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Impact of Himachal Pradesh and Japan International Cooperation Agency Crop Diversification Promotion Project on farmers' income and food security-An appraisal

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Abstract

A Crop Diversification Promotion Project (CDP) was implemented in Himachal Pradesh (HP) with the collaboration of the Japan International Cooperation Agency-Official Development Assistance (JICA-ODA) in 2012. It lasted for 7 years with the objective to improve the socio-economic status of farm families. The operational area had 210 sub project sites spread over five districts viz., Bilaspur, Hamirpur, Kangra, Mandi and Una of the state. The project was implemented following a comprehensive package of multi-pronged strategy encompassing infrastructure development (such as irrigation, farm access roads, markets, etc.), inputs supply (seeds, fertilizers, farm machinery, etc.) supported by technical and capacity building programmes and strengthening of extension services and organized marketing. The impact study on socio-economic status of farm families was carried out based upon the extensive review of information collected from the status reports and evaluation studies conducted by different agencies in the operational area. Study revealed that CDP project has been quite successful in improving the socio-economic status of farm families across project sites. There has been increase in the irrigated area and the area under vegetable crops. Cropping pattern changed resulting into 35-50 per cent of the farms being highly diversified with 50 per cent of the area under vegetable crops. In general, the extent of diversification was 9.69 per cent for vegetables crops in Mid and Low Hills under HPCDP-JICA project. Farm productivity and income increased by more than 3.5 times over the baseline income. In some cases increase in income was 5-6 times. The increase in income was attributed to several contributing factors and interventions carried out under HPCDP initiatives. Major contributors were found to be assured irrigation, capacity building programmes, introduction of improved varieties/ cultivation practices and proper/ balanced use of nutrients. Operational farm efficiency also registered improvement due to use of improved tools and machinery provided under the project. Overall, the project enhanced the cropping intensity, productivity, production and marketed surplus. Keeping in view, the impact on raising income and food security of farm families, it is advocated to expand the HPCDP domain to cover farm families in all districts of Himachal Pradesh.

Key words: Crop diversification, HPCDP sub project, production of vegetable crops, growth rates, gross income, impact factors, input-output ratio.

Crop diversification is viewed as the shift from the regional dominance of few crops to number of crops which takes into account the enhancement of economic returns with complementary marketing opportunities offered through regional advantage. Diversification is fuelled both by demand and supply side forces. Changes in product-mix and input uses are determined largely by the market forces during this transition (Pingali and Rosegrant 1995).

There are visible and concrete implications of diversified production on food availability, nutrition and food security as evidenced through the studies conducted in Malawi (Jones *et al*. 2014). The agricultural diversification has been found to be directly associated with household dietary diversity

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thereby having strong policy implications. The policy support from the government enhanced small holder's agricultural productivity to improve the food security (Mazunda *et al.* 2015). The evidence from high hills in India clearly suggests that apple cultivation strengthened the purchasing power of farmers to buy quality food. Agricultural diversification towards fruit and vegetable crops, especially in high hill areas started in the late sixties, which gathered pace in the seventies and eighties and further momentum in the late nineties (Sharma 2005).

The diversification has been found to enhance individual and social gains besides livelihood security. Cultivation of remunerative crops rewards farmers with better income which enhances their purchasing power to buy food. There are many options through use of technology to increase the productivity of crop in a sustainable way, giving due emphasis to ancillary enterprises, agro-processing and institutional/ market support to double the farmers' income in Himachal Pradesh by 2020 (Sarial 2016). The results reflect growing importance of diversification into higher-value crops and facilitating further diversification involves institutional development to better link small farmers with growing markets for high-value commodities (Joshi *et al*. 2006) and enhanced purchasing in turn leads to positive impact towards family and child nutrition (Bhagowalia *et al.* 2012). Agricultural diversification towards high value crops or commercial crops such as vegetables, potato, sugarcane, horticultural crops and fibre crops potentially rewards the farmers with high income in India (Birthal *et al.* 2007).

