

Study of Land Use Dynamics and Cropping Pattern of Selected Sample Villages of Leh District, Ladakh

Dr. Jigmat Norboo¹
Ms. Tsewang Dolma²

¹Assistant Professor, Department of Geography, Kargil Campus, University of Ladakh, UT Ladakh, India.
²Principal, Jamyang Lamdon School, Khamtse, UT Ladakh, India.

Abstract:

This paper is an attempt to study land use dynamics and cropping pattern in selected sample villages of Leh district, Ladakh. An analysis of spatial variations and temporal changes in cropping pattern and land use during 1996-2011 in Leh District has been carried out using both primary as well as secondary data. Both qualitative and quantitative methods have been used for the analysis. Lorenz curves were drawn to show the inequality in the distribution of land holdings. Primary survey was conducted of three villages to have information of agriculture in Leh district. For this, sampling method has been drawn to collect statistical information regarding population, livestock and agricultural conditions. Primary data was collected with the help of a questionnaire. Three villages from higher, middle and lower altitude zones were surveyed by selecting twenty households from each village. Households were selected on the basis of availability of respondent. Results reveal that area under land put to non-agricultural use has increased substantially. This probably is the reason for decline in net sown area in last decade. Land has been fragmented in all surveyed villages due to increasing nuclear families, abolition of polyandry, declining role of monasteries resulting in further division of already existing uneconomical land holdings. Cropping pattern shows similar human response. Crops are grown according to natural viability and according to socio-economic concerns.

Keywords: Land use dynamics, cropping pattern, inequality, land holdings.

Date of Submission: 05-03-2023

Date of Acceptance: 18-03-2023

I. INTRODUCTION

Mountains are generally characterised by harsh climate, remoteness, a low level of market integration and limited agrarian resource potentials. Their environment and socio-economic conditions are quite unique and varied within agro-pastoral land-use systems. Besides, adaptations and adjustments those the mountain people make in order to harness the specificities and resources of mountain environment provide distinctive characteristics to mountain farming (Vishal Warpa, 2007). Study of various characteristics of agriculture such as land use, land holdings, cropping pattern, yield of crops, agricultural inputs etc. reveals different dimensions of agriculture.

Leh District is one such area where nature presents highly hostile environment in terms of rugged terrain and cold arid climate. Degree of nature's harshness also varies within the region. People living therein do not have a same response in facing this harshness. Thus, human beings traditionally adapted themselves to the requirements of nature by becoming pastoral nomads or by carrying out subsistence farming (Harjit Singh, 1981).

Agriculture has been the mainstay of people of Leh district. However, agricultural land is a scarce. But it is a fundamental resource in the subsistence economy, along with some pastoral activities. For centuries, utilization of land for agriculture was the main economic occupation which sustained livelihood of local people. However, due to population growth, change in occupation of people, use of land for agriculture has also started to change (Deputy Commissioner Office, Leh). Various socio-economic factors have also brought significant changes in the traditional land use system. Environmental factors restrict the possibilities of bringing new land under farming resulting in the emergence of non-farm activities. Non-farm activities have risen significantly in recent decades due to various economic, technological and strategic factors in Ladakh. Forms of non-farm employment seen in recent decades are related to army, tourism, government jobs and paid labour works. But, agriculture and animal husbandry still continue to provide basic needs of households to survive. Thus, an attempt has been made to understand different features of agriculture in terms of land-use, land holdings, cropping pattern, cropping intensity, yield of major crops and agricultural inputs.

II. MAIN OBJECTIVES

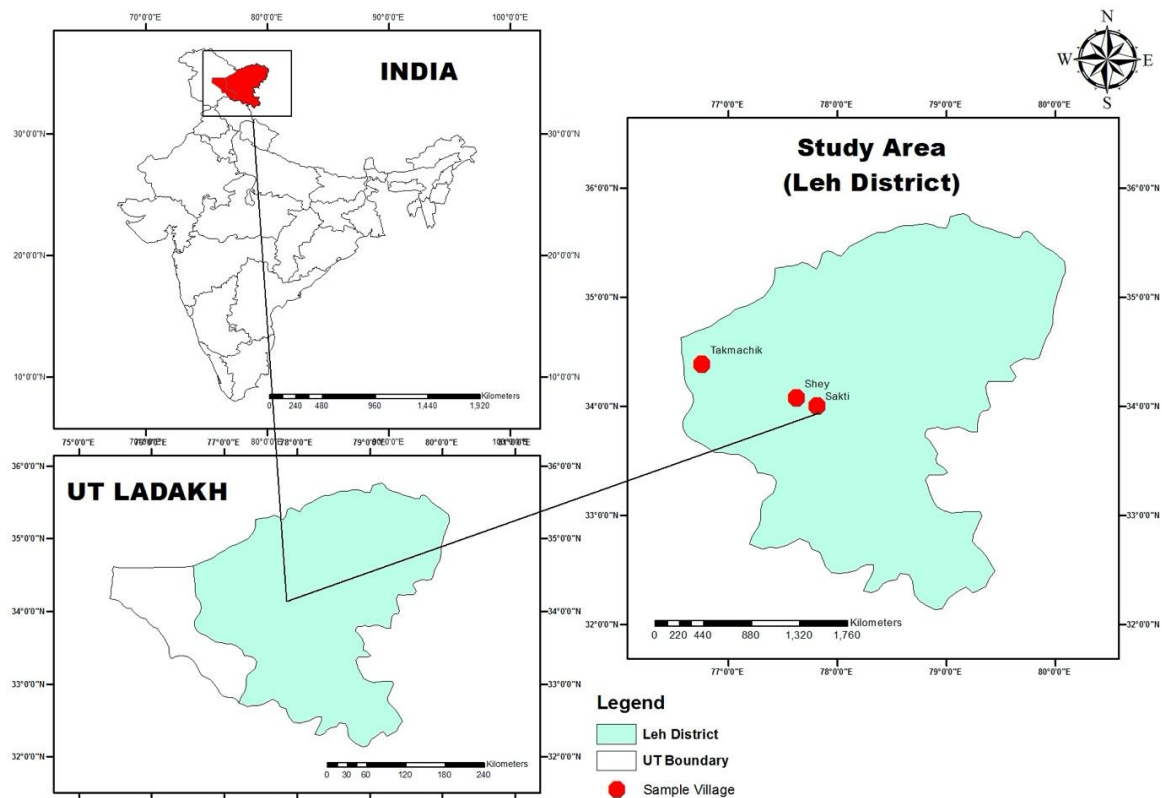
1. To examine the spatial and temporal aspects of land-use pattern and factors which affect changes in it.
2. To analyse spatial variations and temporal changes in cropping pattern and land use during 1996-2011 in Leh District and temporal changes of land use and spatial variations in cropping pattern.

III. STUDY AREA

Leh district lying among the high altitude, remote and inaccessible parts of India, is situated between 32°15' to 6 N Latitude and 75 15' E to 80 E Longitude. It covers an area of 45,110 square kilometres which probably makes it the second largest district in the country in terms of area. It is one of the coldest and most elevated inhabited regions of the world having 112 inhabited villages and one uninhabited village with an altitude ranging from 2,900 to 5,900 metres above mean sea level. Density of population in Leh district was 3 persons per square kilometre in 2011. The district is located in the Eastern portion on Union Territory of Ladakh, bordered by Chinese Sinkiang in the north, Tibet in the East and Lahul Spiti area of Himachal Pradesh in the south, along with the other district of the UT Ladakh Kargil. Leh district forms the northern tip of India.

Since the region lies in the rain shadow, it is one of the driest places of India. Under these harsh conditions agriculture is a difficult and challenging task. Only 0.12 per cent of the total geographical area is under cultivation (Statistical Handbook, Leh District, 2010-11). The district has three major physiographic divisions namely mountain ranges, river valleys and plateau. The region falls in the rain shadow area of the great Himalayan range. Therefore, very low precipitation of around 10 cm is received. The region receives a deficit amount of rainfall which is unevenly distributed.

