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Challenges and Opportunities in Crop Diversification

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Abstract

This paper examines the challenges and production possibilities for diversification of agriculture in Himachal Pradesh. The study is based upon the data drawn from various studies conducted by CSK HPKV in different parts of Himachal Pradesh. It is well known fact that the state is gifted with varied agro-climatic conditions varying from sub-tropical to temperate opening a myriad of opportunities for growing a variety of field crops, fruits, plantation crops, livestock breeds and many other ancillary activities. There are some potential pockets in the state where progressive farm diversification has already taken place leading to tremendous economic progress and transformation. Besides a number of potential farming systems and enterprises exist that can be taken up to diversify farming and enhance the income and employment especially of marginal and small farmers. Despite the availability of potential systems and enterprises, agriculture in large parts of the state faces the problems of deceleration in yields of practically all crops, depletion and degradation of natural resource base and noticeable climatic change having far reaching implications for food security and livelihoods of masses. The study suggests alternative demand driven niche based diversification towards high value cash crops and enterprises and portrays a viable solution to stabilize and raise farmers' incomes, augment employment opportunities, conserve and enhance natural resources in the ultimate pursuit of achieving higher income and enhance quality of life of farmers. The paper highlights these options through use of technology to increase the productivity of crops in a sustainable way, giving due emphasis to high value and hi-tech enterprises, organic/ natural farming and ancillary enterprises, etc.

Key words: Crop/farm diversification, challenges, opportunities, climate change, farming/ cropping systems, ancillary enterprises, organic/natural farming, value addition, straggles/action plan.

Agricultural diversification involves movement of resources from low value commodity- mix to high value commodity-mix. According to British Department for Environment, Food and Rural Affairs (DEFRA), diversification is defined as the entrepreneurial use of farm resources for non-agricultural purpose for commercial gain. Crop diversification has emerged an important alternative to attain the objectives of output growth, employment generation and natural resources sustainability. In India, the concept is applied both to individual farmers and to different regions and seen as referring to the shift from the regional dominance of one crop to regional production of a number of crops which takes into account the economic returns from different value-added crops with complementary marketing opportunities. Further, diversification can be designed to help poverty alleviation, employment planning and environmental conservation. A planned diversification increases both individual and social gains (Haque, 1996). The diversified agriculture also ensures the food security and improves the quality of life by adding to the nutritional security (Kumar and Mathur, 1996).

The broad objectives of diversification are to raise per capita income through opening of avenues for productive employment in farm and non-farm sectors and to make the economic growth broad based and sustainable in the long run. Level of crop diversification largely depends on the geo-climatic conditions, socio-economic conditions and technological development in a region.

Himachal Pradesh is a small hill state located in the Western Himalayas having a total geographical area of about 55.67 lakh hectares (16 % of the total geographical area of Western Himalayas) with a population of about 75.25 lakh (Economic Survey H.P., 2017-18). Around 89.96 per cent of the total population of the state lives in 17,495 rural villages

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spread over the mountainous landscape from low hills subtropical to high mountain alpine zones. There is a wide diversity in agro-climatic conditions with altitude ranging from 350 m to more than 8000 m above mean sea level. This wide diversity in agro-climatic conditions offers immense opportunity for diversification of agriculture by producing wide variety of cereals, fruits, vegetables, flowers, aromatic and medicinal plants as well as myriad of livestock and ancillary enterprises. There are inherent mountain specificities offering agro-diversity or niche for some activities or products in which mountains have comparative advantages over plains (Jodha, 1994). Agricultural diversification towards fruit and vegetable crops, especially in some areas in the district of Shimla, Kullu, Solan and Lahaul & Spiti, started in the late sixties, which gathered pace in the seventies and eighties and further momentum in the late nineties (Sharma, 2005). This perhaps is the most distinguishing feature of hill agriculture unlike the plains where only few specialized crops are cultivated. This study brings out the challenges and opportunities for diversification of agriculture in Himachal Pradesh.

State economy and importance of agriculture

The economy of Himachal Pradesh is mainly agro-pastoral and basically rural with more than 92 per cent of the population living in villages depending directly or indirectly on agriculture and allied activities. The cultivated area accounts for only about 11 per cent of the total geographical area and is the limiting factor for agricultural development. There are vast forests, pastures / grazing and support lands in Himachal Pradesh that provide ample opportunities for developing livestock and also for rangeland farming through conservation and development of rich repository of high value medicinal and aromatic plants.

The contribution of agricultural sector to Gross State Domestic Product (GSDP) has decreased from 26.51 per cent in 1990-91 to just 12.19 per cent in 2014-15. Agriculture is the main occupation of the people of Himachal Pradesh and is the only State in the country whose 89.96 percent population (Census, 2011) lives in rural areas. Therefore, dependency on Agriculture/ Horticulture is dominant as it provides direct employment to about 62 per cent of total workers of the State (Economic Survey of H.P. 2018-19). As per 2013 estimates, total monthly income of farmers in Himachal Pradesh from all sources was Rs. 8777 compared to Rs.6653 at national level. Of the total Rs. 8777, wages contributed Rs. 4030 (45.91%), cultivation Rs. 2876 (32.76%), farming of animals Rs. 1047 (11%) and non-farm business Rs. 824 (9.39%) (Table1). The monthly consumption expenditure was estimated Rs. 7134 implying that about 89 per cent of the monthly income was consumed which is better as compared to all India consumption level of 93 per cent of income (Chandrashekhar and Mehrotra, 2016)). Hence, to double the farmers' income the income earning from these components/activities will have to be doubled (Sarial, 2016).

