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Agricultural Transformation in Trans Himalayan Region of Himachal Pradesh: Cropping Pattern, Technology Adoption and Emerging Challenges§

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Abstract

This paper on agricultural transformation has studied changes in the cropping pattern, adoption process of new technology, sources of information about new technology and emerging threats to the existing cropping pattern in ten villages of the Spiti sub-division of Lahaul-Spiti district of Himachal Pradesh. The study based on the data collected from 200 sample households has revealed significant changes in the cropping pattern with traditional crops like potato, barley and black pea being increasingly replaced by green pea. Apple, another cash crop, is gaining popularity due to perceptible changes in climatic conditions. The factors that have led to the introduction of new crops include improved road connectivity, better means of transportation, decline in the demand of traditional crops, availability of favourable micro climatic niches, availability of new crop inputs like hybrid seeds, chemicals and fertilizes, emerging new markets, etc. The introduction of new crops/technology has taken 1 to 3 years. The officials of the state departments of agriculture and horticulture, followed by relatives and friends have been the important sources of information about new crops/technology. The study has listed some potential threats to the cultivation of high-value cash crops. The technological innovations in terms of educating the farmers about the latest package and practices on farming of high value cash crops, development of disease-resistant varieties of crops like green pea are necessary for promoting economic viability and ecological sustainability in Himachal Pradesh. The most important policy support, therefore, would be enhanced investment on agricultural R&D for evolving new technologies to not only retain but also strengthen the comparative advantage being enjoyed by the state.

Key words: Agricultural transformation**, c**ash crops, technology adoption, emerging threats, trans-Himalayan region, Himachal Pradesh

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Introduction

Agriculture has made considerable progress in Himachal Pradesh since the early-1970s as is evident from increase in foodgrains production from 9.45 lakh tonnes in 1972-73 to 14.94 lakh tonnes in 2010-11 (GoHP, 2012). The productivity of different crops has also increased but the most important change has been the diversification of agriculture towards high-value cash crops, including fruits and vegetables, specially in the areas falling in the temperate agro-climatic zones.

As a consequence, rural areas including remote tribal regions, are experiencing profound changes due to improved means of communication including road connectivity, among other developments. The empirical studies have shown that crop diversification has made a significant impact on the income and employment of the farming households in Himachal Pradesh. The agricultural diversification towards high-value cash crops not only provides economic benefits but ameliorates stress also on natural resource base (Sharma, 2005; 2011; Sharma and Chauhan, 2008; Chauhan and Sharma, 2010)

The present paper has explored the changes in cropping pattern, process of technology adoption, sources of technology adoption, the emerging threats endangering the ecological sustainability and economic viability of the ongoing crop diversification in the remote mountainous regions of western Himalayas.

Data and Methodology

The study has been conducted in the Spiti sub-division of Lahaul-Spiti district of Himachal Pradesh and is based on the primary data. To select the sample households, an amalgam of purposive and random sampling procedure was followed. To begin with, ten villages, namely Kibber, Dhankar, Gue, Sagnam, Losar, Hansa, Poh, Lari, Kungri and Tabo, were purposively selected to represent valleys having different micro-climatic niches and cropping patterns in consultation with the grassroot level functionaries and scientists of agricultural and horticultural universities of the Research Station, Lari and Regional Research Station (RRS), Tabo, respectively. A sample of 200 households was selected randomly from these villages through proportional allocation method. The data on different aspects of agricultural development were collected through personal interview method for two seasons (there is only one crop season in the area from March-April to September-October) 2007-08 and 2008-09 and the average of two seasons was used for analysis. The data were analysed using simple statistical tools like averages and percentages (for details see Chauhan and Sharma, 2010).

Results and Discussion

Temporal Changes in Cropping Pattern

The data on crops grown in sample villages reveal that black pea, potato, barley (hulless and covered both) and wheat were the important crops grown in 1980 (Table 1). In 1990, the number of crops grown increased marginally to 9 with the introduction of garden pea and apple as cash crops. The garden pea was introduced in all the sample villages and covered 27 per cent of the gross cropped area and apple was introduced in 10 per cent of the villages and covered 3 per cent of the cropped area. In the year 2000, though the number of crops remained the same, the area under garden pea increased to 47 per cent of the cropped area. Likewise, the apple was being grown in 20 per cent of the villages on 12 per cent of the area. The cultivation of apple has spread up to Schilling and also in and around Kaza, though the success rate and plant growth were slow due to very low temperature. Keeping in view the changes in climate, the apple cultivation is expected to spread to other villages at higher elevation also. Rajmash, another important cash crop of local strain, was introduced in the area in 2000, though its spread remained limited. Hulless barley, a staple food in the area, is grown in all the sample villages. It is used for extraction of local wine and for making roasted food, *sattus*.