Leh experiences arid to semi-arid climate and it puts fairly strict limitations on activities in which water is an essential factor. Most decisive factor is rainfall and its spatial distribution is fairly heterogeneous. However, scarcity of rainfall is the norm in the areas where agriculture is possible. There are marked differences in the valleys and uplands in Ladakh. Agriculture is mainly confined to the 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 (Anurudh K. Singh, 2009). Barley is the main crop covering two-thirds of cultivated land. Wheat and buckwheat are other important crops. Vegetables like peas, potato, tomato, cabbage are also grown in lower parts of Ladakh. Villages in upper mountains are rich in livestock where sheep, goats, yaks, cows, dzos, donkeys and horses are reared. These play an important role in providing manure, fuel, transport, labour, wool, milk, meat and hides.



Map 1: Study Area, Leh District

IV. DATABASE AND METHODOLOGY

Data for the present study was obtained from both primary as well as secondary sources. Information about household composition, livestock numbers and cultivated area was collected through primary survey by choosing 20 households from each three sample villages. Empirical evidences have been obtained from following three selected villages:

1. Takmachik
2. Shey
3. Sakti

Secondary data was obtained from District Census Handbook Book Leh District, 2009, 2010 and 2011.

Both qualitative and quantitative methods have been used for the analysis. A combination of statistical and cartographic techniques was primarily used in the analysis. Percentages, ratios and averages were computed. Bar and pie diagrams have been used to show data of land use and cropping pattern. Lorenz curves were drawn to show the inequality in the distribution of land holdings. Gini-coefficient was calculated with the help of following formula:

Gini-Coefficient

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

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.

Primary survey was conducted of three villages to have information of agriculture in Leh district. For this, sampling method has been drawn to collect statistical information regarding population, livestock and agricultural conditions. Primary data was collected with the help of a questionnaire. Three villages from higher, middle and lower altitude zones were surveyed by selecting twenty households from each village. Households were selected on the basis of availability of respondent.

The selected villages were three zones demarcated on the basis of altitude (Table 1). It was done to highlight differences in villages across altitudinal zones. Therefore, one village from each zone was taken for the sample.

Table 1
DETAILS OF SAMPLE (SURVEYED) VILLAGES

Sr. No.	Altitudinal zones (heights in metres)	Number of surveyed villages	Name and number of households
1	Higher Above 3800	1	Sakti (20)
2	Middle 3000–3800	1	Shey (20)
3	Lower Below 3,000	1	Takmachik (20)
Total	All Zones	3	

V. RESULTS AND DISCUSSION

Land Use Pattern:

Land is the fundamental means of production in an agrarian society without which no agricultural production can take place (Vikas Rawat, 2008). Availability of land for agriculture is an important factor in high altitude regions. In mountainous regions like Leh district where land for agriculture is extremely limited, preserving, protecting and enhancing such land becomes vital. Limitations to use fertile land due to lack of irrigation, have resulted in small landholdings scattered on undulating terrain that make mechanization a difficult task, "about 52.57 per cent of the reporting area is either barren or uncultivable due to various location-related reasons" (Statistical Handbook, 2009-10). These small holdings are further fragmented because of increasing nuclear families. Sometimes these small holdings can be used just for growing vegetables. In terms of economic determinants of agriculture, "viability of any enterprise including farming is determined by profit that depends on cost of structure (Vladimiro Pellicciardi, 2007). Thus, it is important to study the distribution of agricultural land of Leh District to highlight the socio-economic dimensions as well as environmental constraints therein.

As discussed earlier, high altitude region of Leh District is characterised by arid and semi-arid extremely cold climate and undulating topography. It can be noticed from the table 4.1 that forest cover is absent in the area and huge part of land is barren and uncultivated, which suggests strong environmental impact on the growth of vegetation. Scarcity of cultivable land due to harsh environmental factors is reflected in small proportion of land available for cultivation which has marginally declined over the last few decades. There is an increase in the area sown more than once which seems a positive change despite harsh environmental conditions of the region. As discussed earlier, harsh 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-zonal variations. It is only in lower areas with altitude of less than 3,000 metres that allow cultivation of two crops in an agricultural season. Most agricultural fields are small and fragmented. Soil is relatively more fertile in lower areas, while it becomes skeletal in nature with increasing altitude.

Table 2
LAND UTILISATION IN LEH DISTRICT: 2001-11 (Hectares)

Land-Use Category	Year				Change 2001-02 to 2010-11
	2001-02	2004-05	2007-08	2010-11	
Reporting Area*	45167 (100)	51193 (100)	51359 (100)	51684 (100)	+6517 (+14.43)
Forest Area	-	-	-	-	-
Land put to non-agricultural uses	2908 (6.44)	7004 (13.68)	7066 (13.76)	7073 (13.68)	+4165 (+143.22)
Barren and Uncultivable land	25163 (55.71)	26509 (51.78)	26590 (51.77)	27169 (52.57)	+2006 (+7.97)
Permanent pastures and other grazing lands	1092 (2.42)	983 (1.92)	1058 (2.06)	-	-
Land under misc. tree crops, grooves not included in net area sown	1148 (2.54)	1664 (2.27)	2621 (5.10)	2621 (5.07)	+1473 (+128.31)
Cultivable Waste	4406 (9.75)	4466 (8.72)	4468 (8.70)	4498 (8.70)	+92 (+2.09)
Fallow other than Current Fallows	116 (0.26)	63 (0.12)	60 (0.14)	59 (0.11)	-57 (-49.14)
Current Fallows	118 (0.26)	387 (0.75)	361 (0.70)	358 (1.13)	+240 (+203.39)
Net Area Sown	10210 (22.60)	10117 (19.76)	10193 (19.85)	10197 (19.73)	-13 (-0.13)
Area Sown more than once	313 (0.69)	311 (0.61)	406 (0.79)	1495 (2.90)	+1182 (+377.64)
Total Cropped Area	10523 (23.29)	10428 (20.37)	10599 (20.64)	11692 (22.62)	+1169 (+11.11)

Source: Deputy Commissioner Office, Leh

Note: Figures in brackets denote percentage.

Note*: Reporting area stands for the area for which data on land use classification of area are 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 is lying outside village boundaries which are not included in village records.

Table 2 and Figure 1 reveal largest proportion (55.71 per cent) of total reporting area under the category of barren and uncultivable in 2001-02. Land under cultivation was only 23.29 per cent of the total reporting area in 2001-02. Area sown for more than once covered merely 0.69 per cent of the total reporting area. This reflects the impact of harsh environment on area under cultivation in Leh district. No land under forest shows scarce vegetation cover due to these harsh conditions. Only 9.75 per cent of total reporting area was under cultivable wastes, most such lands could be utilized for agriculture. But lack of water for irrigation is the main problem. A small proportion of 6.44 per cent of total reporting area was under land put to non-agricultural use. Remaining proportion of 5.48 per cent of total reporting area was under other categories like permanent pastures and other grazing lands, land under miscellaneous trees crops and grooves not included in net area sown, fallow other than

current fallows and lastly fallow lands etc. Largest increase by 4165 hectares accounting for 143.22 per cent occurred in area under land put to non-agricultural uses. It became 13.68 per cent from 6.44 per cent of the total reporting areaduring 2001-02 to 2010-11. It is due to establishment of various infrastructural facilities such as roads and buildings etc. in the region. Area under miscellaneous tree crops and grooves increased by 1473 hectares and became 5.07 per cent from 2.54 cent of reporting area during 2001-02 to 2010-11. It highlights steps taken by mountain communities to create man-made vegetation belt where the undulating land unsuitable for cultivation is being used for tree plantations (Harjit Singh, 1978).