Himachal Pradesh has emerged as a model for hi-tech diversification in the country and has a unique advantage for producing off-season vegetable commodities that fetch lucrative prices in markets outside the state due to better quality and off-season supply. All this has been made possible by adopting a well thought out and executed development strategy of the Government of Himachal Pradesh. As a result of continuous endeavours, the production of off-season vegetables like green pea, tomato, cabbage, cauliflower, French bean, capsicum, etc., has emerged as the money spinner in the state. Recently, to promote diversification, the state government with the help of various national and international financial institutions and development agencies undertook several initiatives and policy measures and Himachal Pradesh Crop Diversification Promotion Project (HPCDP) is one of these initiatives. The first phase of this project was started in 2012 aimed at promoting crop diversification in the target areas of five districts namely, Bilaspur, Hamirpur, Kangra, Mandi and Una through multi-pronged strategy of infrastructure development such as irrigation facilities, farm access roads supported by technical and capacity building programmes for vegetable cultivation, food grain production, post-harvest technology and strengthening of extension services and marketing. The operational area of HPCDP has been depicted through Fig. 1.

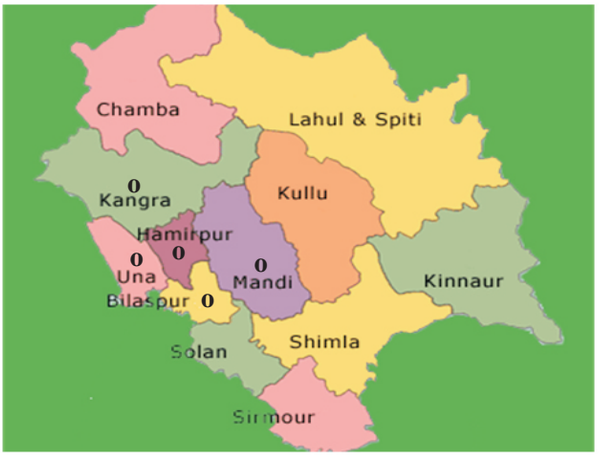

Fig. 1. Operational area (o) of HPCDP Project in Himachal Pradesh

The main objectives of this study are:

i. To examine the diversification progress achieved under HPCDP (JICA-ODA) project in Himachal Pradesh

ii. To examine the impact of HPCDP project on cropping pattern, productivity and farm income in target districts.

Methodology

To accomplish the project objectives, as many as 210 irrigation schemes in the target area were executed that created a CCA of 4671.10 hectares. During the course of implementation of this project, many evaluation and monitoring studies were conducted by State Agricultural University and other agencies including field functionaries of HPCDP (JICA-ODA). The main focus of HPCDP has been on the diversification of agriculture with cash crops mainly vegetables. Therefore, the analysis is focused mainly on vegetable crops. Thus, this paper is based upon the

extensive review of such studies conducted in target districts mainly focusing on promotion of diversification through vegetable crops.

The compound growth rates (CGRs) were estimated to analyses the changes in the area, production and productivity of vegetable crops over the years. The significance of growth rates was tested by employing student's 't' test. The tabular techniques like proportions and ratios were computed to interpret the results.

Agricultural scenario and challenges in Himachal Pradesh

Himachal Pradesh is a dynamic hilly state of Indian Union having an area of 55,673 sq km and a present population of 7.54 million (Dec. 2019). About 90 per cent of its population lives in rural areas where agriculture and allied activities are the main livelihood options. The state has witnessed tremendous overall growth post 1990s and has strong socio-economic parameters with a per capita income of Rs.176968. The landscape in the state provides diverse agro-climatic conditions ranging from sub-tropical to dry temperate. Though a large territory of state constitutes forests, pastures and grazing lands, yet the topography, soil and the climate, provide vast opportunities for agricultural and allied activities. Agriculture is the main occupation of the people in Himachal Pradesh and as such has an important place in the state economy. It provides direct employment to about 62.85 per cent of total workers in the State. Agriculture is an important source of state income, and contributes around 9.0 per cent to the Gross State Domestic Product (GSDP). Land holdings are being increasingly rendered uneconomic and unprofitable for farming in the state due to fragmentation. There are 960.75 thousand operational holdings in the state with an average holding size of 0.99 hectare. The distribution of land holdings according to 2010-11 Agricultural Census shows that 87.95 per cent of the total holdings belong to small and marginal farmers (Anonymous (2018; 2019).