The cropping pattern has been studied in terms of the proportion of gross cropped area under different crops and details regarding area under different crops including new crops are presented in Table 2. In the sample area, due to heavy snowfall and prolonged winters, there is only one crop season from April to October and therefore, the average cropping intensity was 103 per cent which did not vary much across the farm categories. Table 2 shows that cash crops, namely green peas and potato, were being grown on more than 50 per cent of the gross cropped area and the remaining area was devoted to traditional crops like wheat, barley and black peas. Among the traditional crops, barley was the most important crop accounting for as high as 37 per cent of the gross cropped area.

Drivers of Change in the Cropping Pattern

The factors that have facilitated crop diversification in the Spiti valley have been listed in Table 3. The significant drivers of change in cropping pattern were improved road connectivity and better means of transportation. These helped in transportation of agri-produce from the fields to main road head and then to distant markets like fruit and vegetable market of Azadpur, Delhi. The next important factor was decline

Table 1. Temporal changes in crops, varieties and area in Himachal Pradesh: 1980-2000

Year	Crop	Varieties	Villages (%)	Area (%)
1980	Sarson	Local	40	4.30
	Black pea	Local, Arkel	70	13.44
	Potato	Chandermukhi, Kufri jyoti	100	31.18
	Hulless barley	Dolma local	80	23.66
	Wheat	Local	40	17.74
	Buck wheat	Local	10	1.08
	Covered barley	Local	30	8.60
1990	Local turnip	Local	10	0.21
	Green pea	Arkel	100	27.37
	Black pea	Local	40	3.16
	Hulless barley	Dolma	100	34.21
	Potato	Chandermukhi, Kufri jyoti	90	18.21
	Covered barley	Local	20	4.20
	Wheat	Local	30	12.11
	Buck wheat	Local	10	0.53
	Apple	Royal red	10	3.16*
2000	Local turnip	Local	10	0.10
	Hulless barley	Dolma	100	33.00
	Potato	Chandermukhi, Kufri jyoti	90	7.50
	Green pea	Azad pea-I, Arkel	100	47.00
	Black pea	Local	30	1.50
	Rajmash	Improved (Jawala) and local	10	0.30
	Black lentil	Local	10	0.10
	Wheat	Local	40	10.50
	Apple	Royal red , Royal delicious	20	12.00*

Note: *includes other crops also

Source: Field survey, 2007-08 and 2008-09

in demand of traditional crops like black peas, barley and local wheat due to changing food habits of people. The availability of favourable micro climatic niches for growing high-value cash crops (off-season vegetable crops) like green pea and potato was another driver of change in the cropping pattern. The availability of new crop inputs like hybrid seeds, chemicals and fertilizers also hastened the change in cropping pattern. Emergence of new markets has facilitated marketing of produce and fetching a higher price, in particular for green peas. Nearly 30 per cent of the households reported that the successful introduction of new crops by some farmers created demonstration effect on other households persuading them to adopt the new crop.

Adoption Process of New Farm Technology

The time lag in the adoption of new crop technology by farmers of different villages is given in Table 4. During the first year of availability of new crop technology, about 8 per cent of the sample farmers had adopted it. Across villages, the extent of adoption was highest by farmers in Losar (25%), followed by Tabo (20%) villages. Nearness and better connectivity to the adjoining districts through metalled roads might have encouraged the farmers for adoption of new technology. After first year, around one-fourth of the farmers in sample villages adopted the new technology. After two years of the introduction of new technology, the adopters increased to 49 per cent which further

Table 2. Cropping pattern on sample farms in Himachal Pradesh

(ha/farm)

Crop	Irrigated	Unirrigated	Total
Cash crops	0.460 (49.19)	0.008 (13.79)	0.464 (48.18)
(a) Green pea	0.435 (46.52)	0.008 (13.79)	0.439 (45.59)
(b) Potato	0.025 (2.67)	-	0.025 (2.59)
Other crops	0.475 (50.81)	0.05 (86.21)	4.999 (51.82)
(a) Wheat	0.123 (13.16)	-	0.123 (12.78)
(b) Barley	0.346 (37.01)	0.050 (86.21)	0.370 (38.42)
(c) Black pea	0.006 (0.64)	-	0.006 (0.62)
Total cropped area	0.935	0.058	0.963
Cropping intensity (%)	-	-	103

Source: Field survey, 2007-08 and 2008-09
Note: Figures within the parentheses show percentage of total cropped area