Table 1. Source-wise average monthly income during 2013 (Rs./ household)

Particular	Himachal Pradesh	India
Income from wages	4030 (45.91)	3019 (45.37)
Net receipt from cultivation	2876 (32.76)	2146 (32.25)
Net receipt from farming of animals	1047 (11.92)	3194 (48.01)
Net receipt from non-farm business	824 (9.39)	784 (11.78)
Total income	8777	6653
Consumption	7134 (81.28)	6229 (93.62)

Source: Chandrashekhar & Mehrotra (2016)
Figures in parentheses show percentages to total income

Challenges in hill agriculture

The hill and mountain areas exhibit peculiar specificities namely inaccessibility, marginality, fragility and niche areas for specific crops that distinguish hilly regions from the plains. The specificities offer both challenges and opportunities (Jodha, 1994). The main challenges are small, fragmented and scattered land holdings besides undulating topography/ land degradation and declining land for cultivation. Despite, perennial river system, there are meager irrigation facilities limiting the irrigated area to below 20 per cent of the total cropped area. The erratic and uneven rainfall further leads to low yields and fluctuations in crop production. Due to low productivity in agriculture and increasing pressure on land, there is proverbial exudes of rural workers that has aggravated the problems of farm labour scarcity. The menace of monkeys, wild boars, porcupines, stray animals and birds have compelled some farmers to abandoned farming in the marginal and peripheral lands. There is also heavy debit charge on common property resources on account of illicit encroachment, diversion of land for non-agricultural uses, uncontrolled mining and lack of community participation in management and regeneration of common resources. The infestations of obnoxious weeds like *Lantana, Ageratum* and *Parthenium* etc., in common pastures, grazing and forest lands have decreased the bio-mass production and fodder availability from support lands to livestock. Therefore, hill farming is slowly becoming unsustainable because of these challenges.

Climate change, challenges and impact in hills

Climate change is one of the most important environmental challenges facing humanity with implications for agricultural productions, natural resources, fresh water supply and health, etc. Human activity is causing the earth's temperature to increase (IPCC, 2007; Liverman, 2007, 2008). Climate change is expected to have major negative consequences in developing countries (Oxfam, 2007; Stern, 2006; UNDP, 2007; UNFCCC, 2007); Agriculture is the most sensitive to climate change. Agricultural productivity in general could decline between 10-25 per cent by 2080 and the decline in yield in rainfed agriculture could be as much as 50 per cent (Cline, 2007). Small farmers are the most vulnerable to the impacts of climate change on agriculture (Easterling *et al.*, 2007) which may affect them through increased likelihood of crop failure, increased incidences of diseases and mortality of livestock, and/or forced sales of livestock at disadvantageous prices, increased livelihood insecurity, resulting in assets sale, indebtedness, out-migration and dependency on food aid, and downward spiral in human development indicators, such as health and education (IPCC, 2007).

The impacts of climate change are most seriously felt in mountain regions because of them being most vulnerable ecosystems. Evidences of global warming could be clearly deciphered by changes like receding snowfall in the Himalayas, retreating glaciers and shifting of temperate fruit belt upward, adversely affecting productivity of apples and shifting and shortening of *rabi* season rainfall pattern.

The farmers of mountain state of Himachal Pradesh perceive the different quantum of climate change on mountain agriculture (Table 2). The climate change described by farmers as temporal displacement of weather cycle reflecting in change in crop enterprises and livelihood options. Increasing temperature during summers, prolonged summers, delayed onset of South-West monsoon and its uneven distribution, delayed onset of winter, short winter periods, temperature above normal during winters, decreasing snowfall during winters, delayed snowfall, low temperature spell in high altitude during winters, unpredictable rainfalls were the main opinions of the farmers regarding climate change. Farmers' perceptions clearly portray picture of a shift of high water requiring crop like basmati to low water requiring crops like maize and local paddy. The highland farmers from areas above 1500 meter above mean sea level have replaced apple with off-season vegetables, whereas farmers above 2200 meter above mean sea level started growing apple as opportunity due to receding snowfall and warm climate. At all elevations farmers opined that a shift of labour engaged in agriculture to other enterprises primarily due to handsome earnings in other enterprises is a major threat to hill agriculture. Amongst the different categories of farmers, the vulnerability is more in snowfall and warm climate. At all elevations farmers opined that a shift of labour engaged in agriculture to other enterprises primarily due to handsome earnings in other enterprises is a major threat to hill agriculture. Amongst the different categories of farmers, the vulnerability is more in case of marginal farmers compared to small and large farmers. There has been clear impact of climate variability in Himachal Pradesh on crop productivity, shift of apple belt to higher altitude and lower apple area replaced by vegetables (Rana, 2011).