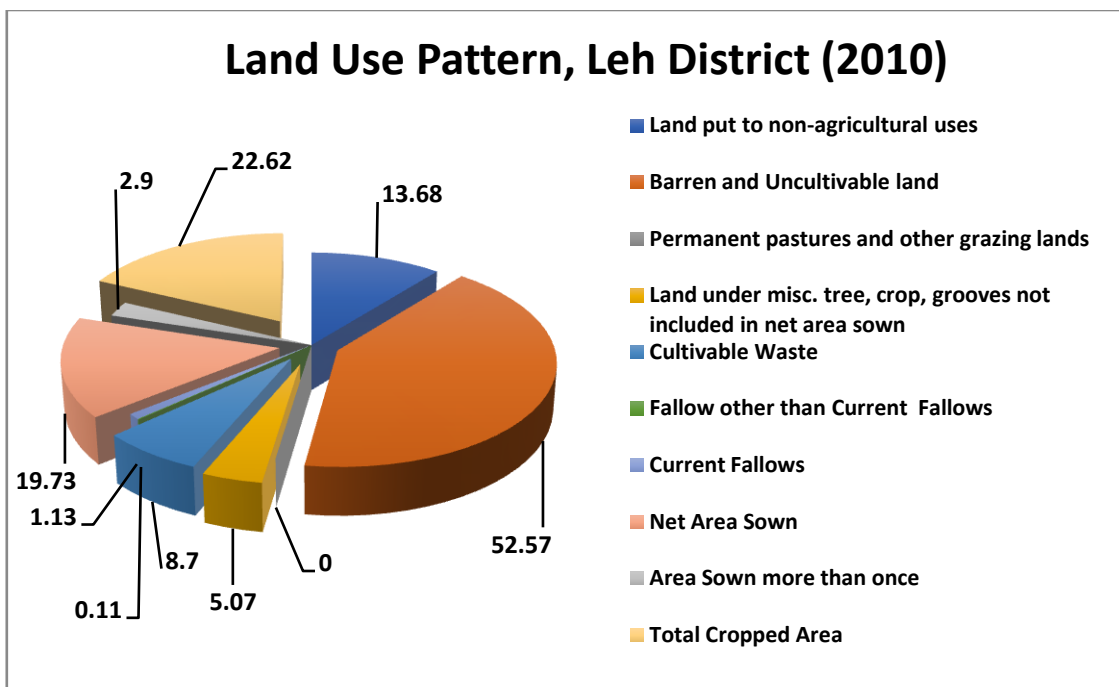


Figure 1: Land use pattern in Leh District, 2010.

On the contrary, total cropped area increased by 11.11 per cent during 2001 to 2011. This was in spite of decline in net sown area by 13 hectares. It can be accounted by increase of 1182 hectares in area sown more than once. Decline of -49.14 per cent was registered in area underfallow other than current fallows. It could be due to increasing irrigation amenities and expansion of area under tree plantations. After comparing figures for 2001-02 and 2010-11, it can be noted that an induction of an additional 6,517 hectares of land, which accounts for an increase of about 14.43 per cent has been added to the total reporting area. It has led to an increase in all categories of land except fallow other than current fallows and net area sown. The main reason could be due to shift of area under fallow other than current fallows to land put to non-agricultural uses and under plantations. Net sown area has decline merely by -0.13 per cent during the same period. It could be due to an increase in the area under current fallows, which accounts for an increase of 203.39 per cent.

Table 3
LAND USE IN SURVEYED VILLAGES OF LEH DISTRICT: 1971-2001(Hectares)

Higher Zone/Sakti Village			
Land-Use Category	Year		% Change
	1971	2001	1971-2001
Reporting Area	671.1 (100.00)	679.1 (100.00)	1.19
Land put Non-Agricultural Uses	3.1 (0.46)	5.7 (0.84)	83.87
Barren and Uncultivated Land	320.3 (47.73)	323.3 (47.61)	0.94
Cultivable Waste	67.7 (10.1)	65.2 (9.60)	-3.69
Net Area Sown	280 (41.72)	284.9 (41.95)	1.75
Middle Zone/Shey Village			
Reporting Area	620.9 (100.00)	647.1 (100.00)	4.22
Land put to Non- Agricultural Uses	6.4 (1.03)	22.2 (3.43)	246.88
Barren and Uncultivated Land	203.2 (32.73)	214.5 (33.15)	5.56
Cultivable Waste	225.3 (36.29)	233.1 (36.02)	3.46
Net Area Sown	186 (29.96)	177.3 (27.40)	-4.68
Lower Zone/Takmachik Village			
Reporting Area	127.9 (100.00)	129.1(100.00)	0.94
Land put to Non-Agricultural Uses	5.4 (4.22)	12.9 (9.98)	138.89
Barren and Uncultivated Land	44.2 (34.56)	55.1 (42.68)	24.94
Cultivable Waste	11.6 (9.07)	13.3 (10.30)	14.66
Net Area Sown	62.5 (48.87)	50.1 (38.81)	-19.84

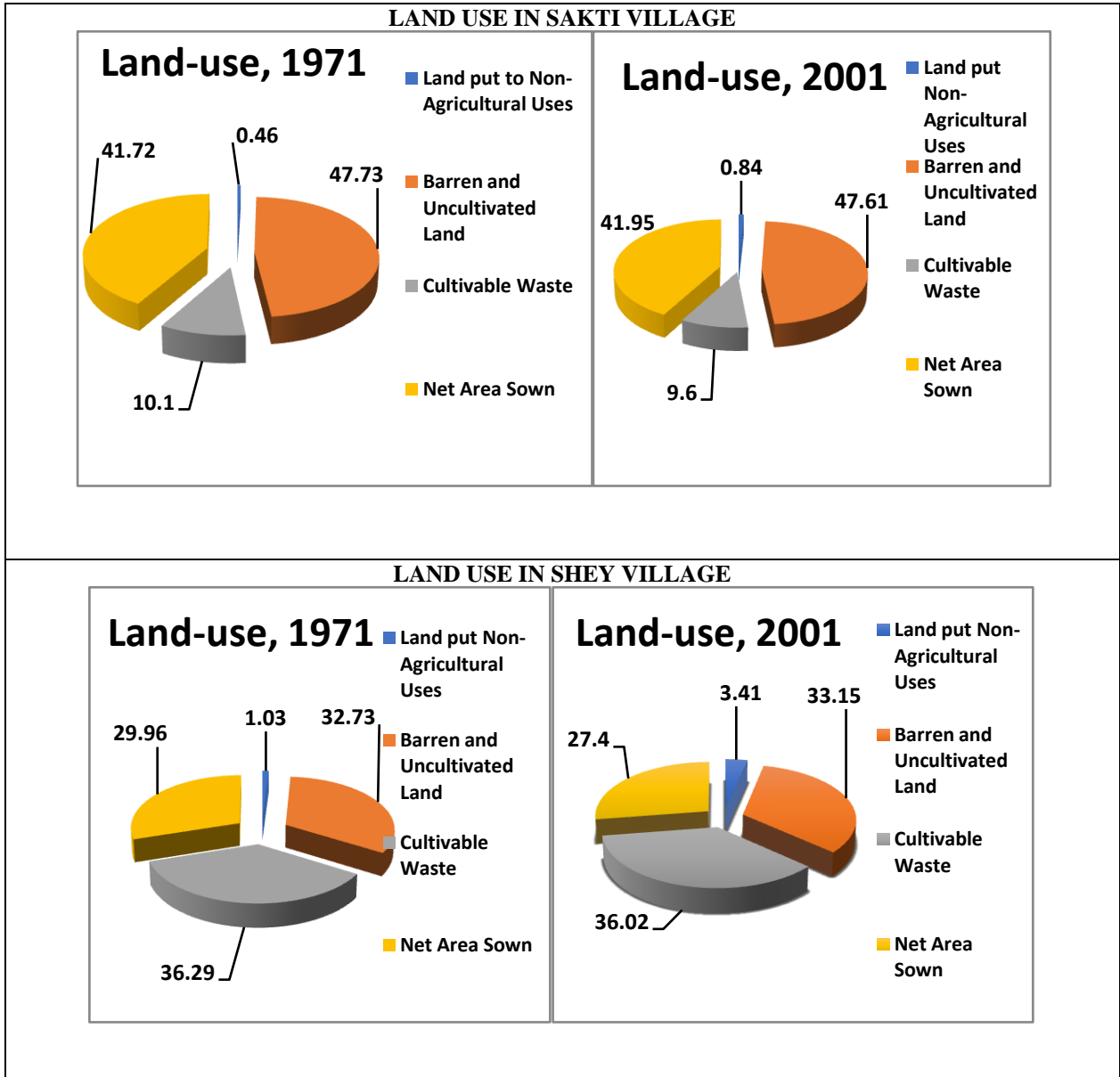
Source: Computed from Census of India, 1971-2001 and Patwari Records.