Table 3. Reasons for change in the cropping pattern

Sl. No.	Reason	Response (%)
1	Availability of new crops	90
2	Availability of new crop varieties	40
3	Improved accessibility (road connectivity)	100
4	Emergence of new markets	40
5	Better transportation facilities	100
6	Decline in demand of traditional crops	100
7	Decline in yield of traditional crops	60
8	Emerging demand for new crop products	70
9	Favourable climate	100
10	Demonstration effect	30

Source: Field survey, 2007-08 and 2008-09

increased to as high as 87 per cent after three years. Table 5 shows that large farmers were the first to adopt the new farm technology, followed by village panchayat pradhans. The households whose family members were employed in government or in non-farm jobs were also among the initial adopters of new technology.

Table 4. Time lag in the adoption of new farm technology in Himachal Pradesh

Village	Time of adoption (Per cent of farmers per village)			
	During the first year	After 1 year	After 2 years	After 3 years
Dhankar	0	5	20	60
Gue	5	20	75	100
Hansa	2	4	50	100
Kibber	10	25	45	100
Kungri	10	75	75	100
Lari	5	10	17.5	100
Losar	25	50	75	100
Poh	1	11	10	50
Sagnam	5	15	45	55
Tabo	20	50	75	100
All villages	8	26	49	87

Source: Field survey, 2007-08 and 2008-09

The reasons reported by sample farmers for late adoption of new technology in terms of new crops and their varieties have been presented in Table 6. Firstly, the farmers were not sure about the marketing of new crops and secondly, there was fear of crop failure in the wake of adoption of new technology. Thirdly, there was fear of food security vis-a-vis adequate amount of fodder from traditional crops. The threat to food security was also reported to be an important factor for the late adoption of new crops/varieties.

Sources of Information about New Farm Technology

Among the main sources of information about new farm technology, summarized in Table 7, the officials of the state department of agriculture and horticulture were the most important, followed by relatives and friends. The traders coming from outside for buying the crop produce and university scientists were the other important sources of the information about new technology. The government agencies also played an important role in hastening the diffusion of new agricultural technology by ensuring a regular supply of necessary/basic inputs like seeds, fertilizers and plant protection chemicals and improving the market infrastructure like road net work, etc. The field level demonstrations and field visits of progressive farmers

Table 5. Initial adopters of new farm technology in Himachal Pradesh

Particulars	Ranking based on per cent response				
	1st	2nd	3rd	4th	Average rank
Village pachayat pardhan	20	50	10	20	2
Large farmers	70	30	-		1
Family having their members in non-farm jobs	10	-	80	10	3
Others	-	20	10	70	4

Source: Field survey, 2007-08 and 2008-09

Table 6. Reasons for late adoption of new farm technology in Himachal Pradesh

Reasons	Response (%)
Not sure about the market	100
Fear of crop failure	80
Threat to food security	70
Others (fodder scarcity)	90

Source: Field survey, 2007-08 and 2008-09

Table 7. Sources of information about new farm technology in Himachal Pradesh

Source	Response (%)
Officials of the Department of Agriculture	100
Officials of the Department of Horticulture	90
Officials of the Department of Agriculture and Horticulture	90
Relatives and friends	90
Traders	20
University scientists	60
Nearby village farmers	60
Others	50

Source: Field survey, 2007-08 and 2008-09

to other parts of the state also helped in the dissemination of new technology (Table 8).

Table 8. Role of government in dissemination of new farm technologies in Himachal Pradesh

Particulars	Response (%)
Development of market infrastructure	50
Regular supply of necessary/basic inputs like seed, chemicals, fertilizers and plant protection material	100
Trainings and demonstrations	
(i) Learning by doing	100
(ii) Field visit	70
(iii) Others	50

Source: Field survey, 2007-08 and 2008-09

Yield and Yield Gaps in Different Crops

The yield gaps were worked out by taking the difference of experimental station yield and also of progressive farmers' yield and actual yield and have been shown in Table 9. A perusal of Table 9 reveals that the yield gaps between progressive farmer's yield and actual yield were very high in case of potato crop, followed by black pea. The yield gap II was almost double in wheat compared to that in barley. Since green pea is a commercial crop, the gap between progressive farmer's yield and actual yield was very narrow, only 3.5 q/ha, though the gap was higher on large than the small farms.

