 to 8 km and has average depth of 10 feet. It is brackish lake with deep blue colour. Tso Kar Lake lies to the north-west of Tso Moriri and is situated at elevation 4,530 metres and is greenish in colour. Water of Tso-kar is so brackish that *Changpas* extract salt from it to trade with merchants from rest of Ladakh.

b) Pangong Tso

Pangong Tso is situated in the eastern part of Leh district at an altitude of 4,180 metres above mean sea level. It is said to be among the largest blackish lakes in

Asia. It is about 6 km in breadth and over 130 km in length. It is very long, narrow basin of water, extending from east to west and stretches across the border into Tibet. More than half of it lies in Tibet. Chushul stream enters the lake but because it has no outlet, the water has salt and mineral content.

Brackish nature of water and their location in the arid area has greatly restricted their agricultural significance. At present, however, these are used by nomads who find a few green patches for their herds in proximity of the lakes.

IV. Water Resources

Above discussion on natural drainage shows predominance of first and second order streams in Leh district. These reflect scarcity of water resources in the district. In winter months most streams get frozen due to extreme cold, which further adds to water paucity in the region. Amount of available water in these streams depends on fluctuating climatic conditions in terms of temperature variations affecting snow melt, amount of precipitation and other related factors. Uncertainty and seasonal variations have greatly enhanced the chronic water shortage in some villages, whereas it causes floods in some low lying fields in some other villages. In general, villages are mostly situated in valleys at higher altitude than the level of water in the main river. Thus, small tributary streams that flow into the main river are primary source of water utilised for irrigation. Water for irrigation is diverted through *kuls* or irrigation channels from the side valley streams to agricultural fields.

Apparent lack of adequate water resources and non-availability of adequate quantities of water in the right season are among most important problems faced by the inhabitants. This can be adequately addressed by improving methods of irrigation such as introducing small and medium projects and by introducing mechanised lift irrigation at select favourable sites. Besides, the existing system of *Kuls* can also be improved by increasing their size and lining them to prevent seepage from the point of origin of village head-works. At present level of technology, water sources are limited to the flow from side tributaries which in turn depend on climatic parameters. These two factors of low technology and low precipitation with the general water scarcity constitute major environment constraints on agricultural economy of Leh district. Apart from rivers, agriculture is also equally determined to a large extent by quality of soil in the region.

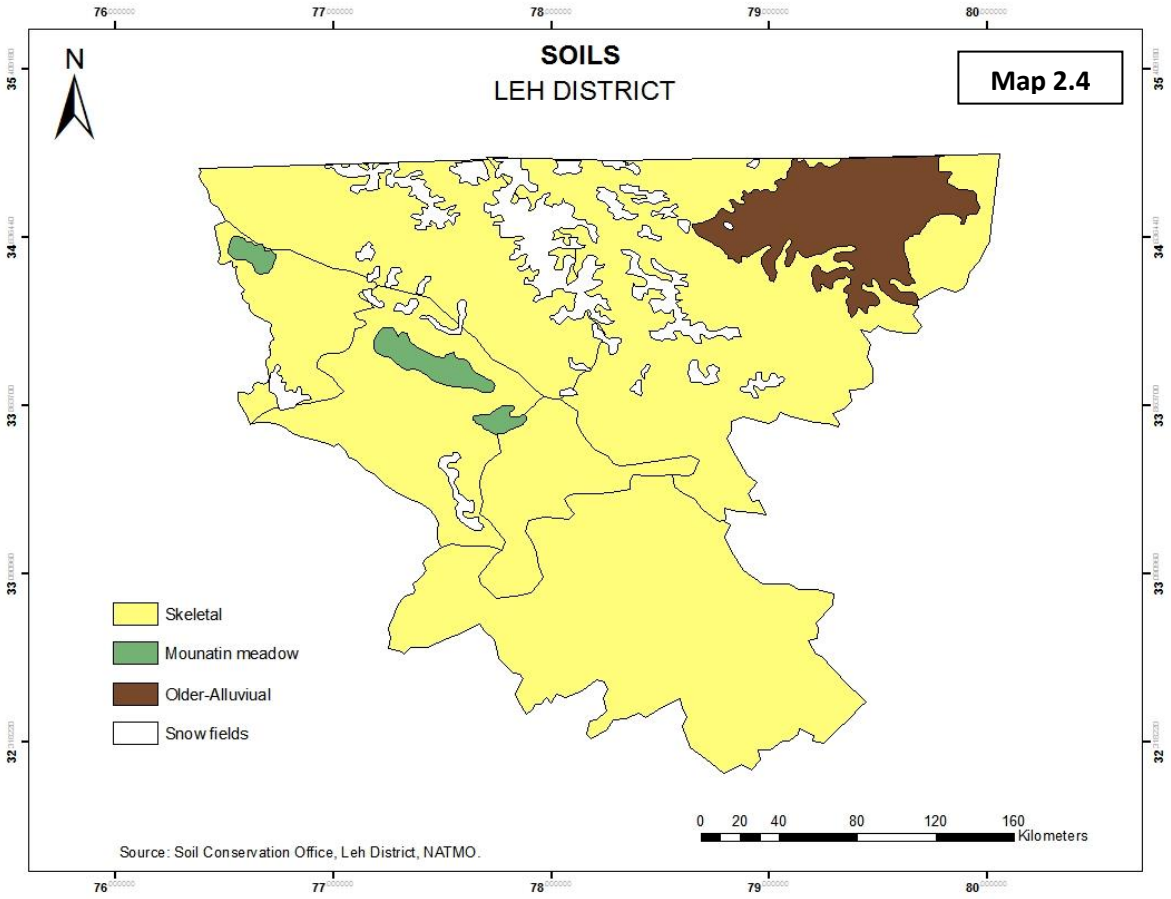
2.4 Soil Type

The physical and chemical composition of soil differs from one area to another depending on altitude, vegetation cover, slope, underlying rocks, structure and stage. There are mark differences in soil between valleys and uplands. Soils found in valleys range from gravelly and sandy loams on alluvial fans and sandy to silty clay loams on flood plain. This category of soil is less stony as well as rich in fertility as it has been formed by deposits of sediments, detritus carried by number of small rivulets. As against this, soil is shallow and stony in upper parts which in turn impede fertility. Main characteristics of mountain soil are immaturity, highly porous nature with high proportion of sand, shallowness and poverty of nutrients on account of leaching and erosion. Therefore, soils found in Leh district are broadly categorised as mountainous skeletal type (Map 2.4).

At higher altitudes of mountains, soils do not get properly developed because of the moderate chemical weathering, mass movement, strong fluvial erosion, practically insignificant wind action and low temperature[48]. As a result, higher areas of slopes and summits have skeletal soil consisting of rock fragments and are not suitable for agriculture. Mountain meadow soils are comparatively more suitable for human settlements, cultivation and for the growth of natural vegetation. This type of soil is found mainly in river valleys and on moderate and gentle sloping area. Texture of soil is fine on glacio-fluvial fans and river terraces compared to those found on upper slopes which have coarser texture. It becomes coarser as altitude increases.

In general, the soils of this region are poor in moisture content due to intense insolation, and rapid radiation and aridity of the region. These are also characterised by low organic matter content and poor water retention capacity.

[48] Singh, J. and Dhillon, S.S. (2006), *op.cit*., p. 51


SOILS
LEH DISTRICT
Map 2.4
N
Skeletal
Mounatin meadow
Older-Alluviual
Snow fields
0 20 40 80 120 160
Kilometers
Source: Soil Conservation Office, Leh District, NATMO.
76
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78
79
80
35
34
33
32

The pH value of soil ranges from 7.4 to 9.5.[49] A study conducted by Defence Institute of High Altitude Research (DRDO), Leh, reports that available nitrogen is low in category because of the slow mineralization process. Available phosphorous is generally low i.e. 2.35- 137.4 Kg/ha, available potassium was found to be high i.e. 11.2-496.15 Kg/ha, while extractible micronutrients like Zinc, Copper, Iron and Magnesium are generally deficient in this cold arid region.

Table 2.5

MECHANICAL ANALYSIS OF SOILS

Place	Course sand (%)	Find sand (%)	Silt (%)	Clay (%)	Textural class
Drass	0.88	19.82	53.90	25.00	SC
Kargil	6.44	61.10	3.30	20.50	LC
Leh	**4.17**	**24.83**	**2.50**	**8.50**	**LS**
Suru	1.00	58.55	28.50	12.00	L
Zanskar	3.77	54.82	15.00	25.50	SC

Source: Department of Agriculture, J&K State.

SC = Silt Clay; **LC = Loamy Clay;**

LS = Loamy Sand; **L = Loam** **SC = Sandy Clay;**

Table 2.5 reveals that soils of Leh district fall under Loamy sand textural class. It has 24.83 per cent Fine sand, followed by 8.50 per cent of Clay. Course sand consist of 4.17 per cent. It has only 2.50 per cent of Silt.

It is clear from the above analysis that soils of Leh district are broadly categorised as mountainous skeletal type. The soils of this region are characterised by immaturity, low organic matter content and poor water retention capacity. However, soil texture is fine on the glacio-fluvial fans, river terraces and flood plains. Therefore, agriculture is mainly confined to river valleys, which have more calcareous soil that are alkaline in nature. Large areas under shallow skeletal calcareous soils in lower areas has been brought under cultivation while upper areas covered by soil are used as pasture land for grazing purposes during summer months.

[49] Ramila et al. (2008), "*Agriculture in Ladakh: Continuity and Change: A Status Report*", for Guyrja: TATA- LAHDC- Development Support Programme, Mumbai, p. 6

2.5 Climate

Climate is one of the important elements of natural environment that exert significant influence on human activities, particularly on crop cultivation. Crop producing capability of a given region is dependent mainly on existing climatic conditions[50]. The success and failure of crops is closely linked to climate in areas of harsh environment. From the perspective of plant response, the most important factors of climate are temperature, water supply and light. In fact, the major climatic elements influencing plant growth and development are day-length, the amount of solar energy received, the amount of precipitation available for transpiration, temperature during the growing season. All these factors restrict kinds of crops and types of livestock that can be raised. Since climatic factors exert mainly regional influence on plant life, the differences in behaviour of a crop or a group of crops over extensive areas, as in a given state or a group of states, may be considered as due primarily to differences in climatic rather than soil conditions[51].

The most important factors that control and influence various aspects of climate are altitude, location and relief. High altitude mainly affects temperature and atmospheric pressure. "With an increase of 305 metres, it tends to fall by 3.5° C and at the same time at an elevation of about 17,500 feet (5.331 metres) above sea level, pressure is reduced to approximately one half its value"[52]. There are wide variations in day and night temperatures in Leh district. Nights are cool in summer, and temperature goes below zero in winters. Summers are short and mild and winters are long and bitter. The entire region lies in rain shadow zone of Great Himalayan Range, which acts as an effective barrier to moisture laden Monsoon winds. Consequently, the region receives less than 10 cm annual precipitation[53]. Precipitation rapidly decreases eastward even within Ladakh; Drass receives 64.8 cm. as against Leh located further east, which gets only 9.1 cm. of annual precipitation. Most of the precipitation occurs in the form of snowfall during winter months. Winter season begins from September and lasts till March-April followed by the spring that lasts up to end of May. The next four months from June to

[50] Singh, J. and Dhillon, S.S. (2006), *op.cit*., p. 60
[51] Klages, K. H. W. (1958), *"Ecological Crop Geography"* New York, Macmillan, p.III.
[52] Trewartha, G.N. (1968), "An Introduction to Climate", McGraw-Hill, New York, p. 399
[53] Singh, Harjit (1978), *op.cit*., p.51

September are summer months. October and first half of November marks the transition phase. Highly uneven relief produces strong intra-regional climatic variations even within small areas. Therefore, the region exhibits extreme climatic conditions in terms of cold and excessive dryness.

Despite such harsh environmental conditions, local people have not only come to terms with extreme physical conditions, but also have developed an agricultural system that has sustained its economy for centuries. In recent years, however, there have been rapid changes in its agricultural economy in terms of change in cropping pattern from traditional crops towards commercial crops. It is, therefore, necessary to analyse the important climatic variables that govern the entire agricultural calendar of this region. Most important climatic elements are temperature and precipitation, which, in turn help in assessing crop structure and productivity so that environmental constraints can be comprehended.

1. Temperature

Of all the climatic elements in Leh district, temperature is the most important because it restricts growing season. This is due to occurrence of lower than required values over substantial part of a year and of high fluctuation in it. Variations in temperature conditions are most significant in affecting crop cultivation as most of plants have their threshold temperature requirements. Each species has its own minimum and maximum temperature beyond which its life activity ceases[54]. In order to thrive well, most of plants require a threshold temperature of 6^0 Celsius as minimal thermal requirement for substantial growth in temperate crops. Temporal and spatial variations of temperature, therefore, deserve a closer scrutiny.

The daily maximum and minimum temperature in Leh District for selected months given in Table 2.6 and Figure 2.1 shows January to be coldest month, with minimum temperature of -15.39˚C, and August the warmest month with a maximum temperature 25.08˚C. Furthermore, it reveals that maximum monthly temperature ranges from 0.13˚C in January to 25.08˚C in August, while minimum monthly temperature varies between -15.39˚C in January to 12.63˚C in July. Mean annual temperature of Leh is 6.4˚C. Temperature rises from March to August and shoots up

[54] Kochar, P.L. (1967), "*Plan Ecology, Genetics and Evolution*", Atma Ram and Sons, New Delhi, p. 10

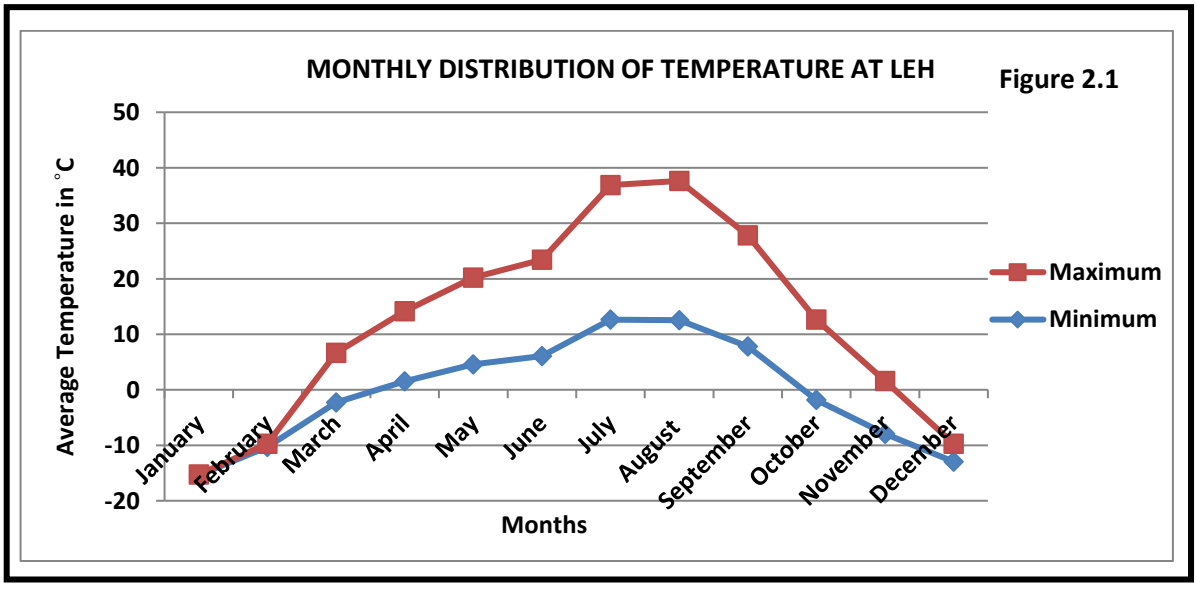
25.08˚C in August. Significant temperature value for plant growth begins in the month of April and lasts up to October beyond which farming activities are not possible. Below freezing temperatures for nearly half a year greatly limit the length of agricultural season and hence the pattern of agricultural economy.

Table 2.6

MONTLY DISTRIBUTION OF TEMPERATURE AT LEH (˚C)

Month	Minimum	Maximum	Mean
January	-15.39	0.13	-7.63
February	-10.32	0.59	-4.86
March	-2.26	8.9	3.32
April	1.53	12.62	7.07
May	4.6	15.58	10.09
June	6.1	17.36	11.73
July	12.63	24.23	18.43
August	12.55	25.08	18.81
September	7.8	20.01	13.90
October	-1.85	14.5	6.32
November	-7.92	9.5	0.79
December	-12.97	3.23	-4.87

So**urce:** Defence Institute of High Altitude Research, C/o 56 APO



2. Precipitation

Amount of precipitation is largely governed by location, altitude and topography of a region. Since Leh district lies in rain shadow zone of Great Himalayan Range, which acts as an effective barrier to moisture laden Monsoon winds, the mount of precipitation is very low. The entire district experiences arid and semi-arid conditions with inter-valley variations. Most of precipitation falls is in the form of snow during winter months. Occurrence of precipitation during the cold winter season reduces to a large extent its direct utility for agriculture. Precipitation, therefore, has negligible direct role to play in agricultural economy of Ladakh[55]. Thus, cultivation without irrigation is not possible.

Table 2.7

MONTHLY DISTRIBUTION OF PRECIPITATION AT LEH

Months	Rainfall (in millimetres)	Snowfall (in centimetres)
January	0	1.5
February	0	7.0
March	0	1.1
April	41.1	8.8
May	19.6	6.7
June	35.5	0
July	2.5	0
August	58.4	0
September	12.5	0
October	0	0.9
November	0	0
December	0	9.7
Total	16.96	35.7

Source: Defence Institute of High Altitude Research, C/o 56 APO

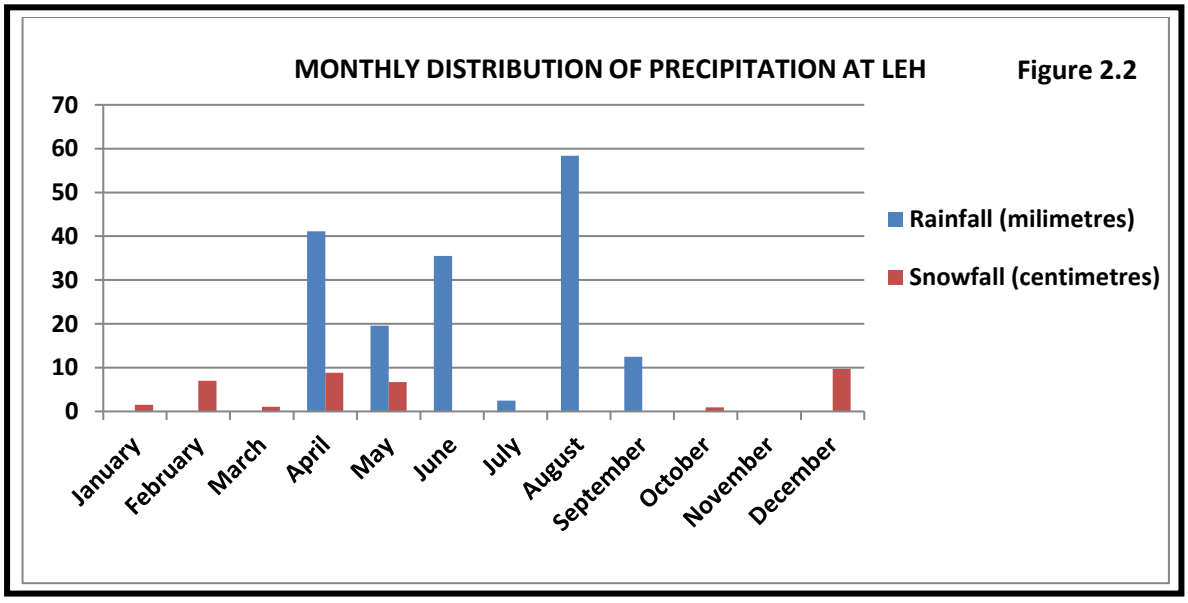
Table 2.7 and Figure 2.2 reveal that maximum rainfall occurs in the months of August, followed by April and June in Leh district. The region receives an annual precipitation of 52.66 millimetres which includes snowfall of 35.7 centimetres. Amount of annual rainfall is 16.96 centimetres which is almost insignificant for crops. Highest snowfall i.e. 9.7 centimetres is recorded in December followed by April, February, May, January and October in that order. Significant amount of snowfall i.e. 6.7 centimetres is recorded in the sowing month of May which is

[55] Singh, Harjit, (1981), *op.cit*. p. 88

important for plant growth in providing moisture but very low temperature in this month may damage crops.

The above analysis shows that the region acutely suffers from deficiency of moisture vital for plant growth. Deficiency of moisture is mainly met by using water through irrigation channels from melt-water streams. People work as a community in constructing and maintain these irrigation channels, which are the main source of irrigation in the region.

It becomes clear from the above discussion that Leh District has harsh climate in terms of low temperature and precipitation that contributes to cold and arid conditions, which in turn, affect agriculture. Below freezing temperatures for nearly half a year greatly limit the length of agricultural season. Corresponding to the ground thaw in April and below freezing minimum temperatures in October, the agricultural season is limited from May to September.



To conclude, Leh district exhibits a system of alternating valleys and mountain ranges, except the eastern part which is a plateau region. Though the mountain ranges form the most important physiographic features of the district in terms of areal coverage presenting a positive physical relief, these are almost totally negative from the point of view of agricultural activity. High altitude mountains ranges restrict land available for cultivation as large tracts of land are either devoid

of soil cover or have too thin soil to sustain crops, mainly due to barren, rocky surfaces and steep slopes. Therefore, crop cultivation is confined to river valleys where soil of fine mature texture occurs mainly on valley floor, river terraces, alluvial fans and talus-cones. Here slope is gentler and land can be cut into terraces.

Characterised by highly uneven topography with snow clad summits at altitude varying between from 5000 to 6000 metres, the district is an elevated territory. Most of the settlements and agricultural activities are confined to river valleys with an altitude varying between 2500 to 4500 metres above mean sea level. The region can be divided into three distinct closed physical units, viz. mountain ranges, river valleys and plateau region. Mountain ranges consist of the Karakoram range, the Ladakh range and the Zanskar range. The river valleys situated at relatively lower altitude, have mild climate and availability of fertile soil that support human population. The eastern part of Leh district presents typical plateau, which is less rugged compared to the mountains and supports some pastoral activities.

Since the region lies in the rain shadow zone of Great Himalayas, which acts as a climatic barrier, occurrence of rainfall is very low which is inadequate in quantity for crops at critical stages of plant growth and flowering. As a result, farming without irrigation is not possible and, therefore, availability of water for irrigation becomes a prerequisite for agricultural sustenance. All agricultural land is concentrated in close proximity to streams or springs. As all crops need water, these streams and springs becomes the major sources of surface irrigation system. Main limitations on irrigation are less usable availability of surface and underground water, high cost of getting it to fields and the nature of crops to be cultivated.

Soils of the region are immature, shallow and poor in moisture content, which hampers the growth of vegetation in higher altitudes and puts a hindrance on suitability of arable land. Most of the soil is sandy clayey in texture and generally acidic in nature. However, there are marked differences in soil between valleys and uplands. The former category of soil is fine clay and less stony as well as rich in nutrients, because it has been formed due to deposition of sediments brought by

numerous streams and rivulets. As against, soil is shallow and stony in upper parts which in turn impede its suitability for cultivation.

Apart from skeletal and immature soils, excessively cold and arid climate is another serious impediment not only for cultivation of crops but also for keeping dairy animals. Cold and arid high altitude climate exert tremendous influence on agricultural land use and cropping pattern. Agricultural activities are carried on within the limits imposed by terrain and climatic constraints. Adverse weather conditions during short growing season continue to pose major limits in the choice of crops to be grown, agricultural operations and pattern. Local people, however, try to weaken the grip of these constraints with the help of local knowledge and technology and have been successful in slightly reducing the adverse impacts of harsh climate on agriculture.

Chapter Three

Land use and Cropping Pattern and Changes Therein

Mountain regions generally present different set of resources, possibilities and constraints for agricultural development. The communities living there make certain adaptations and adjustments to harness the specificities and resources of mountain environment which provide distinctive characteristic to mountain farming. However, this is dependent on the availability and quality of natural resources within the mountain farming. Land is a fundamental resource among mountain communities that provides them with food and livelihood security. Level of its utilization is largely governed by prevailing environmental conditions. Further, land-use and cropping pattern strongly depend on the integration of socio-economic developments, cultural values, external influences, and land tenure. Both land-use and cropping pattern are dynamic aspects of agricultural landscape as these gradually undergo change. Changes in agricultural economy can be captured by analysing changes in land-use and cropping pattern.

Leh district is typical of such areas where nature is hostile and human beings adapted themselves by harnessing possibilities of growing certain remunerative crops. Utilization of land for agriculture has traditionally been the main economic occupation of its inhabitants that has sustained them for centuries. However, the availability of land for cultivation both in terms of quantity and quality has been a major challenge on account of harsh environmental conditions. Both rugged terrain and cold-arid climate put major constraints on human capacity to use land for agricultural purposes. In spite of these impediments, farmers try to exploit available land resource to achieve maximum crop output using limited productive capacity of land with available knowledge and skills. Process of development and general well-being of people in mountains is assessed by intensive utilisation of limited resources in terms of land use and cropping pattern.

With rapid population growth and socio-economic developments, Leh district has witnessed significant changes in traditional land use and cropping pattern in recent years. There have been tremendous changes in land use owing to advent of tourism industry, establishment of army settlements and urbanisation. High demand of food because of increase in population and urbanisation has put agricultural land

under stress resulting in crop intensification and substitution of food-grain crops with commercial crops. There has been a major shift in cropping pattern from traditional food grains to commercial crops over the last few decades owing to improved connectivity and increased access to markets. Ongoing drive for progressive intensification of more remunerative horticultural commercial crops has significantly increased per capita income and improved living standard of people. Therefore, an attempt has been made in this chapter to analyse spatio-temporal changes in land-use and cropping pattern and also to find factors responsible for these.

In the light of the above, it becomes essential to analyse the following to understand changing agricultural economy of Leh district and prevailing socio-economic factors. Thus, an attempt has been made to analyse the followings;

1. Land resources and changes in land-use to see the type and extent of land available for cultivation;
2. Distribution and size of land holdings to see relationship between farm-size and family-size;
3. Cropping pattern to understand increasing importance of vegetable crops over traditional crops;
4. Crop diversification to measure the extent of crop commercialisation;
5. Production of major crops to determine agricultural potential of the region;
6. Average yield to see variations in it across farm-size and altitudinal zones;
7. Cropping intensity to know suitability of some zones to raise two crops in a year;

3.1 Land Resources in Leh District

Land is a fundamental mean of production in an agrarian society without which no agricultural production can take place[56]. Availability of land for farming practices is extremely limited in high altitude mountain areas like Leh district owing to number of adverse physical conditions. Due to rough topography, steep slope and lack of soil cover, the region has small landholdings scattered on undulating terrain that make mechanisation a difficult task. Further, "about 52.57 per cent of the reporting area is

[56]Vikas Rawal (2008), "Ownership Holdings of Land in Rural India: Putting the Record Straight", *Economic and Political Weekly*. Special Article, March 8, 2008. p. 1

either barren or uncultivable due to various location-related reasons"[57]. Cultivable land is largely confined to river valleys at lower altitude. Such land is found on alluvial fans, valley floor and on river terraces and has reasonable soil depth to sustain plant roots and has availability of water for irrigation. It is, therefore, imperative to study distributional pattern of land resources of Leh district to comprehend spatio-temporal variations in land use as well as environmental constraints therein. Land-use data has been analysed from 2001-02 till 2011-12.

Table 3.1

LAND UTILISATION IN LEH DISTRICT: 2001-2011 (are in *hectares*)

Land-Use Category	Year		Change
	2001-02	2011-12	2001-02 to 2011-12
Reporting Area*	45167 (100)	51684 (100)	+6517 (+14.43)
Forest Area	-	-	-
Land put to non-agricultural uses	2908 (6.44)	7092 (13.72)	+4184 (+143.88)
Barren and Uncultivable land	25163 (55.71)	27185 (52.60)	+2022 (+8.04)
Permanent pastures and other grazing lands	1092 (2.42)	-	-
Land under misc. tree crops, grooves not included in net area sown	1148 (2.54)	2639 (5.11)	+1491 (+129.88)
Cultivable Waste	4406 (9.75)	4492 (8.69)	+86 (+1.95)
Fallow other than Current Fallows	116 (0.26)	59 (0.11)	-57 (-49.14)
Current Fallows	118 (0.26)	495 (0.96)	+377 (+319.49)
Net Area Sown	10210 (22.60)	9824 (19.00)	-386 (-3.78)
Area Sown more than once	313 (0.69)	632 (1.22)	+319 (+101.92)
Total Cropped Area	10523 (23.29)	10456 (20.23)	-67 (-0.64)

Source: Computed from Statistical Handbook, Leh District, 2005-06 and 2011-12. **Note:** Figures in brackets denote percentage.

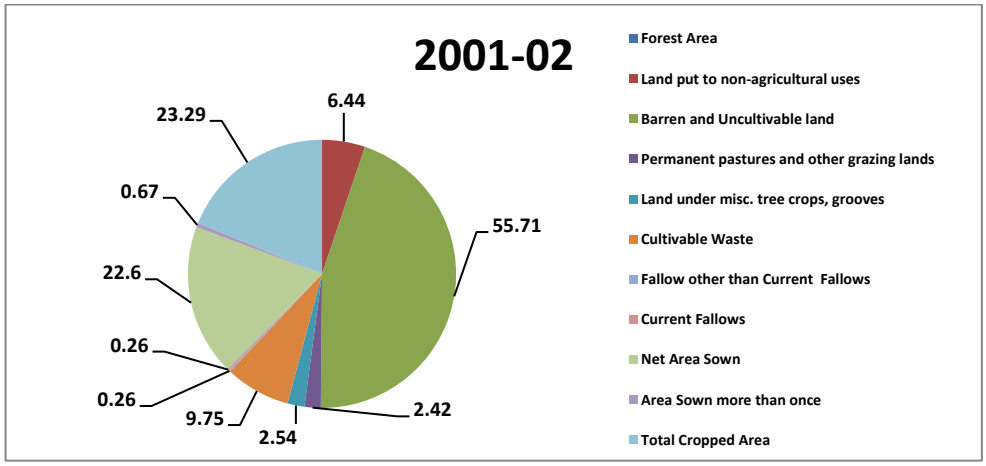
Note*: Reporting area stands for the area for which data on land use classification is available. In areas where land utilization figures are based on land records, reporting area is the area according to village records. In Ladakh, vast land lying outside village boundaries is not included in village records.

[57] Statistical Handbook, Leh District, 2009-10. Note: Reporting area is the area lying within the village boundaries.

It can be seen from Table 3.1 that forest cover is absent in the area and huge part of land is barren and uncultivable, which suggests strong environmental control on vegetation growth even within village boundaries. Scarcity of cultivable land due to harsh environmental factors is reflected in small proportion of land available for cultivation which has marginally declined in the last decade. There is an increase in area sown more than once which seems a positive change despite harsh environmental conditions. As discussed earlier, cold-arid climate restricts the length of growing season. Only one crop can be grown in most parts during this short growing season extending from April to September with some inter-valley variations. It is only in lower areas with altitude of less than 3,000 metres that cultivation of two crops in an agricultural season is possible. Most agricultural fields are small and fragmented. Soil is relatively more fertile in lower areas, while it becomes skeletal in nature with increasing altitude.

LAND USE IN LEH DISTRICT:2001- 2011.

Figure 3.1



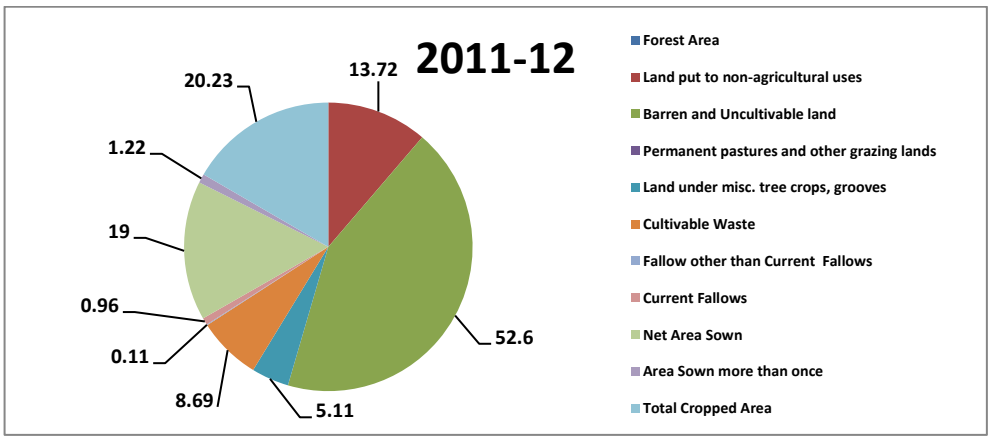


Table 3.1 and Figure 3.1 reveal that largest proportion of 55.71 per cent of total reporting area to be under the category of barren and uncultivable land in 2001-02. It reflects scarcity of land for cultivation in the cold desert. Land under net sown area has next highest proportion of 22.6 per cent of total reporting area. Area sown more than once covered merely 0.69 per cent of total reporting area due to constraining role of environment. There is no area under forest cover. However, land under trees accounting for 2.54 per cent was reported. These trees are generally found in the vicinity of *Gompas* (Buddhist Monasteries) or along water channels and are looked after as carefully tended assets. About 9.75 per cent of total reporting area was under cultivable wastes. Most such lands can be brought under plough provided water for irrigation becomes available. A small proportion of 6.44 per cent of total reporting area was under the category of land put to non-agricultural use. This land is under settlements, roads and other infrastructure. Remaining land was under other categories like permanent pastures and other grazing lands and fallow land etc.

Area under barren and uncultivable land continued to remain the largest category with area accounting for 52.60 per cent of total reporting area in 2011-12. Land under net sown area has next highest proportion with 19 per cent of total reporting area. It reflects the importance of agriculture in the district in spite of unfavourable environmental conditions. Area under land put to non-agricultural uses covered 13.72 per cent of total reporting area. Like earlier time point, there is no area under forest cover. About 8.69 per cent of total reporting was under cultivable waste. There is a slight increase in the area sown more than once, which was 1.22 per cent of total reporting area in 2011-12. Land under miscellaneous tree crops, grooves not included in net area sown accounted for 5.11 per cent of total reporting area.