Table 4 and Figure 2 reveal that the largest proportion of 47.73 per cent of total reporting area was under barren and uncultivated land in Sakti village. It was followed by net sown area accounting for 41.72 per cent in which increased to 41.95 per cent in 2001 in the village. The marginal addition of 4.9 hectares may be due to decline in the area under cultivable waste which accounted for 10.1 per cent in 1971 and became 9.60 per cent in 2001. But land under this category came down by 2-5 hectares only. It means some new land was reclaimed as is clear from some increase in total reporting area between 1971 and 2001. Area under land put to non-agricultural uses also increased from 0.46 per cent in 1971 to 0.84 per cent in 2001. Barren and uncultivated marginally increased during the same time period. Area under forest and current fallow was nil in the village in 1971 and 2001. Area under barren and uncultivated was very high. It reflects the limited agricultural land due to rugged topography in their high altitude village. Net sown area accounted for below half of the total reporting area. It shows environmental impact on agriculture in higher zone villages of Leh district.

Area under cultivable waste was covered with proportion of 36.29 per cent in 1971 and increased by 3.46 per cent in Shey village. Area under barren and uncultivated land accounted for 32.73 per cent to the total reporting area. It rose to 36.02 per cent in 2001. Next largest category was of 29.96 per cent land under net sown area. It shows a decline of 4.68 per cent. Land put to non-agricultural uses was 1.03 per cent in 1971 and became 3.43 per cent in 2001. Area falling under cultivable waste in 2001 was very high in Shey village. The decline in net sown area may be attributed to shift in agricultural land from net sown area to land put to non-agricultural uses. This village is close to Leh town and many tourism related activities have come up in Shey village.

Largest proportion of 48.87 per cent area was under net sown area in 1971 followed by barren and uncultivated land accounting for 34.56 per cent in Takmachik village. It is expected as it has lower altitude an land is more suitable for cultivation. Area under net sown declined to 38.81 per cent whereas area under barren and uncultivated increased to 42.68 per cent. The area under cultivable waste also registered change from 9.07

per cent in 1971 to 10.30 per cent in 2001. Land put to non-agricultural uses covered a substantial area of total reporting area due to development of many facilities. Largest proportion of area under net sown area shows the importance of agriculture in the lower zone village. It may be due to relatively favourable climate which support longer agricultural season in this village. The reason for shift in area from net sown area to land put to non-agricultural uses may be due to increase in land put under horticulture, increasing population, construction of roads and new buildings.



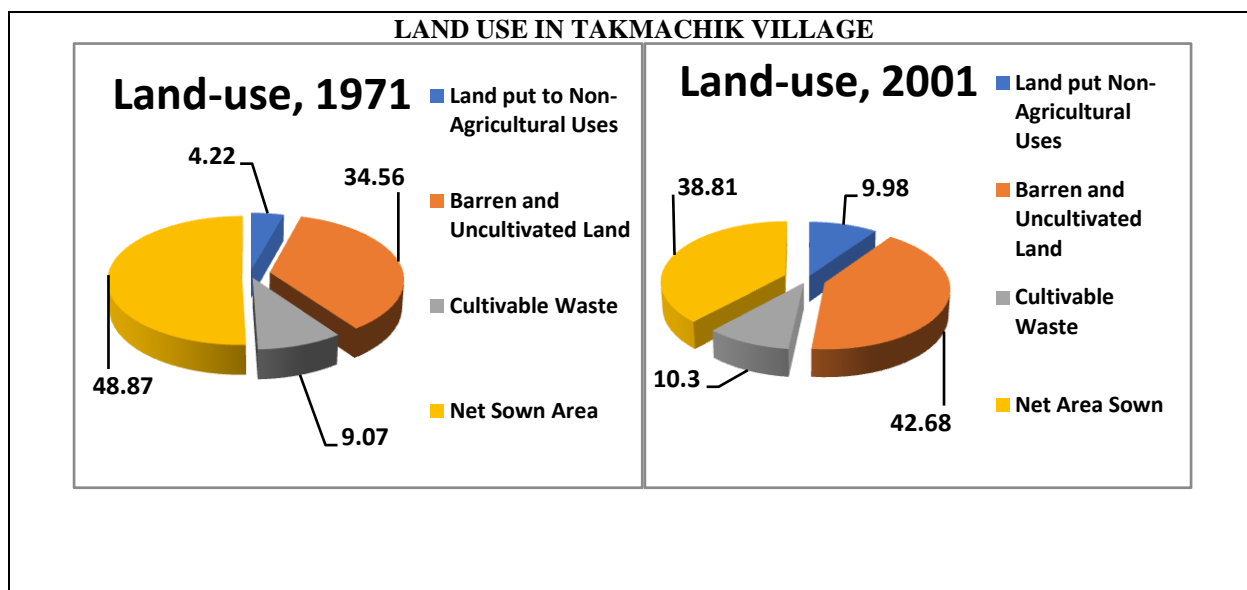


Figure 2: Land use pattern in sample (surveyed) villages

It shows that largest proportion of land under net sown area was seen in Takmachik village, followed by Sakti and Shey villages in 1971. This is mainly due to the fact that lower zone villages have more land under cultivation due to relatively fertile soil and warmer climate. But there is decline in the net sown area in Takmachik and Shey villages in 2001. Decline in this category may be attributed to increase in land put non-agricultural uses due to population explosion, construction of houses, roads etc. Such changes are more pronounced in Shey village due to proximity to Leh town which pull people from agriculture to non-agricultural activities like tourism and other government services. The area under barren and uncultivated land shows high proportion of reporting area in all villages which itself shows the limited agricultural land due to rugged topography. Sakti village being situated in the higher zone has large proportion of cultivable waste. Shey village is close to main town, Sakti village has relatively harsh environmental conditions restricting agricultural activities. This is due to the altitude and access to market, which are closely related in their impacts on the land-use systems (Nigel J R. Allan, 1986).

Distribution and size of land holdings:

Being one of the most inaccessible parts of Himalayan region, Leh District has very limited land resources for cultivation as most of its area is barren and uncultivated due to rugged topography and unfavourable climatic conditions. Moreover, land holdings are small with majority of holding being below 0.5 hectares (Agricultural Census, Ministry of Agriculture, 1995-96). Topographical conditions of the region have resulted mainly in terraced farming in Leh district. Therefore, one rarely finds a large continuous tract of cultivable land (Harjit Singh, 1978). Earlier monasteries owned large land holdings and used to employ community labour. Increasingly lot of land has been put under roads, schools and primary health centres. Land has also been fragmented increasingly due to various social factors such as families as against earlier joint families based on polyandry.

It can be seen from table 4 that most of the land holdings are 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 holdings. There were only a few holdings larger than 7.5 hectares in the district. On the other hand, land holdings above 20 hectares constituted merely 0.27 per cent. These are the holdings 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 2005-06. Proportion of marginal holdings of less than one hectare has become larger accounted for 77.89 per cent in 2005-06. It shows that land holdings are getting fragmented in the region. Reasons are mainly related to the physical factors and fragmentation of families into nuclear families, monasteries giving up on large land holdings, and many other factors. The average size of land holdings has also come down to 0.67 hectares.

Table 4
LAND HOLDINGS ACCORDING TO DIFFERENT SIZE CLASSES, LEH DISTRICT: 1995-2005
(Hectares)

Year	1995-96		2005-06	
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	60.77	16.83
0.5 – 1.0	10.16	11.14	17.12	17.27
1.0 – 2.0	20.21	19.99	14.3	27.86
2.0 – 3.0	9.92	16.99	4.95	16.47
3.0 – 4.0	4.86	11.63	1.55	7.42
4.0 – 5.0	2.30	7.60	0.54	3.41
5.0 – 7.5	1.90	8.56	0.44	3.7
7.5 – 10.0	0.69	4.70	0.14	1.81
10.0 – 20.0	0.27	2.60	0.11	2
20.0 & above	0.27	8.89	0.08	3.22
Total	100.00	100.00	100.00	100.00

Source: Calculated from Agricultural Census, 1995-96 and 2005-06.

In order to find out inequalities in distribution of land holdings, Lorenz curves have been drawn and Gini-coefficients were calculated. Value of Gini-coefficient was found to be 0.577 in 1995-96 and it declined to 0.554 in 2005-06. It shows that inequalities in the distribution of land holdings have decreased in Leh District. Being a Buddhist majority district, a large number of monasteries are there in the region. Traditionally, these monasteries owned large lands, which were cultivated by villagers. It was the rule of inheritance that households and estates passed entirely from generation to generation in the region. Polyandry and primogeniture were there which avoided fragmentation of land holdings. But later, polyandry and primogeniture were abolished in 1941 by the State Government, and simultaneously the take of monastic life was reduced which allowed sub-division of land (Ramila Bisht, et al., (2008).