Due to hilly terrain, the farm mechanization has remained limited to plains and valley areas though considerable progress has been made over time. The overall extent of farm mechanization in the state, in terms of the number of agricultural implements per 1000 ha of gross cropped area, increased continuously from 1,543 machines in 1972-73 to 76,817 in 2011-12. The number of tractors and power tillers per 1000 ha of net sown area also increased from 0.06 in 1972 to 17.74 till 2002 (Kumar *et al.* 2018). However, still several farm operations are performed manually. This calls for developing hill specific farm tools and small machinery to reduce drudgery and save time/cost of farm operations.

Patterns of crop diversification with vegetables

There are myriad of opportunities for vegetable based crop diversification in Himachal Pradesh though there are also several challenges (Sarial 2019). The state has witnessed visible degree of transition and diversification towards commercial vegetable crops as revealed in Table 1 and Fig. 2. It is quite evident that area under food grains crops reduced from 815 thousand hectares in 2000-01 to about 765 thousand hectares in 2015-16 thereby showing decrease of about 6.13 per cent. Contrary to this, the area under vegetable crops increased from 46 thousand hectares to about 77 thousand hectares showing an increase of about 67.39%. The area under potato crop decreased and did not show consistent pattern while production reduced and productivity rise was marginal and inconsistent. In case of food grain crops despite reduction in area, the production increased from 1108 thousand tonnes to 1634 thousand tonnes exhibiting 47.47 per cent rise. The rise was attributed mainly to enhanced productivity of food grain crops from 1.36 t/ha in 2000-01 to 2.14 t/ha in 2015-16. The production of vegetables increased by 123.5 per cent from 740 thousand tonnes to 1654 thousand tonnes during this period. The rise in production was attributed to two factors: i) enhanced productivity from 16 t/ ha to 21.5 t/ ha and ii) increase in area from 46 to 77 thousand hectares. It is evident the diversification through vegetable crops has been consistent during the last one and half decade. Since 2010-11 it got intensified on launch of various schemes to diversify agriculture in the state. It is also evident from Fig. 2 that after 2009-10 onwards, total vegetable production (including potato) has exceeded total foodgrain production in Himachal Pradesh.

Table 1. Changes in area, production and productivity of food grains and vegetable crops in Himachal Pradesh, 2000-01 to 2016-17

Year	Food grains*			Vegetables			Potato		
	Area ('000ha)	Production ('000t)	Productivity (t/ha)	Area ('000ha)	Production ('000t)	Productivity (t/ha)	Area ('000ha)	Production ('000t)	Productivity (t/ha)
2000-01	814.70	1108.41	1.36	46.00	740.00	16.09	30.44	216.20	7.10
2005-06	787.91	1469.60	1.87	49.86	929.98	18.65	16.20	162.56	10.03
2010-11	793.96	1264.79	1.59	65.08	1263.90	19.42	15.26	205.97	13.50
2011-12	788.05	1549.40	1.97	67.97	1356.60	19.96	11.84	152.98	12.92
2012-13	789.53	1554.89	1.97	68.87	1398.05	20.30	14.63	182.88	12.50
2013-14	774.71	1585.15	2.05	72.00	1465.96	20.36	19.20	205.28	10.69
2014-15	755.21	1546.81	2.05	73.89	1576.45	21.34	14.69	181.38	12.35
2015-16	764.85	1634.05	2.14	75.23	1608.55	21.38	18.02	183.25	10.17
2016-17	NA	1745.00	NA	76.95	1653.56	21.49	21.08	202.44	9.60

* Provisional data for 2014-15 to 2016-17
Source: Anonymous (2018)