Table 2. Farmer perceptions about climate change in Himachal Pradesh

Sr.No.	Particulars of change	% Respondents	Extent of change
1.	Increasing temperature during summer months(^{o}C)	100	3.11
2.	Prolonged summer season (days)	92	18.27
3.	Delay in the onset of rainy season (days)	96	16.49
4	Uneven distribution of rainfall (%)	100	20.42
5	Insufficient rainfall during rainy season (% less)	67	15.82
6	Delay in the onset of winter season rains (days)	100	15.25
7.	Short winter period (days)	75	14.76
8.	Temperature above mean during winter (^{o}C)	88	3.24
9.	Reducing snowfall in winter (% less)	54	34.59
10.	Increasing foggy days in winter (days)	13	8.17
11.	Increasing cloudy days in winter / summer (days)	29	6.94
12.	Unpredictability in rainfall pattern (%)	88	21.98
13.	Threat of floods	46	N.A.
14.	High velocity wind	46	N.A.
15.	High intensity of rainfall during winter	17	N.A.
16.	Frost problem during winter	13	N.A.
17.	Increased frequency of hail storm (No. of times/ year)	100	4.83

Source: Ratna (2017)

The climate change is the greatest and widest-ranging market failure ever seen, presenting a unique challenge for economics. Thus, there is a need to take necessary steps including environmental taxes to minimise the economic and social disruptions (Stern, 2006). Wheat is the most vulnerable crop which can be affected by the climate change, more so by the pattern of *rabi* season rainfall as more than 80 per cent of the area under this crop is rainfed. There is, thus, high instability in the production as a consequent of erratic rainfall distribution over time and space. The direct relationship between rainfall and wheat production has been clearly established (Sharma *et al*. 2011). Most worrying scenario is that amount of total precipitation has decreased over the period in all the districts.

During the last 38 years (1975-2013) number of cold nights decreased & warm increased during the months from December to February. Similarly, in last 46 years (1964-2010), annual rainfall has increased upto 1986 for 22 years and thereafter started decreasing. During the period 1964 to 2000 (36 years), 16 droughts occurred out of which 5 were severe droughts. The issue of climate change is most serious in the recent years as during last 10 years (2000-2010), 7 droughts were noticed out of which 3 were severe droughts. In all the zones, temperature is increasing, snowfall is decreasing. In high hills temperate dry zone rainfall is increasing and snowfall is decreasing causing more landslides due to loose strata. Figure 1 clearly shows the decrease in the pattern of snowfall from 1973 to 2010.

Other challenges

The biotic and abiotic stresses are observed in different parts of the world. In rice crop heavy incidence of brown plant hopper was first noticed in some rice growing areas of UK in 2010. Similarly in wheat crop, high severity of yellow rust during late February to mid-March was found in 2011 and with 1^{0}C rise in temperature, there would be 3-4 per cent reduction in yield. In *kharif* crops too drought stress is observed in initial stage and cold stress at grain filling stage while in *rabi* crops low rainfall caused significant reduction in yield. Biologically, climate change impact indicators like shortening of reproductive phase and maturity of wheat by 5-15 days were observed in Zone II. Similarly in the rice varieties Himdhan-1 & K 39 the reproductive phase of the crops was reduced by 1-10 days. In Zone III, a reproductive