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 more pronounced in the last few decades.

Table 5
DISTRIBUTION AND SIZE OF LAND HOLDINGS IN SURVEYED VILLAGES, 2012

Size (Acres)	Zone/Village					
	Higher/Sakti		Middle/Shey		Lower/Takmachik	
	% 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	15	6	30	7	20	6
1 – 2	50	35	35	26	40	28
2 – 3	20	25	15	20	15	16
3 – 5	10	21	15	32	15	21
Above 5	5	13	5	14	10	29

Source: Field Survey, December 2012.

Table 5 shows that about 85 per cent of farmers in Sakti village were cultivating land measuring less than 3 acres. Similarly, 80 per cent of the total agricultural households in Shey village and 75 per cent in Takmachik village had land holdings of less than 3 acres. It can be observed from the table that small farmers owning less than 1 acre of land holdings accounted for 15 per cent in Sakti, 30 per cent in Shey, and 20 per cent in Takmachik village. On the other hand, large farmers owning land holdings more than 5 acres accounted for 5 per cent each in Sakti and Shey villages, while 10 per cent in Takmachik village. It can be seen from that higher village has smaller size of land holdings. Lower village has more land holdings above in the size of 5 acres. The value of the Gini-coefficient was found to be 0.409 for Shey and 0.350 for Takmachik and 0.294 for Sakti village (Figure 4.3). It shows that inequalities in the distribution of land holdings are more pronounced in Shey

village as compared to other two villages. It is mainly due to the fact that Shey was former capital of Ladakh and has large monastery which owns large portion of land.

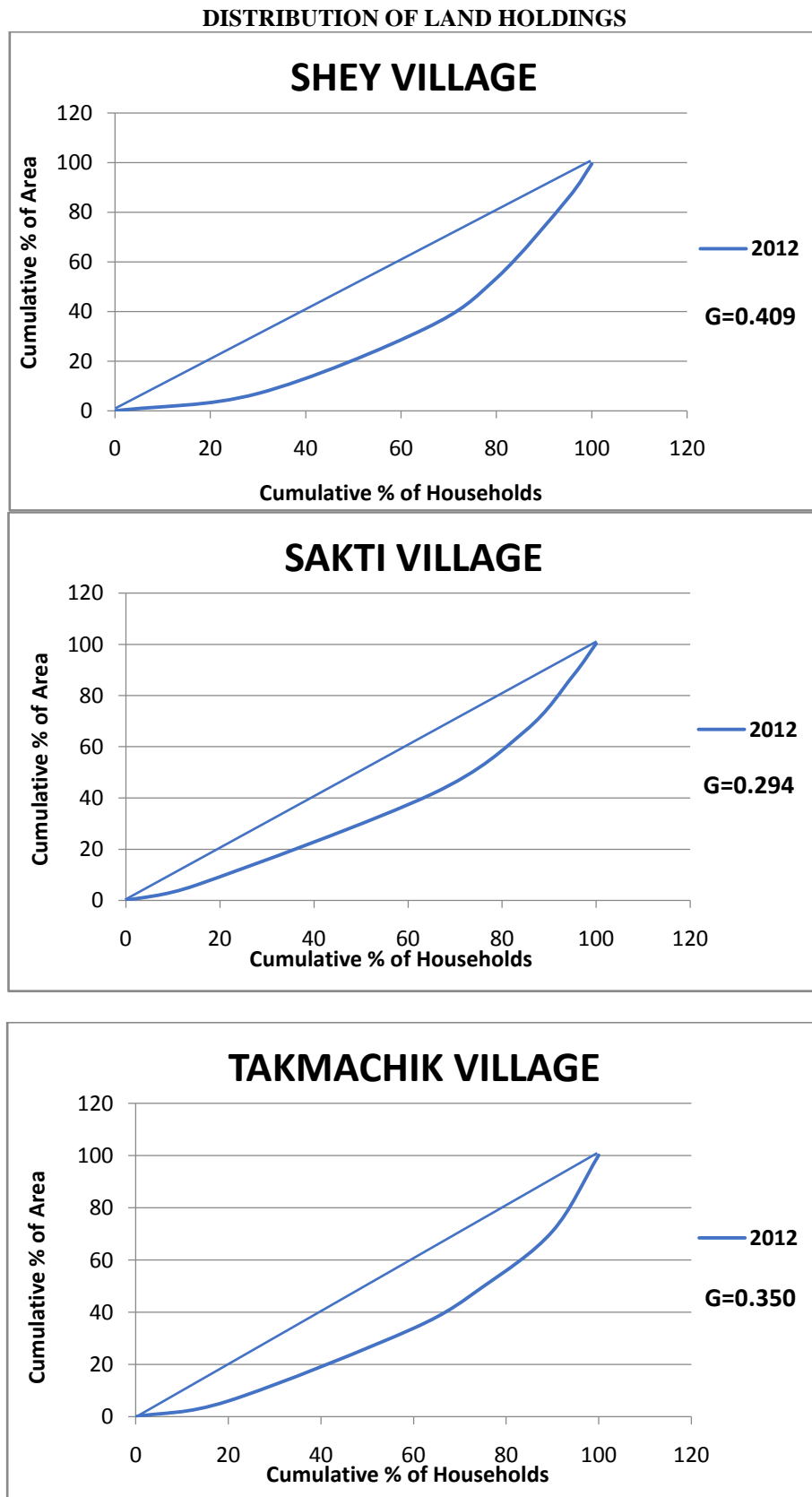


Figure 3: Distribution of land holdings in sample (surveyed) villages

Cropping pattern and changes therein:

Traditionally, agriculture has been the mainstay of people of Leh District. People have been growing different crops to survive in this terrain of harsh environment. High altitude, difficult terrain and harsh climate along with some socio-economic factors determine the choice of crops. Most important food crops grown are *barley* and *wheat*, several different local and adopted varieties of these are grown. *Barley* has a cultural and religious significance, not to mention its fundamental role in brewing of *chang*, local beer (A. Ripley, 1995). Other food crops include *buckwheat*, *some other millets* and *pulses*. Commercial vegetable crops like *potatoes*, *green peas*, *turnip*, *carrot*, *radish*, *cauliflower*, *onion* and *tomato* are also grown. Only one crop in a year is possible in most parts of the region. It is only in a few lower areas, where cultivation of two crops in an agricultural season is possible. Here *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 become important cash crop. These supplement income of farmers. 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 July in the lower zone villages only and harvested in September and October. *Mustard* is sown in the month of May and harvested in August. Apart from that, *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 a huge demand in the area where Army is located. *Potatoes* are sown in the months of April and May and reaped during September to October. It 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.

Table 6
AREA UNDER DIFFERENT CROPS, LEH DISTRICT: 1996-97 to 2010-11 (Hectares)

Crops	Area (Hectares)		% age of total cropped area		Change	
	1996-97	2010-11	1996-97	2010-11	Area	%
Years	1996-97	2010-11	1996-97	2010-11	1996-97 to 2010-11	
<i>Wheat</i>	3225	2579	32.90	26.91	-646	-20.03
<i>Barley</i>	3655	4421	37.29	46.12	+766	+20.96
<i>Other Millets</i>	294	-	3.00	-	-	-
<i>Pulses</i>	274	192	2.80	2.00	-82	-29.93
<i>Fruits</i>	80	131	0.82	1.37	+51	+63.75
<i>Vegetables</i>	212	229	2.16	2.39	+17	+8.02
<i>Oil seeds</i>	84	86	0.86	0.90	-2	-2.38
<i>Fodder</i>	1977	1947	20.17	20.31	-30	-1.52
Total	9801	9585	100	100		

Source: Computed from Deputy Commissioner Office, Leh

Table 6 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*, *oilseeds* and *fruits* covered small proportion of total cultivated area in 1996-97.

Significant changes in the area under different crops were seen during 1996-97 to 2010-11. *Barley* increased to 46.12 per cent of total cropped area. After *barley*, land under *wheat* had largest area accounting for 26.91 per cent. Area under cultivation of *wheat* declined by -20.03 per cent and became 26.91 per cent from 32.90 per cent during this period. It can be observed from the table that land under *fruits* grew by 63.75 per cent from 0.82 per cent to 1.37 per cent during 1996-97 to 2010-11. Area under *fodder* crop also came

down from 1977 hectares in 1996-97 to 1947 hectares in 2010-11. It may be due to the decreasing trend of livestock rearing.