Potential Threats

The potential threats to the existing cropping pattern, as reported by the farmers, have been listed in Table 10. The increasing susceptibility of different crops to insect-pests and diseases, in particular of pea and potato, was reported to be a formidable threat to the ecological sustainability and economic viability of these crops. The falling yield of existing varieties was reported to be another threat to these crops by nearly three-fifths of the respondents. Erratic weather conditions like bouts of dry spell and hailing were also reported as a major threat by 70 per cent of the farm households. Some other potential threats reported by the respondents included harmful effects on soil due to the adoption of same cropping sequences year after year, inadequate irrigation facilities, withdrawal of

Table 9. Estimated yields and yield gaps in different crops in Himachal Pradesh

Sl. No.	Crops/ Particulars	Yield (q/ha)
I	**Wheat**	
1	Experimental station yield	37.0
2	Progressive farmers yield	29.0
3	Actual/average yield	22.7
4	Yield gaps	
	(a) Yield gap I (1-3)	14.3
	(b) Yield gap II (2-3)	6. 3
II	**Barley**	
1	Experimental station yield	50.0
2	Progressive farmers yield	36.0
3	Actual/average yield	32.3
4	Yield gaps	
	(a) Yield gap I (1-3)	17.7
	(b) Yield gap II (2-3)	3.7
III	**Green pea**	
1	Experimental station yield	85.0
2	Progressive farmers yield	71.8
3	Actual/average yield	68.3
4	Yield gaps	
	(a) Yield gap I (1-3)	16.7
	(b) Yield gap II (2-3)	3.5
IV	**Black pea**	
1	Experimental station yield	70.0
2	Progressive farmers yield	57.5
3	Actual/average yield	44.9
4	Yield gaps	
	(a) Yield gap I (1-3)	25.1
	(b) Yield gap II (2-3)	12.6
V	**Potato**	
1	Experimental station yield	300
2	Progressive farmers yield	235
3	Actual/average yield	175
4	Yield gaps	
	(a) Yield gap I (1-3)	125
	(b) Yield gap II (2-3)	60

Source: Field survey, 2007-08 and 2008-09

subsidies/ incentives, etc. The problem has been compounded due to non-availability of inputs like vermi compost, good quality of farm yard manure and other micronutrients (zinc, lime, etc.). The climatic changes like the decrease in the snowfall over the years and consequent decrease in the amount of available water were reported to be yet another important threat to the existing high-value cash crops.

Table 10. Potential threats to the existing cropping pattern in Himachal Pradesh

Sl. No.	Potential threat	Response (%)
1	Lack of new varieties	80
2	Increasing susceptibility to insects, pests and diseases	90
3	Falling yields	60
4	Erratic weather conditions	70
5	Harmful effects on soil	30
6	Lack of availability of supporting inputs	40
7	Inadequate irrigation facilities	70
8	Withdrawal of subsidy / incentives	20
9	Others	10

Source: Field survey, 2007-08 and 2008-09

Summary and Conclusions

This study on agricultural transformation in hilly region of Himachal Pradesh has revealed significant changes in the cropping pattern with traditional crops like potato, barley and black pea being increasingly replaced by green pea. Apple, another cash crop, is gaining popularity due to perceptible changes in climatic conditions. The factors that have led to the introduction of new crops include improved road connectivity; better means of transportation; decline in the demand of traditional crops like black peas, barley and local wheat due to changing food habits; availability of favourable micro climatic niches; the availability of new crop inputs like hybrid seeds, chemicals and fertilizes, emerging new markets; demonstration effect, etc. The introduction of new crops/technology has taken 1 to 3 years with large farmers, village panchayat pradhans, and households whose family members were employed in government or non-farm jobs, acting as the initial adopters. The officials of the state department of agriculture and horticulture, followed by relatives and friends have been most important sources of information about new crops/technology. The other sources like traders from outside and farm scientists in the agricultural research stations also helped in popularizing the new crops/ agricultural technology. Increasing susceptibility of

different crops to insect-pests and diseases, in particular of pea and potato poses a formidable threat to the ecological sustainability and economic viability of these crops. In addition, dwindling yield of the existing varieties, erratic weather conditions like bouts of dry spell and hailing, loss of soil fertility due to adoption of same cropping sequence year after year, changes in climate in terms of decrease in the frequency and quantity of snowfall and consequent decrease in the amount of available water have also been reported the potential threats to the cultivation of high-value cash crops in hilly region of Himachal Pradesh..

The continuous technological innovations in terms of dissemination of latest packages and practices on farming of high-value crops, development of disease-resistant varieties of crops like green pea are a *sine qua non* for promoting economic viability and maintaining ecological sustainability in Himachal Pradesh. The most important policy support, therefore, would be enhanced investment on agricultural R&D for evolving new technologies to not only retain but also strengthen the comparative advantage being enjoyed by the state.

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