
Crop Diversification and Changing Cropping Pattern in Leh District: A Block-Wise Study

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Abstract: In this paper, an attempt has been made to understand the pattern and extent of crop diversification and changing cropping pattern in Leh district based on secondary data collected for the period 1985-86 to 2010-11 from various government sources. To measure the extent of crop diversification, Herfindhal Index has been used. The study has revealed that most of the blocks in Leh districts are experiencing a lateral movement towards crop diversification. An analysis of temporal changes in cropping pattern in Leh district has indicated that the area under fruits and vegetables has witnessed significant increase over the period by varying degree. In the end, it has suggested some developmental strategies for fostering the process of crop diversification.

Keywords – Crop Diversification, Cropping Pattern, Herfindhal Index, Leh District

I

Introduction

Leh district is located in the Eastern portion of Ladakh region in Jammu and Kashmir State, covering an area of 45,110 square kilometres with an altitude ranging from 2,900 to 5,900 metres above mean sea level. The district lies among the high altitude, remote and inaccessible parts of India and therefore, the scope for setting up of industries on a large scale is neither feasible nor desirable due to the fragile ecosystem. As a result, agriculture forms the main occupation of a majority of population, providing food and livelihood security for the mountain communities. However, “agricultural development in the mountainous regions is circumscribed by the mountain specificities, namely, inaccessibility, marginality, fragility,

niche and human adaptation mechanism created by unique vertical dimensions that distinguish them from the plains and other eco-systems”¹. Agriculture in such regions is also characterised by low productivity due to dominance of traditional agricultural practices, inadequate capital formation, low investment, poor resources and small sizes of landholdings. Nevertheless, recent development in terms of road infrastructure and better access to markets coupled with government initiatives have led to the diversification of agriculture towards high value cash crops including fruits and off-season vegetables, which holds the key to the overall development of the region by way of creating employment, generating income and ensuring food security.

The potentiality of crop diversification to high value cash crops in raising farm income and increasing employment opportunities has recently been realised by farmers across the Himalayan region. A number of studies have also shown that crop diversification to high value cash crops has made a significant impact on the quality of life of the local people. The micro level experiences further show that diversification through high value crops is not only economically beneficial but ameliorates stress on natural resource base² (Chand, 1996). According to a study by Sharma (2005), the adoption of high value cash crop also helps mountain farmers in maintaining and improving the ecology and environment by promoting soil conservation and improving soil fertility. It is clear that the adoption of high value crops is not only beneficial in economic terms but also helps in sustainable use of natural environment. However, economic progress attained by diversification through high value crops is not same everywhere as some pockets have experienced remarkable achievements, while others have lagged behind. This has attracted the attention of agricultural researchers and policy makers, and it is suggested that the experience of areas advanced in crop diversification be replicated and expanded to other areas. Therefore, the present study is an attempt to examine crop diversification and changing cropping pattern in Leh district. More specifically, the study examines the extent of crop diversification in Leh district at block level. It also analyses temporal changes in cropping pattern including area under high value crops in Leh district since 1996-97. Block-wise changes in cropping pattern have also been captured.

¹ Agricultural Development and Crop Diversification in Himachal Pradesh: Understanding the Patterns, Processes, Determinants and Lessons

² Chand, Ramesh (1996), “Ecological and Economic Impact of Horticultural Development in the Himalayas: Evidence from Himachal Pradesh”, *Economic and Political Weekly*, Vol. 31, No. 26, June 29, pp. A-93-A-99.

The study is organised into six sections. The second section deals with the data and methods used in conducting the study. Third section discusses crop diversification in Leh district. Cropping pattern and changes therein from 1985-86 to 2010-11 have been analysed in section IV. Section V includes conclusions.

II

Data and Methods

The study is based on secondary data. The secondary data have been collected from various publications and records from government departments, namely, Agricultural Department, Horticulture Department, Leh District. Various appropriate statistical tools have been used to analyse the data. The average and percentages have been computed to understand the changes in the cropping pattern. The temporal changes in the extent of crop diversification have been studied block-wise by constructing Herfindhal Index. The index has been computed using the following method.