The analysis shows that total area under cultivation has decreased in the past decade. Area under *wheat* crop seems to have declined in favour of *barley*. This is mainly due to easy availability of *wheat* in the market and introduction of government subsidised food ration distributed through Public Distribution System which ensured availability of fine wheat flour. These ‘external drivers’ are responsible for change in cropping pattern in the region (Dame and Mankelow, 2010). Beside these, development of science and new agricultural technology brought about changes in age old cropping pattern (Bhat and Shah, 2011). Area under *fruits* and *vegetables* cultivation has registered significant increase which shows growing importance of vegetables and horticultural 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. A wide variety of vegetables crops has been introduced in the region to meet the demand of army, tourists and local urban people.

Cropping pattern in a particular region is determined by physical factors such as fertility of soil, climate as well as socio-economic variables like land-tenancy, size of holdings, irrigation, distance from market, and availability of modern inputs (Majid Husain, 1982). However, in mountainous areas like Leh district, physical environment plays vital role in the decision making about crops to be sown by the farmers. Therefore, it requires analysis of cropping pattern and variations therein.

Cropping pattern in surveyed villages:

Traditionally, cultivation of food grains dominated the cropping pattern in surveyed villages of Leh district. *Barley*, *wheat* and green *peas* are the main crops of all villages in each zone depending upon altitude and weather conditions. There is only one cropping season in all the zone villages except for Takmachik village, where two crops are grown in a year because of its location at lower elevation. *Barley* is grown in almost all zones, whereas *wheat* is restricted to middle and lower zones due to its extreme climatic conditions and rugged terrain that does not favour its growth in higher zone villages. Cropping pattern of the region also is an indicator of land capacity and natural conditions. While *barley* continues to be the most important crop for people in villages, area under *wheat* has decreased considerably from 32.90 in 1996-97 to 26.91 in 2010-11 in Leh district.

Table 7
AREA UNDER DIFFERENT CROPS IN SURVEYED VILLAGES(2012-13)

Altitudinal Zone	Higher Zone/Sakti		Middle Zone/Shey		Lower Zone/Takmachik	
Crops	Area (Acres)	Percentage (%)	Area (Acres)	Percentage (%)	Area (Acres)	Percentage (%)
<i>Barley</i>	21.50	61.09	9.41	31.51	25.22	52.55
<i>Buckwheat</i>	-	-	-	-	8.05	16.77
<i>Wheat</i>	-	-	10.05	33.66	4.40	9.17
<i>Pulses/Peas</i>	0.31	2.10	0.30	1.01	3.19	6.65
<i>Mustard</i>	3.90	11.98	0.25	0.83	1.39	2.90
<i>Vegetables</i>	1.36	3.86	3.28	10.98	1.77	3.69
<i>Potatoes</i>	5.27	14.98	-	-	-	-
<i>Fodder(Alfalfa)</i>	2.42	6.88	6.57	22.01	3.97	8.27
Total	35.19	100.00	29.86	100.00	47.99	100.00

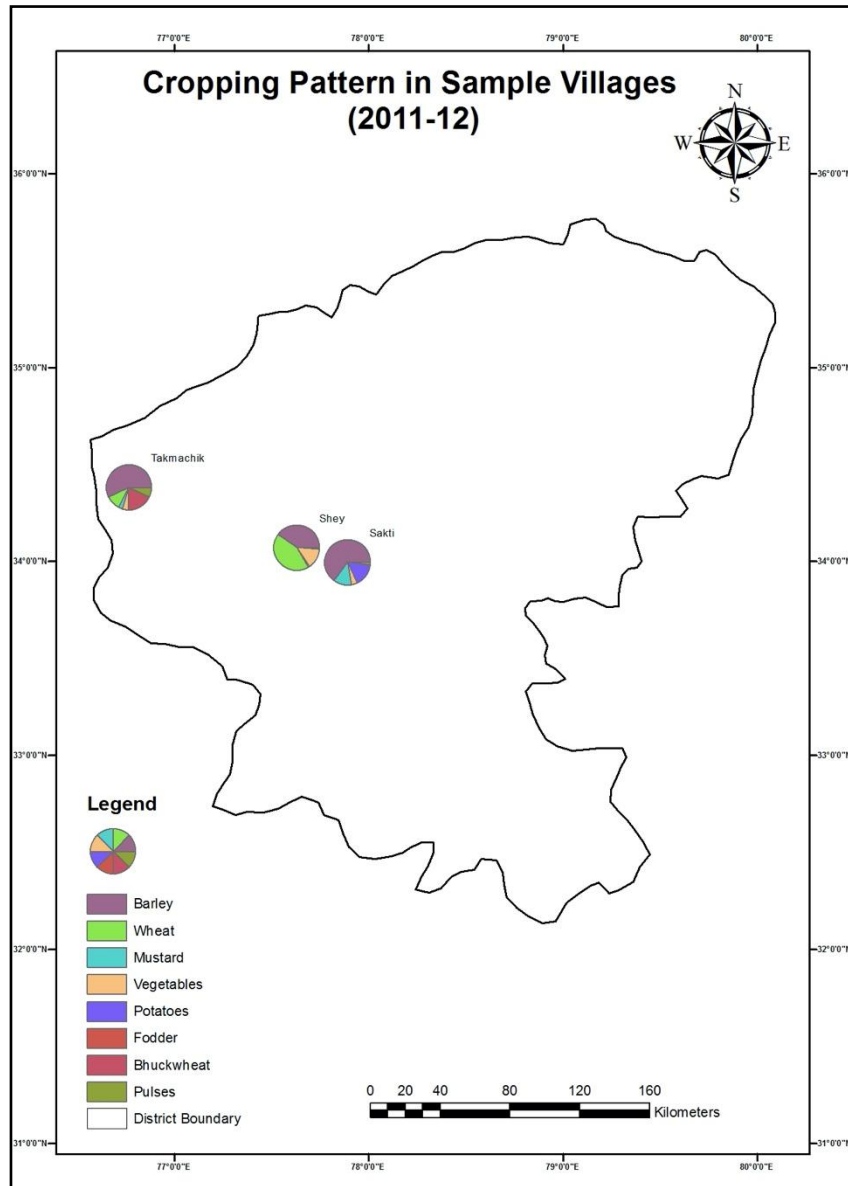
Source: Field Survey, December 2012. **Note:** 1 Acre is equal to 0.40 hectares.

Table 7, Map 2 and Figure 4 show that area under *barley* was 61.09 per cent, followed by *potatoes* with 14.98 per cent of total cropped area in higher zone. It shows the importance of *barley* as a staple crop in the villages of Leh district. It is also due to its unavailability in the market and its socio-cultural significance as a main ingredient of Ladakhi dishes and its usage during various occasions. Moreover, certain quantities of *barley* are required for the production of *chang*, an alcoholic beverage produced by every Buddhist household which is consumed and offered on many occasions. It reflects that *barley* can be grown at the highest altitude due to its short ripening period (C.Troll, 1939). However, its relatively low proportion of 31.51 per cent in the middle zone village could be due to changing food habits. Likewise, the area under *wheat* also varies from one zone to another. The largest proportion i.e. 33.66 per cent of cropped area is in middle zone village, followed by 9.17 per cent in lower zone village. Natural limitations on crop cultivation could have restricted cultivation of *wheat* in upper zone village. Moreover, its importance as a preferred crop for cultivation is coming down as wheat is

freely available in the market. *Wheat* is also distributed by the Government through Public Distribution System (PDS) at very cheap rates.

Buckwheat is grown in lower zone as a second crop after *barley*. It constitutes 16.77 per cent area in lower zone village and it is not sown in other zones due to natural constraints. Growth of *pulses*, promoted due to favourable climatic conditions, is highest in lower zone but limited in upper and middle zones. Even though *mustard* is the main oil seed crop of Ladakh, very low yielding variety of it is grown (Nirmala Bora, 2004). But, *mustard* is grown in all zones which accounted for 11.98 per cent in Sakti village, followed by 2.90 per cent in Shey village and 0.83 per cent of total cropped area in Takmachik village.