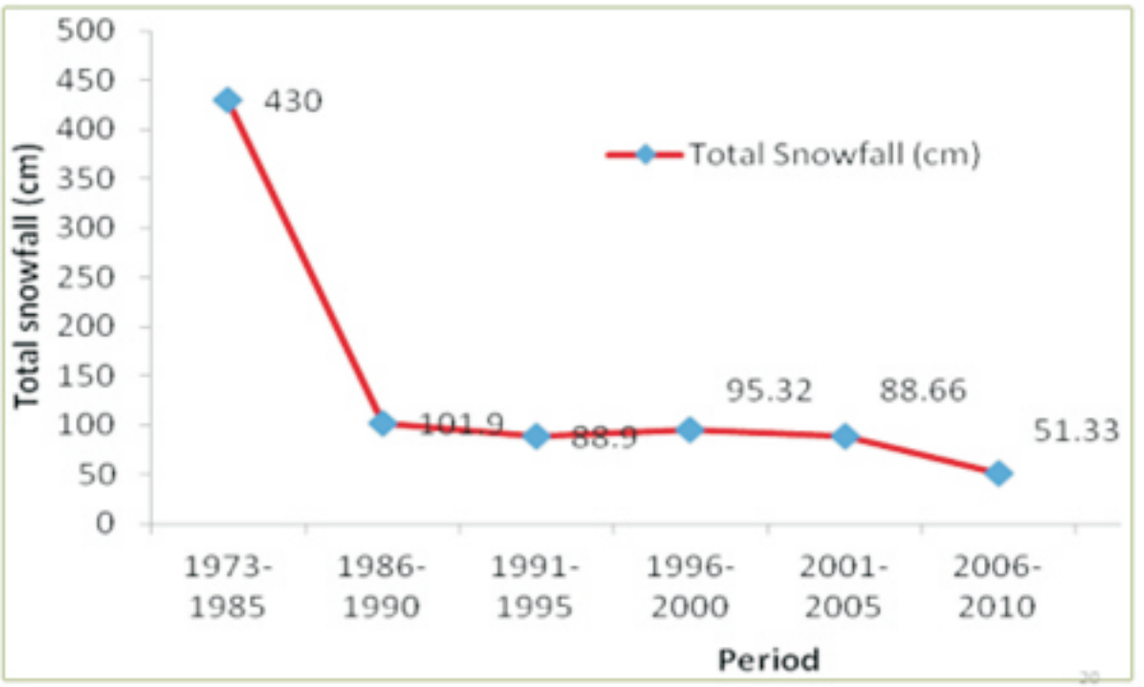

Figure 1. Trends in snowfall in Himachal Pradesh, 1973 to 2010

and maturity phase of barley was enhanced by 10-26 days. In general, in Zone I, II and III, sowing and harvesting time of crops were delayed by 15 to 30 days depending upon the rainfall. In Zone IV, the sowing and harvesting time of crops is preponed by 15 days. The productivity of field crops has been hampered due to high incidences of diseases. The vulnerability to attack of pests had also increased, therefore, requiring more R&D endeavours. There is inadequate coverage of crops under insurance schemes announced by the Govt. of Himachal Pradesh. There is no provision of minimum support prices or effective procurement system for farm products as a result of which farmers have to resort to distress sales. Lack of rural infrastructure also chokes the supply chains both for critical inputs and output. Thus, high risk, low income assurance and lack of mechanization reduce the interests of educated rural youth in farming.

Agro-biodiversity and opportunities for diversification

Himachal Pradesh is divided into four agro-climatic zones depending on altitude, rainfall, temperature, humidity and topography (Anonymous, 1982). This classification has been considered as the benchmark for determining production possibilities and diversification opportunities. The sub-mountain low hills (Zone I) comprises the areas below 650 m above mean sea level adjoining Punjab and Haryana States and account for about 16.40 per cent of the geographical area and 38 per cent of the cropped area of the state. This zone has the potential for sub-tropical fruits, vegetable farming, dairy farming and fishery. Mid-hills (Zone II) comprises the areas ranging from 651 m to 1800 m above mean sea level and account for about 21.25 per cent of the geographical area and 41 per cent of the cropped area. This zone has comparatively more irrigation potential and, thus can emerge as the most productive zone. It has also emerged as the most diversified zone of the state. The high hills temperate wet zone (Zone III) includes the major parts of Shimla district (except Rampur tehsil) and parts of Kullu, Solan, Chamba, Mandi, Kangra and Sirmaur districts with an altitude above 1800 m above mean sea level. This zone accounts for about 23 per cent of the total geographical area and 18 per cent of the cropped area of the state. The irrigated area is just 8 per cent of the net sown area. This zone is known for the production of fruits mainly apple. This zone has the opportunity for raising fruits, off-season vegetables, livestock and variety of agro-forestry and medicinal plants. The high mountain tribal areas of the state fall in temperate dry region (Zone IV). This zone covers the high mountain areas of Kinnaur, Lahaul and Spiti and Pangi and Bharmour tehsils of Chamba district with altitude of 1800 m above mean sea level. Rainfall is scanty with heavy snowfall in winters. This zone covers about 42 per cent of the

geographical area but only 2.6 per cent of the cropped area of the state. This zone is famous for the production of quality seed potato, green peas, dry-fruits and medicinal herbs like *kuth, hops, kaala zeera* and saffron. The zone is also suitable for raising sheep, goats, yak and some rare breeds of horses and ponies (Chamurthi). Despite aboriginal and harsh climate, this zone has the most commercialized farming in the state and harbours vast opportunities for adventure sports and agro-ecotourism.

The structure of annual income earned by a farm household from agriculture in Himachal Pradesh is given in Table 3. It is quite evident that average annual income from agriculture varies from Rs.87,469 in Zone-II to Rs.1,61,037 in Zone-IV with average farm income of Rs. 1,05,770 at the state level. About 34 per cent of the household income is realized from field crops (excluding vegetables), 32 per cent from vegetable crops and remaining about 35 per cent from livestock sector. It is also observed that in Zone-I major proportion of income (about 90%) comes from field crops and livestock but in Zone-II and Zone-III, vegetables contributed the maximum share of farm income (42 to 45%). In Zone-IV about 85 per cent of the farm income is contributed by vegetable crops. This clearly shows that the degree of diversification increases with increase in the altitude *i.e.* high hills agriculture is more diversified than low hill areas.

Water sources and irrigation potential in Himachal Pradesh

It is also true that despite plenty of water resources in the state; only about 19 per cent area is under irrigation. It is a well known fact that 5 of the nation's main rivers originate in Himachal Pradesh irrigating 98 per cent land in Punjab, 84 per cent in Haryana, 40 per cent in Rajasthan and even across the international border in Pakistan. These rivers are Beas, Chenab, Ravi, Sutluj and Yamuna. Hence, the state and centre governments must initiate efforts to utilise this available water to irrigate cultivated area of 5.46 lakh ha. Wherever assured irrigation is available, diversification has picked up momentum. There is need to develop plans for bringing at least 10 per cent of the cultivated area under irrigation every year leading to 69 per cent over a period of 5 years (Sarial, 2016). Instead of major irrigation schemes, micro irrigation policy is more applicable in hills. This can be achieved by constructing micro rainwater harvesting structures, check dams and lift irrigation based on the feasibility.