There have been marked changes in the area under different land use categories during the period under consideration. Largest increase by 319.49 per cent occurred in area under current fallows and but with a slight increase in its share of total reporting area of 0.70 per cent. Next largest increase of 143.88 per cent occurred in area under land put to non-agricultural uses and became 13.72 per cent from 6.44 per cent during 2001-02 to 2011-12. It could be ascribed to the establishment of various infrastructural facilities such as roads, buildings, and hotels on account of huge influx of tourists in the region. Area under miscellaneous tree

crops and grooves increased by 129.88 per cent and became 5.11 per cent from 2.54 per cent of reporting area during 2001-02 to 2010-11. It highlights the nature of serious efforts undertaken by mountain communities to create man-made vegetation belt where undulating unsuitable land for cultivation is being used for tree plantations. Area sown more than once increased by 101.92 per cent during 2001-02 to 2011-12. Major negative change i.e. 49.14 per cent was registered in area under fallow other than current fallow. It could be attributed to increasing use of modem inputs such as hybrid seeds and chemical fertilizers etc. due to shortage of farm yard manure which is rendering some unfit for cultivation. Similarly, area under net area sown also noticed negative change of -3.78 per cent and became 19.00 per cent from 22.60 per cent of total reporting area during 2001-02 to 2011-12. Main reason could be ascribed to increase in area under land put to non-agricultural uses. Remaining area under different categories of land-uses also registered changes between these points of time.

It can be inferred from above that large part of reporting area of Leh district was covered under barren and uncultivable land. It suggests scarcity of cultivable land on account of harsh environmental factors. The region has no forest cover except scanty vegetation, which itself reflects climatic constraints in terms of low precipitation and very low temperature and rocky outcrops which do not allow much of vegetation to grow on large scale. The region also witnessed significant increase in land put to non-agricultural uses with decline in net area sown during the two points of time. It reflects the fact that a large part of agricultural land is being encroached upon for non-farm activities.

Land Use in Surveyed Villages

Table 3.2 shows that largest area constituting 49.88 per cent of village land was under barren and uncultivable land in Domkhar village of lower zone. It was followed by net area sown accounting for 33.33 per cent in 2005-06 which declined to 31.14 per cent in 2015-16. This marginal decline may be due to increase in area under cultivable waste, which increased from 6.57 per cent in 2005-06 to 9 per cent in 2015-16. Land put to non-agricultural use was about 3.89 per cent in 2005-06 and it slightly increased to 4.38 per cent in 2015-16. On the other hand, there has been a considerable decline in land under current fallow during the same period. This could

be due to more intensive cultivation with the help of modern inputs. As is the case in all villages, there was no land under forest.

Table 3.2

LAND-USE IN LOWER ZONE SURVEYED VILAGES OF LEH DISTRICT: 2005-06 TO 2015-16 (area in *hectares*)

Domkhar village	Years		Change in proportion
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	411 (100)	411 (100)	0.00
Forest Area	-	-	-
Land put to non-agricultural uses	16 (3.89)	18 (4.38)	+12.50
Barren and Uncultivable land	205 (49.88)	215 (52.31)	+4.88
Permanent Pastures and other grazing lands	-	-	-
Land under misc. tree, crop, grooves	9 (2.19)	9 (2.19)	0.00
Cultivable Waste	27 (6.57)	37 (9.00)	+37.03
Fallows land other than current fallows	-	-	-
Current Fallows	17 (12.40)	12 (9.38)	-29.41
Net Area Sown	137 (33.33)	128 (31.14)	-6.57
Hanoo village			
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	543 (100)	543 (100)	0.00
Forest Area	-	-	-
Land put to non-agricultural uses	11 (2.03)	15 (2.76)	+36.36
Barren and Uncultivable land	307 (56.54)	303 (55.80)	-1.30
Permanent Pastures and other grazing lands	-	-	-
Land under misc. tree, crop, grooves	9 (1.66)	8 (1.47)	-11.11
Cultivable Waste	51 (9.39)	62 (11.42)	+21.57
Fallows land other than current fallows	1 (0.18)	1 (0.18)	0.00
Current Fallows	7 (1.29)	8 (1.47)	+14.29
Net Area Sown	157 (28.91)	154 (28.36)	-1.91
Hunder village			
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	414 (100)	414 (100)	0.00
Forest Area	-	-	-
Land put to non-agricultural uses	10 (2.42)	30 (7.25)	+200
Barren and Uncultivable land	136 (32.85)	132 (31.88)	-2.22
Permanent Pastures and other grazing lands	28 (6.76)	28 (6.76)	0.00
Land under misc. tree, crop, grooves	47 (11.35)	48 (11.59)	+2.13
Cultivable Waste	58 (14.01)	45 (10.87)	-22.41
Fallows land other than current fallows	1 (0.24)	1 (0.24)	0.00
Current Fallows	-	-	-
Net Area Sown	134 (32.37)	130 (31.40)	-3.70

Source: Patwari records.

Note: Figures in brackets indicate percentages.

In the case of Hanoo village of lower zone too largest proportion of 56.54 per cent of total reporting area was under by barren and uncultivable land in 2005-06. It shows that most of land is not fit for cultivation in spite of being located in lower

zone. It is mainly on account of steep slope and rough topography. Next largest area was under net area sown accounting for 28.91 per cent in 2005-06. However, it marginally declined by -1.91 per cent during 2005-06 and 2015-16. This could be due to increase in area under land put to non-agricultural uses. The village has become an attraction for tourists due to its unique culture and some tourist related facilities have been built here. Area under barren and uncultivable land also declined by -1.30 per cent and became 55.80 from 56.54 per cent during 2005-06 and 2015-16. An increase has been registered in area under cultivable waste. Rest of the land use categories have not witnessed much change.

Largest proportion i.e. 32.85 per cent of total reporting area was under barren and uncultivable land in Hunder village in the year 2005-06. Area under Net Sown Area recorded next largest proportion of 32.37 per cent in 2005-06. It is followed by area under cultivable waste which was 14.01 per cent. Land under misc. tree, crop, grooves was around 11.35 per cent of total reporting area. The area under land put to non-agricultural uses was mere 2.42 per cent of total reporting area. Area under fallows land other than current fallows covered merely 0.24 per cent of total reporting area in 2005-06. Largest increase occurred in area under land put to non-agricultural uses and became 7.25 per cent from 2.42 per cent of the total reporting area during 2005-06 to 2015-16. It could be mainly due to construction of hotels, restaurants and tourism related infrastructural facilities as the village has become one of the important tourist places in recent years. Land under miscellaneous tree crop, grooves also increased by 2.13 per cent. On the other hand, area under cultivable waste declined by-22.41 which became 10.58 per cent from 14.01 per cent during 2005-06 - 2015-16. Similarly, area under barren and uncultivable also declined by -2.22 per cent during the period.

It can be observed from above analysis that land under barren and uncultivable land varies between 31.81 per cent and 56.54 per cent in lower zone. It reflects the constraining role of high altitude environment on cultivation despite falling in lower altitude zone. Consequently, net area sown also varies between 28.36 per cent and 33.33 per cent keeping cultivated land well below half of the total

reporting area. Major changes occurred in land put to non-agricultural uses in all villages of lower zone.

Table 3.3 (a)

LAND-USE IN MIDDLE ZONE SURVEYED VILAGES OF LEH DISTRICT: 2005-06 TO 2015-16 (area in *hectares*)

Thiksey village	Years		Change in proportion
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	646 (100)	646 (100)	0.00
Forest Area	-	-	-
Land put to non-agricultural uses	40 (6.19)	59 (9.13)	+47.50
Barren and Uncultivable land	187 (28.95)	187 (28.95)	0.00
Permanent Pastures and other grazing lands	-	-	-
Land under misc. tree, crop, grooves	30 (4.64)	31 (4.80)	+3.33
Cultivable Waste	79 (12.22)	55 (8.51)	-30.38
Fallows land other than current fallows	1 (0.15)	1 (0.15)	0.00
Current Fallows	-	-	-
Net Area Sown	297 (45.98)	313 (48.45)	+11.45
Stok village			
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	584 (100)	584 (100)	0.00
Forest Area	-	-	-
Land put to non-agricultural uses	28 (4.79)	32 (5.48)	+14.29
Barren and Uncultivable land	142 (24.32)	142 (24.32)	0.00
Permanent Pastures and other grazing lands	-	-	-
Land under misc. tree, crop, grooves	50 (8.56)	57 (9.76)	+14.00
Cultivable Waste	29 (4.97)	16 (2.74)	-44.83
Fallows land other than current fallows	-	-	-
Current Fallows	-	-	-
Net Area Sown	335 (57.36)	337 (57.71)	+0.60
Diskit village			
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	495 (100)	495 (100)	0.00
Forest Area	-	-	-
Land put to non-agricultural uses	21 (4.24)	32 (6.46)	+52.38
Barren and Uncultivable land	170 (34.34)	146 (29.49)	-14.12
Permanent Pastures and other grazing lands	30 (6.06)	34 (6.87)	+13.33
Land under misc. tree, crop, grooves	20 (4.04)	25 (5.05)	+25.00
Cultivable Waste	153 (30.90)	148 (29.90)	-3.27
Fallows land other than current fallows	1 (0.20)	1 (020)	0.00
Current Fallows	-	-	-
Net Area Sown	100 (20.20)	109 (22.02)	+9.00

Source: Patwari records.

Note: Figures in brackets indicate percentages.

Table 3.3 (a) depicts different picture land use in middle zone villages of Leh district where largest share of land was under net area sown followed by land under barren and uncultivable land except in Diskit village. It shows topographic conditions of middle zone villages to be relatively moderate. Largest share of land was under barren and uncultivable category of land in the case of Diskit village like villages of

lower zone. Next largest category was of land under cultivable waste closely followed by Net Area Sown. Rest of the categories including land under miscellaneous tree crop, grooves, and fallow other than current fallows had very low proportion of area. Forest cover was nil as well in all middle zone villages in 2005-06 and 2015-16.

Significant change was observed in land put to non-agricultural uses during 2005-06 to 2015-16. It registered an increase of 52.38 per cent and 47.50 per cent in Diskit and Thiksey villages respectively. It can be attributed to the establishment of various infrastructural facilities and building of houses, hotels and restaurants as both the villages are important from tourism point of view. Land under miscellaneous tree crop, grooves increased by 25 per cent in Diskit and by 14 per cent in Stok village. It reflects the efforts at tree plantation undertaken by mountain communities in recent years. Major negative change was registered in area under cultivable waste, which came down to 2.74 per cent in 2015-16 from 4.97 per cent in Stok village. It can be partly ascribed to increasing irrigation amenities resulting in expansion of land under plough to the expansion of built up area Next major negative change of -14.12 occurred in area under barren and uncultivable land in Diskit village. This could also be due to construction of tourism related facilities.

Table 3.3 (b) shows that largest proportion constituting 44.53 per cent was covered by barren and uncultivable land in case of Likir village in 2005-06. It is followed by net area sown accounting for 35.42 per cent. Area under cultivable waste was 12.76 per cent out of total reporting area. Remaining land use categories had very low area. In case of Basgoo village, largest proportion of 33.66 per cent was under net area sown. Next largest category of barren and uncultivable land was followed by land put to non-agricultural uses. As expected, largest proportion constituting 42.99 per cent out of total reporting area was covered by land under barren and uncultivable land in Hemis Shukpachan village. It is followed by cultivable waste constituting 20.36 per cent out of total reporting area.

Largest increase during 2005-06 to 2015-16 was noted in land put to non-agricultural use, increasing by 83.33 per cent and 66.67 per cent in Hemis

Shukpachan and Likir villages respectively. Net area sown also increased by 28.80 per cent and grew to 32.64 per cent in 2015-16 from 28.28 per cent in 2005-06 in Hemis Shukpachan village. It may be due to increase in total reporting area during the same period. Land under miscellaneous tree crop, grooves also increased by 13.64 per cent and became 6.19 per cent from 5.73 per cent in this period in Likir village. Rest of land use categories have not witnessed major change.

Table 3.3 (b)

LAND-USE IN MIDDLE ZONE SURVEYED VILAGES OF LEH DISTRICT: 2005-06 TO 2015-16 (area in *hectares*)

Basgoo village	Years		Change in proportion
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	404 (100)	429 (100)	+6.19
Forest Area	-	-	-
Land put to non-agricultural uses	85 (21.04)	90 (20.98)	+5.88
Barren and Uncultivable land	116 (28.71)	113 (26.34)	-2.59
Permanent Pastures and other grazing lands	-	-	-
Land under misc. tree, crop, grooves	-	-	-
Cultivable Waste	65 (16.09)	62 (14.45)	-4.62
Fallows land other than current fallows	1 (0.25)	1 (0.23)	0.00
Current Fallows	2 (0.50)	2 (0.47)	0.00
Net Area Sown	136 (33.66)	140 (32.63)	+2.94
Hemis Shukpachan village			
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	442 (100)	499 (100)	+12.90
Forest Area	-	-	-
Land put to non-agricultural uses	6 (1.36)	11 (2.20)	+83.33
Barren and Uncultivable land	190 (42.99)	190 (38.08)	0.00
Permanent Pastures and other grazing lands	-	-	-
Land under misc. tree, crop, grooves	30 (6.79)	31 (6.21)	+3.33
Cultivable Waste	90 (20.36)	96 (19.24)	+6.67
Fallows land other than current fallows	-	-	-
Current Fallows	1 (0.23)	1 (0.20)	0.00
Net Area Sown	125 (28.28)	161 (32.64)	+28.80
Likir village			
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	384 (100)	404 (100)	+5.21
Forest Area	-	-	-
Land put to non-agricultural uses	3 (0.78)	5 (1.24)	+66.67
Barren and Uncultivable land	171 (44.53)	171 (42.33)	0.00
Permanent Pastures and other grazing lands	-	-	-
Land under misc. tree crop, grooves	22 (5.73)	25 (6.19)	+13.64
Cultivable Waste	49 (12.76)	54 (13.37)	+10.20
Fallows land other than current fallows	-	-	-
Current Fallows	2 (0.52)	2 (0.50)	0.00
Net Area Sown	136 (35.42)	150 (37.13)	+10.29

Source: Patwari records. **Note**: Figures in brackets indicate percentages.

Table 3.4 shows that largest proportion of total reporting area constituted barren and uncultivable land in all villages of higher zone, which is significantly more compared to other zones. It becomes clear that large part of land either has undulating land or does not have adequate soil cover. It can be seen from the table that next largest category was net area sown. However, except Gia village, area under net area sown in both Durbuk and Shachukul villages is less compared to other zones. These two villages also had some proportion of total reporting area under permanent pastures and other grazing lands. It shows villages of higher zone supporting rearing of large number of livestock.

There has been a significant change in area under land put to non-agricultural uses in Gia villages, which increased by 7.69 per cent during 2005-06 to 2015-16. This could be mainly because of coming up of many buildings in Gia village. This happened as the village lies on Manali-Leh highway which has become very popular both for tourists and for army in recent years as the other highway of Srinagar-Leh comes through Kashmir Valley which has seen lot of political disturbances. It is followed by cultivable waste land, which also grew by 7.50 per cent during the same period. Net area sown experienced slight increase of 0.15 per cent during 2005-06 to 2015-16. Major negative change occurred in area under barren and uncultivable land, which declined by -4.17 per cent during the same point of time. There has been no change in other land use categories. On the other hand, net area sown shows a marginal rise of 0.96 per cent in Durbuk village during the same period. However, cultivable waste land shows a decline of -1.81 per cent during 2005-06 to 2015-16. Durbuk village has major army settlement.

Shachukul village had largest share of land amounting to 66.91 per cent under barren and uncultivable land in 2005-06, which marginally declined by -2.75 per cent in 2015-16. It could be partly due to increase in total reporting area. Cultivable waste land also suffered a decline and its share came down from 4.41percent of reporting area to 1.46 percent during the same period, which is a positive sign under such conditions. On the contrary, permanent pastures and other grazing lands increased by 60 per cent from 2005-06 to 2015-16. Net area sown also slightly increased by 0.54 per cent. It may be mentioned here that large fluctuations in net area sown can also occur due to weather vagaries. Weather conditions are very

uncertain especially in higher zone that at times either restrict sowing or result in the destruction of crops.

Table 3.4

LAND-USE IN HIGHER ZONE SURVEYED VILAGES OF LEH DISTRICT: 2005-06 TO 2015-16 (area in *hectares*)

Gia village	Years		Change in proportion
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	290 (100)	296 (100)	+46.15
Forest Area	-	-	-
Land put to non-agricultural uses	13 (4.48)	14 (4.73)	+7.69
Barren and Uncultivable land	144 (49.66)	138 (46.62)	-4.17
Permanent Pastures and other grazing lands	-	-	-
Land under misc. tree, crop, grooves	4 (1.38)	4 (1.35)	0.00
Cultivable Waste	40 (13.79)	43 (14.53)	+7.50
Fallows land other than current fallows	1 (0.34)	1 (0.34)	0.00
Current Fallows	-	-	-
Net Area Sown	89 (30.69)	91 (30.74)	+2.25
Durbuk village			
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	857 (100)	866 (100)	+1.05
Forest Area	-	-	-
Land put to non-agricultural uses	-	-	-
Barren and Uncultivable land	743 (86.70)	742 (85.68)	-0.13
Permanent Pastures and other grazing lands	29 (3.38)	38 (4.39)	+31.03
Land under misc. tree, crop, grooves	2 (0.23)	4 (0.46)	+100.00
Cultivable Waste	12 (2.04)	2 (0.23)	-83.33
Fallows land other than current fallows	-	-	-
Current Fallows	-	-	-
Net Area Sown	71 (8.28)	80 (9.24)	+12.68
Shachukul village			
Land-Use Category	2005-06	2015-16	2005-06 to 2015-16
Reporting Area	272 (100)	274 (100)	+0.74
Forest Area	-	-	
Land put to non-agricultural uses	-	-	-
Barren and Uncultivable land	182 (66.91)	177 (64.60)	-2.75
Permanent Pastures and other grazing lands	20 (7.35)	32 (11.68)	+60.00
Land under misc. tree, crop, grooves	2 (0.74)	2 (0.73)	0.00
Cultivable Waste	12 (4.41)	4 (1.46)	-66.67
Fallows land other than current fallows	-	-	-
Current Fallows	-	-	-
Net Area Sown	56 (20.59)	59 (21.53)	+0.54

Source: Patwari records. **Note**: Figures in bracket indicate percentages.

It can be concluded from the above analyses that land use in Leh district is largely governed by the dictates of nature. As it has been observed, largest proportion of the total reporting is lying under barren and uncultivable land followed by net area sown and cultivable waste land. It suggests strong environmental constraints on agriculture. The cold-arid climate restricts villages to relatively lower

areas closer to water sources. This is why economically usable land is confined to river valleys lying below altitude of 4,000 metres. As a result, only such land has been brought under agriculture which is the main economic occupation sustaining livelihood of local people.

3.2 Distribution of Land Holdings in Leh District

As seen earlier, the availability of land for cultivation is an important aspect in mountain regions due to harsh conditions and fragile environment. It becomes more important for high altitude regions like Leh district where arable land is extremely limited. As stated earlier, very little agricultural land is available due to steep slope, rugged and rocky terrain in Leh district. Wherever there is relatively flat area, people have occupied it either by levelling it or by making small agricultural terraces for cultivation. Therefore, it is important to analyse the size and distribution of land holdings, which determine the extent of land available for farming.

Table 3.5

LAND HOLDINGS ACCORDING TO DIFFERENT SIZE CLASSES, LEH DISTRICT: 2010-11 (area in *hectares*)

Class Size	Holdings		% of Total	
	Nos.	Area (ha)	Holdings	Area
Below 0.5	13497	2513	62.76	17.37
0.5 – 1.0	3809	2769	17.71	19.14
1.0 – 2.0	2875	4011	13.37	27.73
2.0 – 3.0	865	2094	4.02	14.47
3.0 – 4.0	259	875	1.20	6.05
4.0 – 5.0	80	356	0.37	2.46
5.0 – 7.5	63	378	0.29	2.61
7.5 – 10	17	143	0.08	0.99
10 – 20	23	336	0.11	2.32
20 & Above	17	992	0.08	6.86
Total	21505	14467	100	100

Source: Computed from Agricultural Census, 2010-11.

Table 3.5 reveals that most of land holdings fall in the category of marginal holdings measuring less than 1 hectare. These accounted for 80.47 per cent in 2010-11. Only about 0.56 per cent households had more than 5 hectares land holdings. A very few households had more than 7.5 hectares of land. Land holdings above 20 hectares constituted merely 0.08 per cent in Leh district. Most of the large land holdings

belong to *Gompas* (Monasteries). This indicates that landholdings are small in the region and large holdings are very less due to steep and rugged topography.

1. Distribution of Ownership Holdings by Size Class

It is important to study the nature and extent of variations in the size distribution of ownership holdings in order to comprehend any significant change in agricultural economy.

Table 3.6

PERCENTAGE DISTRIBUTION OF HOLDINGS AND AREA OWNED, LEH DISTRICT: 2001-02 to 2010-11

Class Size	Percentage of Holdings			Percentage of Area Owned		
	2001-02	2005-06	2010-11	2001-02	2005-06	2010-11
Marginal	76.50	77.89	80.47	32.80	34.35	36.51
Small	15.76	14.30	13.37	28.89	27.86	27.73
Semi-medium	6.49	6.50	5.23	22.21	23.90	20.52
Medium	1.08	1.12	0.74	7.83	8.91	6.06
Large	0.18	0.19	0.19	8.28	5.22	9.18
Total	100	100	100	100	100	100

Source: Computed from Agricultural Census, 2001, 2005 and 2010.

Table 3.6 gives percentage distribution of households and area owned by size class of ownership holdings as per data of Agricultural Census 2001, 2005 and 2010. It shows an increase in the share of marginal holdings. More than 76 per cent of ownership holdings belonged to marginal size group in 2001, which increased to 77.89 per cent and 80.47 per cent in 2005 and 2010 respectively. On the contrary, small and medium land holdings show a slight declining trend over time. Area owned by marginal size group increased over the years. This has largely happened due to sub-division of land holdings. On the other hand, area owned by small size group show a decline trend during the same period. In semi-medium and medium, first it increased and then declined over the years. On the other hand, in large size group, it declined from 8.28 per cent in 2001-02 to 5.22 per cent in 2005-06. But, again it increased to 9.18 per cent in 2010-11.

It can be noticed from the above table that the size distribution of ownership holdings in Leh district is characterised by predominance of marginal holders over time. During 2010, the marginal holdings (less than or equal to 1 ha) constituted more than 80 per cent of the households but owned only about 37 per cent of total area. The medium (owning 4 to 10 hectares of land) and large holders (owning more than 10 hectare of land) accounted for only 0.93 per cent of the households but had a combined share of about 15.24 per cent in the total land owned by all households in 2010.

Thus, over the period under consideration, the size distribution of ownership holdings shows that the proportion of marginal holders (owning less than or equal to 1 ha) has risen from 76.50 per cent in 2001-01 to 80.47 per cent in 2010-11. This rise in the proportion of marginal holders has been accompanied by a steady decline in the proportion of small, semi-medium and medium holders. This shows fragmentation of land due to division among family members. On the other hand, the proportion of large holders remained more or less unchanged over the years.

2. Size of Land Holdings in Surveyed Villages

Surveyed households have been divided into three categories of farmers according to size of land holdings in three zones as given below:

Small Farmers – Up to 2.48 acres;

Medium Farmers – 2.48 – 4.96 acres;

Large Farmers – More than 4.96 acres;

Families have also been divided into four types based on the number of family members. These are as follows;

Small Family – Up to 5 members;

Medium family – 6 to 10 members;

Large Family – More than 10 members

Table 3.7

DISTRIBUTION OF AGRICULTURAL LAND

Higher Zone					
	Farm Size				
Family size	Units	Small Farmers	Medium Farmers	Large Farmers	Total
Small	No. of farmers	29	3	1	33
	% within family size	87.88	9.09	3.03	100.00
	% within farm size	38.67	27.27	25.00	36.67
Medium	No. of farmers	41	6	3	50
	% within family size	82.00	12.00	6.00	100.00
	% within farm size	54.67	54.55	75.00	55.56
Large	No. of farmers	5	2	0	7
	% within family size	71.43	28.57	0.00	100.00
	% within farm size	6.67	18.18	0.00	7.78
Sub-total	No. of farmers	75	11	4	90
	% within family size	83.33	12.22	4.44	100.00
	% within farm size	100.00	100.00	100.00	100.00
Middle Zone					
Small	No. of farmers	51	14	5	70
	% within family size	72.86	20.00	7.14	100.00
	% within farm size	47.66	28.57	20.83	38.89
Medium	No. of farmers	53	31	14	98
	% within family size	54.08	31.63	14.29	100.00
	% within farm size	49.53	63.27	58.33	54.44
Large	No. of farmers	3	4	5	12
	% within family size	25.00	33.33	41.67	100.00
	% within farm size	2.80	8.16	20.83	6.67
Sub-total	No. of farmers	107	49	24	180
	% within family size	59.44	27.22	13.33	100.00
	% within farm size	100.00	100.00	100.00	100.00
Lower Zone					
Small	No. of farmers	35	3	2	40
	% within family size	87.50	7.50	5.00	100.00
	% within farm size	55.56	15.79	25.00	44.44
Medium	No. of farmers	24	15	3	42
	% within family size	57.14	35.75	7.14	100.00
	% within farm size	38.10	78.95	37.50	46.67
Large	No. of farmers	4	1	3	8
	% within family size	50.00	12.50	37.50	100.00
	% within farm size	6.35	5.26	37.50	8.89
Sub-total	No. of farmers	63	19	8	90
	% within family size	70.00	21.11	8.89	100.00
	% within farm size	100.00	100.00	100.00	100.00
All Zones					
Small	No. of farmers	115	20	8	143
	% within family size	80.42	13.99	5.59	100.00
	% within farm size	46.37	25.32	22.22	39.72
Medium	No. of farmers	118	52	20	190
	% within family size	62.11	27.37	10.53	100.00
	% within farm size	47.58	65.82	55.56	52.78
Large	No. of farmers	12	7	8	27
	% within family size	44.44	25.93	29.63	100.00
	% within farm size	4.84	8.86	22.22	7.50

Total	No. of farmers	248	79	36	360
	% within family size	68.89	21.94	10.00	100
	% within farm size	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016.

Table 3.7 reveals that highest proportion of 68.89 per cent is constituted by small farmers followed by medium farmers with a share of 21.94 per cent in all zones. On the other hand, share of large farmer is only 10.00 per cent. It may be due to sub-division of land with increase in the number of nucleated families in recent years. This phenomenon of nucleation gained momentum only after the region got linked to Srinagar by road and later to Manali. Earlier, Leh district used to have large joint families due to limited potential of agricultural land available for cultivation. Moreover, system of polyandry was prevalent wherein one brother got married and his younger brothers generally not exceeding two in number shared the elder brother's wife. Property passed from father to the eldest son avoiding fragmentation of land. Younger brother had no claim on property. Now polyandrous marriages have been vanished almost completely. This happened when both polyandry and inheritance by primogeniture were made illegal by the Government of Jammu and Kashmir in the early 1940s.

Almost similar pattern can be observed in higher, middle and lower zones regarding distribution of land holdings. In higher zone, highest proportion of 87.88 per cent is constituted by small farmers followed by medium and large farmers having a share of 9.09 per cent and 3.03 per cent respectively. However, around 82 per cent of small farmers had medium size of family. There were 5 farmers having large families in this group. As opposed to this, around 54.08 of small farmer had medium family size and 57.14 per cent of small farmers had medium family size in middle and lower zones respectively. Around 70 per cent of larger farmers had medium size of family and remaining had large size of family. Only one large farmer had small family. It may be due to joint families being still prevalent in the more inaccessible villages of higher zone. As against this, there were many large farmers who had medium and large families.

It is evident from the table that small and medium farmers accounted for major proportion of land holdings across altitudinal zones. It highlights limited availability of cultivated land. Pressure on land holdings needs to be seen in terms of size of family and the land holding. It has been seen that there exists a co-

relationship between family-size and landholding size. Smaller family occupying larger land holdings shows lower population pressure on agricultural land.

It is clear from table that largest proportion of smaller families i.e. 80.42 per cent has small size land holdings in all zones. Similarly, largest proportion of medium families accounting for 62.11 per cent owned small size land holdings followed by 27.37 per cent medium and 10.53 per cent large size land holdings. Large families are having moderate proportion i.e. 44.44 per cent small size land holdings followed by 25.93 per cent medium and 29.63 per cent having large size land holdings. It suggests moderate levels of pressure on cultivated land.

Above analysis reveals that there is well defined relationship between family size and farm-size. It shows that small families are exerting least pressure on agricultural land while medium families are putting comparatively high pressure on cultivated land. On the other hand, large families having large size land holdings are exerting moderate levels of pressure on cultivated land. Largest proportion of small families of 87.88 per cent has small land holdings in higher zone. It reflects that small families exert less pressure on cultivated land. Similarly, largest proportion of medium families i.e. 82 per cent constituted small size land holdings. It reflects that pressure on agricultural land increases with increasing farm size. Large families have an equal largest proportion i.e. 71.43 per cent small land holdings. It suggests that some families are nucleated while some are still following joint family system. On the contrary, lowest proportion i.e. 6 per cent having large size land holdings followed by another 12 per cent having medium size land holdings. Almost similar kind of distributional pattern can be noticed in middle and lower zones with some minor variations therein.

It becomes clear from the overall analysis that small families are exerting less pressure on cultivated land in contrast to medium and large families. Population pressure on cultivated land is lowest in higher zone while it is highest in lower and middle zones.

3.3 Cropping Pattern and Changes Therein

Agriculture is the main occupation of mountain communities and tribal areas like Leh district of Jammu and Kashmir. The type of farming is agro-pastoral which has started changing in recent years. It is shifting into a blend of agro-horticultural with the passage of time in many parts of the region except villages situated in higher areas. Considering the severe climate, cultivation is practised mainly during short summer and milder months. Main food crops consist of *barley, wheat, buckwheat, black peas, some other millets*, and *pulses* among food crops. B*arley* has a cultural and religious significance as it is used for fermentation of *chang* (local beer) which is very popular drink among Buddhists of Leh district.

Recent initiatives made by various institutions like Field Research Laboratory (FRL), State Agricultural Department and Horticultural Department have successfully introduced different varieties of new crops especially vegetables in the region. As a result, farmers successfully grow vegetable crops like *potatoes, green peas, turnip, carrot, radish, cauliflower, onion* and *tomato.* Only one crop in a year is possible in most parts of the region due to short growing season. It is only in a few lower areas, where cultivation of two crops in an agricultural season is possible. In this region, *Barley* is sown as the first crop, which is harvested in early July. Usually *buckwheat* and *small millets* are sown in autumn as second crop.

Beside these, fruit crops especially *apricot, apple, walnut, almond* and *peach* have started yielded good results in a few pockets particularly in lower and middle areas. Growing period varies considerably with altitude. *Barley* is sown in the month of May and harvested in August in the lower zone, while it is sown in the month of June and harvested in September in higher zones. *Wheat* is sown in the months of April and May and harvested in September and October in respective zones at varying altitudes. Sowing time for *small millets* is April-May and harvested in August September. *Buckwheat* is sown immediately after harvesting *Barley* in the month of August in the lower zone villages only and harvested in September and October. *Mustard* is sown in the month of May and harvested in August.

Alfalfa is also sown in the months of May-June in the lower zone villages. It is an important fodder crop used to feed livestock in winter when natural pastures are not available due to very cold climate. *Green peas* are sown in April and May and harvested in between July to September in different villages depending on altitude. It has become one of the important commercial crops in recent years, which are supplied to army through different co-operative societies. *Potatoes* are sown in the months of April and May and reaped during September to October. This crop is more popular due to disease free environment. It is also an important cash crop in villages in higher zone. Some *lentils* and *beans* are also sown during June and reaped in the months of September and October in the lower and middle zones. Beside these, a wide range of vegetables are also sown in the months of May and June and harvested in August to October across altitudinal zones.

It may be mentioned that vegetable farming has emerged in recent decades in Leh district. Earlier vegetables could not be grown as there was no demand and people had to grow food-grain for survival. It was only when army moved into the region after Indo-China border conflict of 1962 that the demand for vegetable grew. Moreover, Leh-Srinagar Highway was completed in 1966 due to strategic reasons. Consequently, market developed at Leh town where farmers could sell vegetables and could buy food grain. The demand for vegetables rose many folds with the introduction of tourism in Leh district in 1974. It is important to note that the Defence Institute of High Altitude Research (DIHAR) or Field Research Laboratory (FRL) has played very important role in introducing varieties of vegetables in Leh district (for details see Appendix 1.3).

Table 3.8 reveals that total cropped area was 9801 hectares in 1996-97. A large proportion i.e. 37.29 per cent of total cultivated area was under *barley* crop. It indicates the significance of barley as a staple crop. An area of 32.90 per cent of total cropped area was under *wheat*. *Fodder* crop covered 20.17 per cent of land. *Fodder* crop have to be grown as no natural pastures are available in winters. Other crops like *millets, pulses, vegetables, oil seeds* and *fruits* covered small proportion of total cultivated area in 1996-97.

Table 3.8

AREA UNDER DIFFERENT CROPS, LEH DISTRICT: 1996-97 to 2014-15 (are in *hectares*)

Crops	Area (*Hectares*)		% age of total cropped area		Change	
					Area	%
Years	1996-97	2014-15	1996-97	2014-15	1996-97 to 2014-15	
Wheat	3225	2776	32.90	26.12	-449	-13.92
Barley	3655	4288	37.29	40.35	+633	+17.32
Other Millets	294	564	3.00	5.31	+270	+91.84
Pulses	274	258	2.80	2.43	-16	-5.84
Fruits	80	104	0.82	0.98	+24	+30.00
Vegetables	212	388	2.16	3.65	+176	+83.02
Oil seeds	84	89	0.86	0.84	+5	+5.95
Fodder	1977	2161	20.17	20.33	+184	+9.31
Total	9801	10628	100	100		

Source: Computed from Statistical Handbook, Leh District, 1996-2014.

Significant changes in the area under different crops were observed during 1996-97 and 2014-15. As expected, *barley* increased to 40.35 per cent of total cropped are. After *barley*, land under *wheat* had largest area accounting for 26.12 per cent. Area under cultivation of *wheat* declined by -13.92 per cent and became 26.12 per cent from 32.90 per cent during this period. It can be seen from the table that land under *vegetables* grew by 83.02 per cent from 2.16 per cent to 3.65 per cent during 1996-97 to 2014-15. Similarly, area under *other millets* increased by 91.84 per cent during the same period. Significant increase in area under *fruits* can be observed from the table. Area under *fodder* crop also increased from 1977 hectares in 1996-97 to 2161 hectares in 2014-15.

The above analysis shows that total area under *wheat* cultivation has decreased in the past decade. It seems to have declined in favour of *barley*. The reason could be mainly due to easy availability of *wheat* in the market and introduction of government subsidised food ration distributed through Public Distribution System[58] (PDS) which ensured availability of fine wheat flour. These

[58] Public Distribution System (PDS) is food security system, which envisages the system of management of food economy and distribution of food grains at affordable prices. Established by the Government of India under Ministry of Consumer Affairs, Food and Public Distribution and managed jointly with state governments, it distributes subsidized food and non-food items which include staple food grains, such as *wheat*, *rice*, *sugar* and *kerosene* to poor through a network of Public Distribution Shops established in several states across the country.