Highest proportion i.e. 10.98 per cent of total cropped area under vegetables was in Shey village. The main reasons for this seem to be favourable environmental conditions as well as cash earning opportunities for village people because of proximity to Leh town. Middle zone villagers sell *vegetables* mainly in nearby areas where there is high demand for vegetables like in government housing colonies and hotels which have come up in large number in Choglamsar and Leh town. *Vegetables* sold by farmers of Shey village face competition from other middle zone villages. Main *vegetables* grown in this village are *cabbage, cauliflower, carrot, turnip, onion, tomato* and *potatoes*. On the contrary, area under *vegetables* to total cropped area in Sakti village and Takmachik village was 3.83 per cent and 3.69 per cent respectively. It is mainly due to long distance from Leh market. *Green peas* covered 6.65 per cent of total cropped land. It has been observed during household survey that peas are sold to Kashmiri buyers and to army through Cooperative Society.



Map 2: Cropping Pattern in Sample villages in Leh District

Similarly, area under *potatoes* constituted 14.85 per cent of total cropped area in upper zone village. This is mainly due to a huge demand in army settlements in nearby areas. *Fodder* is other major crop in the villages of Leh district. Particularly *alfalfa* is grown in almost all the zones. It occupied highest proportion of 22.01 per cent area to total cropped area in middle zone village, followed by 8.27 per cent and 6.88 per area in lower zone village and upper zone village respectively. It is mainly used to feed livestock in winter months when natural pasture is not available.

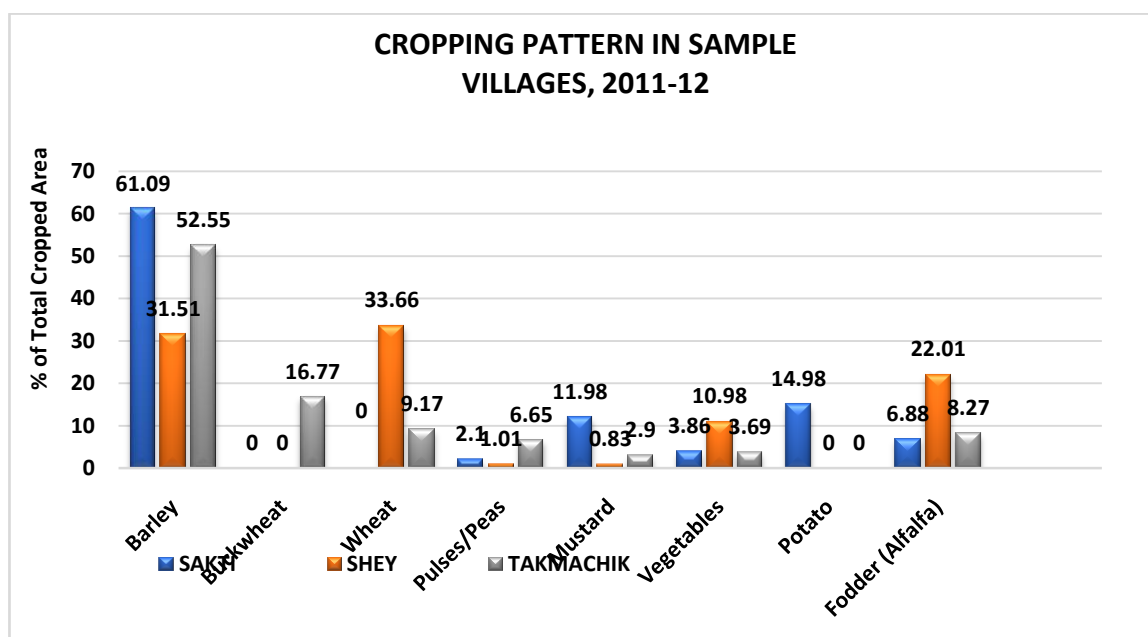


Figure 4: Cropping pattern in sample (surveyed) villages

It can be observed from above discussion that food crops dominate lower and higher zone villages. It could be due to comparative isolation and longer distance from urban centre. On the other hand, commercial crops are replacing traditional crops in middle zone village because of growing demand by tourists and urban people. It was observed in the surveyed villages that importance of traditional crops is declining since last few decades. It is mainly due to economic benefits of cash crops as well as lower economic value of traditional crops. However, rugged topography and harsh climatic conditions continue to pose serious constraints in diversification of crops in the district. It is only in recent years that cash crops preferred by farmers can help them in earning money. Crops like *potatoes*, *vegetables* and *fruits* are grown by farmers in villages of Leh district. However, diversification of crops seems to be more pronounced in villages situated near places of tourist interest, army camps and urban area. These provide huge market facilities. It has been also observed that number of crops grown and altitude have negative relation. It means that number of crops decreases with increasing altitude due to skeletal soil and harsher climate.

Cropping Intensity:

Production of crop can be increased in two ways either expanding the net area under cultivation or intensifying cropping over the existing area. But, it is not very functional in cold desert area like Leh district due to short growing season. Therefore, most of the area is single cropped. However, some areas particularly the lower valley is double cropped area.

Table 8
CROPPING INTENSITY IN TAKMACHIK VILLAGE (ACRES)

Farm Size	Net Sown Area	Total Cropped Area	Cropping Intensity	No. of Farmers
Small	13.76 (29.44)	15.99 (29.19)	116.22	11 (55)
Medium	19.33 (41.38)	22.93(41.86)	118.59	7 (35)
Large	13.63(29.18)	15.86 (28.96)	116.36	2 (10)
Sub-Total	46.72 (100.00)	54.77(100.00)	117.24	20 (100)

Source: Field Survey, December, 2012.

Note: Area sown more than once is found only in lower zone village of Takmachik. Therefore, cropping intensity has been calculated for this village only.

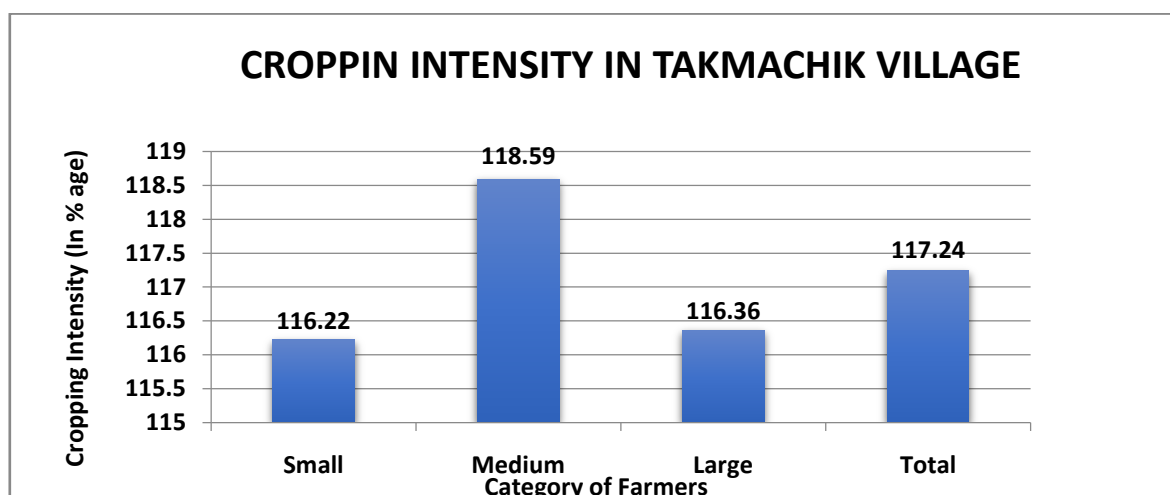


Figure 5: Cropping Intensity in Takmachik Village

Table 8 and Figure 5 show that only one out of three surveyed villages has double cropped area. Cropping intensity has been recorded highest proportion i.e. 118.59 per cent in case of medium farmers, followed by large farmers with a percentage of 116.36. Lowest cropping intensity was found to be 116.22 per cent among small farmers. Though the variations among these categories are not much but it could be that medium farmers can afford more labour.

Area and Yield of Major Crops:

Yield of crop determines the agricultural potential of a region. It is more in plain area with favourable environment. But, increasing crop productivity is a challenging task in a hostile environment of Leh district. However, yield of some crop is quite good despite of these constrains.