The effect of irrigation on diversification is clearly visible through Table 4 showing that the area under cereal crops would reduce drastically with the development of irrigation infrastructure, while the area under vegetable crops would increase from just 6 per cent to 34 per cent. The irrigation will also lead to possibility of multiple cropping resulting in the increase in the cropping intensity.

Crop based opportunities for diversification

Presently, the productivity of cereals in Himachal Pradesh falls below the national average. The productivity of wheat in the state is in the range of 2 t/ha as against about 3t/ ha at the national level. Similarly in rice, the productivity at the state level is hovering around 1.5 t/ ha in comparison to 2.4 t/ ha at the national level. However, Himachal Pradesh enjoys comparative advantage in the productivity of vegetable crops that stands at 19.3 t/ ha in comparison to the national average of 17 t/ ha. This clearly shows the opportunities for diversifying farming by increasing area under vegetable crops.

Table 3. Annual gross household income from agriculture in different agro-climatic zones in Himachal Pradesh

Zone	Average income (Rs./ household)	Sectoral share (%)		
		Fields Crops	Vegetables	Livestock
Zone I	1,11,375	46.98	9.88	43.14
Zone II	87,469	24.57	41.81	33.62
Zone III	1,26,417	29.00	45.48	25.52
Zone IV	1,61,037	5.47	84.91	9.62
H.P	1,05,770	33.62	31.80	34.58

Source: Department of Agricultural Economics, Extension Education & Rural Sociology, CSKHPKV, Palampur.

The production of vegetables in the state has increased from 425 thousand tonnes in 1995-96 to a record level of 1692 thousand tonnes during 2017-18 (Table 5). This increase has been attributed to area expansion under vegetables because of major emphasis accorded to implementation of minor irrigation schemes in different parts of the state. During this period, the production of vegetable crops increased by about 8 per cent per annum out of which 7 per cent increase was contributed by increasing area under vegetables while the remaining 1 per cent was due to the increased productivity of these crops.

The impact study of the promotion of vegetable cultivation conducted under Japan International Cooperation Agency (JICA) project revealed that 9.69 per cent diversification through vegetable crops in low and mid hills (resulted in increased income of about 71 per cent beneficiaries', 57 per cent of beneficiaries reported increase household assets, 43 per cent used enhanced income for better education, 73 per cent had rise in social status while 52 per cent reported rise in nutritional security). About 35 per cent of the job seekers became self-employed. In case diversification increases from the 9.69% to the maximum of 30%, the per hectare income from vegetables is expected to increase by more than 200% (Anonymous, 2017).

The economics of different vegetable crops shown in the Table 6 revealed the prospects of enhancing farm income in the state. It has been found that capsicum grown in Solan gave gross return of Rs. 5,85,000/ ha and net return of Rs. 2,73,140. Similarly, green peas grown in Kinnaur gave the gross and net return to the tune of Rs. 4,97,745 and Rs. 2,49,446/ ha, respectively. The ginger crop cultivated in Sirmaur and Bilaspur resulted into the gross return of Rs. 3,61,850 and net return of Rs. 71,150. The tomato crop grown by the farmers in Solan and Sirmaur yielded gross return of Rs. 4,15,950 and net return of Rs. 43,861. Garlic is also emerging as a commercial crop in Sirmaur and Kullu districts and gave the gross and net return of Rs. 3,30,000/ ha and Rs. 47,386/ ha, respectively.

Table 4. Scope of Diversification with irrigation

Particulars	Without irrigation	With irrigation	Change
Cropping Pattern (%)			
Maize	38	25	-13
Wheat	42	25	-17
Pulses	10	5	-5
Oilseeds	4	3	-1
Vegetables	6	34	+28
Other crops	-	8	+8
Total cropped area (ha)	1.7	2.5	+0.8
Cropping intensity (%)	170	250	+80

Source: Department of Agricultural Economics, Ext. Education & Rural Sociology, CSK HPKV, Palampur

Table 5. Trends in Area, Production and Yield of Vegetable Crops in Himachal Pradesh, 1995-96 to 2017-18

Year	Area (000' ha)	Production (000' tonnes)	Yield (q/ha)
1995-2000	28.17	490.00	173.69
2000-2005	55.48	907.36	163.85
2005-2010	73.15	1253.82	171.43
2010-2015	84.68	1598.89	188.76
2016-2017	78.94	1653.51	209.46
2017-2018	78.68	1691.56	214.99

Source: Directorate of Agriculture, Shimla

The agro-climatic conditions of the state are also suitable for growing variety of exotic vegetables like asparagus, broccoli, lettuce, coloured capsicum, celery, Chinese cabbage, brussels sprouts, European carrot, parsley, leek, etc. During 2010-11, the off season vegetables crops were grown on 7,511 hectares area in tribal districts of Lahaul-Spiti and Kinnaur. Lahaul-Spiti and Kinnaur are the leading districts in the production of exotic off season vegetables.