'external drivers' are responsible for change in cropping pattern in the region[59]. Beside these, "development of science and new agricultural technology brought about changes in age old cropping pattern"[60]. Area under *fruits* and *vegetables* cultivation has registered significant increase which shows growing importance of vegetables and fruit crops in the region. Increased demand for *fruits* and *vegetables* are met by Cooperative Marketing Societies which acquire these from farmers resulting in a shift from subsistence farming to raising cash crops. Recent initiatives taken by various government and non-governmental agencies have enabled local farmers introduce a wide variety of *fruits* and *vegetables*. These crops have been introduced in the region to meet the demand of army, tourists and local urban people.

Table 3.9 clearly depicts nature of shift towards commercial crops during 2005-06 to 2015-16. Traditional crops like *wheat* and *buckwheat* have started losing importance in recent years as seen through decline in their share in the total cropped area of many surveyed villages. On the contrary, *barley* crop has increased in all villages during the same period. It could be mainly due to the fact that farmers devote cultivated land to this crop to fulfil socio-religious customary requirements. Other crops grown in the region are *potatoes, peas, mustard, fruits, vegetables* and *fodder*.

Among the three villages of lower zone, area under vegetables grew significantly by 100 per cent in Domkhar village during 2005-06 and 2015-16. It could be mainly due to the large demand of vegetables by army settlement at Achinathang. On the other hand, it grew marginally by 20 per cent in Hanoo village. Area under *fodder* crop declined in all lower zone villages during this time. It suggests deceasing number of livestock in recent years. There has been a decline in area under *wheat* crop in almost all the villages of lower zone. As mentioned earlier, it could be mainly due to easy availability of wheat through PDS, which have led farmers to devote more land to *fruits* and *vegetables* crops that help them to get better farm returns. Hunder village shows that area under *barley* crop increased by 14.29 per cent during 2005-06 to 2015-16. Area under *peas*, *fruits* and *vegetables*

[59] Dame and Mankelow (2010), "Stongde Revisited: Land-Use Change in Central Zanskar", *Erdkunde*, Vol. 64, No. 4, pp. 355-370

[60] Bhat and Shah (2011), "Agricultural Land Use and Cropping Pattern in Jammu and Kashmir", *Research Journal of Agricultural Sciences*, Vol. 2, No. 3, pp. 710-712

also grew significantly by 100 per cent, 200 per cent and 100 per cent respectively during same time period. It appears that Hunder village, being located near Diskit

Table 3.9

AREA UNDER DIFFERENT CROPS IN SURVEYED VILLAGES OF LOWER ZONE IN LEH DISTRICT: 2005-06 to 2015-16 (area in *hectares*)

Domkhar village						
Crops	Area (*Hectares*)		% age of total cropped area		Change	
					Area	%
Years	2005-06	2015-16	2005-06	2015-16	2005-06 to 2015-16	
Wheat	6	4	5.13	3.42	-2	-33.33
Barley	80	81	68.38	70.09	+1	+1.25
Potatoes	1	3	0.85	2.56	+2	+200.00
Peas	2	4	1.71	3.42	+2	+100.00
Fruits	2	3	1.71	2.56	+1	+50.00
Vegetables	1	2	0.85	1.71	+1	+100.00
Oilseeds(Mustard)	-	-	-	-	-	-
Fodder	25	10	21.37	8.55	-15	-60.00
Total	117	117	100	100		
Hanoo village						
Crops	2005-06	2015-16	2005-06	2015-06	2005-06 to 2015-16	
Wheat	-	-	-	-	-	-
Barley	60	64	37.97	39.51	+4	+6.67
Potatoes	-	-	-	-	-	-
Peas	11	12	6.96	7.41	+1	+9.09
Fruits	7	8	4.43	4.94	+1	+14.29
Vegetables	5	6	3.16	3.70	+1	+20.00
Oilseeds(Mustard)	-	-	-	-	-	-
Fodder	75	72	47.46	44.44	-3	-4.00
Total	158	162	100	100		
Hunder village						
Crops	2005-06	2015-16	2005-06	2015-06	2005-06 to 2015-16	
Wheat	7	6	5.56	4.72	-1	-14.29
Barley	35	40	27.78	31.50	-5	-14.29
Potatoes	-	-	-	-	-	-
Peas	1	2	0.79	1.57	+1	+100.00
Fruits	1	3	0.79	2.36	+2	+200.00
Vegetables	1	2	0.79	1.57	+1	+100.00
Oilseeds(Mustard)	1	4	0.79	3.15	+3	+300.00
Fodder	81	70	64.29	55.12	-11	-13.58
Total	126	127	100	100		

Source: Patwari records.

Note: Figures in bracket indicate percentages

Plate 3.1: A women in her kitchen garden outside her house in Hunder village of Nubra valley.

Plate 3.2: Vegetable Farming in middle zone village of Hunder.

town, provides market for its agricultural produce. Moreover, it shows the growing importance of commercial crops in recent years among lower zone villages. However, net absolute increase in area continues to be small.

It can be seen from above analysis that cropping-pattern is dominated by traditional crops in lower zone villages. However, importance of traditional crops has gone down significantly over the last decade gaining importance of commercial crops. This is more pronounced in villages close proximity to urban areas, army settlements and National Highways. Hunder village being a tourist place provides huge market for its agricultural produce. Besides, lower zone villages located in Indus and Nubra valleys also supports growing of fruit crops especially *apricot, apple*, and to some extent *pear, cherry, grapes* etc. which are considered as an important source of nutritional value.

Table 3.10 depicts that cropping pattern is dominated by traditional crops like *barley* and *wheat* in all the villages of middle zone. However, small in size but significant portion of land has also been put under commercial crops like fruit and vegetable crops. More and more land has been devoted to commercial crops to meet the demand of tourism industry and of army in recent years. According to Defence Institute of High Altitude Research (DRDO), at present 50 per cent of army's fresh vegetables requirement are met by local farmers. Local farmer's cooperative is supplying 20 different kinds of vegetables to army.

It becomes clear from the table that significant shift has taken place in respect of commercial crops in all villages. Area under *wheat* declined by -73.68 per cent during 2005-06 to 2015-16 in Stok village. On the contrary, area under *peas* and *potatoes* grew by 200 per cent and 100 per cent respectively during same period. Area under *vegetables* grew significantly by 170 per cent. It is mainly due to availability of market for fresh vegetables as the village is situated near the main market of Choglamsar. In fact, some farmers especially women farmers sell vegetables at roadside in the market. Area under *fruits* rose by 300 per cent during 2005-06 to 2015-16 in Basgoo village. Diskit village shows an increase in area under *barley* crop by 8 per cent. Area under *vegetables* also grew significantly by 150 per cent during same time period. It could be mainly due to the fact that Diskit being the largest town of Nubra valley, provides market for its agricultural

Table 3.10

AREA UNDER DIFFERENT CROPS IN SURVEYED VILLAGES OF MIDDLE ZONE IN LEH DISTRICT: 2005-06 to 2015-16 (area in *hectares*)

Thiksey village						
Crops	Area (Hectares)		% age of total cropped area		Change	
					Area	%
Years	2005-06	2015-16	2005-06	2015-16	2005-06 to 2015-16	
Wheat	53	40	19.85	13.84	-13	-24.53
Barley	190	192	71.16	66.44	+2	+1.05
Potatoes	6	7	2.25	2.42	+1	+16.67
Peas	7	13	2.62	4.50	+6	+85.71
Fruits	-	-	-	-	-	-
Vegetables	1	3	0.37	1.04	+2	+200.00
Oil seeds (Mustard)	-	-	-	-	-	-
Fodder	10	34	3.75	11.76	+24	+240.00
Total	267	289	100	100		
Stok village						
Crops	2005-06	2015-16	2005-06	2015-06	2005-06 to 2015-16	
Wheat	19	5	5.18	1.30	-14	-73.68
Barley	218	231	59.40	60.00	+13	+5.96
Potatoes	1	2	0.27	0.52	+1	+100.00
Peas	1	3	0.27	0.78	+2	+200.00
Fruits	-	-	-	-	-	-
Vegetables	10	27	2.72	7.01	+17	+170.00
Oilseeds (Mustard)	1	2	0.27	0.52	+1	+100.00
Fodder	118	115	32.15	29.88	-3	-2.54
Total	367	385	100	100		
Diskit village						
Crops	2005-06	2015-16	2005-06	2015-06	2005-06 to 2015-16	
Wheat	37	36	24.34	22.64	-1	-2.70
Barley	50	54	32.89	33.96	+4	+8.00
Potatoes	-	-	-	-	-	-
Peas	1	2	0.66	1.26	+1	+100.00
Fruits	1	3	0.66	1.89	+2	+200.00
Vegetables	2	5	1.32	3.14	+3	+150.00
Oilseeds (Mustard)	1	2	0.66	1.26	+1	+100.00
Fodder	60	57	39.47	35.85	-3	-5.00
Total	152	159				
Basgoo village						
Years	2005-06	2015-16	2005-06	2015-16	2005-06 to 2015-16	
Wheat	83	81	64.34	57.86	-2	-2.41
Barley	20	26	15.50	18.57	+6	+30.00
Potatoes	1	2	0.78	1.43	+1	+100.00
Peas	1	1	0.78	0.71	0	0.00

Fruits	3	4	2.33	2.86	+1	+300.00
Vegetables	1	2	0.78	1.43	+1	+100.00
Oil seeds (Mustard)	-	-	-	-	-	-
Fodder	20	24	3.10	17.14	+4	+20.00
Total	129	140	100	100		
Hemis Shukpachan village						
Crops	2005-06	2015-16	2005-06	2015-06	2005-06 to 2015-16	
Wheat	-	-	-	-	-	-
Barley	120	124	77.92	77.02	+4	+3.33
Potatoes	1	1	0.65	0.62	0	0.00
Peas	3	4	1.95	2.48	+1	+300.00
Fruits	1	1	0.65	0.62	0	0.00
Vegetables	1	1	0.65	0.62	0	0.00
Oilseeds(Mustard)	2	2	1.30	1.24	0	0.00
Fodder	26	28	16.88	17.39	+2	+7.69
Total	154	161	100	100		
Likir village						
Crops	2005-06	2015-16	2005-06	2015-06	2005-06 to 2015-16	
Wheat	1	1	0.68	0.67	0	0.00
Barley	105	107	70.95	71.33	+2	+1.90
Potatoes	2	3	1.35	2.00	+1	+50.00
Peas	1	2	0.68	1.33	+1	+100.00
Fruits	1	1	0.68	0.67	0	0.00
Vegetables	1	1	0.68	0.67	0	0.00
Oilseeds(Mustard)	1	1	0.68	0.67	0	0.00
Fodder	36	34	24.32	22.67	-2	-5.56
Total	148	150				

Source: Patwari records. **Note**: Figures in bracket indicate percentages

products. Moreover, it suggests the growing importance of commercial crops in recent years among middle zone villages. As stated earlier, increase in area under *vegetables* and *fruits* in absolute terms is not very large.

It can be inferred from above analysis that traditional crops still covered more than 50 per cent of cropped land. However, commercial crops are gaining importance in recent years due to various socio-economic factors like advent of tourism industry, army establishment and change in food habits. Fresh vegetables and fruits produced in kitchen garden or on small plots are sold as cash crops directly, either along the main road or at the vegetable markets. However, villages with access to road, proximity to army settlements and main markets are in a better

position to engage in marketing activities. This held especially true for Stok and Diskit villages from lower zone that had a higher degree of market participation.

Table 3.11

AREA UNDER DIFFERENT CROPS IN SURVEYED VILLAGES OF HIGHER ZONE IN LEH DISTRICT: 2005-06 to 2015-16 (area in *hectares*)

Crops	Area (Hectares)		% age of total cropped area		Change	
					Area	%
Years	2005-06	2015-16	2005-06	2015-16	2005-06 to 2015-16	
Wheat	-	-	-	-	-	-
Barley	81	82	93.10	91.11	+1	+1.23
Potatoes	2	2	2.30	2.22	0	0.00
Peas	1	2	1.15	2.22	+1	+100.00
Fruits	-	-	-	-	-	-
Vegetables	1	2	1.15	2.22	+1	+100.00
Oilseeds(Mustard)	-	-	-	-	-	-
Fodder	2	2	2.30	2.22	0	0.00
Total	87	90	100	100		
Shachukul village						
Crops	2005-06	2015-16	2005-06	2015-06	2005-06 to 2015-16	
Wheat	-	-	-	-	-	-
Barley	50	51	94.34	86.44	+1	+2.00
Potatoes	1	2	1.87	3.39	+1	+100.00
Peas	2	6	3.77	10.17	+4	+200.00
Fruits	-	-	-	-	-	-
Vegetables	-	-	-	-	-	-
Oilseeds(Mustard)	-	-	-	-	-	-
Fodder	-	-	-	-	-	-
Total	53	59	100	100		
Durbuk village						
Crops	2005-06	2015-16	2005-06	2015-06	2005-06 to 2015-16	
Wheat	-	-	-	-	-	-
Barley	72	73	96.00	91.25	+1	+1.39
Potatoes	1	4	1.33	5.00	+3	+300.00
Peas	1	2	1.33	2.50	+1	+100.00
Fruits	-	-	-	-	-	-
Vegetables	-	-	-	-	-	-
Oilseeds(Mustard)	1	1	1.33	1.25	0	0.00
Fodder	-	-	-	-	-	-
Total	75	80	100	100		

Source: Patwari records. **Note**: Figures in bracket indicate percentages

Table 3.11 reveals that *barley* occupied more than 90 per cent of total cropped area in all villages of higher zone. It suggests that only few crops can be grown at higher

altitude due to unfavourable climatic conditions. Main noticeable changes occurred in area under *peas,* which increased from 3.77 per cent to 10.17 per cent showing an increase of 300 per cent during 2005-06 to 2015-16 in Shachukul village. It is mainly due to the fact that despite harsh climatic conditions, the region supports some commercial crops of *peas* which are supplied to the army established there. Similarly, area under *potatoes* also saw a huge change in Durkbuk village, which grew to 5.00 per cent of total cropped are from 1.33 per cent during same period. It may again be attributed as stated earlier to meet the demand of army which has large concentration along this village.

Thus, it is quite clear from above analysis that farmers allocate largest proportion of total cropped area under *barley* in all villages of higher zone. *Wheat* doesn't mature properly in higher areas due to occurrence of lower than required temperature. The region shows remarkable adjustments by adopting suitable cropping-pattern operating under harsh environmental constraints. Despite harsh and uncertain weather conditions, proportion of land under commercial crops is going up.

It can be observed from above analysis that cropping pattern is still dominated by traditional crops in all surveyed villages. However, importance of traditional crops has gone down significantly in recent years. A growing number of households have recently started to engage in producing a variety of commercial crops to get better farm returns. But the shift towards commercial crops is more pronounced in lower and middle zone villages on one hand, villages located close proximity to administrative town, army settlement and tourists places on the other. Therefore, it is important to understand the extent of crop diversification.

Plate 3.3: Women selling fresh vegetables on roadside in Diskit village of Nubra Valley.

Plate 3.4: Vegetable Farm in Diskit village of Nubra valley.

3.4 The Extent of Crop Diversification

With sustained economic growth, increase in per capita income and growth in urbanisation, there has been a shift in consumption patterns in favour of high-value food commodities like fruits, vegetables, and dairy and poultry products from staple food such as barley, wheat and coarse cereals. Diversification of agriculture towards high value crops is reckoned as an important strategy for mountain communities to augment income and employment. Crop diversification is slowly picking up momentum in Leh district in favour of high-value commodities primarily on account of access to markets, improvement in road infrastructure, development of tourism industry, and deployment of armed forces. Several non-food grain crops such as fruits and vegetables have substituted mainly coarse cereals in the farmers' pursuit for higher income. It is, therefore, pertinent to analyse changes in crop diversification, which can be seen through temporal changes in cropping pattern.

Table 3.12

TEMPORAL CHANGES IN CROPPING PATTERN IN LEH DISTRICT: 1985-86 to 2010-11
(*per cent to total cropped area*)

Sr.No. (1)	Crops (2)	1985-86 (3)	1990-91 (4)	1995-96 (5)	2000-01 (6)	2005-06 (7)	2010-11 (8)
1.	Barley	44.26	35.07	46.64	44.99	42.16	44.54
2.	Wheat	26.04	28.68	23.45	24.75	23.09	25.98
3.	Fodder	19.33	21.80	18.14	19.65	19.74	19.61
4.	Other Millets	3.73	6.88	4.83	4.14	3.54	3.45
5.	Pulses	3.21	3.30	2.92	2.57	2.57	1.93
6.	Vegetables	1.76	2.35	2.33	2.28	2.93	2.31
7.	Fruits	1.02	0.87	0.75	0.93	0.36	1.32
8.	Oilseeds	0.64	1.05	0.94	0.69	0.61	0.87

Source: Computed from Statistical Handbook, Leh District, 2005-06 and 2010-11.

Table 3.12 shows that among food grain crops the share of area under wheat steadily declined with some fluctuations, while that under barley remained more or less same. Among the non-food grain crops, the area fruits and vegetables increased over the period by varying degree. It, however, needs to be mentioned that district level averages do not reveal much about the extent of crop diversification especially in the

context of Leh district where there are marked variations in the climatic conditions among different blocks and even among different areas in the same block. For example, Khaltse and Nubra block that fall in the temperate region have potential to grow temperate fruits and vegetables. It is, therefore, essential to examine the changes in the area under different crops at a much more disaggregated level, preferably at a block level.

Table 3.13

TEMPORAL CHANGES IN THE AREA UNDER NON-FOOD GRAIN CROPS ACROSS BLOCKS IN LEH DISTRICT: 2005-06 TO 2010-11 ***(per cent to total cropped area)***

Block	Year		
	2004-05	2007-08	2011-12
Leh-Karu	24.80	28.36	28.73
Khaltse	21.39	25.76	25.79
Nubra	17.76	20.67	22.96
Nyoma-Durbuk	0.65	3.50	4.54
Leh District	20.35	20.41	21.18

Source: Computed from Statistical Handbook, Leh District, 2004-05 and 2011-12.

Table 3.13 shows significant increase in the extent of crop diversification in terms of per cent share of area under non-food grain crops in two blocks of Nubra and Nyoma-Durbuk. However, it was less pronounced in the other two blocks. The process of crop diversification had gathered momentum in all these blocks in recent decades. The share of area under non-food grain crops is less in Nyoma-Durbuk blocks as compared to other blocks. These blocks fall in higher altitude area, thus have less favourable climatic conditions to grow non-food grain crops like fruits and vegetables.

Crop diversification has been seen using Herfindhal Index (HI). As stated earlier, the index value of unity implies complete specialization and zero value show high diversification. It means lower the value of the index more diversified cropping of the block is and vice versa. Its block-wise values are presented in the table below.

Plate 3.5: A family harvesting potato with the help of draught animals in Likir village

Plate 3.6: A farmer showing vegetable grown in his kitchen garden in Durbuk Village

Table 3.14

BLOCK-WISE CROP DIVERSIFICATION INDEX IN LEH DISTRICT: 2005-06 to 2010-11

Block	HI Index Value		
	2005-06	2007-08	2010-11
Leh-Karu	0.36	0.29	0.27
Khaltse	0.32	0.33	0.37
Nubra	0.27	0.29	0.27
Nyoma-Durbuk	0.52	0.79	0.82

***Source**:* Author's calculations based on 'area' data for crops taken from Statistical Handbook, Leh District, 2005-06 and 2010-11. **Note:** Only combined data was available for Nyoma and Durbok blocks. Same is the case with Leh and Karu blocks.

Table 3.14 reveals that all other blocks except Nyoma-Durbuk had relatively more diversified crops in 2005-06. Same is true in 2007-08 and 2010-11. Nyoma-Durbuk, located in the high altitude region of Leh district has shown higher values of HI of above 0.5. The value for Nyoma-Durbuk blocks go up from 0.52 in 2005-06 to 0.82 in 2010-11. It shows crop diversification to be declining in these high altitude blocks. Opposite is true of Leh-Karu blocks where value of the index is declining depicting increasing crop diversification. Picture of Nubra block has remained static with minor fluctuation in 2007-08. But Khaltse block has followed the trend of Nyoma-Durbuk though on a much smaller scale. It shows that Leh-Karu blocks have experienced significant change towards crop diversification. As against this Nyoma-Durbuk are going towards crop specialisation. The same pattern is also noted in case of Khatse block but on much smaller level.

3.5 Production and Yield of Major Crops

Crop production and crop yield often determine agricultural potential of that region. Agricultural production has always been a matter of great concern for farmers as well as for agricultural geographers and agricultural economists. Farmers' well being is also greatly influenced by production and yield of crops. Presently, yield of crops can be substantially increased with the aid of modern inputs. Change in agricultural economy of a particular region can be easily understood by analysing production and yield of different crops over the years. Therefore, it becomes

necessary to analyse yield and production of crops in Leh district to comprehend restrictive role of environmental constraints in generating inter-zonal variations on the one hand and socio-economic aspects of changing agricultural economy on the other.

Table 3.15

PRODUCTION OF DIFFERENT CROPS IN LEH DISTRICT: 1996-97 to 2014-15

Crops	Total Production (*tonnes*)		Yield (*tonnes*/*hectare*)		% age change in yield
Year	1996-97	2014-15	1996-97	2014-15	1996-97 to 2014-15
Barley	3263 (47.16)	3829 (46.12)	0.89	0.89	0.00
Wheat	2520 (36.42)	2457 (29.60)	0.78	0.89	+14.10
Potato	532 (7.69)	1878 (22.62)	9.33	13.71	+46.95
Other Millets	251 (3.63)	226 (2.72)	0.85	0.40	-52.94
Fruits &Vegetables	157 (2.27)	287 (3.46)	0.74	0.74	0.00
Pulses	133 (1.92)	125 (1.51)	0.49	0.48	-2.04
Oil seeds	63 (0.91)	100 (1.20)	0.75	1.12	+45.33
Total	6919 (100)	8302 (100)			

Source: Computed from Directorate of Economics and Statistics, Jammu & Kashmir, Jammu, 1996-97 to 2014-15. **Note**: Figures in brackets indicate percentages.

Table 3.15 shows that total production of all crops was 6919 tonnes in 1996-97. *Barley* formed the most important crop contributing 47.16 per cent of total production. *Barley* production was followed by *wheat* which accounted for 36.42 per cent of total production in Leh District. However, the situation changed significantly in 2014-15 and production rose to 8302 tonnes registering an increase of 19.99 per cent 1996-97. *Barley* remained the most important crop but its share in the total production slightly came down to 46.12 per cent. Production of *wheat* also came down to 29.60 per cent, which still remained the second most important crop of the district. Production of *potato*, which accounted for 7.69 per cent in 1996-97, drastically increased to 22.62 per cent in 2014-15 per cent. This shows growing importance of *potato* as a cash crop in recent years. Production of *fruits* and *vegetables* which accounted for 2.27 per cent in 1996-97 also rose to 3.46 per cent in 2014-15. On the other hand, production of *other millets* and *pulses* came down from

3.63 per cent and 1.92 per cent respectively in 1996-97 to 2.72 per cent and 1.51 per cent in 2014-15.

Potato accounted for largest yield of 9.33 tonnes per *hectare*. Second largest yield was for *barley* i.e. 0.89 tonnes per *hectare*. Remaining crops had yield figures varying between 0.49 to 0.85 tonnes per *hectare*. *Potato* registered yield of 13.71 tonnes per *hectare* in 2014-15. This was an increase of 46.95 per cent over 1996-97. This shows clear commercialisation of agriculture in Leh District which was closely related to the development of infrastructure particularly road network, opening up of the region for tourists and deployment of security forces. The next largest yield was of *oilseeds* of 1.12 tonnes per *hectare*. *Other millets* registered a decline of -54.94 per cent and its yield came down to 0.40 tonnes per hectare from 0.85 tonnes per *hectare* during this period. Yield of *wheat* also registered an increase of 14.10 per cent. This was in spite of the fact that area and production of *wheat* declined during the same time.

Table 3.16 shows that yield of *green peas* to be 9 quintals per *kanal* in all zones. *Potato* had yield of 16.3 quintals per *kanal*. These two crops are cash crops. Average yield of *barley* was found to be 4.7 quintals per *kanal*. Area under *barley* has gone up throughout region in last few decades. As stated earlier, *wheat* is not grown in higher zone and its yield was 4.9 quintals per *kanal* in other two zones. Crop of *kidney beans* is grown in Indus and Nubra valleys of Leh District. It is mainly grown in lower area in river terrace villages and also in a few middle zone villages on land having moderate slope and relatively thicker soil cover. Average yield of *kidney beans* was found to be 1.1 quintals per *kanal* in these two zones. *Lentil* crop is not grown in higher zone and its yield was 2.1 quintals per *kanal.*

Next crop is *mustard* and its average yields was found to be 11.8 litres per *kanal*. Mustard is grown in all zones in Leh district. There are not large variations across farm-size. Average yield of *buckwheat* was found to be 2.3 quintals per *kanal* in lower zone. Area under buckwheat has gone down significantly in the region. Earlier *black peas* were grown in large number, but now the crop has lost importance after the introduction of *green peas* as a commercial crop. Yield of various crops shows positive relation with decreasing altitude except *wheat*, which

has higher yield in middle zone. It means that by and large yield decreases with increasing altitude on account of skeletal soil cover and near absence of modern farm inputs etc. in higher areas.

Table 3.16
AREA AND YIELD OF DIFFERENT CROPS IN THE SURVEYED VILLAGES OF LEH DISTRICT (*quintals*/*kanal*)

Lower Zone	**Barley**		**Wheat**		**Buckwheat**		**Potatoes**	
Farm Size (Nos.)	Area	Yield	Area	Yield	Area	Yield	Area	Yield
Small (63)	123	5	76.5	3.8	13.5	2.1	39.4	17
Medium (19)	107.5	5.4	34	4.5	19	2.3	13.9	17.6
Large (8)	23	6.1	36	5.3	12.5	2.6	11.2	18
Sub-Total (90)	253.5	5.5	146.5	4.5	45	2.3	64.5	17.5
Lower zone	**Green peas**		**Lentil**		**Kidney beans**		**Mustard**	
Farm Size (Nos.)	Area	Yield	Area	Yield	Area	Yield	Area	Yield
Small (63)	53.6	8.2	5	2.2	6.8	1.2	2.5	12.5
Medium (19)	17.4	9.5	1.5	2.5	2.9	1.8	5	12.9
Large (8)	5.2	10.1	3.5	2.8	3.1	2.5	3.8	13.1
Sub-Total (90)	76.2	9.3	10	2.5	12.8	1.8	11.3	12.8
Middle Zone	**Barley**		**Wheat**		**Potatoes**		**Green peas**	
Farm Size (Nos.)	Area	Yield	Area	Yield	Area	Yield	Area	Yield
Small (107)	286.2	4.6	252.7	4.8	57	15	27	9.5
Medium (49)	204.5	5	270	5.1	42.6	15.8	19.6	10.3
Large (24)	313	5.4	195	5.7	59.2	16	18.7	11
Sub-Total (180)	803.7	5	717.7	5.2	158.8	15.6	65.3	10.3
Middle Zone	**Mustard**		**Kidney beans**		**Lentil**			
Farm Size (Nos.)	Area	Yield	Area	Yield	Area	Yield		
Small (107)	25.7	10.7	6.1	0.7	9	1.1		

Medium (49)	22.8	11	10.3	1	8.2	1.8		
Large (24)	26.7	11.8	10.7	1.6	10.5	2		
Sub-Total (180)	75.2	11.2	27.1	1.1	27.7	1.6		
Higher zone	**Barley**		**Potatoes**		**Green peas**		**Mustard**	
Farm Size (Nos.)	Area	Yield	Area	Yield	Area	Yield	Area	Yield
Small (75)	319	2.9	29.3	15.1	29.7	7	9.9	10.1
Medium (11)	142	3.4	10.9	15.7	11.3	7.5	2.3	11.3
Large (4)	100	4.5	21.3	16.3	23	8.1	5	12.4
Sub-Total (90)	561	3.6	61.5	15.7	64	7.5	17.2	11.3
All zones	**Barley**		**Wheat**		**Buckwheat**		**Potatoes**	
Farm Size (Nos.)	Area	Yield	Area	Yield	Area	Yield	Area	Yield
Small (245)	728.2	4.2	329.2	4.3	13.5	2.1	125.7	15.7
Medium (79)	454	4.6	304	4.8	19	2.3	67.4	16.4
Large (36)	436	5.3	231	5.5	12.5	2.6	91.7	16.8
Sub-Total (360)	1618.2	4.7	864.2	4.9	45	2.3	284.8	16.3
All zones	**Green peas**		**Lentil**		**Kidney beans**		**Mustard**	
Farm Size (Nos.)	Area	Yield	Area	Yield	Area	Yield	Area	Yield
Small (245)	110.3	8.2	14	1.7	12.9	1.1	38.1	11.1
Medium (79)	48.3	9.1	9.7	2.2	13.2	1.4	30.1	11.7
Large (36)	46.9	9.7	14	2.4	13.8	2.1	35.5	12.4
Sub-Total (360)	205.5	9	37.7	2.1	39.9	1.1	92.7	11.8

Source: Field Survey, September-October, 2016**.**

Note I: Figures in bracket denote the number of farmers under each class**.**

Note II: Yield of Mustard is in litres oil per *kanal.* It may be noted that the yield of crops has been calculated by taking the area under the particular crop and production of that crop. These are rough estimates as stated by the respondents in household survey. Therefore, the accuracy may be doubtful. However, the data provide a rough comparative picture across zones.

3.6 Cropping Intensity

Production of crop can be increased in two ways either by expanding area under cultivation or increasing cropping intensity. This perception may hold relevance in case of plains and low lying regions. But it is not very true in high altitude regions like Leh District due to severe winters resulting in short growing season. As most of the suitable land in the light of environmental constraints has been brought under plough, thus scope for expanding cultivated land is limited. As mentioned earlier, most of Leh district has single cropping. However, some villages in a few pockets in lower valleys grow more than one crop in a year. Thus, cropping intensity has limited purpose in Leh district.

Table 3.17

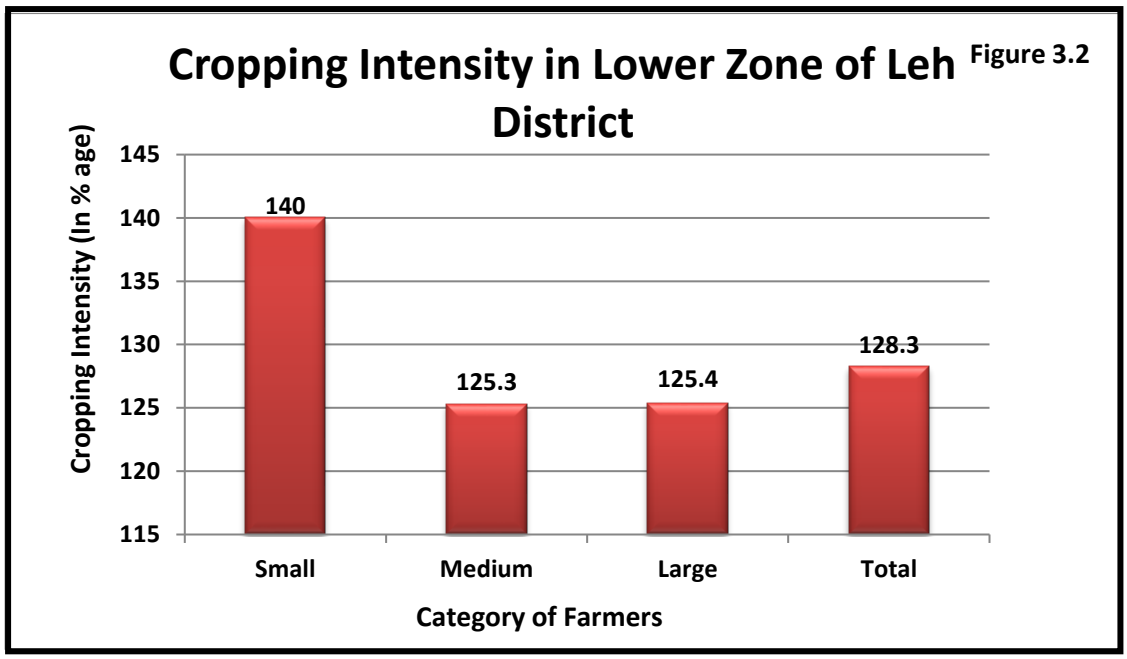
CROPPING INTENSITY IN SURVEYED VILLAGE OF LEH DISTRICT: 2016 (area in *kanal*)

HIGER ZONE AND MIDDLE ZONE – NOT APPLICABLE					
Surveyed Village	Farm Size	Net Sown Area	Total Cropped Area	Cropping Intensity	No. of Farmers
Domkhar	Small	35 (20.23)	49 (22.07)	140.0	15 (50.00)
Lower Zone	Medium	79 (45.66)	99 (44.59)	125.3	10 (33.33)
	Large	59 (34.10)	74 (33.33)	125.4	5 (16.67)
	Sub-Total	173 (100.00)	222 (100.00)	128.3	30 (100.00)

Source: Field Survey, September-October, 2016

Note I: Figures in brackets indicate percentages.
Note II: Area sown more than once is found only in lower zone village of Domkhar. Therefore, cropping intensity has been calculated for this village only.

Table 3.17 and Figure 3.2 show that there was only one village namely Domkhar lying in lower zone had double cropping out of the 12 surveyed villages. Cropping intensity was found to be highest at 140.0 per cent in the case of small farmers in Domkahr village. Lowest intensity of cropping is noticed among medium farmers of 125.3 per cent. Though the variations among these categories are not much but it could be because of the fact that small farmers can put in more labour.



It can be concluded from the above discussion that overall land use and cropping pattern reflects mainly subsistence nature of agriculture which is the main occupation in Leh district. Availability of suitable land for agriculture is a major challenge due to rugged and rocky topography, steep slope, severely cold-arid climate and in adequate supply of water for irrigation. Only a small part of the total reporting area is available for cultivation. It has been noticed that area under land put to non-agricultural use has increased substantially over the last few decades. The already small sizes of land holdings are getting fragmented due to various socio-cultural factors. Crops are grown according to natural viability and according to socio-economic concerns. Cropping pattern shows that there is diversification of agriculture with traditional uneconomical crops being replaced with more remunerative cash crops. The values of Herfindhal Index show majority of blocks experiencing some degree of crop diversification over years, showing a shift towards more valuable crops. The current ongoing drive towards more remunerative commercial crops is expected to herald a new phase in agricultural economy of Leh district. Nevertheless, this requires proper assessment of environmental conditions in terms of topography, climate and soil conditions to produce specific crops that ensures maximum benefits to the farmers. Farmers need to have open mind and willingness to experiment with new technology and develop a model with a blend of traditional and modern scientific knowledge. Thus, it is important to organise land-

use and cropping-pattern in such a manner that it becomes principally sound and environmentally viable in the future scenario of specific regions like Leh district.