Herfindhal Index

$$HI = \sum_{i=1}^n p_i^2$$

Where, p_i is the proportion of area under i^{th} crop,

$$p_i = \frac{A_i}{\sum_{i=1}^n A_i}$$

Here, A_i is area under i^{th} crop, $\sum_{i=1}^n A_i$ denotes the total cropped area and the value of HI ranges from 0 to 1. While, unity implies complete specialization, zero implies high diversification

III

Crop Diversification

The computed values of Herfindhal index are presented in Table 1 block-wise for the district of Leh. The table reveals that during the first period (2005-06), except Nyoma-Durbok, all

other blocks were relatively diversified blocks with HI-index value lower than the district's average value. In the second period (2007-08) too, except Nyoma-Durbok, all other blocks have depicted HI-index value lower than 0.43, thereby showing relatively diversified. Similar pattern has been found in the third period (2010-11). A comparison of HI values for the periods 2005-06 and 2007-08 reveal that except Nyoma-Durbok, all other districts have experienced a significant degree of crop diversification.

The block Nyoma-Durbok, located in the high altitude region of Leh district, have depicted higher values of HI, close to 0.5 in the second period. From first to second period, there is a clear trend of decline in HI value for Leh-Karu block, depicting crop diversification in the block. On the contrary, all other blocks have depicted higher values of HI, showing crop specialisation. In the next phase, second to third, the values for Nubra and Leh-Karu block have shown a significant change towards crop diversification. On the other hand, the values for Khaltse and Nyoma-Durbok have depicted crop specialisation.

Hence, we may conclude that crop diversification is taking place in two blocks of Leh-Karu and Nubra, whereas other two blocks have shown a significant change towards crop specialisation. The finding needs to be seen in the context of the fact that Nyoma block, which is located at a high altitude, has depicted a higher level of specialisation. Due to data constraints, changes in the extent of crop diversification have not been able show clearly.

Block	HI Index Value		
	2005-06	2007-08	2010-11

Therefore, further study needs to be done to capture the extent of crop diversification.

Table 1

BLOCK-WISE CROP DIVERSIFICATION INDEX IN LEH DISTRICT, 2005-2010

Leh-Karu	0.36	0.29	0.27
Khaltse	0.32	0.33	0.37
Nubra	0.27	0.29	0.27
Nyoma-Durbok	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.

IV

Cropping Pattern and Changes therein

Cropping pattern in the region is dominated by traditional and low productivity crops which occupy majority of the crop area. Most important among them are *barley*, *wheat*, *buckwheat*, *some other millets* and *pulses*; several different local and adopted varieties of these crops are grown. Only one crop in a year is possible in most parts of the region due to short growing season because of harsh climatic conditions. It is only in a few lower or warmer 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. However, in recent years, fruit crops especially *apricot*, *apple*, *walnut*, *almond* and *peach* have become important cash crop, supplementing income to the local farmers. In addition to this is the cultivation of commercial vegetable crops like *potatoes*, *green peas*, *turnip*, *carrot*, *radish*, *cauliflower*, *onion* and *tomato* that has led to change in the cropping pattern of the region.

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.³ However, in mountainous areas like Leh district, physical environment plays vital role in the decision

³ Majid Husain (1982), "*Crop Combinations in India*", Concept Publishing Company, Bali Nagar, New Delhi, p. 34

making about crops to be sown by the farmers. Therefore, it requires analysis of cropping pattern and variations therein.

Table 2 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

Crops	Area	% age of total	Change
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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.

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 are. 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.

Table 2

					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		

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

Source: Computed form Deputy Commissioner Office, Leh

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 to 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.⁴ Beside these, “development of science and new agricultural technology brought about changes in age old cropping pattern”.⁵ 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. Therefore, temporal changes in cropping pattern need to be analysed.

⁴ Dame and Mankelov (2010), “Stongde Revisited: Land-Use Change in Central Zanskar”, *Erkunde*, Vol. 64, No. 4, pp. 355-370

⁵ 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

Table 3

TEMPORAL CHANGES IN CROPPING PATTERN IN LEH DISTRICT, 1985-86 TO 2010-11

(per cent to total cropped area)

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

Table 3 shows that among food grain crops the share of area under wheat declined steadily while that area under barley remained more or less same. Among the non-food