There is also immense scope for diversification of maize-wheat cropping system by including vegetables in the cropping sequence in accordance with the suitability to a particular location/ zone (Table 7). Sarial (2016) reported that farm income can be increased manifold by adopting non-conventional improved cropping sequences. The cropping sequence like babycorn+ frenchbean-pea-summer squash would yield a net returns of Rs. 2,61,600/ ha per year (Rs. 10,900/ 0.5 ha/ month). Similarly, baby corn+asparagus bean-pea-summer squash may give net returns worth Rs, 2,89, 288 (Rs. 12054/0.5 ha/ month). Contrary to this, the net income from conventional maize–wheat cropping sequence has been significantly low. Therefore, shifting to non-conventional high value crops sequence especially in irrigated areas is required to increase or double farmers' income in the near future.

There are many other alternatives for diversification of traditional farming systems for enhancing production, reducing input cost and obtaining remunerative prices for farm products. Rising to the occasion, CSK HPKV started Niche Area of Excellence in Organic and Natural Farming since 2006. Since then, a number of technologies have been developed and more than 39000 farmers, covering an area of 19000 ha, have adopted organic farming. It is projected that 10% of the total cropped area of the state (94060 ha) would be converted into organic farming by 2020, which can help mitigate a total of 9855.61 ton CO_2 equivalent (104.78 kg carbon equivalent CO_2/ ha) annually. Zero Budget Natural Farming (ZBNF) is also one such practice which may increase the profit to farmers by reducing cost incurred on external inputs beside preventing poisoning of soil with hazardous fertilizers and chemicals. The university is carrying out different ZBNF activities including preparation of various ZBNF inputs (*Jeevamrita Ghan-jeevamrita, Beejamrita, etc.),* generating and disseminating ZBNF to farmers through Krishi Vigyan Kendras (KVKs). Two KVKs of the university located at Una and Kullu

Table 6. Returns from different vegetable crops (Rs/ ha)

Crop	Gross Returns	Net Returns
Capsicum (Solan)	5,85,000	2,73,140
Pea (Kinnaur)	4,97,745	2,49,446
Pea(Lahaul & Spiti)	3,14,750	1,05,400
Ginger (Sirmaur & Bilaspur)	3,61,850	71,150
Tomato (Solan & Sirmaur)	4,15,950	43,861
Garlic (Sirmaur & Kullu)	3,30,000	47,386

Source: Department of Agricultural Economics, Ext. Education & Rural Sociology, CSK HPKV, Palampur

Table 7. Diversification with remunerative cropping system

Cropping Sequence	Net returns (Rs./ha/year)	Net returns (Rs./0.5ha/month)
Maize-Wheat (traditional)	21,564	898
Babycorn + Frenchbean–Pea–Summer squash	2,61,600	10,900
Babycorn + Asparagus bean-Pea–Summer squash	2,89,288	12,054
Brinjal-garlic	38,131	1,588
Brinjal-Broccoli-Wheat	38,151	1,590
Okra-Radish-Onion	1,28,622	5,360

Source: Sarial (2016)

are actively engaged in generating and disseminating ZBNF techniques to the farmers.

It has been observed that with the adoption of ZBNF practices, the yields of pulses and oilseeds increased as compared to inorganic farming while the yields of cereal crops declined in the initial years. However with the passage of time cereal crops yields are also expected to increase with the improvement in the soil fertility and beneficial microbes (Table 8).

There are also ample opportunities to diversify mountain farming system by including fruit crops. During 2016-17, fruit crops occupied an area of 2.29 lakh hectares with the production of 6.12 lakh tonnes. Besides apple and citrus other fruits like, mango, litchi, pomegranate, strawberry, kiwi, pecanut and nectarine, etc. can be included to diversify horticulture. The area under these fruits is continuously increasing in the lower and mid hills as shown in Table 9.

Moreover, floriculture is also emerging as the profitable venture in the state. The area under floriculture crops has increased from 25 ha in 1993-94 to about 709 ha in 2016-17. The farmers are earning income to the tune of Rs. 9191.97 lakh annually from the cultivation of flower crops in the state.

Protected cultivation

The protected cultivation has not only raised the productivity of vegetables crops but also has opened up more avenues for diversification with season and year round supply of vegetables with remunerative prices to the growers. Protected cultivation is emerging as the future prospects of high-tech farming in the state because of the shrinking arable land and water resources. The studies conducted at various agro climatic locations of the state indicated high income potential from protected cultivation of vegetable crops. Different vegetable cropping systems produced substantial returns ranging from Rs. 47,000 to Rs. 50,000 from 250 m^2 area (Table 10). Similarly, cultivation of vegetable crops in kitchen gardening under backyard cultivation system under open condition or in small scale polyhouse will also help to maintain a round the year supply of vegetable *vis-à-vis* income to farming families.