Chapter Four

Horticulture Development

With agriculture sector finding alternative ways of increasing productivity, horticulture as a sub-sector is a revelation showing remarkable signs of progress. It has emerged as a fast expanding and profitable sub-sector within agriculture offering a wide range of choices to farmers for crop diversification. Mountain farmers across the globe have realised that it could prove to be profitable venture to grow a few cash crops along with traditional crops. Host of government programmes also emphasize development of horticulture to make mountain agriculture more sustainable and remunerative. One such centrally sponsored scheme is the "Technology Mission", which is divided into four components encompassing Mini Mission I, II, III and IV. The scheme is designed to promote Integrated Development of Horticulture in Jammu and Kashmir. Mini Mission I concentrates on technology development and Mini Mission II is meant for production enhancement strategies, whereas, Mini Missions III and IV are related to post harvest management, marketing and processing techniques etc. leading to Integrated Development of Horticulture[61].

Integrated Development of Horticulture is expected to diversify the age-old practices of agriculture, improve economic status of mountain inhabitants and create ample job opportunities in Himalayan region. It is quite clear that Ladakh has vast potential for development of horticulture owing to versatile agro-climatic variations. Local farmers cannot depend solely on cereal production as means of livelihood in such areas; therefore horticulture along with agriculture forms main economic activity. Successful development of horticulture sector in such areas demonstrates its potential to provide viable base for households to rise above subsistence level and to augment their farm income. Many agricultural geographers and economists are of the view that farm income in any region can only be enhanced through parallel growth of horticultural activities. It holds relevance to the economy of plains as well as mountainous regions. Therefore, importance of high value cash crops for

[61]The Technology Mission for Integrated Development was launched in 2001-02 to address the issues related to production and productivity, post harvest handling, marketing and processing of horticultural crops in the North Eastern States. Later, it was extended to three Himalayan states namely Himachal Pradesh, Jammu and Kashmir and Uttrakhand in 2003-04.

improving economy of upland populations has been realized in several pockets of mountainous regions.

High altitude areas are generally characterised by relative isolation, severe climate, and skeletal soils along with low level of infrastructure especially poor transportation facilities and lack of modernisation of farm techniques. However, the climatic conditions of such regions provide wide range of suitability for production of various horticultural crops, particularly temperate fruits and some other crops. Horticultural crops not only supplement diet of native people, but also enable mountain farmers to augment their income. It is being realised by mountain farmers that by bringing more area under horticultural crops, they can significantly increase their farm income. "Since horticultural products are more remunerative as compared to traditional agricultural products; therefore, development of horticulture sector could prove to be a harbinger of revolution in terms of substantial rise in farm income" [62]. Thus, it becomes apparent that alternative cash crop farming in right niches would give better benefits to high altitude farming communities.

Leh district being a high altitude cold desert is characterised by rough topography, cold-arid climate and low man-land ratio. However, because of varied agro-climatic variations, the region is endowed with such congenial natural conditions those permit the growth of many horticultural crops. "Although some physical stresses like poor soil conditions, low atmospheric humidity, poor irrigation facilities, short growing period, low temperatures and isolation from the mainland for about seven months in a year are major limitations for development of horticulture in Leh district. However, long day light with high intensity, higher day temperature followed by low night temperature and low atmospheric humidity makes conditions congenial for quality production of certain fruits"[63]. Therefore, a number of indigenous temperate fruits genotypes are grown either as individual trees or small group of trees. Major fruit crops grown in Leh district are apricot, apple, walnut, pear, peach, plum, cherry, mulberry and grapes. Apricot is the major fruit crop grown on commercial scale and its scattered plantations are found along

[62] Warpa, Vishal (2007), "Environmental Constraints on the Agricultural Economy in High Altitude Region of Lahaul-Spiti", Unpublished PhD. Thesis, JNU, New Delhi. Pp. 149-150.
[63] Dwivedi, S.K. et al. (2009), "Fruit Production in Cold Arid Regions of India: Challenges and Opportunities", In *Advances in Agriculture, Environment and Health*. (eds. S.B. Singh, O. P. Chaurasia, A. Yadav, A.M. Rimano, T.M. Terril). SSPH Delhi, India. pp. 63.

agricultural fields. Defence Institute of High Altitude Research (DIHAR) has reported prominence of following cultivars of apricot in arid region such as Halman, Rakchey-Karpo, Tokpopa, Rogan, Safaida, Nari, Australian, Shakarpara, Charmagz, Kaisi and Suka. Apple is the second major fruit crop of the region. A study conducted by DIHAR (DRDO) has highlighted the presence of valuable indigenous apple genotypes in Leh. This institute has identified various local varieties of apple such as Tha, Mongol, Kharkichoo, Shing, Mar, Nas, Yangm, Squirmo, Khara, Shamer Kushu genotypes, which have not been reported so far from Leh district[64]. "The local varieties of apple are generally small in size, highly juicy but have short shelf life"[65]. Other fruit crops grown are only a few in numbers, found in limited patches, especially at lower altitude below 3,000 meters above mean sea level.

There has been a gradual transformation in the development of horticultural crops in Leh district. Traditional cropping pattern is getting diversified with increasing access to market, development of infrastructure and application of modern techniques. Hence fruit crops are coming up at substantial scale with more promising economic returns. This has led to commercial development of horticultural crops. Development of horticulture on commercial scale could be possible only by brining additional land under vegetable and fruit crops, using hybrid seeds and use of improved agro-techniques. But the recent shift to intensive horticultural system with application of modern inputs such as chemical fertilizers and pesticides can also cause damage to human health and environment. Therefore, the ongoing drive for horticultural development needs to be carefully handled in consultation with farm scientists of different research stations. Keeping in mind the consideration of vulnerability and fragility of mountain environment, some farmers in certain pockets of both developed as well as developing parts of high altitude regions have switched to organic farming. Since mountain regions and their farmers are traditionally well acquainted with the practice of organic farming, role of traditional knowledge combined with scientific know-how is likely to herald new era in the practice of organic farming. This can play vital role in environmental sustainability and economic development of Leh district.

[64] Dwivedi, S.K. et al. (2009),ib.pp.65
[65] Ibid.pp.65

In the light of above, it becomes imperative to see the expansion of land under horticulture which has been an emerging trend in recent years. Changes in area, production and yield need to be analysed to assess the changing agricultural economy of Leh district. It is important to see spatial and temporal changes those have taken place in agricultural economy of the region.

4.1 Growth of Horticulture

Despite of having a huge potential for horticultural crops, the growth and development of horticultural crops has been limited due to various natural as well as socio-economic factors. Poor soil conditions, low humidity, poor irrigation facilities, short growing period, low temperature, lack of access to markets and poor technological development are major limitations for the development of horticulture in Leh district. Nevertheless, land with moderate climatic conditions especially relatively low and middle altitude areas on river terraces and moderately sloping land have seen the rise of horticultural crops.

Table 4.1

AREA UNDER DIFFERENT FRUITS CROPS IN LEH DISTRICT: 2001 – 2015 (area in *hectares*)

Fruits	**Years**				**Per cent Change**		
	2001	**2005**	**2010**	**2015**	**2001-05**	**2005-10**	**2010-15**
Apricot	633 (54.15)	815 (56.32)	816 (53.68)	792 (48.03)	28.75	0.12	-2.94
Apple	479 (40.98)	568 (39.25)	639 (42.04)	796 (48.27)	18.58	12.5	24.57
Peach	4 (0.34)	2 (0.14)	4 (0.26)	4 (0.24)	-50.00	100.00	0.00
Pear	2 (0.17)	5 (0.35)	2 (0.13)	3 (0.18)	150.00	-60.00	50.00
Grapes	2 (0.17)	4 (0.28)	2 (0.13)	2 (0.12)	100.00	-50.00	0.00
Plum	0 (0.00)	2 (0.14)	1 (0.07)	1 (0.06)	0.00	-50.00	0.00
Sub-Total	1120 (95.81)	1396 (96.48)	1464 (96.32)	1598 (96.91)	24.64	4.87	9.15
Nuts							
Walnut	47 (4.02)	49 (3.39)	54 (3.55)	49 (2.97)	4.26	10.20	-9.26
Almond	2 (0.17)	2 (0.14)	2 (0.13)	2 (0.12)	0.00	0.00	0.00
Sub-Total	49 (4.19)	51 (3.52)	56 (3.68)	51 (3.09)	4.08	9.80	-8.93
Total	1169 (100.00)	1447 (100.00)	1520 (100.00)	1649 (100.00)	23.78	5.04	8.49
N.S.A	10210 (11.45)	10186 (14.21)	10197 (14.91)	9982 (16.52)	-0.24	0.11	-2.11

Source: Computed from Department of Horticulture, Jammu & Kashmir, Jammu, 2001-15.

Note: Figures in brackets indicate percentages.

Table 4.1 reveals that largest proportion of land i.e.54.15 per cent was under apricot trees followed by apple, peach and pear in the proportion of 40.98 per cent, 0.34 per cent and 0.17 per cent respectively in 2001. Area under temperate fruits constituted 95.81 per cent of total fruit crops area. On the other hand, largest proportion i.e. 4.02 per cent was covered under walnut trees followed by almond under the category of other fruit crops/nuts accounting for 4.19 per cent. Proportion of land under different fruit crops to net sown area was only 11.45 per cent in 2001. It reflects that area under fruit crops was limited in 2001. However largest proportion of 56.32 per cent was under apricot tress followed by apple, pear and grapes with 39.25 per cent, 0.35 per cent and 0.28 per cent respectively in 2005. These fruits constituted 96.48 per cent land of the total fruit crop area while area under nuts covered 3.52 per cent. Proportion of area under different fruit crops to net sown area rose to 14.21 per cent in 2005.

The share of land under apricot declined to 53.68 per cent in 2010. It was not actual decline in area which rose from 815 *hectares* in 2005 to 816 *hectares* in 2010. The share of land under apple rose to 42.04 per cent followed by peach and grapes in the proportion of 0.26 per cent and 0.13 per cent in the same year. Walnut share was 3.55 per cent of total area under nuts which was 3.68 per cent of the total fruit crop area. Proportion land under different fruit crops to net sown registered minor increase to 14.91 per cent in 2010. Area under apricot orchard registered actual decline both in terms of area as well as in its share in 2015. As against this area under apple orchards grew from 639 *hectares* in 2010 to 796 *hectares* in 2015 and its share accounted for 48.03 per cent in 2015. Temperate fruit crops accounted for 96.91 per cent of total land under fruit crops in 2015. Remaining area of 3.09 per cent was under nuts of which 2.97 per cent land was under walnut followed by almond crop. Fruit crop land formed 16.52 per cent of net sown area in 2015.

A major increase of 150 per cent and 100 per cent was recorded in the area under pear and grapes respectively during 2000-2005. However, in actual terms area under each of these fruit crops grew from 2 *hectares* to 5 *hectares*. Thus, it is because of small base that caused high proportionate change. Plantations of these two crops are confined to low lying areas of Indus valley because of better moisture availability and moderate temperature. Area under apricot trees registered an increase of 28.75 per cent from 2001 to 2005. Apricot trees were followed by area

under apple, which also registered an increase of 18.28 per cent. It reflects higher commercial importance and climatic suitability of apricot and apple trees as compared to other fruit crops. Area under peach registered an increase of 100 per cent during 2005-2010. The proportion of area under apple trees also rose by 12.5 per cent during the same time period. The share of land under apple crop rose from 39.25 per cent in 2005 to 42.02 per cent in 2010 and then to 48.27 per cent in 2015. Area under apricot registered a marginal increase during 2005-2010. On the other hand, area under pear, plum and grapes declined. Larger decline in land under plum and apricot trees could be due to less adaptability and suitability of these fruits crops due to prevailing harsh climatic conditions. Area under apricot trees also registered marginal decline during 2010-2015. On the contrary, area under apple trees registered an increase of 24.57 per cent during the same time period. This shows growing importance of apple crop in Leh district.

Area under all fruit crops registered an increase of 23.78 per cent and rose to 14.21 per cent from 11.45 per cent of net sown area during 2001-2005. Land under fruit crops further registered an increase of 5.04 per cent during 2005-2010. Its share grew to 14.91 per cent of net sown area. Further, area under fruit crops registered an increase of 8.49 per cent during 2010-15. It rose to 16.52 per cent. However, in actual terms Net Sown Area came down to 9982 *hectares* from 10197 *hectares*. Apricot continued to dominate with slight decline of -2.94 per cent during this period. Apple trees are becoming more and more popular due to improved infrastructure and marketing facilities in recent years. These crops are certainly emerging as an important source of income especially in lower parts of Leh District.

Fruit crops are mainly concentrated in middle and lower part of Indus valley and in Nubra valley. These places have relatively milder climate. Only apricot and apple trees occupy substantial proportion of net sown area and have greater commercial significance. Therefore, it is important to understand production and yield trends of various fruit crops to comprehend their relative role in agricultural economy of Leh district and to assess their changing nature.

Table 4.2

AREA, PRODUCTION AND YIELD OF DIFFERENT FRUIT CROPS IN LEH DISTRICT
(*metric tonnes*/yield per *hectare*)

Fresh Fruits	2001			2005			2010			2015		
	Area	Pro.*	Yield	Area	Pro.*	Yield	Area	Pro.*	Yield	Area	Pro.*	Yield
Apricot	633	2650	4.19	815	2916	3.58	816	3396	4.16	792	3189	4.03
Apple	479	3350	6.99	568	3593	6.33	639	5308	8.31	796	4327	5.44
Peach	4	6	1.50	2	0	0.00	4	8	2.00	4	7	1.75
Pear	2	7	3.50	5	8	1.60	2	9	4.50	3	9	3.00
Grapes	2	8	4.00	4	0	0.00	2	10	5.00	2	9	4.50
Plum	0	0	0.00	2	1	0.50	1	1	1.00	1	1	1.00
Sub-Total	1120	6021	5.38	1396	6518	4.67	1465	8730	5.96	1598	7542	4.72
Nuts												
Walnut	47	105	2.23	49	110	2.24	54	120	2.22	49	109	2.22
Almond	2	1	0.50	2	1	0.50	2	1	0.50	2	1	0.50
Sub-Total	49	106	2.16	51	111	2.18	56	121	2.16	51	110	2.16
Total	1169	6127	5.24	1447	6629	4.58	1520	8852	5.82	1649	7652	4.64

Source: Computed from Records of Department of Horticulture, Jammu & Kashmir, 2001-15.

Note: Pro.* means Production.

Table 4.2 shows that largest production of 3350 *metric tonnes* has been recorded of apple followed by apricot with 2650 *metric tonnes* and grapes with 8 metric tonnes of fresh fruits in 2001. On the other hand, walnut recorded a production of 105 *metric tonnes* among nuts. Production of apple rose to 3593 *metric tonnes* and of apricot to 2916 *metric tonnes* in 2005. It was mainly due to substantial rise in land under these fruits trees. Production of walnut marginally increased to 110 *metric tonnes* in 2005.

Similar trend can be noticed in 2010 when apple production rose to 5308 *metric tonnes*. It was followed by apricot and pear with a production of 3396 *metric tonnes* and 9 *metric tonnes* respectively. The rise in apple production can be attributed to increase in land under apple trees. On the other hand, production of

walnut also rose to 120 *metric tonnes*. It happened due to increase in area under walnut from 49 *hectares* in 2005 to 54 *hectares* in 2010.

Production of apple declined to 4327 *metric tonnes* followed by apricot with 3189 *metric tonnes* in 2015. Surprisingly apple registered major decline in production in spite of substantial rise in area by 157 *hectares*. It may be because some young trees planted after 2010 were yet to bear fruit in 2015. It is also substantiated by decline in yield of apple from 8.31 *tonnes* per *hectares* in 2010 to 5.44 *tonnes* per *hectares* in 2015. Part of it can also be attributed to some plant diseases. Production of walnut also fell to 109 *metric tonnes*. It could be attributed to decline in area under walnut from 54 *hectares* in 2010 to 49 *hectares* in 2015. A major proportion of area and production reflect increasing importance of apple and apricot plantations as fast emerging cash crops after green peas and potatoes in the region. It was in spite of slight decline in area under apricot trees during 2010-2015. Thus, more production and yield of fruit crops especially apple and apricot are likely to add to better income of mountain cultivators especially in climatically conducive pockets in the high altitude region of Leh district.

It needs to be mentioned that except apricot, apple, and walnut, all other fruit crops are chiefly grown for self-consumption on a very small scale. If we look at the scale of area, production and yield under various fruit crops, only apple and apricot emerge significant. A few entrepreneurial orchard owners with large landholdings have recently taken up plantation of pear and cherry mainly in lower Indus valley. Juvenile nursery plants of these two fruit crops are more fragile compared to apricot and apple plants, therefore, are not able to withstand the rigours of snowfall during severe winters in rest of the valleys.

Except higher parts of Leh district, other areas are found to be suitable for growing fruits with some minor intra-valley variations on account of local relief factors. These include altitude, slope, aspect to Sun, sunshine duration and moisture availability etc. In addition, most of temperate fruit crops require at least 90 days of chilling hours to get good harvest. A good quantum of snow is required as it protects fruit crop from frost and pests. It also makes available required moisture and acts as an atmospheric nutrients fixing mechanism. Arid and semi-arid cold desert of Leh district lying on leeward side of Great Himalayan range does receive some

precipitation mainly in the form of snow which is considered as white manure for these temperate fruit crops. This specific aspect of region acts as an additional advantage as opposed to other low lying apple and apricot producing regions of the state.

4.2 Horticulture Growth in Surveyed Villages

As mentioned earlier, agro-climatic conditions prevailing in Leh district are quite conducive for the growth of horticultural crops especially of apricot, apples, pears and walnut as well as different variety of European type of vegetables. The entire scenario of farming system has started witnessing gradual transformation leading to more dynamic agro-agricultural system to increase farm income. But level of growth and development is not uniformly distributed in this high altitude region owing to certain environmental as well as socio-economic factors. Rough terrain, low temperature and poor soil cover coupled with lack of access to market and weak infrastructural facilities restrict cultivation of horticultural crops to certain favourable pockets of the region. Only lower and middle parts of valleys are suitable for horticultural production on account of milder climate and relatively gentle slope.

Out of twelve surveyed villages representing different valleys spatially and in terms of altitude, a few villages were found to be more developed in respect of apricot and apple plantations. Only the villages located in the lower and middle zones with comparatively lesser degree of environmental constraints support plantation of fruit crops. Fruits cannot be grown in higher areas due to severe cold climate. Primary data has been collected only for apricot and apple plants as these have more commercial value compared to other fruit crops. But the current extensive ongoing plantation drive throughout the region in different valleys across altitudinal zones surely presents a diversifying picture. Nevertheless, it needs to be pointed out that higher zone has been excluded from this analysis because of reasons mentioned above.

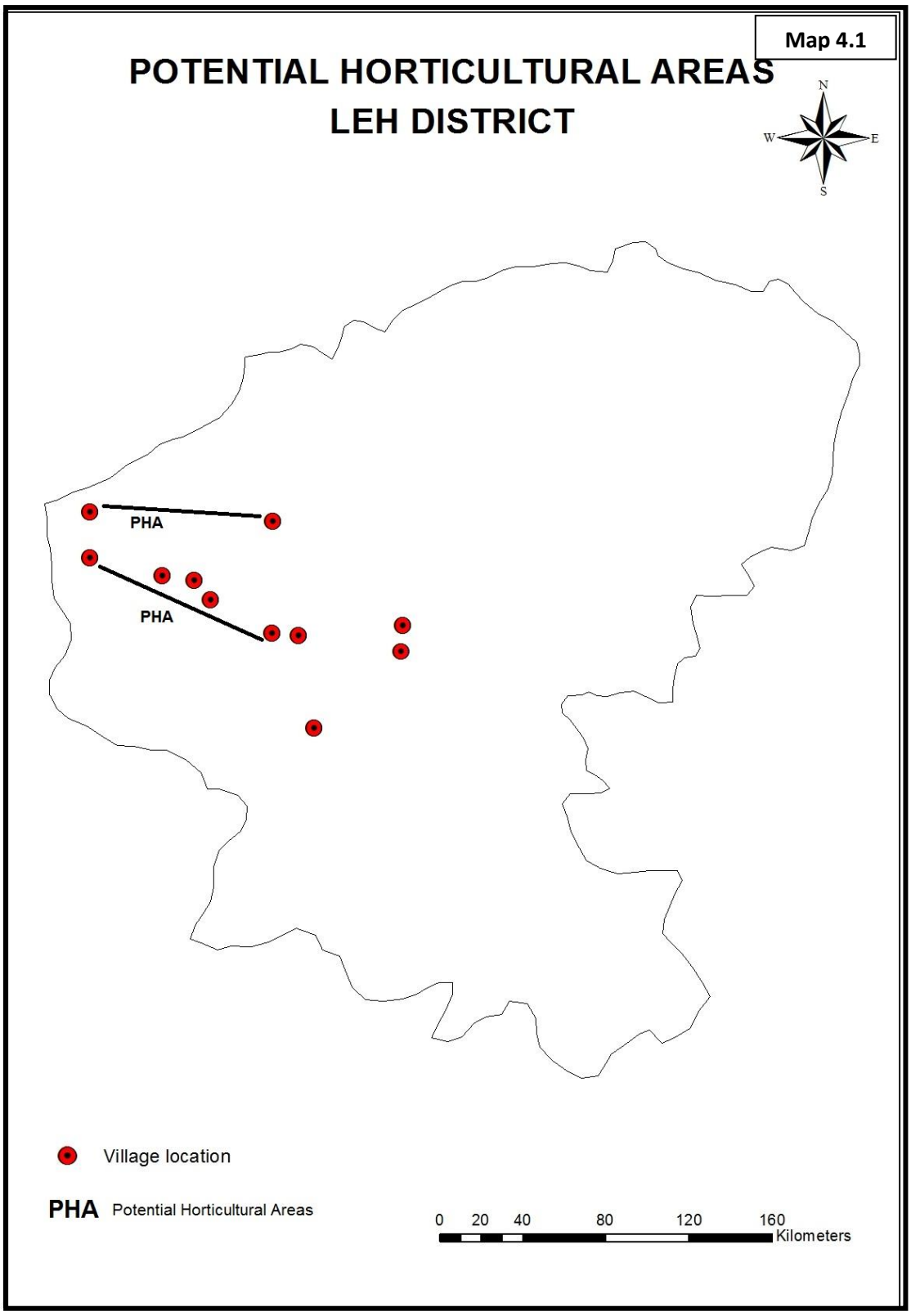

Map 4.1
POTENTIAL HORTICULTURAL AREAS
LEH DISTRICT
N
W
E
S
PHA
PHA
Village location
PHA Potential Horticultural Areas
0 20 40 80 120 160
Kilometers

Table 4.3

AREA UNDER APRICOT TREES IN SURVEYED VILLAGES OF LEH DISTRICT (in *kanal*)

HIGHER ZONE – NOT APPLICABLE					
MIDDLE ZONE					
Area (in *kanal*)	Units	Farm Size			Total
		Small	Medium	Large	
Up to 5	No. of Farmers	70	35	17	123
	Percentage	65.42	71.43	70.83	68.33
More than 5	No. of Farmers	3	2	1	6
	Percentage	2.80	4.08	4.16	3.33
Nil	No. of Farmers	34	12	6	51
	Percentage	31.78	24.49	25.00	28.33
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Up to 5	No. of Farmers	46	11	5	61
	Percentage	73.02	57.89	62.50	67.78
More than 5	No. of Farmers	4	5	2	11
	Percentage	6.35	26.32	25.00	12.22
Nil	No. of Farmers	13	3	1	18
	Percentage	20.63	15.79	12.50	20.00
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100
BOTH ZONES					
Up to 5	No. of Farmers	116	46	22	184
	Percentage	68.24	67.65	68.75	68.15
More than 5	No. of Farmers	7	7	3	17
	Percentage	4.12	10.29	9.38	6.30
Nil	No. of Farmers	47	15	7	69
	Percentage	27.65	22.06	21.88	25.56
Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016.

Table 4.3 reveals that 22 large farmers accounting for 68.75 per cent of total surveyed households of large farmers were having up to 5 *kanals* of total area under apricot trees in both zones. The share of medium and small farmers out of surveyed household of medium and small farmers was 67.65 per cent and 68.24 per cent respectively. Only 3 large farmers out of total 32 large farmers accounting for 9.38 per cent had more that 5 *kanals* land under apricot trees. Similarly, 10.29 per cent of all medium farmers and 4.12 per cent of all small farmers had more than 5 *kanals* under apricot trees. Around 27.65 per cent of all small farmers numbering 47 did not

have apricot plantations. Figure of farmers not having land under apricot trees was 22.06 percent of all medium farmers and 21.88 per cent of all large farmers. It shows lower proportion of small farmers having more than 5 *kanals* of land under apricot trees. It reflects that area under apricot trees increases with increasing in farm size more so for medium farmers.

A significant proportion numbering 69 households accounting for 25.56 per cent of total surveyed households did not have apricot plantations in both zones. On the whole, 201 out of 270 surveyed households accounting for 74.44 per cent have varying proportion of land under apricot trees. It is a positive sign as more fruit production and additional area brought under it are liable to bring vital changes in the structure of rural economy.

Comparison of area under apricot plantations in lower and middle zone surveyed villages shows that proportion is higher as 80 per cent numbering 72 households out of 90 surveyed households have land under apricot trees in lower zone. The share of apricot growing farmers was 71.67 per cent of total surveyed households in middle zone. It reflects that lower areas provide more suitable climatic conditions for growing apricot plants. Largest proportion i.e. 26.32 per cent of all medium farmers followed by 25 per cent of all large farmers of total surveyed households have more than 5 *kanals* of total area under apricot plantations in lower zone. As against this, only 4.16 per cent of all large farmers followed by 4.08 per cent of all medium farmers are having more than 5 *kanals* of total area under apricot plantations in middle zone.

Thiksey, Stok, Basgoo, Hemis Shukpachan and Likir villages falling in Indus valley and Diskit village in Nubra valley lying in the middle zone have apricot plantations. Basgoo village alone has large scale plantations followed by Likir and Hemis Shukpachan due to feasible climatic conditions and its high economic value. Domkhar village lying in lower Indus valley has extensive apricot plantations in the lower zone. It is followed by Hanoo village, which also has large scale of apricot plantations. These villages lying in lower zone of Leh district are more suitable for apricot plantations on account of favourable conditions in terms of milder climate and fertile soil. In addition, Defence Institute of High Altitude Research (DIHAR), at Leh also offers an opportunity to farmers to interact with scientists who provide

them up-to-date knowledge regarding plantation methods. Diskit village falling in Nubra valley also has apricot plantations in the lower zone.

It can be concluded from above discussion that almost all categories of farmers have apricot plantations with some intra-category variations in lower and middle zones. As apricot is dominant horticultural crop of the district, some farmers in lower and middle zones have brought large portion of land under apricot plantations. It is a major source of livelihood for some inhabitants. However, the area under apricot plantations is varied across the zones depending upon the landscape and climate of that particular zone. It can be seen from the above analysis that area under apricot trees is highest in lower zone, which is followed by middle zone.

It is also important to see the number of apricot trees per farming household across farm-size as well as altitudinal zones in order to understand the growing importance of horticultural crops.

Table 4.4 depicts that largest proportion i.e. 69.12 per cent of all medium farmers were having up to 50 apricot trees in both zones. On the other hand, around 11.76 per cent of all medium farmers were having more than 50 apricot trees. Most of the farmers irrespective of categories were found to be having apricot trees in both zones. Majority of them across farm size categories were having up to 50 trees. Largest proportion constituting 15.63 per cent of all large farmers followed by 11.76 per cent of all medium farmers of the total surveyed households were having more than 50 apricot trees. On the contrary, smallest proportion i.e. 4.17 per cent of all small farmers had more than 50 apricot trees. It reflects that there is a clear-cut relationship between number of apricot trees and that of land holding size. It means that number of apricot trees also increases with larger land holding size. As a whole, 185 out of 270 surveyed households accounting for 68.52 per cent had up to 50 apricot trees whereas 21 households constituting 7.78 per cent were having more than 50 apricot trees in both zones.

Table 4.4

APRICOT TREES IN SURVEYED VILLAGES OF LEH DISTRICT (in *numbers*)

HIGHER ZONE – NOT APPLICABLE					
MIDDLE ZONE					
Apricot Trees (no's)	Units	Farm Size			Total
		Small	Medium	Large	
Up to 50	No. of Farmers	72	34	17	123
	Percentage	67.29	69.39	70.83	68.33
More than 50	No. of Farmers	3	4	2	9
	Percentage	2.80	8.16	8.33	5.00
Nil	No. of Farmers	32	11	5	48
	Percentage	29.91	22.45	20.83	26.67
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Up to 50	No. of Farmers	45	13	4	61
	Percentage	71.43	68.42	50.00	67.78
More than 50	No. of Farmers	5	4	3	12
	Percentage	7.94	21.05	37.50	13.33
Nil	No. of Farmers	13	2	1	17
	Percentage	20.63	10.53	12.50	18.89
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
BOTH ZONES					
Up to 50	No. of Farmers	117	47	21	185
	Percentage	68.82	69.12	65.63	68.52
More than 50	No. of Farmers	8	8	5	21
	Percentage	4.71	11.76	15.63	7.78
Nil	No. of Farmers	45	13	6	64
	Percentage	26.47	19.12	18.75	23.70
Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016.

A significant variation can be seen in the number of apricot trees in middle and lower zones. It shows that largest proportion constituting 37.50 per cent of all large farmers were having more than 50 apricot trees in lower zone. On the contrary, only 8.33 per cent of all large farmers of total surveyed households in middle zone had more than 50 apricot trees. On the whole, largest proportion i.e. 68.33 per cent out of total surveyed households were having up to 50 apricot trees in middle zone villages. On the other hand, smallest proportion of only 5 per cent of total surveyed households had more than 50 apricot trees. Whereas, largest proportion accounting

for 67.78 per cent out of total surveyed households were having up to 50 apricot trees in lower zone villages. On the contrary, smallest proportion accounting for 13.33 per cent out of total surveyed households had more than 50 apricot trees, which is higher than middle zone under same the same category. It highlights that low lying areas have better climate and infrastructural facilities to support plantations in larger number compared to higher areas.

It can be concluded from above analysis that farmers with large landholdings have planted more apricot trees in surveyed villages in middle zone. A few medium farmers and small farmers have also planted large number of apricot trees in surveyed villages of lower zone. It is possible due to adequate supply of moisture and milder climate. Large number of apricot trees in middle zone is possible due to suitable climatic condition and its high economic value. It shows that some farmers in middle zone villages have also started adopting horticulture as an important economic pursuit.

It is also important to see the number of apricot fruit bearing trees per farming household across farm-size as well as altitudinal zones in order to understand the growing importance of horticultural crops.

Table 4.5 shows that 7 large farmers constituting 21.88 per cent of all large farmers followed by 29 small farmers accounting for 17.06 per cent of small farmers of total surveyed households had up to 25 apricot fruit bearing trees in both zones. On other hand, around 16.18 per cent of all medium farmers were having up to 25 apricot bearing trees. Largest proportion accounting for 25.53 per cent of all medium farmers followed by large farmers having a share of 21.88 per cent per of total large farmers were having more than 25 apricot fruit bearing trees. As against this, only 6.47 per cent of all small farmers had more than 25 apricot bearing trees. It shows that farmers with comparatively bigger farm size have more apricot fruit bearing trees.

Table 4.5

FRUIT BEARING APRICOT TREES IN SURVEYED VILLAGES OF LEH DISTRICT (in *numbers*)

HIGHER ZONE – NOT APPLICABLE					
MIDDLE ZONE					
Fruit Bearing Apricot Trees (no's)	Units	Farm Size			Total
		Small	Medium	Large	
Up to 25	No. of Farmers	11	8	5	24
	Percentage	10.28	16.33	20.83	13.33
More than 25	No. of Farmers	5	6	4	15
	Percentage	4.67	12.24	16.67	8.33
Nil	No. of Farmers	91	35	15	141
	Percentage	85.05	71.43	62.50	63.33
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100
LOWER ZONE					
Up to 25	No. of Farmers	18	3	2	23
	Percentage	28.57	15.79	25.00	25.56
More than 25	No. of Farmers	6	10	3	19
	Percentage	9.52	52.63	37.50	21.11
Nil	No. of Farmers	39	6	3	48
	Percentage	61.90	31.58	37.50	53.33
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
BOTH ZONES					
Up to 25	No. of Farmers	29	11	7	47
	Percentage	17.06	16.18	21.88	17.41
More than 25	No. of Farmers	11	16	7	34
	Percentage	6.47	23.53	21.88	12.59
Nil	No. of Farmers	130	41	18	189
	Percentage	76.47	60.29	56.25	70.00
Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016.

In all 47 out of 270 surveyed farmers accounting for 17.41 per cent had up to 25 apricot bearing trees whereas 34 farmers constituting 12.59 per cent were having more than 25 apricot fruit bearing trees in both zones. The number of fruit bearing apricot trees shows a slightly different distributional pattern in surveyed villages of middle and lower zones. It can be seen from the table that largest proportion of 52.63 per cent of all medium farmers had more than 25 apricot bearing trees in lower zone. As against this, only 12.24 per cent of total medium farmers had more than 25 apricot bearing trees in the middle zone. Likewise, a significant proportion of 37.50 per cent of all large farmers of surveyed households had more than 25 apricot

bearing trees in lower zone. On the other hand, there were only 16.67 per cent of all large farmers were having more than 25 apricot bearing trees in the middle zone.

It can be inferred from the above analysis that farmers with larger landholdings sizes have more number of apricot bearing trees as compared to other categories. However, a few small and medium farmers have also started getting produce of fruit in the lower and middle zones. It shows that the lower zone has comparatively more number of apricot fruit bearing trees than the middle zone due to better topographical and climatic conditions. Nevertheless, some villages in middle zone have also started getting yield of apricot in recent years on account of warmer climate.

Table 4.6 reveals that highest proportion of 36.76 per cent of all medium farmers of surveyed households were getting apricot production of up to 3 *quintals* per plant in both zones. The figure of the same was 28.13 per cent of all large farmers. However, small farmers having production of up to 3 *quintals* per plant had the smallest proportion of 21.18 per cent. Largest proportion constituting 18.75 per cent of large farmers of surveyed households had production of more than 3 *quintals* per plant in both zones. The share of medium farmers in this category was 5.88 per cent. None of the small farmers had more than 3 *quintals* per plant apricot plants. It shows larger farmers getting better yield which could be because they can afford more inputs in both zones. It may be noted that 190 farmers of surveyed households did not have any apricot production.