Sr.No.	Crops	1985-86	1990-91	1995-96	2000-01	2005-06	2010-11
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Wheat	26.04	28.68	23.45	24.75	28.09	25.98
2.	Barley	44.26	35.07	46.64	44.99	42.16	44.54
3.	Other Millets	3.73	6.88	4.83	4.14	3.54	3.45
4.	Pulses	3.21	3.30	2.92	2.57	2.57	1.93
5.	Fruits	1.02	0.87	0.75	0.93	0.36	1.32
6.	Vegetables	1.76	2.35	2.33	2.28	2.93	2.31
7.	Oilseeds	0.64	1.05	0.94	0.69	0.61	0.87
8.	Fodder	19.33	21.80	18.14	19.65	19.74	19.61

grains, the area under fruits and vegetables increased over the period by varying degree. It can be attributed to the fact that the district fall in the temperate region has potential to grow temperate fruits and vegetables. It is, therefore, essential to examine the changes in the area under different crops at a block-level.

Table 4

AREA UNDER DIFFERENT CROPS, BLOCK –WISE, 2007-08 TO 2011-12 (Hectares)

Crops	Area (Hectares)		% age of total cropped area		Change	
	2007-08	2011-12	2007-08	2011-12	2007-08 to 2011-12	%
Leh-Karu Block						
Years	2007-08	2011-12	2007-08	2011-12	2007-08 to 2011-12	
Barley	1505	1841	28.44	35.61	+336	22.33
Wheat	2001	1670	37.81	32.35	-331	-16.54
Other Millets	191	90	3.61	1.74	-101	-52.88
Pulses	94	78	1.78	1.51	-16	-17.02
Fruits	16	16	0.38	0.31	0	0
Vegetables	140	172	2.65	3.33	+30	22.86
Oil seeds	42	43	0.79	0.83	+1	2.38
Fodder	1303	1252	24.62	24.25	-51	-3.91
Total	5292	5162	100	100		
Khaltse Block						
Barley	1123	975	55.62	59.41	-148	-13.18
Wheat	222	182	11	11.09	-40	-18.02
Other Millets	91	1	4.51	0.06	-90	-98.9
Pulses	63	64	3.12	3.9	+1	1.59
Fruits	12	12	0.59	0.73	0	0
Vegetables	74	38	3.67	2.32	-36	-48.65
Oil seeds	5	8	0.25	0.49	+3	60
Fodder	429	361	21.25	22	-68	-15.85
Total	2019	1641	100	100		
Nubra Block						
Barley	883	717	39.94	36.51	-166	-18.8
Wheat	728	731	32.93	37.22	+3	0.41
Other Millets	56	-	2.53	-	0	0
Pulses	87	65	3.93	3.31	-22	-25.29
Fruits	11	12	0.5	0.61	+1	9.09
Vegetables	85	53	3.84	2.7	-32	-37.65
Oil seeds	12	17	0.54	0.87	+5	41.67
Fodder	349	369	15.78	18.79	+20	5.73
Total	2211	1964	100	100		
Nyoma-Durbok Block						
Barley	941	955	88.94	90.35	+14	1.49
Wheat	17	12	1.61	1.14	-5	-29.41
Other Millets	21	6	1.98	0.57	-15	-71.43
Pulses	42	36	3.97	3.41	-6	-14.29
Fruits	-	-	-	-	-	-
Vegetables	14	17	1.32	1.61	+3	21.43
Oil seeds	15	22	1.42	2.08	+7	46.67
Fodder	8	9	0.76	0.85	+1	12.5
Total	1058	1057	100	100		

Source: Computed from Statistical Handbook, Leh District, 2010-11

Note: Only combined data was available for Nyoma and Durbok blocks. Same is the case with Leh and Karu blocks.