Table 8. Yield of different crops under ZBNF and inorganic farming at CSK HPKV

Crop	Yield (q/ha)			
	2016		2017	
	ZBNF	Inorganic	ZBNF	Inorganic
Gram	12.0	9.6	8.8	7.2
Lentil	7.2	5.0	7.0	6.4
Soybean	12.4	11.8	16.4	15.1
Black gram	-	-	8.3	7.0
Red Mash	-	-	7.1	6.3
Wheat	20.0	22.0	26.0	26.6
Paddy	26.8	27.2	27.9	28.1
Ogla/ Phapra	-	-	9.2	9.5
Ragi	-	-	8.5	9.2

Source: Department of Organic Agriculture and Natural Farming, CSK HPKV, Palampur (2016-17)

Table 9. Trends in the area under new fruit crops in Himachal Pradesh

Fruit	Area(ha)			
	2013-14	2014-15	2015-16	2016-17
Kiwi	113	121	123	123
Pomegranate	2196	2332	2482	2670
Olive	37	36	34	34
Strawberry	54	55	55	54
Pecan nut	855	874	903	918
Mango	40298	41105	41523	41765
Litchi	4972	5231	5409	5673

Source: Department of Horticulture, Himachal Pradesh

Livestock rearing and ancillary enterprises for income diversification

Livestock forms an integral part of farming in hilly areas. There is a complementary relationship between crop production and livestock rearing. Livestock contributes 25-30% of the total farm income in Himachal Pradesh and it is the fastest growing sector with annual growth rate of 14.5 per cent per annum. Rearing of a *desi* cow is also a boon and basic requirement for adopting ZBNF practices because cow urine and cow dung are the major ingredients for preparation of various inputs (*Jeevamrita,Ghan-jeevamrita, Beejamrita, etc.)*. The working model of livestock herd as shown in Table 11 comprising 2 cows, 6 goats (5+1) and 50 poultry birds will generate gross annual income of Rs. 3.89 lakh and net income worth Rs. 98,000 (Rs. 8, 167/ month).

There are number of other ancillary enterprises that can be taken up to diversify farm income and employment in rural areas of the state. Such ancillary enterprises are beekeeping, mushroom production, vermi-compost unit and variety of food processing units. The cost and return structures of these enterprises have been shown in Table 12. These alternatives ensure sustained monthly net earnings to the tune of Rs.3000/ household to Rs. 39000/ household. Obviously, the ancillary enterprises will provide income and livelihood security to the rural households. This in turn may also reduce the rural migration which has become threat to sustainable agriculture.

Table 10. Returns from polyhouse crops

Location	Cropping system	Output (q)	Gross returns (Rs.)	Variable cost (Rs.)	Net returns (Rs.)	Output-input ratio
Palampur- Mid hill conditions						
Polyhouse-I (250m^2)						
Cropping season-I	Capsicum (March-November)	12.00	36000	17554	18446	2.05
Cropping season-II	Garden Pea (November-February)	5.50	11000	9834	1166	1.12
	Total		**47000**	**27388**	**19612**	**1.72**
Polyhouse-II (250m^2)						
Cropping season-I	Cucumber (March-August)	13.00	26000	16373	9627	1.59
Cropping season-II	Tomato (September-February)	12.00	24000	16476	7524	1.46
Total			**50000**	**32849**	**17151**	**1.52**

Source: Sharma *et al.* (2015)

Table 11. Livestock farming

Proposed working model per household	=	Cattle = 2, Goats = 5 + 1 (buck) Poultry = 50
Gross Earning (Rs) /annum	=	3,89,000
Net Earnings (Rs) per annum	=	98000
Net earnings Rs. per month	=	8167

Source: Sarial (2016)

Table 12. Ancillary enterprises available for income and employment diversification

Enterprises	Proposed working model/ household	Cost fixed/ variable (Rs.)	Gross earning (Rs. /annum)	Net earnings (Rs./annum)	Net earnings per month (Rs.)
Apiculture	Colonies = 50 (large scale)	Fixed cost 1.52 lakh (stationary colonies) to 1.86 lakh (migratory) and variable cost 0.54 to 0.87 lakh	0.99 to 1.94 lakh	0.22 to 0.77 lakh	1834 to 6417
	Colonies = 10 (small scale)	0.40 lakh	0.50 lakh	0.30 lakh	2500
Mushroom (Two crops Oct. - March & One summer)	No. of bags = 200	Fixed cost.40000 and variable cost 13500	0.60-0.70 lakh	0.35 to 0.57 lakh	3000-4750
Vermicompost	Size = 12 x 5 x 2.5 cu. Ft 5 units	Fixed cost 90000 to 1.80 lakh and variable cost 22500	90000	67500	5625
Bakery confectionary	500 sq.ft.	Fixed cost 1.30 lakh and variable cost 7.16 lakh	8.69 lakh	1.53 lakh	12,700
Beverages	1000 sq.ft	Fixed cost 2.84 lakh and variable cost 8,05 lakh	9.77 lakh	1.72 lakh	14,334
Papad	300 sq.ft	Fixed cost 1.80 lakh and variable cost 8.10 lakh	9.83 lakh	1.73 lakh	14,335
Pickle	1000 sq.ft	Fixed cost 2.19 lakh and variable cost 8.40 lakh	10.19 lakh	1.79 lakh	15,000
Jam, Jelly and Murabba	1000 sq.ft	Fixed cost 2.34 lakh and variable cost 4.89 lakh	6.32 lakh	1.43 lakh	12,000
Wheat flour mill	300 sq.ft.	Fixed cost 1.36 lakh and variable cost 2.94 lakh	3.57 lakh	0.63 lakh	5,600
Frymes Manufacturing	1000 sq.ft.	Fixed cost 2.29 lakh and variable cost 22.00 lakh	26.70 lakh	4.70 lakh	39,000
Soya Milk, Paneer & Curd	1000 sq.ft.	Fixed cost 2.38 lakh and variable cost 9.98 lakh	11.69 lakh	1.71 lakh	14,175
Organic produce/ grain packaging	2000 quintal	Fixed cost 3.13 lakh and variable cost 33.15 lakh	35.98 lakh	2.83 lakh	23,600