In short, only 70 out of 270 surveyed households accounting for 25.93 per cent had apricot production up to 3 *quintals* per tree in both zones. Another 10 households i.e. 3.70 per cent of surveyed households had production of above 3 *quintals* per plant. Different production trends can be seen in the middle and lower zones. About 40 households out of total 180 households of the middle zone accounting for 22.22 per cent had apricot production of up to 3 *quintals* per plant against 4 households having above 3 *quintals* production per apricot plant. A slightly different picture emerged in the lower zone with 30 out of 90 surveyed households constituting 33.33 per cent had up to 3 *quintals* apricot production per tree. On the other hand, 6 households out of 90 surveyed households accounting for 6.67 per cent had more than 3 *quintals* per plant apricot production. It could be attributed to more

Table 4.6

APRICOT PRODUCTION IN SURVEYED VILLAGES OF LEH DISTRICT (*quintals* per plant)

HIGHER ZONE – NOT APPLICABLE					
MIDDLE ZONE					
Production (in *quintals* per plant)	Units	Farm Size			Total
		Small	Medium	Large	
Up to 3	No. of Farmers	18	15	7	40
	Percentage	16.82	30.61	29.17	22.22
More than 3	No. of Farmers	0	1	3	4
	Percentage	0.00	2.04	12.50	2.22
Nil	No. of Farmers	89	33	14	136
	Percentage	83.18	67.35	58.33	75.56
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Up to 3	No. of Farmers	18	10	2	30
	Percentage	28.57	52.63	25.00	33.33
More than 3	No. of Farmers	0	3	3	6
	Percentage	0.00	15.79	37.50	6.67
Nil	No. of Farmers	45	6	3	54
	Percentage	71.43	31.58	37.50	60.00
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
BOTH ZONES					
Up to 3	No. of Farmers	36	25	9	70
	Percentage	21.18	36.76	28.13	25.93
More than 3	No. of Farmers	0	4	6	10
	Percentage	0.00	5.88	18.75	3.70
Nil	No. of Farmers	134	39	17	190
	Percentage	78.82	57.35	53.13	70.37
Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016.

Note: It may be noted that production of apricot has been calculated by taking the apricot plant and production from that plant tree. These are rough estimates as stated by the respondents in household survey. Therefore, the accuracy may be doubtful. However, the data provide a rough comparative picture across zones.

favourable climatic conditions of lower zone to production of different varieties of apricot trees. Largest proportion of 62.53 per cent of all medium farmers followed by 28.57 per cent of all small farmers had below 3 *quintals* apricot production per tree in lower zone. On the contrary, around 30.61 per cent of all medium farmers followed by 29.17 per cent of all large farmers were having below 3 *quintals* apricot production per tree in middle zone.

Plate 4.1: A fruit bearing *laktse-karpo* variety of apricot tree in the month of September in Leh district. (2800 meters)

Plate 4.2: A fruit bearing *pollinizer* variety of apple tree in September in Leh district. (3200 meters)

It can be concluded from the above discussion that large farmers with more fruit bearing apricot trees had more production compared to medium and small farmers. A few medium farmers are also having more production in some cases. Lower zone large and medium farmers are getting more production compared to large and medium farmers of middle zone.

Table 4.7

AREA UNDER APPLE TREES IN SURVEYED VILLAGES OF LEH DISTRICT (in *kanal*)

HIGHER ZONE – NOT APPLICABLE					
MIDDLE ZONE					
Area (in *kanal*)	Units	Farm Size			Total
		Small	Medium	Large	
Up to 5	No. of Farmers	78	35	19	132
	Percentage	72.90	71.43	79.17	73.33
More than 5	No. of Farmers	2	5	3	10
	Percentage	1.87	10.20	12.50	5.56
Nil	No. of Farmers	27	9	2	38
	Percentage	25.23	18.37	8.33	21.11
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Up to 5	No. of Farmers	38	10	4	52
	Percentage	60.32	52.63	50.00	57.78
More than 5	No. of Farmers	4	5	3	12
	Percentage	6.35	26.32	37.50	13.33
Nil	No. of Farmers	21	4	1	26
	Percentage	33.33	21.05	12.50	28.89
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
BOTH ZONES					
Up to 5	No. of Farmers	116	45	23	184
	Percentage	68.24	66.18	71.88	68.15
More than 5	No. of Farmers	6	10	6	22
	Percentage	3.53	14.71	18.75	8.15
Nil	No. of Farmers	48	13	3	64
	Percentage	28.24	19.12	9.38	23.70
Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016.

Table 4.7 shows largest proportion of 71.88 per cent of total large farmers followed by 68.24 per cent of small farmers of surveyed households to be having apple trees on land up to 5 *kanals* in both zones. On the other hand, significant share of 66.18

per cent of all medium farmers have up to 5 *kanals* of area under apple plantations. Farmers with more than 5 *kanals* land under apple trees included 18.75 per cent of all large farmers, 14.71 per cent of medium farmers of surveyed households. As against this of all small farmers only 3.53 per cent had more than 5 *kanals* of area under apple trees. It reflects that area under apple production increases with increasing farm size in both zones.

A significant proportion numbering 64 households i.e. 28.24 per cent of all small farmers followed by 19.12 per cent of all medium farmers of surveyed households did not have apple plantations in both zones. Only 9.38 per cent of all large farmers were in this category. On the whole, 206 households out of total 270 surveyed households had varying sizes of land under apple trees. This is a positive sign as apple is an important source of nutritive diet along with being a source of income and employment. Moreover, the scope of apple plantations is quite good in Leh district because of improvement in its connectivity and rising demand by tourists.

Slightly different pattern can be observed in terms of area under apple plantations in the lower and middle zone surveyed villages along with some similarities. It reflects that proportion of area under apple plantation increases with increasing farm size. However, proportion is higher at 78.88 per cent households numbering 142 out of 180 surveyed households had land under apple trees in the middle zone. The share of apple growing farmers was 71.11 per cent of total surveyed households in the lower zone. It suggests that large number of farmers in middle zone have brought land under apple plantation. It could be as many of middle zone villages are on main National Highway and better linked with Leh town which is the major market and tourist destination. Moreover, many of these villages get support from Horticulture Department of Leh.

Basgoo village lying in Indus valley alone has large scale apple plantations in the middle zone. Thiksey, Stok, Hemis Shukpachan and Lekir falling in Indus valley in the middle zone also have apple plantations at various scales. Diskit village in Nubra valley has apple plantations. Domkhar and Hanoo viilages located in the lower Indus valley have extensive apple plantations among lower zone villages. Defence Institute of High Altitude Research (DIHAR), Leh has been working

extensively with the local farmers in terms of creating awareness, and development of processing and cultivation technologies etc. A few large farmers have started bringing large tracts of land under plantation crops with the help of modem scientific techniques in lower parts of the district.

It can be inferred from above discussion that almost all categories of farmers are gradually moving towards apple plantations with some minor intra-category variations in the lower and middle zones. One progressive and innovative farmer from Domkhar village has successfully developed a private open farm apple plant nursery with approximately 4000 juvenile plants in lower zone. He stated about his attempt to promote sustainable farming and fruit based agricultural activities for sustainable agro-based local economy in the region. There is significant area under apple plantations in lower zone and large tracts of land in the villages of middle zone have also been brought under apple trees in recent years.

It is also important to see the number of apple trees per farming household across farm-size as well as altitudinal zones in order to understand the growing importance of horticulture crops.

Table 4.8 reveals that 118 small farmers constituting 69.41 per cent of all small farmers followed by 22 large farmers accounting for 68.75 per cent of large farmers of surveyed households had up to 50 apple trees in both zones. On the other hand, the proportion was slightly less at 63.24 per cent of all medium farmers in this category. Next largest proportion accounting for 21.88 per cent of large farmers followed by 16.18 per cent of medium farmers of surveyed households had more than 50 apple trees. Only 3.53 per cent of all small farmers had more than 50 apple trees. It highlights that the number of apple trees increases with increasing size of landholding. As whole 183 households out of 270 surveyed households accounting for 67.78 per cent had up to 50 apple trees whereas 24 households constituting 8.89 per cent were having more than 50 apple trees.

The number of apple plants depicts slightly different pattern in middle and lower zones. A major difference can be observed among surveyed households where 12 farmers accounting for 13.33 per cent of total surveyed households were having

Table 4.8

APPLE TREES IN SURVEYED VILLAGES OF LEH DISTRICT (in *numbers*)

HIGHER ZONE – NOT APPLICABLE					
MIDDLE ZONE					
Apple Trees (no's)	Units	Farm Size			Total
		Small	Medium	Large	
Up to 50	No. of Farmers	80	33	18	130
	Percentage	74.77	67.35	75.00	72.22
More than 50	No. of Farmers	2	6	4	12
	Percentage	1.87	12.24	16.67	6.67
Nil	No. of Farmers	25	10	2	38
	Percentage	23.36	20.41	8.33	21.11
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Up to 50	No. of Farmers	38	10	4	51
	Percentage	60.32	52.63	50.00	56.67
More than 50	No. of Farmers	4	5	3	12
	Percentage	6.35	26.32	37.50	13.33
Nil	No. of Farmers	21	4	1	27
	Percentage	33.33	21.05	12.50	30.00
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
BOTH ZONES					
Up to 50	No. of Farmers	118	43	22	183
	Percentage	69.41	63.24	68.75	67.78
More than 50	No. of Farmers	6	11	7	24
	Percentage	3.53	16.18	21.88	8.89
Nil	No. of Farmers	46	14	3	63
	Percentage	27.06	20.59	9.38	23.33
Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016.

more than 50 apple trees in lower zone. As opposed to this, only 6.67 per cent numbering 12 farmers had more than 50 apple trees in middle zone. Similarly, a significant proportion of 37.50 per cent of large farmers of surveyed households were having more than 50 apple trees in lower zone. As against this only 16.67 per cent of all large farmers were having more than 50 apple trees in middle zone. It could be because low areas have better climatic conditions that are conducive for growing of large number of apple trees.

It can be inferred from the above discussion that farmers with larger landholdings are planting more apple trees in surveyed villages of both zones. However, a few small and medium farmers are also planting large number of apple trees in villages of lower and middle zone. This is because of adequate moisture supply and milder climate. Most farmers are now going for apple plantations owing to better farm returns compared to other fruit crops. North-western part of Leh district, lying in lower zone, has better suitability to produce superior quality apples because arid-cold climate keeps it relatively free from early autumn frost and from various diseases. However, some farmers even in suitable pockets are still reluctant to opt for apple plantations due to other climatic and socio-economic uncertainties.

It is also important to see the number of fruit bearing apple trees in Leh district. It can be seen from Table 4.9 that largest proportion accounting for 25.00 per cent of large farmers followed by 17.65 per cent of medium farmers of surveyed households had up to 25 apple bearing trees in both zones. On the other hand, 13.53 per cent of all small farmers were having up to 25 apple bearing trees. The share of farmers having more than 25 apple trees was found out to be 15.63 per cent of large farmers followed by 8.82 per cent of medium farmers. As against this, only 1.18 per cent of all small farmers had more than 25 apple bearing trees. It shows that farmers with comparatively bigger farm size had taken up apple plantation at least a decade earlier. However, apple plants requires long gestation period to yield fruit.

In total 43 out of 270 surveyed households accounting for 15.93 per cent had up to 25 apple bearing trees in the surveyed villages of both zones. On the other hand, 13 out of 270 surveyed households constituting 6.07 per cent were having more than 25 apple bearing trees. A slightly different picture can be noticed if we compare middle and lower zone. It shows that 19 farmers accounting for 21 per cent of total surveyed households had up to 25 apple bearing trees in lower zone. As opposed to this, only 13.33 per cent farmers out of total surveyed households in middle zone were having up to 25 apple bearing trees. A significant proportion of 37.50 per cent of large farmers followed by 10.53 per cent of medium farmers of surveyed households had more than 25 fruit bearing apple trees in lower zone. On the contrary, only 8.33 per cent of all large farmers followed by 8.16 per cent of all

medium farmers had more than 25 apple bearing trees in middle zone. It could be due to the fact that lower zone villages have taken up apple plantations at least a decade earlier.

Table 4.9

FRUIT BEARING APPLE TREES IN SURVEYED VILLAGES OF LEH DISTRICT (in *numbers*)

HIGHER ZONE – NOT APPLICABLE					
MIDDLE ZONE					
Fruit Bearing Apple Trees (no's)	Units	Farm Size			Total
		Small	Medium	Large	
Up to 25	No. of Farmers	13	5	6	24
	Percentage	12.15	10.20	25.00	13.33
More than 25	No. of Farmers	2	4	2	8
	Percentage	1.87	8.16	8.33	4.44
Nil	No. of Farmers	92	40	16	148
	Percentage	85.98	81.63	66.67	82.22
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Up to 25	No. of Farmers	10	7	2	19
	Percentage	15.87	36.84	25.00	21.11
More than 25	No. of Farmers	0	2	3	5
	Percentage	0.00	10.53	37.50	5.56
Nil	No. of Farmers	53	10	3	66
	Percentage	84.13	52.63	37.50	73.33
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
BOTH ZONES					
Up to 25	No. of Farmers	23	12	8	43
	Percentage	13.53	17.65	25.00	15.93
More than 25	No. of Farmers	2	6	5	13
	Percentage	1.18	8.82	15.63	6.07
Nil	No. of Farmers	145	50	19	214
	Percentage	85.29	73.53	59.38	79.26
Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016.

It can be concluded from the above discussion that farmers with larger landholdings have more number of apple bearing trees. However, a few small and medium farmers have also started getting yield of fruit in lower and middle zones. Such a low proportion of farmers producing fruits could be due to the fact that apple plantations

have picked up momentum mainly in post 2000 period. Apple plants require long gestation period of 4 to 10 years depending on variety of apple tree.

Table 4.10

APPLE PRODUCTION IN SURVEYED VILLAGES OF LEH DISTRICT (*quintals* per plant)

Production (in quintals per plant)	Units	Farm Size			Total
		Small	Medium	Large	
Up to 3	No. of Farmers	14	8	6	28
	Percentage	13.08	16.33	25.00	15.56
More than 3	No. of Farmers	0	4	5	9
	Percentage	0.00	8.16	20.83	5.00
Nil	No. of Farmers	93	37	13	143
	Percentage	86.92	75.51	54.17	79.44
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Up to 3	No. of Farmers	11	8	2	21
	Percentage	17.46	42.11	25.00	23.33
More than 3	No. of Farmers	1	2	4	7
	Percentage	1.59	10.53	50.00	7.78
Nil	No. of Farmers	51	9	2	62
	Percentage	80.95	47.37	25.00	68.89
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
BOTH ZONES					
Up to 3	No. of Farmers	25	16	8	49
	Percentage	14.71	23.53	25.00	18.15
More than 3	No. of Farmers	1	5	9	15
	Percentage	0.59	10.87	28.13	5.56
Nil	No. of Farmers	144	46	15	205
	Percentage	84.71	67.65	46.88	75.93
Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016. **Note:** As mentioned earlier, the production data is rough estimate based on what was told by the respondents during the survey.

Table 4.10 reveals that highest proportion of 25 per cent of large farmers was followed by 23.53 per cent of total medium farmers of surveyed households who were having apple production of up to 3 *quintals* per plant in both zones. The figure for small farmers under the same category was 14.71 per cent. Similarly, largest proportion of 28.13 per cent of large farmers followed by 10.87 per cent of medium farmers of surveyed households were getting production more than 3 *quintals* per

plant. On the contrary, the share of small farmers having more than 3 *quintals* per plant was merely 0.59 per cent of all small farmers. It reflects that large farmers are getting more production as compared to other categories of farmers.

In total, 49 out of 270 surveyed households accounting for 18.15 per cent had below 3 *quintals* per plant apple production in both zones. Another 15 households i.e. 5.56 per cent of total surveyed households had above 3 *quintals* per plant apple production. A significantly different picture of apple production can be seen from the table in the case of middle and lower zones. About 28 out of 180 surveyed households accounting for 15.56 per cent had up to 3 *quintals* per plant apple production against 9 households making 5.00 per cent were having above 3 *quintals* production in middle zone. A slightly different picture emerged in lower zone with 21 out of 90 surveyed households constituting 23.33 per cent had below 3 *quintals* apple production per tree. As against this, 7 households out of 180 surveyed households constituting 7.78 per cent had above 3 *quintals* production per tree. Furthermore, largest proportion of 50 per cent of all large farmers followed by 10.53 per cent of all medium farmers had more than 3 *quintals* per plant apple production in lower zone. As against this, 20.83 per cent of all large farmers followed by 8.16 per cent of medium farmers of surveyed households were getting more than 3 *quintals* per plant apple production in middle zone. It highlights that lower zone farmers were getting more production as compared to middle zone on account of more favourable climatic conditions.

It can be concluded from the above discussion that large farmers with more fruit bearing apricot trees had more production as compared to medium and small farmers in both zones. However, a few small and medium farmers also had more production in other cases. Large farmers followed by medium farmers in lower zone are getting more production as compared to middle zone farmers under the same category of farmers. There is a positive relationship between farm-size and production of apple. It means production increases with increasing in farm-size. However, it is more pronounced in lower zone compared to middle zone.

Plate 4.3: Sun drying of apricots in locally made dryer in Domkhar village.

Plate 4.4: Family packing roasted-barley and apricot kernel to be sold in market in Domkhar village.

4.3 Disposal of Fruit Production

Keeping in view the above discussion, it is also important to look at other aspects of horticulture such as marketing and nature of major problems faced by farming households. This will help in understanding relative importance of each zone for apricot and apple plantations. Besides, it will also provide an insight in the nature of changing agricultural economy of Leh district. Thus, an attempt has been made to comprehend the restrictive role played by environmental constraints on one hand, and various socio-economic factors on the other.

Table 4.11

DISPOSAL OF APRICOT FRUITS IN SURVEYED VILLAGES OF LEH DISTRICT

HIGHER ZONE – NOT APPLICABLE					
MIDDLE ZONE					
Disposal	Units	Farm Size			Total
		Small	Medium	Large	
Marketing	No. of Farmers	5	8	5	18
	Percentage	4.67	16.33	20.83	10.00
Both*	No. of Farmers	13	7	6	26
	Percentage	12.15	14.29	25.00	14.44
Nil	No. of Farmers	89	34	13	136
	Percentage	83.18	69.39	54.17	75.56
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Marketing	No. of Farmers	6	5	3	14
	Percentage	9.52	26.32	37.50	15.56
Both*	No. of Farmers	12	8	2	22
	Percentage	19.05	42.11	25.00	40.74
Nil	No. of Farmers	45	6	3	54
	Percentage	71.43	31.59	37.50	60.00
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
BOTH ZONES					
Marketing	No. of Farmers	11	13	8	32
	Percentage	6.47	19.12	25.00	11.85
Both*	No. of Farmers	25	15	8	48
	Percentage	14.71	22.06	25.00	17.78
Nil	No. of Farmers	134	40	16	190
	Percentage	78.82	58.82	50.00	70.37
Sub-Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016. Note: Both* means marketed and self-consumption

Table 4.11 reveals that 25 per cent of all large farmers stated they were growing apricot only for selling in the market in both zones. The share of such farmers was 19.12 per cent of all medium farmers and 6.47 per cent of all small farmers. Similarly other 25 per cent of large farmers responded that they produced apricot both for marketing as well as for self-consumption. Proportion of farmers producing apricot for both purposes was 22.06 per cent of all medium farmers and 14.71 per cent of small farmers. As a whole, 48 out of 270 households accounting for 17.78 per cent of surveyed households were growing apricot both for marketing as well as self-consumption; whereas 32 households constituting 11.85 per cent of total surveyed households responded that they were growing apricot for selling in the market. About 190 farmers were in the category of nil. These included farmers who did not either have apricot trees or were using the produce only for self-consumption.

Out of total apricot growing farmers, the share of those producing for market was highest at 20.83 per cent of large farmers of surveyed households in middle zone and 25 per cent large farmers were selling the produce as well as consuming it at the household level. Largest proportion of 37.50 per cent of all large farmers in the lower zone was producing apricot for selling the produce in the market. Another 25 per cent of large farmers were producing apricot for both purposes of selling and for self consumption. But the share of medium farmers those were producing for market and for both purposes presented a slightly different picture in lower zone. Significant proportion of 42.11 per cent of all medium farmers was selling apricot as well as consuming the produce at household level in the lower zone as against only 14.29 per cent of such medium farmers in the middle zone.

It can be inferred from the above that large farmers followed by medium farmers were in a better position to sell as well consume their apricot production as compared to small farmers in both zones. However, it is slightly different in case of lower zone as large proportion of medium farmers was marketing and self-consuming the produce as against large farmers being in the same category in the middle zone.

Table 4.12

DISPOSAL OF APPLE FRUITS IN SURVEYED VILLAGES OF LEH DISTRICT

HIGHER ZONE – NOT APPLICABLE					
MIDDLE ZONE					
Disposal	Units	Farm Size			Total
		Small	Medium	Large	
Marketing	No. of Farmers	4	6	7	17
	Percentage	3.74	12.24	29.17	9.44
Both*	No. of Farmers	10	7	4	21
	Percentage	9.35	14.29	16.67	11.67
Nil	No. of Farmers	93	36	13	142
	Percentage	86.92	73.47	54.17	78.89
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Marketing	No. of Farmers	5	3	4	12
	Percentage	7.94	15.79	50.00	13.33
Both*	No. of Farmers	4	6	3	13
	Percentage	6.35	31.58	37.50	14.44
Nil	No. of Farmers	54	10	1	65
	Percentage	85.71	52.63	12.50	72.22
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
BOTH ZONES					
Marketing	No. of Farmers	9	9	11	29
	Percentage	5.29	13.24	34.38	10.74
Both*	No. of Farmers	14	13	7	34
	Percentage	8.24	19.12	21.88	12.59
Nil	No. of Farmers	147	46	14	207
	Percentage	86.47	67.65	43.75	76.67
Sub-Total	No. of Farmers	170	68	32	270
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016. Note: Both* means marketed and self-consumption

Table 4.12 shows that 34.38 per cent of all large farmers were growing apple only for selling in market in the both zones. The share of such farmers was 13.24 per cent for medium farmers and 5.29 per cent for small farmers in this category. As against this, 21.88 per cent of all large farmers were producing apple for both purposes. The proportion of farmers producing apple for both purposes varied from 19.12 per cent for medium farmers to 8.24 per cent of small farmers. As a whole, 34 out of 270 households accounting for 12.59 per cent of total surveyed households were

producing for market and 29 households constituting 10.74 per cent were growing apple for marketing as well as for self-consumption.

A slightly different pattern can be seen terms of disposal apple production in the middle and lower zone surveyed villages. Out of total apple growing farmers, the share of those producing for market was highest at 50.00 per cent of large farmers in lower zone and 37.5 per cent were producing for both purposes. As opposed to this, the share of those producing for market as well as for both purposes was 29.17 per cent and 16.67 per cent respectively of large farmers in middle zone. Small farmers had lowest proportionate share in these two categories.

Most apricot and apple producing farmers pointed out marketing to be a major problem in selling the produce. Many of them were facing the problem of insects-pests and diseases in apple fruits. Though Leh district being a cold desert, the incidences of insects-pests and diseases were low due to low temperature and low humidity yet apricot producing farmers of lower Indus valley have observed severe insects-pests problem in recent years. This problem is related to especially to defoliator and aphid insects in their apricot orchards[66].

Above discussion shows only a few farmers producing apricot and apple as many of them have taken up plantation recently. Out of 270, 201 households constituting 74.44 per cent of farmers have brought some land under apricot trees across farm-size. About 206 households i.e. 76.30 per cent of surveyed household have started apple plantation. Apricot being the major fruit tree of the region is not surprising as it is grown in large numbers of villages in Leh district. However, mountain farming households are gradually shifting in favour of apple plantation. It is mainly due to its rising demand and it being more remunerative. Plantation fruit crops especially apricot and apple are conceived as future cash crops grown in the region under harsh climatic conditions coupled with poor transportation facilities. Apple plantation is not successful in higher zone on account of severe cold conditions.

[66] Raghuvanshi, M.S. et al. (2016), Introduction of New Insect-Pests on Apricot and Its Preliminary Management Options in Cold Arid Region of Ladakh, *Indian Journal of Ecology* (2016) No. 43, Vol. 2, pg. 590-592

It is evident that many farming households are getting inclined towards alternate and more promising remunerative fruit crops. Apart from providing better farm income, fruit crops also add to greenery in otherwise barren and rugged landscape. Nevertheless, since the region consists of environmentally fragile area, the ongoing drive for horticultural production needs to be carefully handled in consultation with farm scientists to harness the comparative advantages of Leh district. It is quite clear that land with suitable climate to grow temperate fruit crops is getting diversified in terms of traditional cropping pattern. Fruit crops are coming up at substantial scale with more promising economic returns. Therefore, it is important to analyse various problems in the adoption of fruit crops.

4.4 Problems in Adoption of Horticulture Crops

It is quite clear that environmental constraints coupled with poor infrastructure pose serious problems for farming practices and more so for adopting perishable fruit crops. Their role becomes quite significant in high altitude areas where inaccessibility and relative isolation restricts interface with low-lying areas. Types of crops to be grown are greatly determined by specific climatic niche and availability of various farm inputs in high altitude regions of Himalayas. These create inter-zonal variations due to prevalence of environmental constraints at varying altitude on the one hand, and various socio-economic factors on the other. It is, thus, significant to analyse the nature of problems confronted by households in the adoption of fruit crops. This would help in providing directions and efforts required to overcome these problems by combining traditional with modem techniques in the light of local climatic necessities.

Table 4.13 shows that largest proportion accounting for 36.71 per cent of medium farmers followed by small farmers of 26.12 per cent of surveyed households mentioned lack of knowledge as a major problem. On the other hand, around 25 per cent of all large farmers revealed lack of knowledge as a major problem. Next largest proportion constituting 15.92 per cent of all small farmers followed by 13.92 per cent of medium farmers of surveyed households faced problems due to insufficient capital. On the contrary, none of the large farmers confronted this

Table 4.13
MAJOR PROBLEMS IN ADOPTION OF HORTICULTURAL CROPS IN SURVEYED VILLAGES OF LEH DISTRICT (*percentage*)

Major Problems	Units	Farm Size			Total
		Small	Medium	Large	
HIGHER ZONE					
Lack of Knowledge	No. of Farmers	18	6	2	26
	Percentage	24.00	54.55	50.00	28.89
Insufficient Capital	No. of Farmers	13	2	0	15
	Percentage	17.33	18.18	0.00	16.67
Small Sizes of Landholdings	No. of Farmers	24	0	0	24
	Percentage	32.00	0.00	0.00	26.67
Labour Shortage	No. of Farmers	1	2	2	5
	Percentage	1.33	18.18	50.00	5.56
1+2+3+4*	No. of Farmers	19	1	0	20
	Percentage	25.33	9.09	0.00	22.22
Sub-Total	No. of Farmers	75	11	4	90
	Percentage	100.00	100.00	100.00	100.00
MIDDLE ZONE					
Lack of Knowledge	No. of Farmers	29	18	4	51
	Percentage	27.10	36.73	16.67	28.33
Insufficient Capital	No. of Farmers	15	3	0	18
	Percentage	14.02	6.12	0.00	10.00
Small Sizes of Landholdings	No. of Farmers	27	0	0	27
	Percentage	25.23	0.00	0.00	15.00
Labour Shortage	No. of Farmers	6	15	20	41
	Percentage	5.61	30.61	83.33	22.78
1+2+3+4*	No. of Farmers	30	13	0	43
	Percentage	28.04	26.53	0.00	23.89
Sub-Total	No. of Farmers	107	49	24	180
	Percentage	100.00	100.00	100.00	100.00
LOWER ZONE					
Lack of Knowledge	No. of Farmers	17	5	3	25
	Percentage	26.98	26.32	37.50	27.78
Insufficient Capital	No. of Farmers	11	6	0	17
	Percentage	17.46	31.58	0.00	18.89
Small Sizes of Landholdings	No. of Farmers	16	0	0	16
	Percentage	25.40	0.00	0.00	17.78
Labour Shortage	No. of Farmers	2	5	5	12
	Percentage	3.17	26.32	62.50	13.33
1+2+3+4*	No. of Farmers	17	3	0	20
	Percentage	26.98	15.79	0.00	22.22
Sub-Total	No. of Farmers	63	19	8	90
	Percentage	100.00	100.00	100.00	100.00
ALL ZONES					
Lack of Knowledge	No. of Farmers	64	29	9	102
	Percentage	26.12	36.71	25.00	28.33
Insufficient Capital	No. of Farmers	39	11	0	50
	Percentage	15.92	13.92	0.00	13.89
Small Sizes of Landholdings	No. of Farmers	67	0	0	67
	Percentage	27.35	0.00	0.00	18.61
Labour Shortage	No. of Farmers	9	22	27	58
	Percentage	3.67	27.85	75.00	16.11
1+2+3+4*	No. of Farmers	66	17	0	83
	Percentage	26.94	21.52	0.00	23.06

Sub-Total	No. of Farmers	245	79	36	360
	Percentage	100.00	100.00	100.00	100.00

Source: Field Survey, September-October, 2016.
Note: 1+2+3+4* stands for lack of knowledge, insufficient capital, small size of landholdings and labour shortage etc.

problem. Around 67 small farmers accounting for 27.35 per cent of small farmers of surveyed households faced problem of small size of landholdings. Largest proportion i.e. 75.00 per cent of large farmers followed by 27.85 per cent of medium farmers pointed out labour shortage to be the main problem. As against this, only 3.67 per cent of small farmers mentioned this problem. It could be because large farmers have capacity to employ large number of hired labourers though facing shortage of family labour. Largest proportion constituting 26.94 per cent of all small farmers followed by 21.52 per cent of medium farmers of surveyed households confronted combination of all problems including lack of knowledge, insufficient capital, small size of landholdings and labour shortage etc.

If we look at across the zones, it shows that about 54.55 per cent of all medium farmers followed by 50 per cent of large farmers of surveyed households stated lack of knowledge to be the main hurdle in adopting new crops in higher zone villages. On the other hand, 24.00 per cent of all small farmers stated this to be the problem.

Similarly, about 36.73 per cent of all medium farmers followed by 27.10 per cent of all small farmers responded lack of knowledge to be the main problem in the middle zone. As against this, largest proportion i.e. 37.50 per cent of all large farmers followed by 26.98 per cent of all small farmers stated this to be the main problem in lower zone. About 18.18 per cent of medium farmers followed by 17.33 per cent of small farmers of surveyed households faced problem of insufficient capital in higher zone. However, none of the large farmers stated this to be a problem. This problem was faced by 14.02 per cent of all small farmer followed by 6.12 per cent of all medium farmers in case of middle zone. On the contrary, none of the large farmers mentioned this to be a problem. Almost all small farmers responded small size of land holdings a major problem in adopting fruit crops across the zone. None of the medium and large farmers faced this to be problem. However, it needs to be mentioned here that small size of land holdings is one the major

problems in a high altitude region like Leh district given its rough nature of terrain with poor soil cover.

Largest proportion of 83.33 per cent of large farmers followed by 30.61 per cent of medium farmers of surveyed households highlighted labour shortage as main problem in the middle zone. This problem was faced only by 5.61 per cent of all small farmers in this zone. Share of farmers facing labour shortage accounted for 62.50 per cent of large farmers followed by 26.32 per cent of medium farmers in the lower zone. Only 3.17 per cent of all small farmers faced this problem in this zone. Largest proportion of 50 per cent of all large farmers followed by 18.18 per cent of all medium farmers faced the problem of labour shortage in higher zone. It highlights that large farmers across the zone mentioned labour shortage as major main problem in adopting fruit crops. However, it is more pronounced in middle zone villages. It could be due to proximity of villages of middle zone to Leh town. Leh town offers lot of job opportunities in tourism industry and many other activities. Around 28.04 per cent of small farmers followed by 26.53 per cent of all medium farmers confronted combination of all problems including lack of knowledge, insufficient capital, small size of landholdings and labour shortage etc. in the middle zone. However, no large farmers stated combination of these problems to be an issue. A significant proportion of 26.98 per cent of all small farmers followed 15.79 per cent of all medium farmers stated combination of all problems to be the cause of not adopting new crops in lower zone. The share of farmers confronting combination of all problems was 25.33 per cent of all small farmers and 9.09 per cent of medium farmers.

It can be observed from above analysis that almost all farming households confront one or other problems in producing horticultural crops. Various problems occur right from beginning till marketing of horticultural produce at different levels. Small and medium farmers faced majority of the problems on the one hand whereas large farmers revealed labour shortage as main problem. It is more pronounced in middle zone villages. However, many such problems are being overcome in the wake of increasing modern scientific knowledge coupled with governmental aid. It is also important to minimise various problems relating to the decision-making choice of farmers. However, many of such problems have been tackled to some

extent in recent years with constant support of various agencies including Horticulture Department, Leh Nutrition Project, Defence Institute of High Altitude Research in Leh district. Consequently, local farmers are getting superior farm income with their hard working attitude supported by improved infrastructure on the one hand and climatic suitability to grow specific cash crops during lean season on the other. It needs to be emphasised that many research stations have been established in Leh district. Main objective of these research stations is to accelerate growth of horticulture particularly fruit and vegetable crops. As stated in chapter three, their efforts are likely to herald a new era in horticulture sector and significantly augment the on farm income of farming household (For details see Appendix 1.3).

To sum-up, the above analysis shows that horticulture in mountain region of Leh district is of great importance not only for economic development but also for environmental sustainability. The region has features that are favourable for the development of certain horticultural crops, especially temperate fruits. It reflects that farming communities are gradually showing signs of adopting horticultural crops. Area under various temperate fruit crops especially apricot and apple has increased substantially in the district. An extensive drive for the plantation of fruit crops across the region is going on. Almost all categories of farming households have started gradually bringing varying proportion of land under apricot and apple plantations. Some large farmers have started putting cultivable land under plantation fruit crops in lower areas. However, lack of knowledge, absence of efficient market network, lack of tested technology/methods for cultivation and value addition, and weak infrastructural facilities are major problems in the development of horticultural crops on a commercial scale. Therefore, efforts need to be made to address these problems through exchange of knowledge from other horticultural crops growing regions. Further, marketing and processing facilities need to be made available at subsidized rates for local farmers.

Chapter Five

Socio-economic Aspects of Agriculture and Changes Therein

Human beings always try to modify natural environment according to their own needs in wherever ways possible with available knowledge and skill. They, unlike animals, do not adapt themselves to nature but interacts with it constantly and get transformed in the process. Their interaction with nature began with the use of traditional methods and tools for gathering food for survival. This has undergone various changes over time with the advancement of human society. However, advanced technology was developed only after the Industrial Revolution of eighteenth century. The industrial revolution had led to technological breakthroughs ushering in an era of mass scale mechanised production by the beginning of twentieth century. This inevitably led to increase in demands for inputs in agricultural process and thus enhanced productivity. Technological revolution greatly amplified human power to modify and adapt environment through mechanisation and energy conversion. This in turn led to increased agricultural production providing food and livelihood security.

Nevertheless, spread and assimilation of better technology was limited to a few regions. Relative inaccessibility and remoteness of some parts of upper Himalayas has caused these areas to remain relatively untouched by modern technological development. Therefore, people living in such regions have developed community ties and certain socio-religious institutions in response to the requirements of environment. Besides, indigenous knowledge based on accumulation of experience, informal experiment and understanding of environment also played vital role in human response to nature through crop production. For example, some studies suggest that technology of irrigation was transferred from neighbouring regions, with local modifications[67]. According to Bell[68], the practice of skilful irrigation is said to have been introduced by Buddhist scholar-saint Atisa in

[67] Crook, J. and Osmaston, H. (1994), "Himalayan Buddhist Villages: Environment, Resources, Society and Religious Life in Zanskar, Ladakh", Motilal Banarsidas Publishers Private Limited, New Delhi, pp. 40.

[68] Bell, C. (1928), "The People of Tibet", The Clarendon Press, Oxford. Quoted in Crook, J. and Osmaston, H. (1994), *op.cit.*p.40

10th century. The traditional local technology and innovation have been instrumental in decision making process in agricultural system.