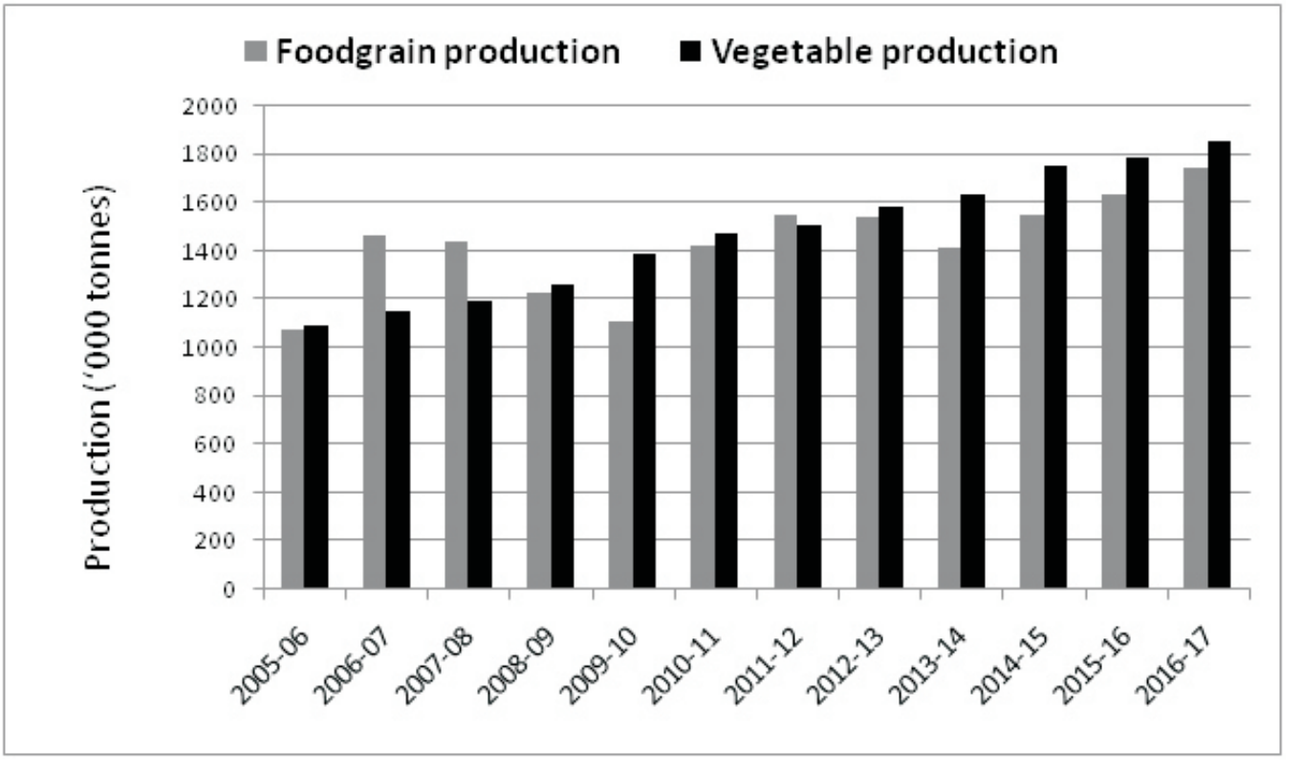

Fig. 2. Trends in production of foodgrains and vegetables in Himachal Pradesh

The agro-climatic conditions of Himachal Pradesh exhibit unique blending of sub-tropical to sub-temperate to temperate and dry temperate/ alpine regions, thus offering myriad of opportunities for production of different crops in different seasons/ regions and same crop in different seasons. The crop based opportunities and comparative productivity potential with respect to the country has been presented in Table 2.