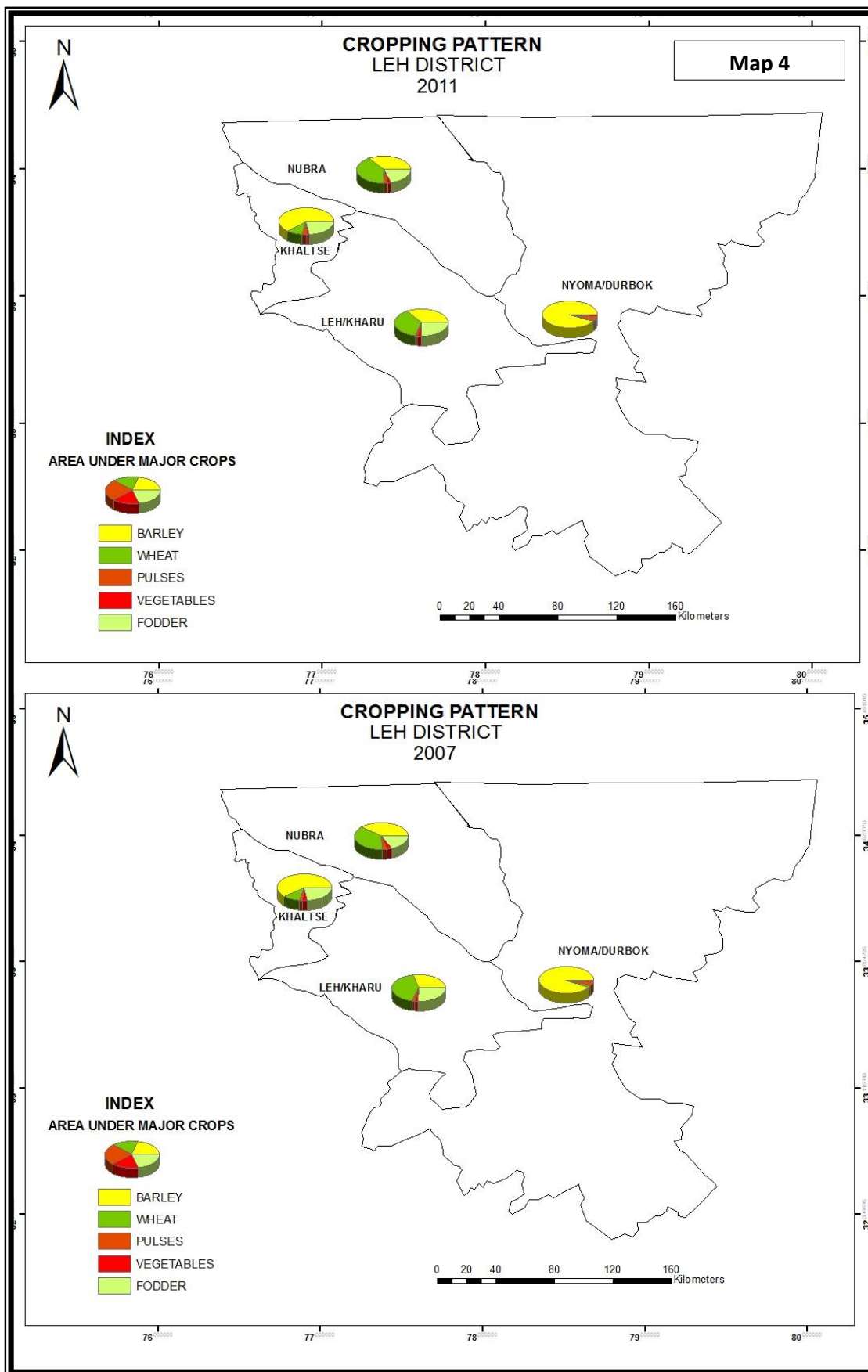
Table 4 and Map 4 reveal that most cultivated land is occupied by *food grain* crops which are largely grown for domestic consumption. Almost same pattern is seen in all blocks of the district with a few exceptions. Nearly 70 per cent of cultivated land was under *food grain* crops. *Barley* predominates over all other crops and its magnitude has increased. It is grown in all the blocks irrespective of varied physical conditions. It is mainly due to the fact that *barley* matures in short span of time. It is clear from table that highest proportion i.e. 88.94 per cent of total cropped area was under *barley* in Nyoma-Durbok block in 2007-08. It has marginally increased by 1.49 per cent in 2011-12. Area under *wheat* was 1.61 per cent of total cropped area in 2007-08. It declined to 1.14 per cent in 2011-12. Major portion of land is devoted to *barley* in favour of *wheat* due to very short agricultural season especially in higher areas. It shows the importance of *barley* in this block which has the highest altitude. Here, climatic conditions restrict growing other crops. However, crops such as other *millets*, *pulses*, *vegetables* and *oil seeds* are also grown in some pockets but their proportion in total cropped area is very less.