Development of modern technology and institutional changes required to achieve greater productivity have been realised recently in these regions. Consequently, there has been a significant improvement in technology that raised productivity of land and labour. Labour acquires additional importance when technological innovations are introduced especially in the early stages of development, as many of these require extra labour for the application of inputs and to switch over to more scientific methods of cultivation. Moreover, the traditional practices, combined with modern inputs and know-how for modernisation of agriculture, are likely to reduce cultivation cost of production. This would lead to an increase in total production and thus income and purchasing power.

Leh district with its high altitude, arid and cold environment exhibits one of the most impressive cases of human adaptation to harsh environment. Local people have adapted to the vagarious of natural environment by designing certain social institutions that influence its agricultural system in terms of agricultural land use, cropping pattern and agricultural processes. However, in recent years, with the advent of modernisation, population growth, the region has started witnessing tremendous changes in the traditional methods of agriculture. The traditional community ties those were designed keeping in mind the way of adapting to harsh environment are now getting weakened. For example, labour for agriculture was traditionally provided by mutual exchange of labour among the cultivators, but now is being replaced by wage labour. Therefore, an attempt has been made in this chapter to understand the nature of socio-economic aspects of agriculture in order to comprehend their impact on agricultural activities and changes therein.

In the light of the above, it becomes important to analyse the following to capture the changing agricultural economy of Leh district:

1. Land tenancy and system of Ownership to know the rights and possession of land.
2. Size of land holdings to see inequality in the distribution of land holdings and Changes therein.

3. Pressure of population on agricultural land by measuring share of population engaged in agriculture.
4. Workforce in Agriculture to understand the proportion of agricultural workers to total workers and changes in Agricultural Workers during 2001-2011.
5. Labour use and gender division of labour to see availability of labour its gender composition.

5.1 Land Ownership and Tenancy

Land tenancy and land tenure system greatly influence agricultural operations and cropping pattern in many ways. Agricultural development depends not only on technological change but also on institutional changes as well. For example, tenure relationships within farming community greatly determine social and political status and economic power. Land tenure system is, thus, a key element of agrarian structure. Cultivators are either owners, part tenants or labourers, joint owners. In general, owner operator without debt has greater freedom of action in determining the input mix. At the other extreme are hired farm labourers who have no rights in decision making.

Table 5.1 reveals that majority of cultivators in surveyed villages of Leh district own land which they cultivate. It can, therefore, be summarised that approximately 68.33 per cent of cultivators have control over their agricultural activity. Next category includes those farmers who rent in land from monasteries in addition to their own land. The monasteries provide only land and the tenants arrange all other inputs. They may be called part tenants. These farmers constitute about 19.44 per cent of the cultivators. There are an equal proportion i.e. 43.33 per cent part tenants in Thiksey and Stok. It is followed by Diskit and Likir both having 36.67 per cent part tenants each. All these villages have monasteries, which own large tracts of agricultural land. In addition, Stok village also has palace of erstwhile ruler who own large agricultural land which is also leased out to tenants.

Table 5.1

TENANCY CONDITIONS AND CULTIVATED AREA (*kanals*), 2016

Village	Owners			Part tenants			Joint owners		
	Percent cultivators	Area operated	% area operated	Percent cultivators	Area operated	% area operated	Percent cultivators	Area operated	% area operated
HIGHER ZONE									
Gia	70	194	63.82	23.33	66	21.71	6.67	44	14.47
Shachukul	80	340	75.89	10	62	13.84	10	46	10.27
Durbuk	93.33	258	87.46	-	-	-	6.67	37	12.54
MIDDLE ZONE									
Thiksey	43.33	255	54.03	43.33	162	34.32	13.33	55	11.65
Basgoo	63.33	359	65.04	20	107	19.38	16.67	86	15.58
Diskit	56.67	194	53.88	36.67	120	33.33	6.67	46	12.78
Hemis shukpachan	80	383	87.05	13.33	28	6.36	6.67	29	6.60
Stok	46.67	280	62.50	43.33	140	31.25	10	28	6.25
Likir	46.67	348	58.78	36.67	168	28.38	16.67	76	12.84
LOWER ZONE									
Hunder	73.33	472	81.94	-	-	-	26.67	104	18.06
Hanoo	80	247	79.17	-	-	-	20	65	20.83
Domkhar	86.67	416	82.54	6.67	46	9.13	6.67	42	8.33
Total	68.33	3746	70.64	19.44	899	16.95	12.22	658	12.41

Source: Field Survey, September-October, 2016. **Note:** 1 *Kanal* is equal to 0.124 Acre or 0.050 hectare. 1 Acre =8 *Kanals* and 1 Hectare =20 *Kanals.*

Tenancy rights are significantly influenced by the prevailing socio-religious customs. Strong interaction among owner cultivators, joint owners and tenants in Leh district is seen through their close cooperation. Collective action is undertaken at the hamlet level by groups of families constituting *Phaspun* who usually function as pools of agricultural labour. The decision making is also centralised in tightly knit alliance of all cultivators. However, the role of *Phuspun* in agricultural pursuits has declined to a large extent in recent years due to some new socio-economic developments.

Apart from this, other socio-religious customs that affect the tenancy conditions are related to Buddhist norms. Since majority of population in Leh district is Buddhist, socio-cultural systems are based on the tenets of Tibetan-Buddhist tradition. The Buddhist tradition in the region followed the right of

primogeniture where land ownership passes from father to eldest son. Moreover, polyandry system of marriage was prevalent. This checked fragmentation of land holdings. However, the traditions of polyandry and primogeniture were abolished with the advent of modernisation resulting in subdivision of land holdings. Besides, all the major monasteries own land which is rented out to villagers. The rent paid by tenants to monastery is either in the form of fixed amount of grain or share of the produce or fixed amount of butter.

The category of joint owners accounted for only 12.22 per cent of cultivators. These farmers are usually members of the same family consisting of brothers or close relatives and they operate land together. They own land jointly and have common pool of assets with co-operative use of inputs. In essence this means that brothers or cousins own land, livestock and other assets together, work on the land and share the produce equally. This system is more common among Muslim families of Leh district. There are 26.67 per cent joint owners in Hunder village followed by Hanoo, Basgoo and Thiksey with 20 percent, 16.67 per cent and 13.33 per cent joint owners respectively. Variations seen in these villages are mainly due to differences in religious structures. Most of these villages have some Muslim cultivators who inherit land equally and operate the family holdings jointly. Compared to this, lowest share of joint owners of 6.67 per cent was seen in Gia, Durbuk, Domkhar, Hemis Shukpachan and Diskit villages. Some Buddhist joint owners are marginal farmers where land has been inherited by eldest son and parents jointly own small plot of land.

Most of the land in all the surveyed villages is operated by owner cultivators. They cultivate above 80 per cent in Durbuk, Hemis Shukpachan, Domkhar and Hunder villages. Their share is above 60 per cent in Hanoo, Shachukul, Basgoo and Stok. Similarly, more than 50 per cent land is with owner cultivators in Likir, Thiksey and Diskit villages. About 20.83 per cent of cultivated land is operated by joint owners in Hanoo village who are mostly marginal farmers. It is followed by Hunder with 18.06 per cent of cultivated land owned by joint owners who are mostly Muslim. The predominantly owner cultivator tenure system of Leh district provides a positive aspect to traditional institutional structure, as agricultural development is more easily adopted by farmers who can make their own decisions. This system can

thus provide the basis for a highly productive agrarian structure if incentives are provided to cultivators.

One of the most important aspects of the tenure structure is its relationship with farm size, as the institutional organisation of the agrarian community and the man-land ratio largely determine the size of farms. Variations in farm size in Leh district, thus, become an important aspect for the present analysis.

Farm Size

For all practical purposes, most land operated by farmers whether as owner cultivators, monastery tenants or joint owners, is under their control in terms of decisions regarding inputs. Under such conditions, the scale of operations or size of holdings become an important determinant in affecting farm management input mix and, thus, ultimately output. Obviously owner cultivators are in the best position to maximise and to profit, whereas tenants are comparatively at disadvantage since part of the output has to be given the owners. The relationship between farm size and the ownership has been in a table given below.

Like most mountain areas, size of individual land holdings is small in Leh district. Five size classes have been identified on the basis of total land operated. The first class includes very small farmers who cultivate land below 1 acre; the second class of farmers includes those operating between 1 to 2 acres; the third class of medium sized holdings is between 2 to 3 acres; the fourth class of large sized holdings is between 3 to 5 acres; and the fifth class is of very large of over 5 acres of land.

Table 5.2

LAND OWNERSHIP AND FARM CLASSES (*acres*)

HIGHER ZONE						
Farm Size/Ownership	Below 1	1 – 2	2 – 3	3 – 5	Above 5	Total
GIA / Owners	7 (29.17)	8 (33.33)	4 (16.67)	5 (20.83)	-	24 (63.16)
Tenants	2 (25)	1 (12.50)	2 (25)	-	3 (37.50)	8 (21.05)
Joint Owners	1(16.67)	2 (33.33)	3 (50)	-	-	6 (15.79)
Total	10 (26.32)	10 (26.32)	9 (23.68)	4 (10.53)	3 (7.89)	38 (100)
SHACHUKUL/Owners	20 (46.52)	7 (16.28)	-	8 (18.60)	8 (18.60)	43 (76.79)
Tenants	3 (37.50)	2 (25)	2 (25)	1 (12.50)	-	8 (14.29)
Joint Owners	4 (80)	1 (20)	-	-	-	5 (8.93)
Total	27 (48.21)	10 (17.86)	2 (3.57)	9 (16.07)	8 (14.29)	56 (100)
DURBUK/Owners	12 (37.50)	7 (21.88)	10 (31.25)	-	3 (9.38)	32 (86.49)
Tenants	-	-	-	-	-	-
Joint Owners	3 (60)	2 (40)	-	-	-	5 (13.51)
Total	15 (40.54)	9 (24.32)	10 (27.03)	-	3 (8.11)	37 (100)
MIDDLE ZONE						
THIKSEY/Owners	11 (34.38)	5 (15.63)	7 (21.88)	5 (15.63)	4 (12.50)	32 (54.24)
Tenants	4 (20)	7 (35)	3 (15)	6 (30)	-	20 (33.90)
Joint Owners	3 (42.86)	2 (28.57)	-	2 (28.57)	-	7 (11.86)
Total	18 (30.51)	14 (23.73)	11 (18.64)	17 (28.81)	4 (6.78)	59 (100)
DISKIT/Owners	12 (50)	7 (29.17)	-	3 (12.50)	2 (8.33)	24 (53.33)
Tenants	4 (26.67)	7 (46.67)	4 (26.67)	-	-	15 (33.33)
Joint Owners	-	2 (33.33)	4 (66.67)	-	-	6 (13.33)
Total	16 (35.56)	16 (35.56)	8 (17.78)	3 (6.67)	2 (4.44)	45 (100)
HEMIS/Owners	8 (16.67)	15 (31.25)	9 (18.75)	10 (20.83)	6 (12.50)	48 (87.27)
Tenants	1 (25)	-	3 (75)	-	-	4 (9.09)
Joint Owners	-	2 (66.67)	1 (33.33)	-	-	3 (14.55)
Total	9 (16.36)	17 (30.91)	13 (23.64)	10 (18.18)	6 (10.91)	55 (100)
LIKIR/Owners	12 (27.91)	9 (20.93)	10 (23.26)	8 (18.60)	4 (9.30)	43 (58.11)
Tenants	1 (7.69)	4 (15.38)	7 (30.77)	7 (30.77)	2 (15.38)	21 (28.38)
Joint Owners	2 (20)	4 (40)	4 (40)	-	-	10 (13.51)
Total	15 (20.27)	17 (22.97)	21 (28.38)	15 (20.27)	6 (8.11)	74 (100)
STOK/Owners	13 (37.14)	12 (34.29)	6 (17.14)	-	4 (11.43)	35 (62.50)
Tenants	5 (29.41)	2 (11.76)	1 (5.88)	5 (29.41)	4 (23.53)	17 (30.36)
Joint Owners	1 (25)	3 (75)	-	-	-	4 (5.36)
Total	19 (33.93)	17 (30.36)	7 (12.50)	5 (8.93)	8 (14.29)	56 (100)
BASGOO/Owners	12 (26.67)	10 (22.22)	8 (17.78)	10 (22.22)	5 (11.11)	45 (65.22)
Tenants	4 (30.77)	2 (15.38)	3 (23.08)	-	4 (30.77)	13 (18.84)
Joint Owners	4 (36.36)	1 (9.09)	2 (18.18)	4 (36.36)	-	11 (15.94)
Total	20 (28.99)	13 (18.84)	13 (18.84)	14 (20.29)	9 (13.04)	69 (100)
LOWER ZONE						
HANOO/Owners	7 (22.58)	9 (29.03)	11 (35.48)	-	4 (12.90)	31 (79.49)
Tenants	-	-	-	-	-	-
Joint Owners	3 (37.50)	-	5 (62.50)	-	-	8 (20.51)
Total	10 (25.64)	9 (23.08)	16 (41.03)	-	4 (10.26)	39 (100)

HUNDER/Owners	22 (50)	11 (17.65)	10 (14.71)	9 (11.76)	7 (5.88)	59 (81.94)
Tenants	-	-	-	-	-	-
Joint Owners	5 (40.91)	1 (4.55)	2 (13.64)	2 (18.18)	3 (22.73)	13 (18.06)
Total	27 (37.50)	12 (16.67)	12 (16.67)	11 (15.28)	10 (13.89)	72 (100)
DOMKHAR/Owners	16 (30.77)	14 (26.92)	10 (19.23)	8 (15.38)	4 (7.69)	52 (82.54)
Tenants	2 (33.33)	2 (33.33)	-	1 (16.67)	1 (16.67)	6 (9.52)
Joint Owners	3 (60)	2 (40)	-	-	-	5 (7.94)
Total	21 (33.33)	18 (28.57)	10 (15.87)	9 (14.29)	5 (7.94)	63 (100)
ALL ZONE						
TOTAL/Owners	152 (32.48)	114(24.36)	85 (18.16)	66 (14.10)	51 (10.90)	468 (70.59)
Tenants	26 (23.21)	27 (24.11)	25 (22.32)	20 (17.86)	14 (12.50)	112 (16.89)
Joint Owners	29 (34.94)	22 (26.51)	21 (25.30)	8 (9.64)	3 (3.61)	83 (12.52)
Total	207 (31.22)	163(24.59)	131(19.76)	94 (14.18)	68 (10.26)	663 (100)

Source: Field Survey, September-October, 2016.
Note I: Figures in bracket represent percentage of households in size class to total households in the sample village.
Note II: Land records in the village are kept on the basis of *Kanals* and *Marlas* such that 20 *Marlas* =1 *Kanal*; 8 *Kanals* = 1 acre. The break points in size classes were taken from the local concept of farm sizes for distinguishing between marginal, small, medium and large farms.

Table 5.2 reveals that all twelve sample villages taken together have 31.22 per cent cultivators with very small farms, 24.59 per cent small farms, 19.76 per cent medium sized farms. Only 14.18 per cent and 10.26 per cent cultivators have large and very large farms respectively. The number of farms is inversely related to size in the case of owners and joint owners. The tenants, however, have a larger number of small, very small and medium sized farms.

Variations between size of farms and ownership were determined through Che–square test. The magnitude of difference between the sample observed data and theoretical expected distribution[69] was seen with help of this test. Table 5.3 shows significant variation between ownership and size classes in all twelve sample villages among owners, tenants and joint owners. This would denote that there is

[69] G.B. Norchiffe, Inferential Statistics for Geographers (Hutchinson, London, 1977), p.98

$$X^2 = \sum_{i=1}^{k} \sum_{j=1}^{1} \frac{(Oij - Eij2)}{Eij}$$

k = total number of categories.

1 = total number of samples.

Oij = the observed frequency in category i of sample j.

Eij = the expected frequency in category i of sample j.

some difference in the size of farms between cultivators in different tenancy groups. This in turn would imply that though owners and tenants form the largest agrarian group in Leh district, they mostly operate smaller sized farms compared to joint owners. Favourable conditions of tenants could be due to the fact that monasteries do not function like traditional landlords, and tenants in Leh district are not among the downtrodden lower classes but instead form part of tightly knit community.

Table 5.3

RELATIONSHIP BETWEEN LAND OWNERSHIP AND FARM SIZE (x^2 test)

Category of Ownership	Category of Farm Size	Oij	Eij	(Oij – Eij)	$(Oij – Eij)^2$	$\frac{(Oij - Eij2)}{Eij}$
1	1	152	146.12	5.88	34.57	0.236
1	2	114	115.06	1.06	1.12	0.010
1	3	85	92.47	7.47	55.80	0.603
1	4	66	66.35	0.35	0.12	0.002
1	5	51	48	3.00	9	0.188
2	1	26	34.97	8.97	80.46	2.301
2	2	27	27.54	0.54	0.29	0.011
2	3	25	22.13	2.87	8.24	0.372
2	4	20	15.88	4.12	16.97	1.069
2	5	14	11.49	2.51	6.30	0.548
3	1	29	25.91	3.09	9.55	0.369
3	2	22	20.41	1.59	2.53	0.124
3	3	21	16.40	4.60	21.16	1.290
3	4	8	11.77	3.77	14.21	1.207
3	5	3	8.51	5.51	30.36	3.568
Total		663	663	0		11.898

H_O = Ownership does not vary in size classes; H_j = There is significant variation between them;

V = (3-1) (5-1) = 8; Table value of X^2 = 11.89 Calculated value of X^2 = 11.898; ∴ there is significant variation in ownership and size classes.

There is some land in villages which belongs to entire community[70] and rest is owned by individual farmers– cultivator is either a sole owner or tenant farmer.

[70] Community owned lands are those that are owned by the entire community, village in this case. Such lands are managed and controlled through representative mechanism that allows its members to influence their operation or use and to enjoy the benefit arising.

Individual farmers are allowed to grow crops along with other members of the community for specific period of time on community land. Apart from these, G*ompas* (Buddhist Monasteries) also own large land holdings. Inhabitants of villages work on *Gompa* land either as tenants or as agricultural labourers as *lamas* (Monks) are prohibited to undertake work themselves[71]. The tenants have to pay 1/5 to ½ of the produce to the *Gompa* as rent and they hold nothing in their own right. At times even crops to be sown are decided and implements supplied by the *Gompas* through *Chakk-zod*: the *lama* who looks after economic affairs of *Gompas*. Allotment of *Gompa* land to the cultivators is normally done for one or two years. *Gompa* provides land and the cultivators are required to provide labour and livestock in return of a fixed share of the produce. Land belonging to G*ompas* is scattered over large number of villages which is leased out for specific period of time. The cultivators have limited rights on *Gompa* land which often hinders development and efficient management of the land.

Chakk-zod [72] performs, organises and manages tasks such as employing agricultural labourers or appointing tenants, taking decisions about cropping and other agricultural issues. As *lamas* (Monks) do not work on land keeping in view Buddhist practices, it is cultivated by villagers either as tenants or as agricultural labourers[73]. Produce from the monastery farms is used by the tenant farmers who cultivate it and some fixed part of it is given to the monastery which is called *shaes la*. *Gompas* also demand services from villagers to rear its herds, cultivate un-leased land and for construction works etc. Bigger the *Gompa*, more land it owns.

[71] One of the 253 rules of the code of conduct prescribed by Buddha prohibits a lama from ploughing the land himself. The concept underlying the rule is that ploughing of land by lamas result in the death of numerous life bearing objects. Memorandum submitted to Mr Qasim, Chief Minister, Jammu and Kashmir, by All Ladakhi Gompa Association 1971, p.3
[72] Monk who looks after economic affairs of the Gompa. Every Gompa in Ladakh has a Chakk-zod.
[73] Harjit Singh (1978), *op.cit.*p.221

Table 5.4

LAMD OWNED BY GOMPAS, LEH DISTRICT

Name of Gompas	Land Owned (Acres)	No. of Villages in which land is owned
Hamis	1998.3	51
Thicksay	1307.8	25
Spituk	582.8	13
Stagna	516.7	12
Rezong	496.4	19
Chamrie	375.8	22
Fiang	360.3	14
Likir	263.3	18
Matho	242.1	5
Lamayuru	234.5	16
Takthak	40.3	2

Source: Singh, Harjit (1976), Territorial Organisation of Gompas in Ladakh, "Himalaya–ECOLOGIE–ETHNOLOGIE" CNRS Paris

Table 5.4 reflects that Hamis *Gompa* owned largest share i.e. 1998.3 acres of land which lies in 51 villages of the region. Hamis is the biggest and the richest monastery in Ladakh because of its ancient links with the erstwhile royal families of Ladakh. It is followed by Thicksay *Gompa* with land owning 1307.8 acres spread in 25 villages. Other *Gompa* owners of land are Stagna, Rezong and Chamrie etc.

Though monasteries still own large land but its cultivation by villagers have decreased leaving agricultural land as fallow or being planted with trees. Land owned by a *Gompa* is linked to the number of monks (*lamas*) and nuns (*Chomos*) enrolled under it and its position among various other *Gompas* of the same lineage. The head *Gompa* is the biggest among its branch *gompas*. Hamis monastery has around 200 branch monasteries[74].

[74] Singh, Harjit (1976), Territorial Organisation of Gompas in Ladakh, "Himalaya–ECOLOGIE–ETHNOLOGIE" CNRS Paris

5.2 Size of Land Holdings and Distribution of Agricultural Land

Since Leh district falls in one of the most inaccessible parts of Himalayas, land resource are very limited for cultivation coupled with very small sizes of land holdings. Majority of land holdings are below 0.5 hectares[75]. Distribution of land holdings is unequal and most peasants cultivate small piece of land. In addition, rough topographical conditions have led to terraced farming in most parts of Leh district. Therefore, a large continuous tract of cultivable land is very limited[76]. Already small land holdings are getting further fragmented due to various social factors such as emergence of nucleated families as against earlier joint families based on polyandry.

Table 5.5

CHANGES IN LAND HOLDINGS ACCORDING TO DIFFERENT SIZE CLASSES, LEH DISTRICT: 1995-2010 (*hectares*)

Year	1995-96		2010-11	
Size Class (Hectares)	% of total number of land holdings	% of total cultivated land	% of total number of land holdings	% of total area of land
Below 0.5	49.42	7.89	62.76	17.37
0.5 – 1.0	10.16	11.14	17.71	19.14
1.0 – 2.0	20.21	19.99	13.37	27.73
2.0 – 3.0	9.92	16.99	4.02	14.47
3.0 – 4.0	4.86	11.63	1.20	6.05
4.0 – 5.0	2.30	7.60	0.37	2.46
5.0 – 7.5	1.90	8.56	0.29	2.61
7.5 – 10.0	0.69	4.70	0.08	0.99
10.0 – 20.0	0.27	2.60	0.11	2.32
20.0 & above	0.27	8.89	0.08	6.86
Total	100.00	100.00	100.00	100.00

Source: Calculated from Agricultural Census, 1995-96 and 2010-11

Table 5.5 and Figure 5.1 show most of the land holdings to be in the category of marginal holdings measuring less than one *hectare*. These accounted for 59.58 per cent of total holdings in 1995-96. Only about 3.13 per cent households had more than 5 *hectares* of land. There were only a few land holdings larger than 7.5 *hectares* in the district. On the other hand, land holdings above 20 *hectares* constituted

[75]Agricultural Census, Ministry of Agriculture,1995-96
[76] Harjit Singh (1978), op.cit. p. 150

merely 0.27 per cent. These consisted of land either owned by monasteries or rich landlords. This shows that landholdings are small in the region and large holdings are very less due to rugged topography. Average size of land holdings was 1.3 *hectares* in 1995-96.

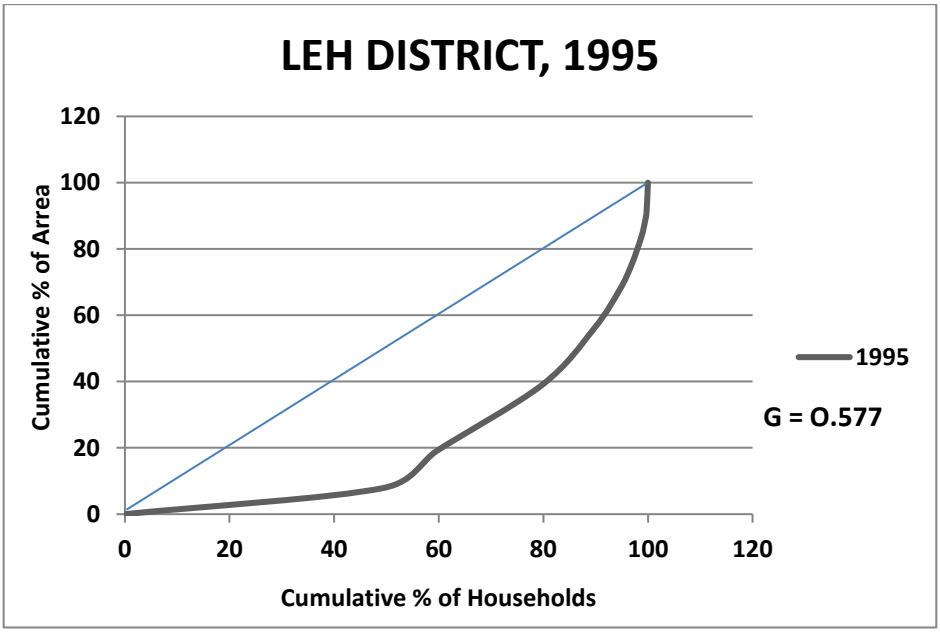
Significant changes in the distribution of land holdings are seen during 1995-96 and 2010-11. Proportion of marginal holdings of less than one *hectare* has become larger accounted for 80.47 per cent in 2010-11. On the other hand, proportion of land holdings more than 5 *hectares* constituted merely 1.28 per cent. It shows that land holdings are increasingly getting fragmented in the district. Main reasons are related to economic factors whereby land is getting divided for non-agricultural usage and fragmentation of families into nuclear families. Some monasteries are also giving up large land holdings. Average size of land holdings came down to 0.67 hectares in 2010-11.

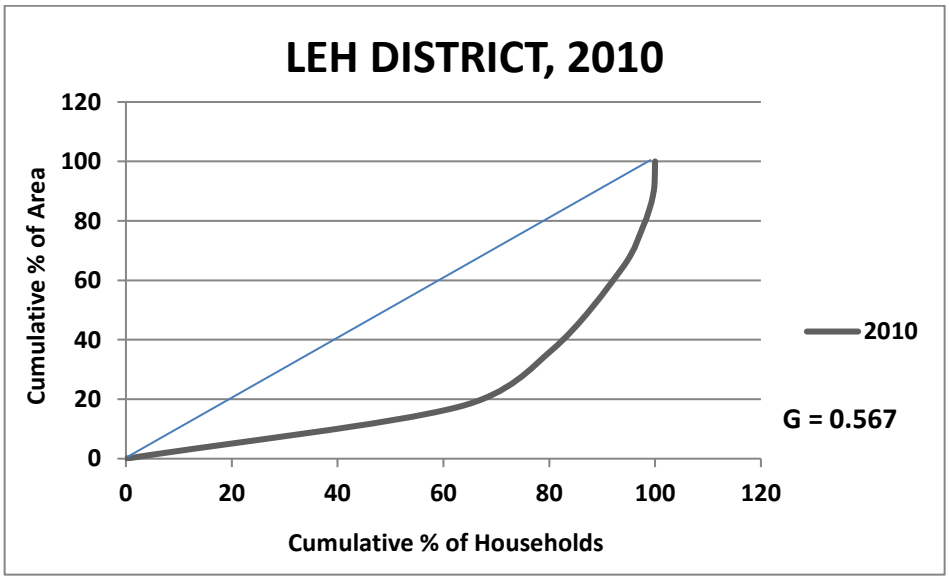
Lorenz Curves have been drawn and Gini-coefficients (a measure of inequality) were calculated in order to find out inequalities in distribution of land holdings. Value of Gini-coefficient was found to be 0.577 in 1995-96 and it slightly declined to 0.567 in 2010-11. It shows decrease in inequalities in the distribution of land holdings in Leh district. Traditionally, monasteries owned large tract of lands, where they employed community labour. It was the rule of inheritance that households and estates passed entirety from generation to generation in the region. Polyandry system of marriage and primogeniture inheritance ensured no fragmentation of land holdings. But polyandry and primogeniture were abolished in 1941 by the State Government, and simultaneously the on take of monastic life was reduced which allowed sub-division of land[77]. It may be mentioned that the practice of polyandry continued to persist in spite of it being illegal till 1970s especially in more remote villages. However, it has now completely disappeared due to presence of large army and tourism. Fragmentation of large holdings and in cases part of large land holding being put to non-agricultural use could have resulted in decline in disparities.

[77] Ramila Bisht. et al. (2008), "*Agriculture in Ladakh: Continuity and Change A Status Report*", for Guyrja: TATA- LAHDC- Development Support Programme, Mumbai, p. 45

DISTRIBUTION OF LAND HOLDINGS, LEH DISTRICT

Figure 5.1





It can be concluded from the above discussion that land holdings are very small in size. These got further fragmented due to various social, economic and cultural factors. Inequalities in the distribution of land holdings have become less pronounced in the last few decades.

Table 5.6

LAND HOLDINGS ACCORDING TO DIFFERENT SIZE CLASSES IN SURVEYED VILLAGES: 2016 (in *acres*)

HIGHER ZONE						
Village	GIA		SHACHUKUL		DURBUK	
Size (Acres)	% of total no. of land holdings	% of total area of land	% of total no. of land holdings	% of total area of land	% of total no. of land holdings	% of total area of land
Below 1	60	25	53	29	47	18
1 – 2	24	27	20	18	40	38
2 – 3	10	20	7	12	7	11
3 – 5	3	8	10	23	3	7
Above 5	3	20	10	18	3	26
MIDDLE ZONE						
Village	THIKSEY		BASGOO		STOK	
Below 1	27	9	23	7	43	8
1 – 2	33	22	33	28	17	18
2 – 3	13	15	17	24	13	6
3 – 5	17	25	13	25	10	17
Above 5	10	29	13	17	17	51
Village	LIKIR		HEMIS SHUKPACHAN		DISKIT	
Below 1	33	8	33	6	50	14
1 – 2	20	12	23	15	27	26
2 – 3	27	29	17	12	10	14
3 – 5	10	19	10	26	7	20
Above 5	10	32	17	42	7	25
LOWER ZONE						
Village	DOMKHAR		HANOO		HUNDER	
Below 1	24	30	40	16	47	12
1 – 2	29	16	37	30	27	14
2 – 3	21	20	17	25	7	7
3 – 5	12	17	3	9	10	15
Above 5	15	26	3	20	10	52

Source: Field Survey, September-October, 2016.

Table 5.6 reveals that about 87 per cent of farmers in Durbuk village were cultivating land measuring less than 2 *acres* in the higher zone. Similarly, 84 per cent of the total agricultural households in Gia village and 73 per cent in Shachukul

village had land holdings of less than 2 *acres*. On the contrary, only 3 per cent each of farmers owned more than 5 *acres* in Gia and Durbuk villages. Further, 10 per cent of the total agricultural land holdings in Shachukul village were more than 5 *acres* in size.

Similar pattern can be observed in middle zone villages too with slight differences. It can be seen from the table that farmers owning less than 2 *acre* of land holdings accounted for 77 per cent in Diskit, 60 per cent in Thiksey and 60 per cent in Stok village. Further, 56 per cent each of total households in Basgoo and Hemis Shukpachan villages, and 53 per cent in Liker village had land holdings of less than 2 *acres* in middle zone villages. On the other hand, farmers owning land holdings more than 5 *acres* accounted for 7 per cent in Diskit village, 10 per cent each in Thiksey and Likir villages. Further, 13 per cent farmers in Basgoo village and 17 per cent each in Stok and Hemis Shukpachan had land holdings of more than 5 *acres*.

Around 77 per cent farmers in Hanoo village, 74 per cent Hunder village and 53 per cent in Domkhar village had land holdings of less than 2 *acres* in lower zone. On the contrary, about 15 per cent farmers owned land holdings more than 5 *acres* in Domkhar village. Similarly, 10 per cent farmers of Hunder village and 3 per cent farmers of Hanoo village owned land holdings more than 5 *acres*.

It can be seen from the above analysis that higher zone villages have more smaller sized land holdings compared to middle and lower zone. It shows that unfavourable physical conditions restrict larger holdings in the higher zone. On the other hand, lower village has more land holdings above 5 *acres* in size.

The value of the Gini-coefficient was found to be 0.442 for Gia, 0.438 for Durbuk and 0.295 for Shachukul village in higher zone. It shows that inequalities in the distribution of land holdings are more pronounced in Gia and Durbuk as compared to Shachukul village. Most of the farmers in these villages are cultivating small land holdings. In Middle zone villages, the value of Gini-coefficient was found to be 0.504 for Stok, 0.495 for Diskit and 0.471 for Hemis Shukpachan village. It shows highest disparities in the distribution of land holdings in Stok. It could be mainly due to the fact that the former ruler still owns large holdings in Stok. Furthermore, Stok *Gompa* also owns a large tract of land there. It is followed by

Diskit village, where the Diskit Gompa too owns large tract of agricultural land which are given on lease to the villages. Value of Gini-coefficient was found to be 0.454 for Liker, 0.411 for Basgoo and 0.379 for Thiksey village. It could be because some land got concentrated in a fewer hands either by buying it from poor peasants or by reclaiming new land with the help of irrigation. Likewise, the value of Gini-coefficient was found to be 0.579 for Hunder, 0.411 for Hanoo and 0.396 for Domkahr village. As mentioned earlier, Muslim cultivators in some villages like Hunder continue to be joint owners without fragmentation of land.

It can be concluded from the above discussion that inequalities are marked in the more developed villages of Stok and Hunder in the middle and lower zone. However, the majority of peasants continue to cultivate small holdings in all villages of Leh district. The already small land holdings are further getting fragmented in recent years due to various socio-economic changes in the region. Therefore, it becomes important to analyse the pressure of population on agricultural land.

5.3 Pressure of Population

Agricultural density has been calculated to have an idea of population pressure on agricultural land. Agricultural density here means ratio between agricultural workers and cultivated area[78]. It has been calculated by adding cultivators and agricultural labourers as agricultural workers and dividing net sown area of the village by agricultural workers. This reflects variations in agricultural workers per unit cultivated area. It is very important in mountain areas like Leh district as agricultural land is a scarce resource. Availability of agricultural land is dependent to a large extent on nature of physical environment in such areas. That is why large tracts of land are barren and devoid of soil cover and cannot be put to agricultural use with the present level of available technology.