Source: Sarial (2016)

Suggested strategies to enhance farmers' income

The farmer's income in Himachal Pradesh can be increased by adopting 3 pronged strategy as given in Table 13. The farm income can be increased through the growth in production, ensuring higher prices of the produce and income/ employment diversification in non-farm sector. The income can also be increased by reducing cost of production by replacing the use of purchased inputs (through efforts like Zero Budget Natural Farming) and exploring the advantage of enterprise complementarities leading to exchange of byproducts as inputs. The farm income can be stabilized by expansion in irrigation facilities to reduce yield shocks and implementing the crop insurance scheme on easy terms and flexibility. Diversification endevour will not be successful until there are targeted technological interventions. For enhancing productivity and production of crops, matching with all India average under irrigated production system and doubling farmers' income

under rainfed conditions, there is a need for diversification with high value cash crops, improving fertility of land and reducing cultivation cost with techniques like ZBNF/ Organic Farming.

There is a need for breeding varieties and management practices as adaptation strategies to cope up with climate change. Genetic enhancement approaches are required to develop crop varieties with traits like high yield, resource use efficiency, yield stability and tolerance to biotic/ abiotic stresses. The scientific approaches like genetic variation, natural variations, germplasm resources, induced variations, mutant resources and genomic assistance breeding need to be used as the advance tools for developing crop varieties.

Diversification shall also play an important role in doubling farmer's income by 2022 as envisioned by the Prime Minister of India. In this regard, diverse agro-climatic conditions can prove to be advantageous to produce diversified crops in off-season when there is no competition in plains. Moreover, small holdings have become uneconomic for production of food grain crops. As such, there is high demand for fruits and vegetables produced in hills since these are produced with low or no use of chemicals or pesticides (and these are organic by default).

There is no denying the fact that the extent and degree of diversification may vary depending upon critical factors desirable for backward and forward linkages as shown in Figure 2. These factors *inter alia* determine the processes of diversification in a region (Sharma *et al*. 2004; Sharma, 2005).

Table 13. Strategies to enhance farmers' income

Enhance gross income through	Reduce costs through	Stabilize income through
1.Production growth	1.Reduce purchased inputs	1.Coping up mechanism
2.Higher prices	2. Exploit complementarities	2.Insurance
3.Diversify/Non-farm income		3.Expansion in irrigation

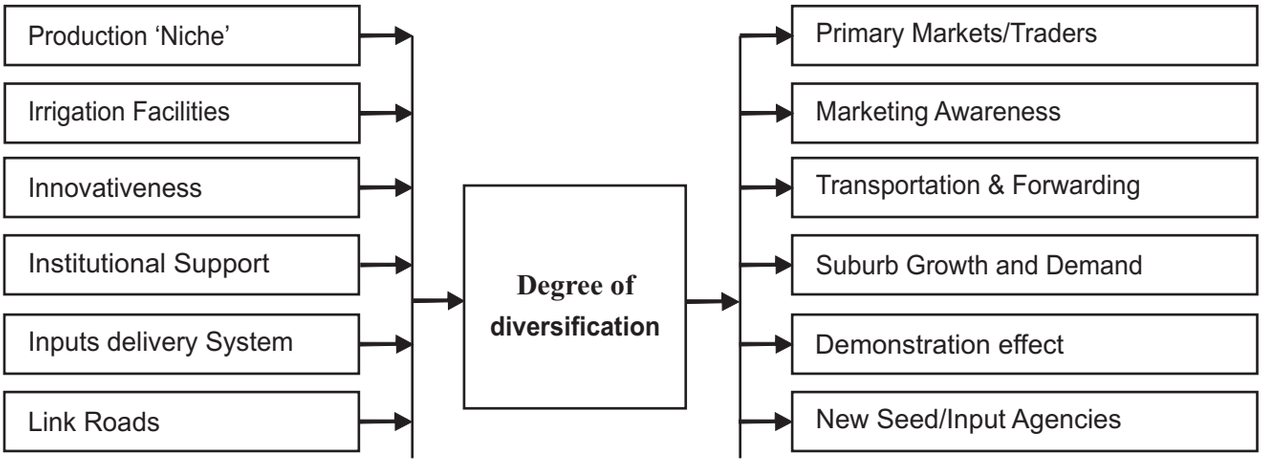

Fig.2. Backward and forward linkages determining degree of diversification in Mountain Farming System (MFS) and suggested strategies to enhance farmers' income

Harnessing production niches, creating irrigation facilities, strengthening institutions and input delivery systems followed by development of markets, transportation facilities and expansion of processing industries would provide impetus to high growth and high income diversification in the state.

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