An area covered by *barley* was 39.94 per cent, followed by *wheat* with 32.93 per cent of total cropped area during 2007-08 in Nubra block. This block is comparatively lower in altitude and has more fertile land compared to Nyoma-Durbok. Area under *wheat* grew by 0.41 per cent in 2011-12 and *barley* recorded decline by -18.8 per cent during the same year. Next, *fodder* crop occupied 5.78 per cent in 2007 which increased to 18.79 per cent in 2011-12. Area under *pulses* was 3.93 per cent in 2007-08 and it declined by -25.29 per cent in 2011-12. It may be due to increase in area under *fruits* which increased by 9.09 per cent during 2007-08 to 2011-12.

Largest proportion of 55.62 per cent of total cropped was occupied by *barley* in 2007-08 in Khaltse block. It is mainly due to importance of *barley* in Ladakhi society. It is followed by area under *wheat* which accounted for 11 per cent in 2007-08. Area under *other millets* was 4.51 per cent which declined to 0.06 per cent during 2007-08 to 2011-12. *Fodder* crop covered 21.25 per cent of cropped are in 2007-08. It has increased to 22 per cent in 2011-12. It is mainly due to unavailability of large pastures land which forced farmers to grow *fodder*. Area under *fruits* and *vegetables* was 0.59 per cent in 2007-08 and was 3.67 per cent in 2011-12. This block is more suitable for vegetable and fruit farming. Moreover, this



block is situated along Srinagar- Leh Highway which makes marketing of these perishable items easier.



Most important crop after *barley* is *wheat* which accounted for 37.81 per cent of total cropped area during 2007-08 in Leh-Karu block. It is significant to note that area under *wheat* is constantly decreasing and it registered a decline of -16.54 per cent during 2007-08 to 2011-12. Area under *barley* covered of 28.44 per cent and it increased to 35.61 per cent from 2007-08 to 2011-12. *Fodder* crop covered 24.62 per cent of total cropped area. Area under *vegetables* was 2.65 per cent in 2007-08 and it registered significant increase by 22.86 per cent in 2011-12. It is mainly due to proximity of this block to Leh town which provide huge market for villages of this block.

It is clear from the above discussion that farmers allocate almost equal proportion of the total area under *barley* and *wheat* crops in lower altitude blocks. *Wheat* does not mature properly due to extreme weather conditions leading to short growing season in the higher altitude blocks. It has been observed that proportion of land under commercial crops is going up. *Vegetables* are grown in almost all the blocks but there are huge variations in the distribution. It has become an important trend in agricultural development in the region due to modernisation of agriculture. This suggests that cropping pattern is changing in the district, and there is a shift from food crops to cash crops such as vegetables and fruits. Lower altitude blocks have higher proportion of area under *vegetables* than the higher ones. *Fruits* cannot be grown in Nyoma-Durbuk block due to unfavorable climate. Area under other crops such as other millets, pulses and oilseeds are also growing in the region with varied distribution.

IV

Conclusions

To summarise, the foregoing study reveals that agriculture in Leh district had diversified towards fruits and off-season vegetables like peas, potato, cabbage, cauliflower, etc. The process of crop diversification was, however, more pronounced in the blocks enjoying favourable (temperate) agro-climatic conditions. Further, the extent of crop diversification crops seemed to be more pronounced in blocks situated near places of tourist interest, army camps and urban area. These provide huge market facilities for fruits and vegetables grown in the region.

The analysis of cropping pattern indicated that the last few decades had seen traditional crops being replaced by commercial crops because of growing demand by tourists and deployment of security forces in the region. The area under fruits and vegetables had increased from 1985-86 to 2010-11 by varying degree. Block-wise analysis also revealed that cropping pattern is changing in the district thereby shifting from food crops to cash crops such as vegetables and fruits. Lower altitude blocks have higher proportion of area under *vegetables* than the higher ones. *Fruits* cannot be grown in Nyoma-Durbuk block due to unfavorable climate.

Crop diversification through fruits and vegetables has a huge potential for employment and income generation in Leh district. To harness this potentiality, infrastructural facilities like access to motorable road and market, adoption of modern technology and irrigation facilities need to be strengthened through government intervention. Further, the adoption of developmental strategies incorporating regional specificities is an essential pre-requisite for creating enabling environment for fostering the process of crop diversification.

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