[78] Agricultural Density = $\frac{\text{Agricultural Workers}}{\text{Cultivated Area}}$

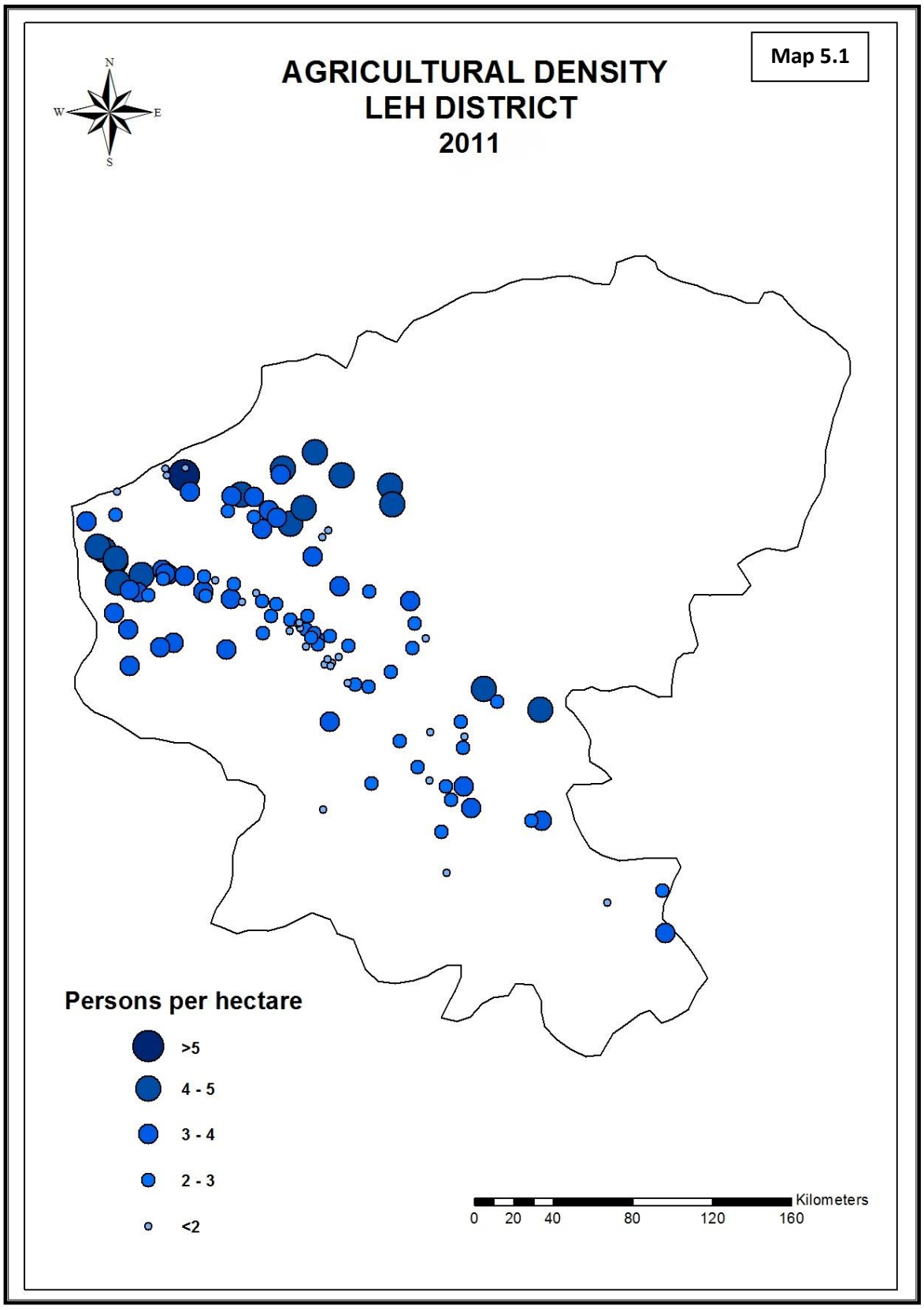
Table 5.7

AGRICULTURAL DENSITY BY VILLAGES, 2011 (Persons per *hectare*)

Agricultural Density	No. of Villages	% Villages
More Than 5	15	14.02
4 – 5	14	13.08
3 – 4	18	16.82
2 – 3	27	25.23
Less Than 2	33	30.84
Total	107	100.00

Source: Computed from Census of India, Village and Town Directory, Leh District, 2011
Note: Out of 112 inhabited villages, unfortunately data for only 107 villages were available. Therefore, 6 villages have been excluded from the analysis.

Table 5.7 and Map 5.1 show large variations in terms of agricultural density in villages of Leh district. It varies from highest agricultural density of 34 persons per *hectare* of cultivated land in Bogdang to the lowest agricultural density of less than 1 person per *hectare* of cultivated land in Lakjung. Around 15 villages had highest agricultural density of more than 5 persons per *hectare* of cultivated land. Important such villages included Bogdang, Khaltse, Takmachik, Skurbuchan, Tegar, Panamic and Diskit. Probable reason for high agricultural density in these villages could be due to high carrying capacity of land with favourable environmental conditions. Furthermore, all these villages are located in the lower and middle zone of Indus and Nubra-Shyok valleys. Fourteen villages had agricultural density of 4 to 5 workers. Eighteen villages had agricultural density between 3 to 4 persons per *hectare* of cultivated land. Important villages in this category were Temisgam, Basgoo, Dah and Khardong. Agricultural density ranging between 2 to 3 persons per *hectare* of cultivated land was found in 27 villages accounting for 25.23 per cent of total villages in 2001. Low agricultural density of less than 2 persons per *hectare* of cultivated land was found in 33 villages those constituted 30.84 per cent of the total villages. These included nomadic villages like Kharnak, Karzok, Anlay and Samad Rakchan which have low net sown area due to higher altitude and majority of workers being engaged in livestock rearing. All these villages are located in higher zone. Other villages in this category included Chuglamsar, Nimoo and Kharoo etc. which have low agricultural workers due to diversification of economy. Chuglamsar is close to Leh town and has many offices and hotels etc. Nimoo is situated on


Map 5.1
AGRICULTURAL DENSITY
LEH DISTRICT
2011
N
W
E
S
Persons per hectare
>5
4 - 5
3 - 4
2 - 3
<2
Kilometers
0 20 40 80 120 160

Leh-Srinagar Highway and Kharoo has army concentration around it. Large proportions of people are engaged in other services apart from agriculture in these villages.

5.4 Workforce in Agriculture and Changes Therein

Agriculture has been the mainstay of population proving livelihood and food security in Leh district. However, pressure of population on land was comparatively more before diversification of economy. Realisation of Ladakh's strategic importance at the time of Indo-China border conflict of 1962, massive deployment of armed forces, opening up of the region for tourism in 1974, increased literacy, low productivity from land and various other factors have resulted in creation of many non-agricultural jobs leading to diversification of economy. This has brought tremendous changes in workforce engaged in agriculture in terms of proportion of agricultural workers to total workers. Agricultural workers include main cultivators, marginal cultivators as well as main agricultural labourers and marginal agricultural labourers[79].

Table 5.8

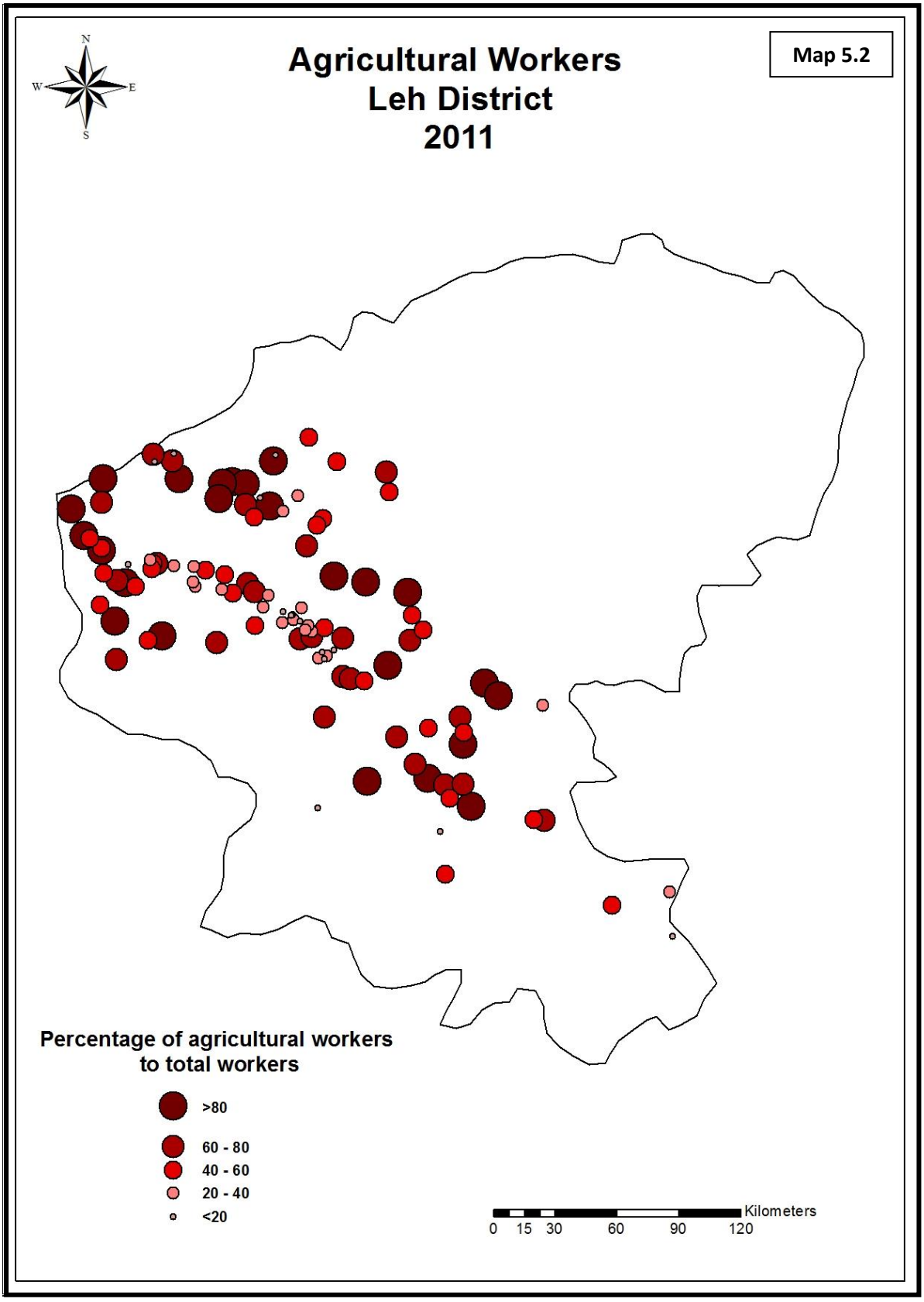
PROPORTION OF AGRICULTURAL WORKERS TO TOTAL WORKERS, 2011

% of Workers	No. of Villages	% Villages
More Than 80	22	19.42
60-80	40	35.71
40-60	27	24.11
20-40	10	8.93
Less Than 20	13	11.61
Total	112	100.00

Source: Computed from Census of India, Village and Town Directory, 2011

Table 5.8 and Map 5.2 show that 22 villages accounting for 19.42 per cent of total villages had more than 80 per cent agricultural workers in 2011. Important villages among these included Warisfistan (100 per cent), Photoksar (96.67 per cent),

[79] Census of India defines Main worker as "persons who worked for 6 months or more during the reference year" and Marginal worker as "persons who worked for less than 6 months".


Agricultural Workers
Leh District
2011
Map 5.2
N
W
E
S
Percentage of agricultural workers to total workers
>80
60 - 80
40 - 60
20 - 40
<20
Kilometers
0 15 30 60 90 120

Himya (95.68 per cent) and Hunndar Dog (90.77 per cent). All these villages are located in far off areas and it seems that these have no other source of livelihood. Therefore, agriculture remained major economic activity. Villages like Tanyar (89.63 per cent), Digger (88.24 per cent), Man Pangong (84.93 per cent), Takmachik (84.01 per cent) Phuktse (82.98 per cent), Tarhipiti (82.46 per cent), Skuru (82.43), Dah (81.73 per cent) etc. also had very high very high proportions of agricultural workers due to the same reason. Most of these villages are located in river valleys of Indus, Shyok and Nubra which provides fertile land and relatively warmer climate for settled agriculture. It is followed by 40 villages comprising 35.71 per cent of total villages having between 60 to 80 per cent agricultural workers in 2011. Important villages among these are Chiling Sumdo (79.55 per cent), Lanokar (78.43 per cent), Skanpuk (77.95 per cent), Hanoo (77.90 per cent), Umla (77.78 per cent), Sakti (75.89 per cent) and Upshi (75.71 per cent) etc. All these villages have favourable environmental conditions for cultivation of crops.

There were 10 villages which had agricultural workers between 20 to 40 per cent. Important villages among these included Chushot Yakma (38.98 per cent), Hemis Shukpachan (38.75 per cent), Chushot Gongma (37.84 per cent), and Hamis (27.68 per cent). Relatively lower proportion of agricultural workers may be attributed to various reasons such as proximity of these villages to Leh town, tourism, proximity to army camps and having main monasteries. These villages are comparatively more developed in other sectors of economy than agriculture. Around 13 villages constituting 11.61 per cent had agricultural workers less than 20 per cent. Important such villages are Kharnak (1.50 per cent), Karzok (1.43 per cent), Samad Rakchan (1.29 per cent), Anlay (1.10 per cent). These villages are mostly in Changthang where land is not suitable for cultivation. Therefore, rearing of livestock is their main occupation. Other important villages under this category are Spituk (19.23), Shey (16.70 per cent), Nimmo (2.05 per cent) and Chuglamsar (3.53 per cent). These villages are located close to Leh town which provides large scope of employment in non-farm activities. Therefore, a large number of people are engaged in other activities and services due to more diversified economy.

It can be observed from above that majority of villages had high proportion of workers engaged in agriculture. Higher proportion of agricultural workers is concentrated in river valleys such as Indus, Shyok and Nubra. Besides, more isolated

villages also fall in this category. On the contrary, lower proportion of workers engaged in agriculture was seen in villages of nomads, administrative centres, villages situated on Leh-Srinagar and Leh-Manali road, monastic villages and villages near army camps.

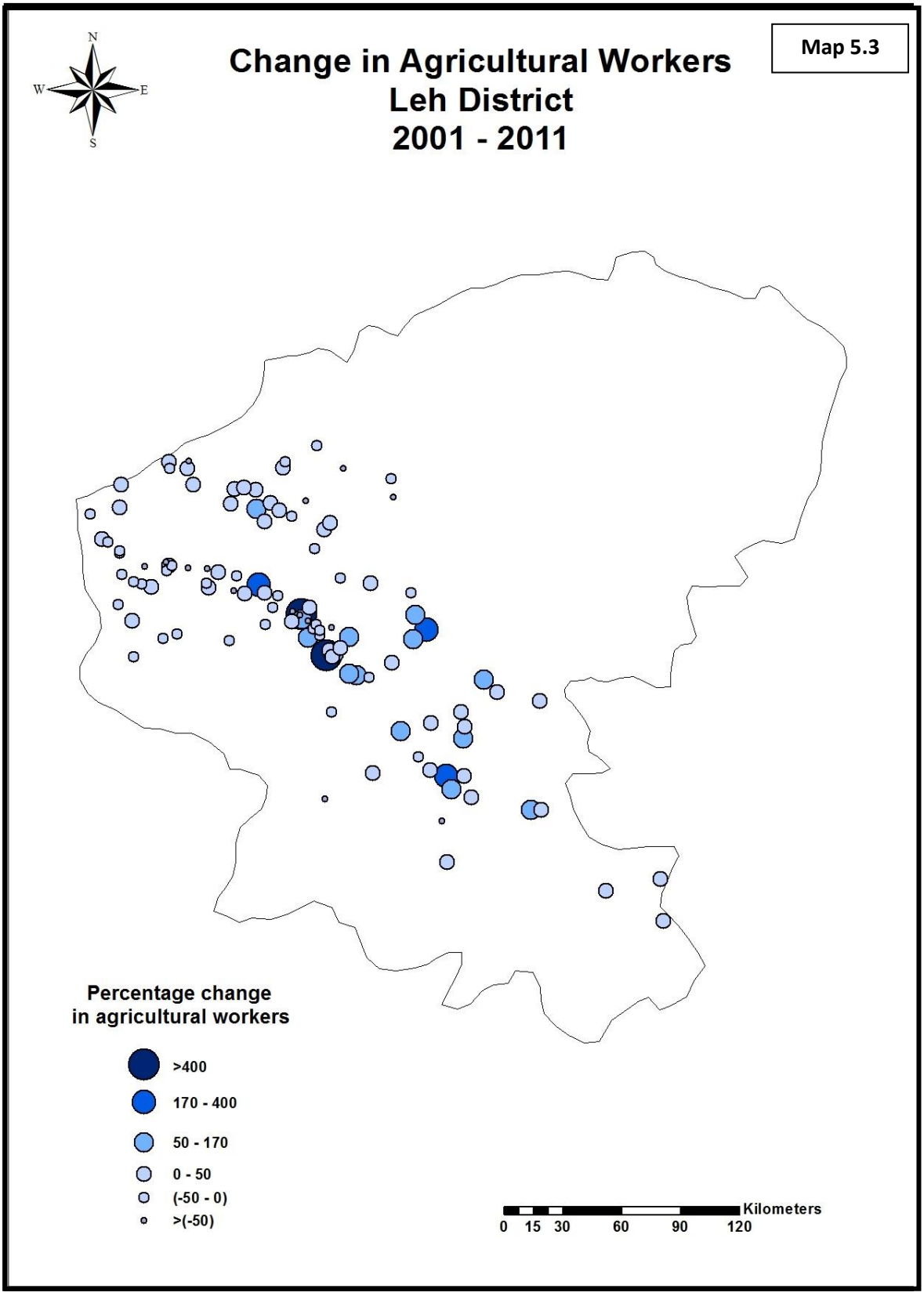
Table 5.9

CHANGE IN AGRICULTURAL WORKERS BY VILLAGES, 2001 – 2011

% Change in Agricultural Workers	No. of Villages	% of Villages
Less than –50	17	16.67
(-50) – 0	38	37.25
0 – 50	26	25.49
50 – 170	15	14.71
170 – 400	3	2.94
More than 400	3	2.94
Total	102	100

Source: Computed from Census of India, Village and Town Directory, 2001, 2011

Table 5.9 and Map 5.3 highlight decline in the proportion of agricultural workers in many villages. There were 55 villages, accounting for 53.92 per cent of the total villages with proportion coming down from -85.15 per cent for Khaltse to -2.22 per cent in Hunder. It could be due to emergence of tourism industry whereby many agricultural workers are now being counted as marginal workers. On the other hand, only 2.94 per cent of the total villages had an increase in proportion of agricultural workers of more than 400 per cent. Hamis had the highest increase of 880 per cent. The change can be attributed to more rigorous enumeration in 2001 and 2011, when many workers who were earlier counted as non-workers were now included in main and marginal agricultural workers. It seems true of some *Gompa* villages where it appears that even lamas have been counted as agricultural workers, as probably is the case of Hamis.


Map 5.3
Change in Agricultural Workers
Leh District
2001 - 2011
N
W
E
S
Percentage change
in agricultural workers
>400
170 - 400
50 - 170
0 - 50
(-50 - 0)
>(-50)
Kilometers
0 15 30 60 90 120

5.5 Age-Sex of Agricultural Workers in Surveyed Villages

Age-sex of agricultural workers in the surveyed villages has been analysed to know the structure of agricultural workforce in the villages. Table 5.10 reveals that non-workers age group below 20 years is highest in Middle zone villages, followed by Lower and Higher zone villages. The reason is mainly due to large number of school children within this age group. Higher zone villages slightly situated away from Leh town had highest proportion of 32.87 per cent males and 45.90 per cent females as non-working population.

It is interesting to see that female agricultural workers are more than male workers in all surveyed villages. (Figure5.2). Highest proportion of 76.47 per cent female agricultural workers in the middle zone villages was followed by 63.35 per cent in higher zone villages. On the other hand, lower zone villages had slightly lower than other two zones with 62.43 per cent female agricultural workers. It could be due to the fact that villages close to Leh town had more male selective out-migration which keeps larger number of women in agriculture. It has been seen that women have always been very active in traditional economic activities like agriculture etc. in Leh district. Moreover, a larger number of male workers have started joining non-farm activities related to tourism and service sector. On the contrary, relatively lower proportion of female agricultural workers in the lower zone may also be due to some women participating in other activities apart from agriculture such as government and non-government services.

Most of agricultural workers were found in age group of above 50 years, there were 36 males and 85 females in middle zone villages, followed by 45 males and 51 females in higher zone villages. There were 28 males and 41 females in age group of above 50 years in lower zone villages. These were either cultivators or agricultural labourers. In other services group, most of workers came in the age group between 21–40 years in surveyed villages. Their number was 182 males and 73 females in middle zone villages, followed by 77 males and 22 females in higher zone village and 70 males and 41 females in lower zone villages. These are mainly employed in tourist related activities, government services such as teachers, medical and administrative staff etc. Besides, majority of households had at least one or two members in army. It shows that due to growth of tourism industry and other

Table 5.10

AGE-SEX AND OCCUPATIONAL STRUCTURE IN SURVEYED VILLAGES

HIGER ZONE																
	Below 10		11 – 20		21 – 30		31 – 40		41 – 50		50 Above		Total		% Percent of Total	
Occupation	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Non-Workers	42	53	31	57	15	24	2	0	0	0	5	6	95	140	32.87	45.90
Agricultural Workers	0	0	1	0	7	23	15	35	13	31	45	51	81	140	28.03 (36.65)	45.90 (63.35)
Other Workers	0	0	3	0	38	17	39	5	16	3	17	0	113	25	39.10 (81.88)	8.20 (18.16)
Total	42	53	35	57	50	64	56	40	29	34	67	57	289	305	100.00	100.00
MIDDLE ZONE																
Non-Workers	104	86	52	73	33	52	0	0	0	0	13	6	202	217	34.18	40.64
Agricultural Workers	0	0	0	2	7	32	10	50	19	65	36	85	72	234	12.18 (23.53)	43.82 (76.47)
Other Workers	0	0	15	4	99	39	83	34	46	8	74	1	317	83	53.64 (79.25)	15.54 (20.75)
Total	104	86	67	79	139	123	93	84	65	73	123	92	591	534	100.00	100.00
LOWER ZONE																
Non-Workers	50	47	53	34	13	25	0	0	0	0	9	5	125	111	40.85	40.81
Agriculture Workers	0	0	1	2	10	20	16	32	13	18	28	41	68	113	22.22 (37.57)	41.54 (62.43)
Other Workers	0	0	4	3	43	29	27	12	11	3	28	1	113	48	36.93 (70.19)	17.65 (29.81)
Total	50	47	58	39	66	74	43	44	24	21	65	47	306	272	100.00	100.00

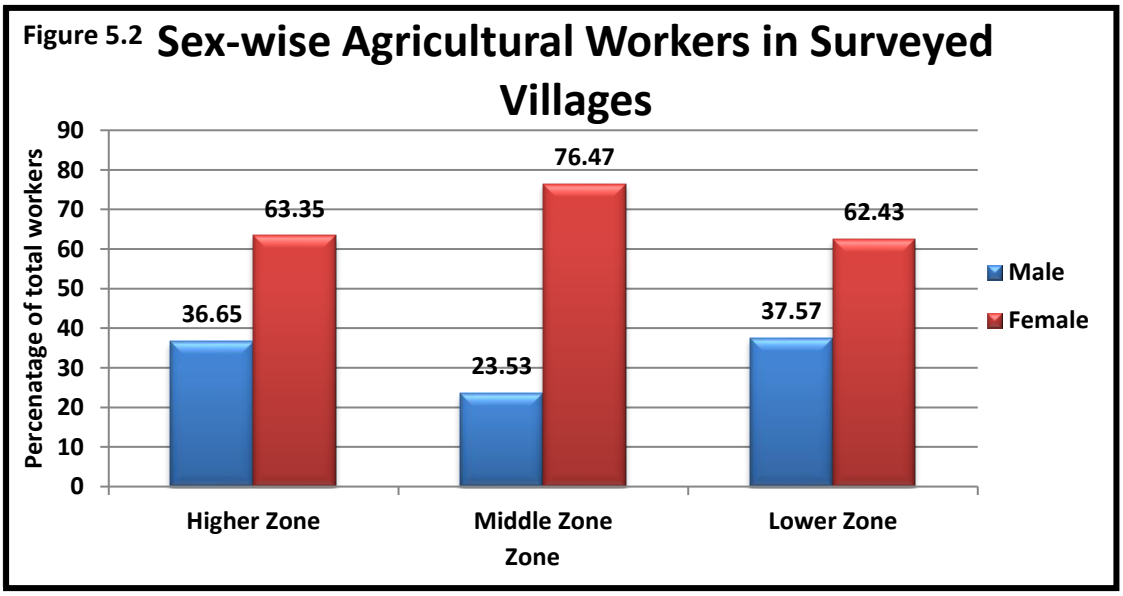
Source: Source: Field Survey, September-October, 2016. **Note:** Figures in brackets are percentage of respective total.

government jobs, large young people of these villages have joined such sectors in recent years. Army, of course, has come up as major job provider in the region.

Plate 5.1: Women preparing field for sowing in middle zone village of Hemis Shukpachan

Plate 5.2: Hired labourers threshing barley using a threshing machine in middle zone village of Stok. Use of farm machinery is a recent phenomenon in Ladakh.

It can be observed from above discussion that agriculture is an important occupation in surveyed villages in Leh district. More people of older age group fall under agricultural workers. However, in recent years socio-economic changes have led to development of other activities leading to changes in occupation structure. It was noticed that middle zone villages are economically more diversified due to its proximity to Leh town where lot of commercialisation of economy has taken place. Women agricultural workers were found more in numbers than males especially villages located close to Leh town.



5.6 Labour use in surveyed villages

Labour plays an important role as a basic input in agriculture. Agricultural productivity is dependent on the optimum utilisation of human capital.[80] It is the key assets for farmers as crop production is influenced by the quality and quantity of labour available in households. The availability of labour for crop cultivation is largely dependent on the population distribution of the region. Agriculture in Leh district is labour intensive. The type of labour used in agricultural production in the

[80] H.C. Pokhriyal (1993), "*Agrarian Economy of the Central Himalaya*", Indus Publishing Company, FS-5, Tagore Garden, New Delhi, p.88

region can be broadly classified into three categories. These are family labour, hired labour, and combinations of both types of labour.[81]

Advent of globalisation has resulted in the breakdown of joint families in the villages especially in villages close to Leh town. Added to it is the increasing literacy rate which has resulted in most of the young people going out of the region for higher education. Also opportunities generated due to opening up of the region for tourism and establishment of armed forces have absorbed huge chunk of potential farmers. All these have led to decline of family labour in the fields.

In traditional agriculture, labour was provided by the family and by *Phaspun*. *Phaspun* is a grouping system in which several families form a group. The group is formed on the basis of a common deity called *Lha* that families of a *phaspun* share. *Phaspuns* work for each other in times of need for large number of workers e.g. on events like birth, death, marriages and also for agricultural works of harvesting and sowing etc. Social norms represent importance of communal labour in Leh district where harsh physical conditions make communal work a necessity. In addition to complex network of irrigation, application manure from livestock and human wastes also require lot of labour. This has resulted in the establishment of social customs which reflect response of people to environment.

Today the work of *Phaspun* is restricted only to events like birth, death and marriages. With significant changes in agricultural system of Leh district, the role played by *phaspun* is also declining.[82] But agriculture still remains a communal work. *Bes* is another system of communal labour offered by neighbours in the village for agricultural purposes. *Bes* is a system of sharing human resources and is a form of mutual labour. A family offering labour in hour of need will be offered labour back when needed. This system still continues in the surveyed villages of Leh district and is a major source of agricultural labour.

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[81] S.H. Baba. et al. (2011), "*Scarcity of Agricultural Labour in Cold-Arid Ladakh: Extent, Implications, Backward Bending and Coping Mechanism*", Agricultural Economics Research Review, Vol. 24, 2011, pp. 391-400

[82] Harjit Singh (1995), "Ecological Set-up and Agrarian Structure of High Altitude Villages of Ladakh", *Recent Research on Ladakh, Proceeding of the 4th and 5th International Colloquia on Ladakh,* (eds., Henry Osmaston and Philip Denwood) Motilal Banarsidas Publishers, Delhi, pp.193-208

Plate 5.3: Family harvesting potatoes with the help of community labour in Hemis Shukpachan village.

Plate 5.4: Hired labourers carrying barley crop to threshing point in Stok village

With decreasing sources of labour, apart from marginal labour provided through *Bes*, cultivators are increasingly hiring labour. Hired labour is replacing communal labour and therefore, influencing labour-owner relationship. It has also affected cultural and social norms which once also brought people closer and imbibed in them a sense of mutual responsibility. Hired labour is an indicator of decreasing family and village labour, changing occupational structure and also changing norms. Therefore, in the last few years, farmers have started to hire labour due to insufficient family labour. The changes are more pronounced in villages near the town of Leh. Labour use varies from village to village depending on socio-economic conditions of the farmers.

Table 5.11 reveals that 203 small farmers accounting for 83.5 per cent of total small farmers in all zone used hired labour. Out of these 106 small farmers used 5-10 hired labourers per *kanal*. They were followed by 77 farmers hiring up to 4 labourers per *kanal*. On the other hand, only 20 small farmers used hired labour more than 10 persons per kanal. Around 40 small farmers did not use hired labour at all. It reflects as to how hired labour has started replacing traditional communal labour in recent years. Among medium farmers 45 farmers accounting for 56.3 per cent of total medium farmers used hired labour of between 5-10 persons per *kanal*, 15 famers used hired labour more than 10 persons per *kanal*, while only 7 farmers did not use hired labour at all. On the contrary, 18 farmers accounting for 45.6 per cent of total large farmers used hired labour of more than 10 persons per *kanal*. Around 12 farmers used hired labour between 5-10 persons per *kanal*, whereas only 2 farmers consisting of 5.4 per cent of total large farmers did not use hired labour at all. It suggests that maximum number of small farmer hired less labour per *kanal*. This is because of the fact that small farms have less capacity to absorb more hired labour as against large farmers. Number of hired labourers employed also reveals that communal and family labour are increasingly becoming rare resulting in maximum numbers of farmers hiring labour i.e. 94.6 per cent large farmers, 91.3 per cent medium farmers and 83.5 per cent small farmers.

Likewise, the table also shows that 187 small farmers accounting for 76.95 per cent of total small farmers in all zones used communal labour, 78 of them used communal labour of between 5-10 persons per *kanal*, followed by which 70 of which used communal labour up to 4 persons per *kanal*. On the contrary,

Table 5.11

LABOUR USE IN SURVEYED VILLAGES

Higher Zone						
Inputs			Farm Size			
Hired Labour (Persons per *Kanal*)	Units in nos.	No. of Farmers	Small	Medium	Large	Total
	Up to 4	No. of Farmers	18 (24.0)	0 (0.0)	0 (0.0)	18 (20)
	5 – 10	No. of Farmers	39 (52.0)	7 (63.6)	2 (50.0)	48 (53.3)
	More than 10	No. of Farmers	6 (8.0)	3 (27.3)	2 (50.0)	11 (12.2)
	Not Used	No. of Farmers	12 (16.0)	1 (9.1)	0 (0.0)	13 (100)
Total (each above)		No. of Farmers	75 (83.3)	11 (12.2)	4 (4.4)	90 (100)
Communal Labour/*Bes* (Person per *Kanal*)	Up to 4	No. of Farmers	26 (34.7)	3 (27.3)	3 (75.0)	32 (35.6)
	5 – 10	No. of Farmers	22 (29.3)	4 (36.4)	0 (0.0)	26 (28.9)
	More than 10	No. of Farmers	14 (18.7)	3 (27.3)	1 (25.0)	18 (20)
	Not Used	No. of Farmers	13 (17.3)	1 (9.1)	0 (0.0)	14 (15.6)
Total (each above)		No. of Farmers	75 (83.3)	11 (9.1)	4 (4.4)	90 (100)
Middle Zone						
Hired Labour (Persons per *Kanal*)	Up to 4	No. of Farmers	35 (33.3)	9 (18)	1 (4)	45 (25)
	5 – 10	No. of Farmers	47 (44.8)	31 (62)	9 (36)	87 (48.3)
	More than 10	No. of Farmers	11 (10.5)	8 (16)	14 (56)	33 (18.3)
	Not Used	No. of Farmers	12 (11.4)	2 (4)	1 (4)	15 (8.3)
Total (each above)		No. of Farmers	105 (58.3)	50 (27.8)	25 (13.9)	180 (100)
Communal Labour/*Bes* (Person per *Kanal*)	Up to 4	No. of Farmers	31 (29.5)	9 (18)	3 (12)	43 (23.9)
	5 – 10	No. of Farmers	27 (25.7)	13 (26)	5 (20)	45 (25)
	More than 10	No. of Farmers	9 (8.6)	12 (24)	7 (28)	28 (15.6)
	Not Used	No. of Farmers	38 (36.2)	16 (32)	10 (40)	64 (35.6)
Total (each above)		No. of Farmers	105 (58.3)	50 (27.8)	25 (13.9)	180 (100)
Lower Zone						

Hired Labour (Persons per *Kanal*)	Up to 4	No. of Farmers	24 (38.1)	4 (21.1)	4 (50)	32 (35.6)
	5 – 10	No. of Farmers	20 (31.8)	7 (36.8)	1 (12.5)	28 (31.1)
	More than 10	No. of Farmers	3 (4.8)	4 (21.1)	2 (25)	9 (10)
	Not Used	No. of Farmers	16 (25.4)	4 (21.1)	1 (12.5)	21 (23.3)
Total (each above)		No. of Farmers	63 (70)	19 (21.1)	8 (8.9)	90 (100)
Communal Labour/*Bes* (Person per *Kanal*)	Up to 4	No. of Farmers	13 (20.6)	1 (5.3)	2 (12.5)	16 (17.8)
	5 – 10	No. of Farmers	29 (46)	4 (21.1)	3 (37.5)	36 (40)
	More than 10	No. of Farmers	16 (25.4)	11 (57.9)	2 (12.5)	29 (32.2)
	Not Used	No. of Farmers	5 (7.9)	3 (15.8)	1 (12.5)	9 (10)
Total (each above)		No. of Farmers	63 (70)	19 (21.1)	8 (8.9)	90 (100)
All Zone						
Hired Labour (Persons per *Kanal*)	Up to 4	No. of Farmers	77 (31.7)	13 (16.3)	5 (13.5)	95 (26.4)
	5 – 10	No. of Farmers	106 (43.6)	45 (56.3)	12 (32.4)	163 (45.3)
	More than 10	No. of Farmers	20 (8.2)	15 (18.8)	18 (45.6)	53 (14.7)
	Not Used	No. of Farmers	40 (16.5)	7 (8.8)	2 (5.4)	49 (13.6)
Total		No. of Farmers	243 (67.5)	80 (22.2)	37 (10.3)	360 (100)
Communal Labour/*Bes* (Person per *Kanal*)	Up to 4	No. of Farmers	70 (28.8)	13 (16.3)	8 (21.6)	91 (25.3)
	5 – 10	No. of Farmers	78 (32.1)	21 (26.3)	8 (21.6)	107 (29.7)
	More than 10	No. of Farmers	39 (16)	26 (32.5)	10 (27)	75 (20.8)
	Not Used	No. of Farmers	56 (23)	20 (25)	12 (32.4)	88 (24.4)
Total		No. of Farmers	243 (67.5)	80 (22.2)	37 (10.3)	360 (100)

Source: Field Survey, September-October, 2016. **Note:** Figures in brackets represent percentage of respective total.

only 39 small farmers used communal of more than 10 persons per *kanal*. A significant number of small farmers i.e. 56 farmers accounting for 23 per cent of total small farmers did not use communal labour at all. Among medium farmers 26 farmers accounting for 32.5 per cent of total medium farmers used communal labour of more than 10 persons per *kanal*, 21 famers used communal labour of between 5-10 persons per *kanal*. On other hand, 20 medium farmers did not use communal labour at all. About 12 farmers accounting for 32.4 per cent of total large farmers did not use communal labour. It suggest that large farmers have more capacity to employ hired labour and whereas small farmers are still more dependent on communal labour. On the other hand, 10 large farmers used communal labour more than 10 person per *kanal*.