Table 9
AREA AND YIELD OF MAJOR CROPS IN SURVEYED VILLAGES (Quintals/Acre)

Higher Zone/Sakti						
Crops	Barley	Mustard	Potato	Fodder		
Area	22.12	4.09	5.45	3.16		
Yield	7.84	58.8	47.28	18.8		
Middle Zone/Shey						
Crops	Barley	Wheat	Potato	Fodder		
Area	7.75	28.06	2.73	9.91		
Yield	14.48	9.68	57.84	19.44		
Lower Zone/Takmachik						
Crops	Barley	Wheat	Buckwheat	Mustard	Green Peas	Fodder
Area	21.31	4.46	8.05	1.80	2.23	3.97
Yield	15.76	13.28	6.32	57.92	34.8	20

Source: Field Survey, December, 2012.

Note: Yield of Mustard is in litres oil per *acre*. 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 doubted. However, the data provide a rough comparative picture across zones.

Table 9 reveals that crop yields vary from one village to another depending upon the nature of physical environment on the one hand and socio-economic factors on the other. It highlights that yield of *barley* is 15.76 quintals per *acre* in the lower zone village, followed by 14.48 quintals per *acre* in the middle zone village. On the other hand, it was 7.84 quintals per *acre* in upper zone village. It shows the degree of environmental constraints on the yield of crops. Average yield of *potato* was found to be 57.84 quintals per *acre* in middle zone followed by 47.28 quintals per *acre* in higher zone. This crop is main cash crop of the farmers of higher and middle zone villages. It is grown by most of the farmers in the Leh district which shows adaptability of this crop in such an environment.

Wheat is not grown in higher zone due to its longer germination period. The average yield of this crop in lower and middle zone was found to be 13.28 and 9.68 quintals per *acre* respectively. As discussed earlier, area under *wheat* has gone down significantly throughout region since last few decades. Average yield of buckwheat was found to be 6.32 quintals per *acre* in lower zone whereas it is not grown in the other zones. Area under this crop also has gone down recently due to change in food habits. Next crop of commercial importance is *green peas* which had yield of 34.8 quintals per *acre* in lower zone. Yield of different crops shows positive relation with decreasing altitude. It means that yield decreases with increasing altitude due to skeletal soil cover and very low temperature.

VI. CONCLUSION

To conclude, land use and cropping pattern reflects human-nature interaction conditioned by socio-economic factors like economic value of the crop, fragmentation of joint families and declining monastic role in agricultural activities of villages. It has been noticed that area under land put to non-agricultural use has increased substantially. This probably is the reason for decline in net sown area in last decade. Land has been fragmented in all surveyed villages due to increasing nuclear families, abolition of polyandry, declining role of monasteries resulting in further division of already existing uneconomical land holdings.

Cropping pattern shows similar human response. Crops are grown according to natural viability and according to socio-economic concerns. While barley is still the main stable crop, production of wheat is decreasing due to Public Distribution System. Similar is the case of productivity or yield of the crops. While productivity is better in lower zone village of Takmachik, it decreases as we move upwards to middle zone and upper zone villages. Irrigation has and remained important in the lives of people of Ladakh in general and Leh district in particular despite changing lifestyles and livelihood of the people. Water for irrigation depends solely on glacial and snow-fed sources which are channelized through Khuls to agricultural fields. Concern over shrinking glaciers is important.

Farm inputs in agriculture reflect low level of technological development because of its non-feasibility due to difficult terrain as well as due to low economic power as well as social customs of the people. Surveyed villages, therefore, reflected human- nature interaction: - modification of nature as much as possible and adaptation to it using their own ways.

Acknowledgement

The authors are thankful to *Patawaris*, Government officials, NGO workers, Deputy Commissioner Office, and villagers for their cooperation and assistance extended in carrying out the research work in the sample villages of Leh district in Ladakh.

References:

- [1]. Aima A. (1986), "Farm Economy of Cold Desert Regions: A Case Study of Leh, Ladakh", *Indian Journal of Economics*, Vol. 65, Part – 3, No – 263, pp223-28.
- [2]. Angchok and Singh. (2006), "Traditional Irrigation and Water Distribution System in Ladakh", *Indian Journal of Traditional Knowledge*, Vol. 5, No. 3, pp. 397-402
- [3]. Ashish, Madhava. (1979), "Agricultural Economy of Kumaon Hills: Threat of Ecological Disaster", *Economic and Political Weekly*, Vol. 14, No. 25, Jan. 23, 1997, pp. 1058-1064
- [4]. Baba, S.H. 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.
- [5]. Basu, Subhashranjan (1992), "Physical Factors Affecting Agriculture", *New Dimensions in Agricultural Geography: The Ecology of Agricultural System*. Edited by Noor Mohammad.
- [6]. Battershill, Martin R.J. and Gilg, Andrew W. (1997), "Socio-economic Constraints and Environmentally Friendly Farming in the Southwest of England", *Journal of Rural Studies*, Vol. 13, No. 2, pp. 213-228
- [7]. 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
- [8]. Bhatta, Gopal Datt and Doopler Werner (2010), "Socio-Economic and environmental Aspects of farming Practices in the Peri-Urban Hinterlands of Nepal", *The Journal of Agriculture and Environment*, Vol. 11, 2010, pp. 26-39.
- [9]. Birthal, Pratap S. (2010), "Hill Agriculture in India: Problems and Prospects of Mountain Agriculture", *Indian Journal of Agricultural Economics*, Vol. 65, No. 3, July-Sept. 2010
- [10]. Dame, Juliane. (2009), "Barley and Potato Chips: New Actors in the Agricultural Production of Ladakh", *International Association for Ladakh Studies*, June 2009, pp. 15-24
- [11]. Dame, Juliane. and Mankelov, J.SeB. (2010), "Stongde Revisited: Land-use Change in Central Zanskar", *Erdkunde*, Vol. 64, H.4, October-December 2010, pp.355-370

- [12]. Dame, Juliane. and Nusser, Marcus. (2011), "Food Security in High Mountain Regions: Agricultural Production and the Impact of Food Subsidies in Ladakh, Northern India", *Food Security*, Vol. 3, pp. 179-194
- [13]. Jodha, Narpal S. (2009), "Mountain Agriculture: Development Policies and Perspectives", *Indian Journal of Agricultural Economics*, Vol. 64, No. 1, Jan-March 2009
- [14]. Johnston, Bruce F. and Mellor, John W. (1961), "The Role of Agriculture in Economic Development", *The American Economic Review*, Vol. 51, No. 4, pp. 566-593
- [15]. Karan, Pradyumna P. (1989), "Environment and Development in Sikkim Himalaya: A Review", *Human Ecology*, Vol. 17, No. 2, pp. 257-271
- [16]. Levy, Victor. (1985), "Cropping Pattern, Mechanization, Child Labour, and Fertility Behaviour in a Farming Economy: Rural Egypt", *Economic and Cultural Change*, Vol. 33, No. 4, pp. 777-791
- [17]. Paniagua, A. and Baker, K. (2005), "The Socio-economics of Agriculture", *Social and Economic Development*, Vol. I. pp. 1-8
- [18]. Sati, V.P. (1993), "Cropping Pattern in the Hill Environment of the Garhwal Himalaya: A case study of a village", *National Geographer*, Vol. 28. No. 1, pp. 31-37
- [19]. Sat, V.P. (2005), "Systems of Agriculture Farming in the Uttranchal Himalaya, India", *Journal of Mountain Science* Vol. 2 No 1 pp. 76-85
- [20]. Singh, Harjit. (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
- [21]. Singh, Harjit. (1998), "Economy, Society and Culture-Dynamics of Change in Ladakh", *Karakorum-Hindukush-Himalaya: Dynamics of Change*, Vol. 4, Part II, ed. by IrmtraudStellrecht, RudigerKoppe Verlag Koln, Germany
- [22]. Singh, Harjit. (1981), "Environmental Constraints in a Cold Desert – A Case Study of Ladakh", *Perspectives in Agricultural Geography* ed. by Noor Mohammad, New Delhi
- [23]. Tulachan, Pradeep M. (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

Dr.Jigmat Norboo, et. al. "Study of Land Use Dynamics and Cropping Pattern of Selected Sample Villages of Leh District, Ladakh." *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*, 28(3), 2023, pp. 01-18.