If we look at across the zones, it shows that 77 farmers constituting 85.56 per cent of total farmers used hired labour in higher zone. The share of such farmers was 91.67 per cent for middle zone and 76.67 per cent for lower zone. It shows that middle zone villages have started using hired labour due to shortage of family labour. As against this, only 13 farmers accounting for 14.44 per cent of total farmers did not use hired labour at all in higher zone. The proportion of farmers not using hired labour was 8.33 per cent and 23.33 per cent in middle and lower zone respectively. Reasons for less hired labour in more distant villages can be attributed to the prevalence of large number of joint families. Next 76 farmers accounting for 84.44 per cent of total farmers used communal labour in higher zone. The proportion of farmers using communal labour was 64.44 per cent and 90 per cent in middle and lower zone respectively. It shows the prevalence of large number of joint families in lower and higher zone villages.

Therefore, it can be observed from above analysis that insufficient family labour on account of young people leaving out of farming has led to shortage of labour force in agriculture. As a result, farmers have started using hired labour in combination of communal labour. Small farmers employ less hired labour compared to medium and large farmers across agro-altitudinal zones. Middle and lower zone villages have started using hired labour, replacing communal labour due to proximity of their villages to the Leh town, which provides hired labour easily. The more distant villages still uses family labour due to prevalence of large number of

joint families. However, with decreasing sources of labour, farmers are increasingly hiring labour and therefore, influencing labour-owner relationship.

To sum up, overall analysis shows that agriculture is not only determined by physical factors but also by various other socio-economic and cultural factors. Social institutions like monasteries, *phaspun*, primogeniture and polyandry etc. played an important role in agriculture in Leh district. However, their role has declined in the last few decades due to recent socio-economic developments in the region. As a result, the already small land holdings are further getting subdivided. Further, the majority of cultivators in surveyed villages of Leh district own the land they operate. Land ownership and tenancy are significantly influenced by the prevailing socio customs of the region. Pressure of population on agricultural land was found to be very high in villages of Nubra and Shyok and lower Indus valleys. Large families put more pressures on land holdings compared to small families. *Gompas* still own large tracts of land and have exclusive control on it. Women still plays an important part in agriculture as agricultural workers especially in villages away from Leh and where other economic activities have not developed. Many new economic activities have absorbed many males who could otherwise have been farmers. Therefore, it was found that hired labour is also becoming an important part of agriculture. These have led to changes in traditional social institutions like *phasphun* which was an important source of communal labour.

Chapter Six

Summary and Conclusions

Mountain regions are generally characterised by rudimentary accessibility and considerable intra-regional disparities. Life sustenance in such areas is dependent on successful adjustment to specific mountain specificities that include inaccessibility, environmental fragility, marginality, diversity, niche and specific human adaption mechanism to the above features. These features present a range of opportunities as well as constraints for human activities. Indigenous mountain communities, through trial and error over the generations, have evolved their own human adaptation mechanisms to harness the potentials of mountain lands and to deal with the constraints of physical environment. They tend to adapt to mountain environment either through modifying mountain characteristics to suit their needs or through designing activities to adjust to the requirements of nature. In high altitude areas, for instance, people respond to nature generally either by adopting pastoral economy or by carrying out subsistence farming based on local knowledge evolved based on their own culture and interaction with environment.

Many mountain societies have responded to sustainable utilization of resources, thereby utilising less vulnerable land consisting of river valleys, river terraces and alluvial fans. Their economy has been of subsistence type for centuries. Traditionally, subsistence agriculture or pastoralism has been main economic activities in mountains. However, commercial economy has made inroads in many mountain regions in the last few decades. It resulted in increase in urbanisation and development of tourism. This, in turn, has raised the demand for commercial products like fruits and vegetables. As a result, mountain agriculture underwent significant change with diversification from traditional growing food crops to commercial agro-horticultural crops.

Nevertheless, the main concern of mountain communities is to limit or minimise the restrictions imposed by harsh environment on agriculture in terms of rough terrain, moisture stress, poor soil conditions and short growing season. It has been possible for mountain farmers to overcome to some extent these constrains by modifying their traditional agriculture system into more profitable commercial one

with the help of modern scientific technology. This possibility offers new opportunities for exploiting the potentials of mountain areas and enhances food security of farmers. However, lack of access to appropriate institutional support, limited agricultural research and inefficient marketing structure are critical for the long term sustainability of commercialization of agriculture in mountains.

Leh district lies in high altitude zone of Trans-Himalayan region. Traditionally, agriculture has produced just enough for self-subsistence, with very limited surplus. There has been a shift in its agriculture from subsistence traditional agro-pastoral towards agro-horticultural due to increased accessibility, enhanced income levels and improvement in infrastructure in recent years. The present trends towards rapid expansion of horticultural crops have a huge potential in improving food and livelihood security of local people through direct use of products or trade in high-value products. As Leh district is endowed with diverse agro-ecological conditions, proper harnessing of niche-based farming can also enhance income levels of local farmers thereby improving the standard of living. However, the nature of agricultural diversification varies across villages owing to varied socio-economic and topographical conditions. The villages situated in close proximity to urban areas and located at lower altitude have been in better position to take advantage of resource endowments and comparative advantages. Therefore, efforts are being made to convert potential marginal uplands areas into productive system through effective support system and modern technology.

Success of diversification of agriculture towards cash crops has been dependent on access to improved technologies, quality inputs and formal insurance mechanism. Easy accessibility, use of fertilizers, insecticides, HYV seeds and development of irrigation facilities have shown signs of improving yield levels thereby benefiting local farmers. However, it has been noted that excessive use of chemical fertilizers and pesticides in commercial production may lead to adverse impacts on the fragile environment. Concerns have been raised regarding the long term sustainability of recent development of high-value cash crops. Therefore, it requires adequate attention for protecting the environment and development of sustainable way of farming given the vulnerability of this fragile mountain ecosystem. Besides, farmers need to be given added incentives to take productivity-enhancing risks such as adopting new technologies and switching to high-value

crops. Thus, various environmental and socio-economic aspects of changing agricultural economy of Leh district can be summarised as follows:

2.1 Leh district is characterised by high altitude, rugged terrain and extremely cold-arid climate which makes it difficult for human habitation. Cultivation is possible only during summer season.

2.2 It has wide intra-regional physiographic variations. Majority of inhabited and cultivated area falls in lower zone i.e. below 3900 metres. Land lying above 4700 metres is unfit for cultivation.

2.3 On the basis of altitude and physiography, Leh district can be divided into three sections; Mountain ranges, River Valleys and Plateau region. The mountain ranges are Saltora Range and Southern face of Karakoram Range, Ladakh Range and Zanskar Range. Main river valleys of Leh district include those of Indus, Shyok-Nubra and Hanle rivers. Most of agricultural activities are found in the relatively lower parts of these valleys. Plateau region situated in the eastern part of the district is commonly called Changthang having sub-divided into Rupshu Plain and Lingzithang Plain. Most parts of Changthang are suitable only for pastoral activities.

2.4 Indus river is the master river which drains of the region along with a number of its tributaries which include Shyok, Nubra, Hanle and Zanskar. Nubra River is a right-bank tributary of Shyok river which joins Shyok at Diskit.

2.5 Availability of land suitable for cultivation is closely associated with the length and order of the streams. The higher order streams tend to have wider stretches of flat land and more water discharge, which can be used for irrigation.

2.6 Topography, altitude, slope of land, and stream ordering reflect that most of the area is highly rocky, undulating and very elevated. Very large portion of land has steep slope and hence, unfit for agriculture. Large part of Leh district lies at very high altitude making climate to be very cold or has rock out-crops. Agriculture is limited to valley floors, alluvial fans and river

terraces where the soil depth and water availability determine its suitability for cultivation.

2.7 Soils of Leh district is of skeletal type and is characterised by immaturity, low organic matter content and poor water retention capacity. A marked difference can be observed in soils between valleys and uplands.

2.8 Climate exerts a strong influence on human activities, particularly crop cultivation and considered to be a crucial determinant of the kinds and duration of crops grown and types of livestock that can be raised.

2.9 Climate of Leh district has a significant bearing on its agricultural land use and cropping pattern. The amount of precipitation is very low due to the region's location in rain shadow zone of Great Himalayan Range, which acts as an effective barrier to moisture laden Monsoon winds. Most of precipitation falls is in the form of snow during winter months, which has negligible direct role in agricultural economy as most farming activities are confined to summer months. However, the amount of snowfall in winter months indirectly determines the availability of water for irrigation in summer which is the agricultural season. Irrigation is a prerequisite for agriculture in this cold arid desert.

2.10 Temperature is an important element of climate as it restricts the growing season to a few summer months. Temperature has very large seasonal as well as diurnal range. For substantial part of a year, the mean temperature remains below the critical value required for the growth of plant. Marked variations can be observed in terms of temperature between low lying areas and uplands as low lying areas offer better climatic conditions for agriculture.

2.11 The growing season in most part of Leh district is very short. Except a few pockets, most of the region is single cropped area. Double cropping is restricted to lower parts where some additional early maturing varieties of crops can be raised.

2.12 Leh district receives very low precipitation as the entire region falls under rain-shadow zone of Great Himalayan range. As a result, it acutely suffers from the deficiency of moisture vital for the plant growth. This moisture deficiency is overcome with the help of irrigation carried out with the help of narrow gravity channels locally known as '*kuls'.*

3.1 Large part of total reporting area of Leh district falls under the category of barren and uncultivated land. It is more pronounced in higher zone as compared to middle and lower zones. The region has no forest cover except scanty vegetation in the form of shrubs and grasses.

3.2 Only a small portion of total geographical area is under cultivation. This land is being judiciously utilized by farmers by raising both traditional as well as commercial crops.

3.3 Leh district witnessed significant increase in land put to non-agricultural uses with decline in net area sown over the years. This is because of expanding infrastructure mainly related to recently emerged tourism. Area under miscellaneous tree crops and grooves and Area Sown more than once also registered significant increase during the last few decades.

3.4 Higher zone villages have low proportion of land under the category of net sown area to total reporting area than lower and middle zone villages in Leh district. It was highest in Stok village lying in middle zone, whereas Durbuk village lying in higher zone has lowest.

3.5 Small and medium owned major proportion of land holdings across the three altitudinal zones. Population pressure on cultivated land is lowest in higher zone while it is highest in lower and middle zones. This is because farmers have more land but with less productivity in the higher zone. It means that carrying capacity of land declines with increasing altitude.

3.6 Leh district is endowed with varied agro-climatic conditions that are conducive for production of food crops as well as cash crops like potatoes,

peas, vegetables and pulses etc. Here, crops are less vulnerable to fungal diseases due to cold-arid climate.

3.7 Shift from traditional crops in favour of commercial crops has started taking place except in higher areas of Leh district. Area under wheat crop seems to have declined in favour of barley. This is mainly because now wheat is easily available either through Public Distribution System or from open market. This has happened because of coming in of large contingent of army due to strategic reasons and introduction of large scale tourism, and these both factors have resulted in enhanced connectivity of the district. Area under fruits and vegetables has also registered significant increase which shows growing importance of vegetables and fruit crops in the region on account of change in food habits and the socio-economic developments. It is more pronounced in middle and lower zone villages as well as in villages situated close to urban centres, administrative centres, tourist places and army settlements.

3.8 There is significant crop diversification in favour of fruits and vegetables cultivation in Leh district. It is more pronounced in lower and middle zone villages and villages close to Leh town.

3.9 The process of crop diversification had gathered momentum in recent decades. Crop diversification is taking place in two blocks of Leh-Karu and Nubra. Better road infrastructure, access to market, governmental aids etc. are the main factors of crop diversification in the region.

3.10 Yield of traditional crops as well as cash crops shows positive relation with decreasing altitude except wheat which has higher yield in middle zone. It highlights restrictive role exerted by physiographic and climatic parameters.

3.11 Cropping intensity is higher among small and large farmers in north-western parts of the region where second crop is grown. Rest of the region is predominantly single cropped area.

4.1 Apart from food crops, agro-climatic conditions of Leh district are quite congenial to the growth of temperate fruits mainly apricot and apple and to some extent pear and cherry etc. Arid and semi-arid cold desert of Leh district lying on the leeward side of Great Himalayan range receives precipitation mainly in the form of snow which is considered as white manure for some of these fruit crops.

4.2 Potential horticultural areas suitable for apricot and apple plantations are concentrated in Indus and Shyok-Nubra valleys and north-western portion of Leh district having relatively milder climate.

4.3 Number of crops grown and altitude shows negative relationship which means that their number decreases with increasing altitude.

4.4 Area under various temperate fruit crops especially apricot and apple has increased substantially in the district. Apricot continues to dominate, whereas Apple trees are becoming more and more popular owing to improved infrastructural and marketing facilities which have come up in recent years.

4.5 There is extensive diversification drive for horticultural crops in the parts of the district having better environmental conditions especially lower and middle parts of valleys.

4.6 Farmers from all categories have started bringing some part of land under apricot plantations especially in lower and middle zones. Large farmers have more area under apricot plantations as compared to other categories of farmers. It is more pronounced in the lower zone than the middle zone.

4.7 Large farmers with more fruit bearing apricot trees have more production as compared to medium and small farmers. A few small and medium farmers are also having more production in some case cases. Large and medium farmers are getting more production as compared to small farmers. Marked variations can be observed in terms of production of apricot between lower and middle zones.

4.8 Almost all categories of farmers are gradually moving towards apple plantations with some minor intra-category variations in the lower and middle zones. While a significant area under apple plantations is in lower zone, large tracts of land in the villages of middle zone have also been brought under apple trees in recent years.

4.9 Farmers with larger landholdings are planting more apple trees in surveyed villages of Lower and Middle zones. However, a few small and medium farmers have also started planting large number of apple trees in villages of these zones. However, Higher zone villages have no fruit trees.

4.10 Large farmers followed by medium farmers were in a better position to sell as well as self consume apricot produce compared to small farmers in both zones. Large proportion of medium farmers was marketing and self-consuming the produce in the lower zone as against large farmers being in the same category in the middle zone.

4.11 Most apricot and apple producing farmers are facing major problem of marketing while other farmers complained about insects-pests and diseases in fruit crops to be the problem. Small and medium farmers confronted majority of the problems as against large farmers whose main problem was labour shortage. Problem of labour shortage is more pronounced in middle zone villages. Middle zone has all urban centres and most of tourism related activities.

5.1 Majority of cultivators are land owners followed by part tenants and joint owners. Tenancy rights are significantly influenced by the prevailing socio-religious customs. Customs like polyandry, primogeniture and monasticism checked the fragmentation of land holdings in the past. However, the traditions of polyandry and primogeniture were abolished with the advent of modernisation resulting in subdivision of land holdings.

5.2 Apart from land owned by individual farmers, large tracts of land are owned by G*ompas* (Buddhist Monasteries) on which villagers work either as tenants or as agricultural labourers.

5.3 Most of the land holdings fall in the category of marginal holdings measuring less than one *hectare,* which have further increased over the years. It is largely because land holdings are increasingly getting fragmented in the district mainly due to economic factors whereby land is getting divided for non-agricultural usage and fragmentation of families into nuclear families. This is more pronounced in villages that are located close proximity to Leh town, which has become a major centre of non-farm activities in recent years.

5.4 Lorenz curve and Gini-coefficients (a measure of inequality) show a decrease in inequalities in the distribution of land holdings in Leh district. Inequalities are more marked in the more developed villages of Stok and Hunder. It could be mainly due to the fact that the former ruler still owns large holdings in Stok village. Muslim cultivators in some villages like Hunder continue to be joint owners without fragmentation of land.

5.5 Highest agricultural density of 34 persons per *hectare* of cultivated land was found in villages situated in lower and middle zones of Leh district mainly due to higher carrying capacity of land owing to favourable environmental conditions. As against this, lowest agricultural density of less than 1 person per *hectare* of cultivated land was found in villages located in higher zone, which have less net sown area due to higher altitude and majority of workers are engaged in livestock rearing.

5.6 Higher proportion of agricultural workers is concentrated in river valleys such as Indus, Shyok and Nubra of middle and lower zones. It is due to better conditions for agriculture. Besides, more isolated villages also fall in this category. On the contrary, lower proportion of workers engaged in agriculture was seen in villages of nomads, administrative centres, villages situated on Leh-Srinagar and Leh-Manali highways, monastic villages and

villages near army camps. It is because administrative centres, villages on the highway and near army settlements have evolved many alternative job opportunities in many cases related to tourism.

5.7 Most of agricultural workers were found in age group of above 50 years. Recent socio-economic changes have led to development of service sector and tourism related activities which provide job prospects to younger people. All this has led to changes in occupation structure. As a result, middle zone villages have become economically more diversified due to their proximity to Leh town where lot of commercialisation of economy has taken place. Women agricultural workers were found more in numbers than males especially villages located close to Leh town.

5.8 Labour used in agricultural production in the region can be broadly classified into three categories of family labour, hired labour and community labour/*bes.* In recent times, community labour available through *Bes* and *Phaspun* has largely declined and has been replaced by hired labour.

5.9 Small farmers employ less hired labour compared to medium and large farmers across altitudinal zones. Middle and lower zone villages have started using hired labour due to shortage of family labour. It is especially true in villages near Leh town. Here lot of commercialisation has occurred and labour is easily available for hiring.

Agriculture continues to be the major occupation of majority of people and it provides food and livelihood security to large population. However, it is still strongly influenced by the diktats of harsh environment along with certain other socio-economic constraints. Many such constraints have been overcome to an extent through combination of factors of modern scientific techniques and traditional know-how of mountain farmers. The adoption of modern scientific techniques coupled with institutional supports, government aids, emergence of market and infrastructural development have led to agricultural diversification. The diversification and consequent commercialisation of agricultural economy has started gaining momentum as more remunerative commercial crops are replacing the traditional/subsistence crops more significantly in lower and middle zones.

Therefore, new techniques and changing cropping pattern are expected to partly overcome environmental constraints and are likely to boost economy of Leh disrtict.

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Appendix 1.1

VILLAGE SCHEDULE

1. Village Code:

2. Village Altitude: **Block:**

Latitude: **Longitude:**

3. Road Connectivity: **Metalled:** **Non-Metalled**

4. Land use (Table) in *Kanals*

Total Geo Area	Agricultural Area	Culturable Waste	Forest Area	Pasture Area	Other Areas

5. Land Ownership (Table)

Community		Monastery		Farmers	
Operated by Institution self	Given on tenancy	Operated by Institution self	Given on tenancy	Operated by Institution self	Given on tenancy

6. Agricultural Aspects

Crop	Traditio-nal	New	Sowing Months	Harvesti-ng Months	Production *Quntals/kanal*	Marketed	Self Consumpti-on

8. Veterinary Facility

Veterinary Hospital	Veterinary Dispensary	Veterinary Clinic	Veterinary Extension Clinic	Veterinary Breeding Centre

9. Development programmes introduced in the village

S.No.	Programme	Year	Project	Amount	Benefits	Remarks

Observations/ Own Remarks

Appendix 1.2

QUESTIONNAIRE

HOUSEHOLD SURVEY

Date…… Questionnaire No.……. Village Code…….

1. Details of Household

Village Name			
Head of Household			
Household Name/Number			
Name of the respondent			
Age of the respondent			
Gender of the respondent	**Male**	**Female**	**Others**
Type of family	**Joint**	**Nucleated**	**Extended**
Total no. of dependents in the family			
Religion			

2. Demographic particulars of household members

Sl. No.	Name of Member	Relation to Head	Sex M/F	Age (Years)	Marital Status	General Education Level	Usual Activity Status

3. Main source of income in your household:

a) Agriculture b) Service c) Tourism Business

d) Others

4. Type of land ownership: a) Self b) Leased

5. Have you taken any land on lease? If yes, when and from whom?

1. ***Gompa***
2. **Any other household**
3. **From community**
4. **Others (Specifiy)**

6. What role do you think *Gompa* plays in practicing agriculture, land consolidation/fragmentation? Has there been any change?

7. How do you see the effect of (declining) polyandry on land holdings?

8. Have you rented out your land? If yes, to whom, how much and why? Have you always rented your land? If No, since when?

9. Have you left your land uncultivated? If yes, when and why?

10. Details of possessed land (in *Kanals*)

Total Area	**Operated Area**	**Un-operated Area**

11. Size of land holdings (*hectares*)

Size	**Category**	**No. of Holdings**
Below 1	**Marginal**	
1 – 4	**Small**	
4 – 10	**Medium**	
Above 10	**Large**	

12. Labour Use

	Family Labour		Hired Labour (since when)		Communal Labour or exchange labour, including *Bes*	
Crops	**Per/kanal**	**No. of days**	**Per/kanal**	**No. of days**	**Per/kanal**	**No. of days**
Barley						
Wheat						
Potato						
Peas						
Beans						
Vegetables						
Others						
Total						

13. Supply of modern inputs: Government Subsidised improved seeds, fertilizers and pesticides (Adoption of agricultural Inputs)

Sr. No.	Crops	Area sowed	Seed used		Chemi-cal Fertiliz-ers	Organic Fertiliz-ers	Pesti-cides	No. of wateri -ng	Improved Implements
			I	H					
1									
2									
3									
4									
5									

Note: I = Indigenous, H = Hybrid

14. From where do you get farm inputs?

15. Access to Market

Name of the Market	Location	Time taken in hours	Distance from the Farm (in kms)	Mode of Transport

16. Where do you sell your produce and agency employed?

1. **Own Shop**
2. **Village Trader (Middle Man)**
3. **Wholesale Mundy**
4. **Co-operative society**
5. **Private Company**
6. **Other (Specify)**

17. Dou you face any problems while selling your produce? Y/N, if yes, explain

18. Have you encountered any problem in the adoption of cash crops? What are the major problems in the adoption of cash crops?

1. **Lack of knowledge**
2. **Insufficient capital**
3. **Small size of landholdings**

19. Crop Input costs

Cost of Crop	Machinery	Total Labour	Seeds	Fertilizers	Hired Labour	Draught Animal

20. Levels of farm mechanisation

Indigenous (Bullock drawn)		Tractor (Since when)		Thresher (Since when)		Any Other
		Owned	On Rent	Owned	On Rent	

21. What are the problems do you face while adopting farm machines?

22. Status of Animal resources

Sr. No.	Animals	Total Number	High Breed	Indigenous	Total Income (Rs.)	Use/Benefits	Remarks
1	Cow						
2	Dzo						
3	Dzomo						
4	Yak/Demo						
5	Horses						
6	Donkey						
7	Poultry						
8	Camel						
9	Goat						
10	Sheep						

23. Where do you take animals for grazing during summers?

1. **Stall Feeding**
2. **Open pastures**
3. **Village common lands**
4. **Stubbing**
5. **Any other**

24. Is there any scarcity of fodder during any part of the year? 1) Yes 2) No

25. If yes, for what reasons

26. From where do you get the additional amount of fodder?

1. **Purchase from neighbouring areas**
2. **By-products from agriculture**
3. **Any other (Specify)**

27. Monthly income from sold milk, milk products?

28. Horticultural sector developments (Apricots and Apples)

Fruit	**No. of fruit plants**	**Area in Kanals**	**No. of fruit bearing plants**	**Marketing Problems**		**Production and disposal in quintals**	
Apricots				**Yes**	**No**	**Production**	**Self Consumption**
Apples							

29. Where do you sell horticultural products?

30. What according to you are the main factors responsible for diversification of crops?

1. **Construction of Roads**
2. **Access to market**
3. **Army establishments**
4. **Access to improved modern inputs**
5. **Favouring government policies**
6. **Any other (specify)**

31. Do you get any aid from any departments such as agriculture and horticulture to pursue agriculture?

32. Who maintains irrigational canals (community/own)?

33. Yield of Major crops (Quintals/Kanal)

	Crops	Annual Yield (quintals/kanal)	Able to sell	Annual Quantity sold	Annual Revenue (in rupees)
1	Barley				
2	Wheat				
3	Buckwheat				
4	Potatoes				
5	Peas				
6	Kidney Beans				

34. Cropping Pattern

S.No.	Crops	Area (*Kanal*)	Yield (*Quintals*/*kanal*)
Cereals			
1	Wheat		
2	Barley		
3	Buckwheat		
Oil Seeds			
1	Mustard		
Pulses			
1	Lentil		
2	Kidney beans		
Vegetables			
1	Turnips		
2	Beans		
3	Peas		
4	Carrot		
5	Cauliflower		
6	Green leaves		
7	Potatoes		
Fruits Crops			

1	**Apple**		
2	**Apricot**		
3	**Walnuts**		
Fodder			
1	**Alfalfa**		

35. Details of Livestock

Animal type	**Expenses (Rs.) per year**			**Total Input Cost (Rs.) per year**
	Forage	**Veterinary**	**Labour**	
Cows				
Yaks				
Dzo				
Sheep				
Goats				
donkeys				
Horses				

36. Other Sources of Income (Give details)

S.No.	**Nature of Job**	**Main Working days/Year/Season**	**Income/Year**
1	**Labourer Under MNREGA/REP (Rural Employment Programme)**		
2	**Livestock Rearing**		
3	**Tourism**		
4	**Trade**		
5	**Local Handicraft Industry**		
6	**BRDO Labour (beacon)**		
7	**Army Potter**		
8	**Remittances from migrant**		
9	**Any other work especially done by women**		

37. Who plays the major role in agricultural practices? Is any part of work distributed between men and women?

38. What are the major reasons which are affecting the present yield of the crops?

1. **Non availability of sufficient water**
2. **Low Yielding Seeds**
3. **Low dose of Fertilizers**
4. **Wide spread of insects and diseases**
5. **Paucity of Fund**
6. **Non availability of Machinery**
7. **High Prices of Inputs**
8. **Others (Specify)**

39. What is the role (social/economic) of *Phasphun* and *Bes* system in agriculture? Is it changing? If yes, why?

40. Does self help group (eg *ama tsogspa*) play any role in agricultural development?

42. Would you prefer some other work over agriculture?

43. Do you think there is a threat to sustenance of agriculture? Give Reasons?

Appendix 1.3

RESEARCH STATIONS ENGAGED IN THE INTEGRATED DEVELOPMENT OF HORTICULTURE

A number of research stations are operating research schemes to accelerate the growth of horticulture particularly crops such as apricot and apple under artificially maintained scientific conditions in Leh district. Their efforts are likely to herald a new era for this sector. Here, major thrust is on research outcome to meet farm requirements. The Defence Institute of High Altitude Research (DIHAR) or Field Research Laboratory (FRL) as it is popularly called was established under the administrative control of Defence Research & Development Organization (DRDO) at Leh in 1962. The institute is located at an altitude of 3500 metres above mean sea level. Its principal aim is to do basic research directed towards productivity enhancement in vegetable cultivation; exploitation of high altitude plant wealth for herbal products; collection, evaluation and permafrost based conservation of elite germ-plasm; minimal processing, freeze preservation of vegetables and post-harvest technology for perishable food items; sustainable utilization of biodegradable waste for energy production; high altitude physiology; conservation and up-gradation of local unproductive animal population with elite germ-plasm etc. The institute has its research stations at Ranbirpura and at Partapura (Nubra-Siachen Brigade).

The major achievements of this institute are as follows[83]:-

1. Surveyed, identified, evaluated and conserved 54 genotypes of indigenous apricot from cold arid Ladakh.
2. Developed vegetative methods of propagation in apricot by grafting, chip budding and top working.
3. Established scion bud wood bank and progeny orchard of apricot. Standardized propagation techniques for apple through grafting and budding.
4. Established gene bank of apricot, apple, seabuckthorn, cherry, walnut, strawberry, mulberry
5. Developed processing /value addition techniques for low quality apricot for production of nectar, jam, jelly, juice, nectar / RTS, puree, hurdle technology, Intermediate moisture, bar etc. which have industrial potential.

[83] https://www.drdo.gov.in/drdo/labs1/DIHAR/English/indexnew.jsp?pg=achieve.jsp

6. Surveyed variability and area under seabuckthorn, a wonder plant of cold dessert (about 11,500ha) using remote sensing technology.
7. Developed the technology for preparation of herbal beverage from fruits of seabuckthorn. The beverage is rich sources of vitamin A, C, B, K, & E and does not freeze up to -22 degree centigrade. Since the product is having anti-aging and anti-stress properties, it has been included in the special ration of Indian Army. Transferred the technology to 4 vendors and they are manufacturing the herbal beverage commercially.
8. Also developed technology for production of jam, sauce, puree, pickle, chyavanaprash and other beverage from seabuckthorn, which will be exploited on commercial scale.
9. The laboratory has designed & developed low cost drier such as solar polyhouse drier, Tunnel drier, LPG driers, drier for scientific dehydration of surplus fruit and vegetables of the region.
10. Developed mechanical harvester for Seabuckthorn fruit collection without damaging the plant.
11. -Developed polyploids of Seabuckthorn through colchine treatment for developing ideal ideotype.
12. Developed grafted Seabuckthorn through intergeneric (Elaegnus sp) grafting technique having less thorn
13. In order to develop floriculture industry in the region the laboratory has introduced and demonstrated the cultivation of improved varieties of gladiolus, Asiatic Lilium, carnation for their commercial production.
14. FRL recognized as nodal centre for FPO licensing and granted FPO license No. 19066.

The institute has carried out a systematic experimentation and introduced 78 different types of vegetables, standardized their cultivation of practices and transferred the technology to local farmers to grow them in their own fields.

NEW VEGETABLES VARIETIES AND HYBRIDS DEVELOPED BY DEFENCE INSTITUTE OF HIGH ALTITUDE RESEARCH

S.No.	Group	Vegetables	Variety/Hybrids
1	Cole Crops	Cabbage	Golden Acre, Gonzales (F1), S-25 (F1), Drum Head
2		Cauliflower	Amazing (F1), Snow Crown (F1), Lateman Krishna (F1)
3		Knol Khol	White Vienna, Purple Vienna
4		Chinese Cabbage	Wong Bok; Optiko
5		Red Cabbage	Red Acre
6		Broccoli	CBH-1, Packmen, Pirite
7		Brussels Sprout	Hills Ideal
8		Kale	Red Russian
9		Karam Sag	Kashmir
10		Romanasco	Bejo Sheetal
11	Roots	Carrot	Nantes, Pusa Yamdagini, Samson (F1)
12		Radish	Pusa Himani, FRL Local Sel, Japanese White
13		Turnip	Purple Top, White Globe, Pusa Chandrima
14		Beet Root	Detroit Dark Red, Action
15		Swede	FRL selection
16	Bulb crops	Onion	Brown Spanish, Sindhu Sweta, Agrifound Dark Red
17		Bunching Onion	-
18		Garlic	Agrifound Parvati, Single Clove
19		Leek	Suttind Leek
20	Tuber	Potato	Kufri Chandramukhi, Kufri Jyoti, Kufri Jawahar
21		Artichoke	Jerusalem, Local
22	Pulses	Pea	Arkel, Bonneville, Lincoin, VL-3, Pusa Pragati
23		Snow Pea	(Toledo)
24		French Beans	Contender, VL Boni-1, Pusa Parvati, French Yellow
25		Broad Beans	Sindhu Brahmha, Local
26		Gram	BG-361, BG-374, Pusa-209, C-104
27		Sem	Kalyanpur Type-2
28		Cowpea	Pusa Komal

29		Cluster Bean	Pusa Mausami
30		Moth Bean	C-2M-2
31		Soybean	Bragg
32	Solanaceous	Tomato	BSS-347 (F1), Tolstoi (F1), Sultan (F1), Sindhu-1
33		Capsicum	California wonder, Pusa Deepti (F1), and Sindhu Naren
34		Brinjal	Long: Pusa Hybrid-5, Raveena (Green)
35		Chilli Peprika	Pusa Jwala, BSS-344 (F1)
36	Salad	Lettuce	Great Lake, Chinese Yellow
37		Parsely	Masscurled, Pogoda
38		Celery	Trimmuf
39		Coriander	Cori-1
40		Mint	FRL selction
41		Beet Leaf	Mongol, Sindhu Harit
42		Spinach	Sporter
43		Swiss Chard	Red Petiole
44		Veg. Mustard	ARU-Black, Hill Sarson
45		Amaranth	Red & Green
46		Chenopodium	Pusa Red
47		Fenugreek	Kasuri, Early Bunching
48		Orich (Ustak)	Sindhu Green
49		Packchoy	Sindhu Early
50		Chicory	Local, Pluto
51		Endive	Bossa
52		Cress Cresida	-
53		Portulaca	S-4
54	Spices	Turmeric	BSR-1
55		Ginger	Himgiri
56	Cucurbitaceous	Pumkin	MPH-1, Sindhu-Yellow, Sindhu Green, Pusa Vishwas
57		Bottle Guard	Pusa , Naveen, Pusa Sandesh, Pusa Hybrid-3, BSS-333
58		Summer Squash	Australian Green, Pusa Alnkar, Zucchini, Season Opener
59		Cucumber	Japanese Long Green, Pusa Sanyog (F1), Poinstte, Astix
60		Long Melon	Tar green, Long green
61		Water Melon	Asahi Yamato, Sugar Baby, BSS-358,

			Swapnil, Apoorva
62		Musk Melon	Punjab Hybrid No-1, Madhubala, Hara Madhu, BSS-361
63		Sarda Melon	Sindhu Sweet, Sindhu Leopard, Sindhu Honey
64		Ridge gourd	Pusa Nasdhar, Harita, BSS-405
65		Sponge gourd	Pusa Chikini
66		Bitter gourd	Pusa do Mausmi, Arka Harit, Monsoon Mircle
67		Round melon	Arka Tinda, JLM-83025
68		Wax gourd	Mah-1, Co-1
69		Snap melon	-
70		Buffalo gourd	FRL Sel
71	Other crop	Okra	Varsa (F1), Harbhagan
72		Baby Corn	G-5406
73	Local Vegetable	Kabra	-
74		Shantgso	-
75		Shoma	-
76		Khala -	-
77		Lamanchu	-
78		Lachu	

Source: Singh, N. (2012), "Innovative Approaches in Vegetable Research to Meet the Nutritional Requisites in Cold Arid Desert Areas", *Innovations in Agro Animal Technologies*, (Authored by Ravi Bihari Shrivastava and W.Selvamurthy), Satish Serial Publishing House, New Delhi, pp. 5