Table 2. Crop based opportunities for diversification

Crop	Area (lakh ha)	Productivity (t/ha)	
		State	National
Wheat	3.5	2.0	3.0
Maize	3.0	2.3	2.6
Rice	0.76	1.5	2.4
Barley	0.23	0.9	
Pulses	0. 30	1.0	0.73
Total	9.46	1.5	
Vegetables	0.88	19.3	17.0
Oilseeds	0.49	1.0	0.9

Source: Agri. Statistics at a Glance, 2016

Pea, potato and tomato are the predominant crops in terms of area and production. Pea crop can be grown in summer season as well as in winter season, thus ensuring year round supply. During 2016-17 total area under pea crop was around 23965 hectares. Similarly, potato is grown as summer season as well as winter season crop with a total area of 21080 hectares. In tomato introduction of hybrid varieties has revolutionized its production exhibiting an increase accounting for about 25 per cent of the total vegetable production in the state. This attainment has been mainly due to significant increase in productivity. Cauliflower, cabbage and beans have been grown by the farmers since 1980s largely in mid-hill regions with cropping intensity of 200 to 300 per cent. Besides, a large number of other summer and winter season vegetable crops namely; capsicum, chillies, okra, brinjal, cucurbits, garlic, onion, radish, turmeric, etc. offer plethora of opportunities for diversification in different parts of the state. With the introduction of precision farming and Crop Diversification promotion (CDP) initiatives, the vegetable based opportunities have increased tremendously. Further the prevailing congenial climate in the region has given impetus for cultivation of even exotic vegetables like broccoli, lettuce, brussels sprouts, kale, red/ yellow cabbage, etc. Consequently, lured by lucrative returns and facilitation through positive government policy initiatives, the process of diversification would yield discernible progress in the future ahead.

Growth scenario of vegetables

Since the launch of important schemes namely HPCDP (JICA-ODA) and precision farming (protected cultivation) in 2010-11, the growth scenario of vegetable crops in the state improved. There was a significant increase in area (3.51%) and production (4.14%) under all vegetable crops. Tomato, pea and other vegetables crops showed increase in area, production and productivity while the potato crop revealed decrease in productivity that might be due to incidence of diseases and pests in the recent years (Table 3).

Table 3. Growth in area, production and yield of vegetable crops in Himachal Pradesh, 2010-11 through 2016-17

(% per annum)

Crops	Area	Production	Productivity
Potato	6.69*	1.08	-5.26**
	(3.04)	(2.14)	(1.19)
Tomato	2.26**	4.23**	1.92**
	(0.34)	(0.64)	(0.47)
Peas	0.48	1.47*	0.98*
	(0.25)	(0.53)	(0.39)
Others vegetables	4.47**	5.94**	1.40**
	(0.25)	(0.39)	(0.16)
Total	3.51**	4.14**	0.61
	(0.50)	(0.23)	(0.49)

** Significant at 1% and * Significant at 5% level of significance

Figures in parentheses indicate standard errors of growth rates

Bharathi (2019) predicted that area under cereal crops would decrease marginally from 81.23 per cent (2010-11) to 80 per cent (2020-21) indicating that cereal crops would continue to dominate in rainfed area in the state. In contrast, the area under vegetable crops is expected to increase from 8.56 per cent (2010-11) to 11.52 per cent (2020-21) signifies the diversification (Table 4). The area under other crops mainly fruits is also expected to increase marginally while under pulses would decrease drastically. The predicted scenario is a clear pointer towards diversification in the near future.

Impact of Crop Diversification Promotion Project

Crop Diversification Promotion (CDP) Project jointly implemented by HP and JICA has been a success story model in the state. HPCDP Status Report had documented success stories of 25 sub-projects on the basis of their performance rating evaluated by field functionaries. These sub-project models across different districts determined the extent to which diversification could enhance the farm income in the target districts. District Bilaspur registered an increase in gross farm income from INR 272586 to INR 577355 followed by Una INR 354627 to INR 507269. Across all five districts of the project, gross farm income increased by 4 to 8 times ranging from INR 207835 to INR 577355. This remarkable rise in farm income resulted due to diversification replacing cereals with vegetable crops. Through diversification maximum area brought under vegetable crops was in Mandi district (16.66% to 88.24%) followed by Kangra (22.98% to 68.75%), Una (29.32% to 58.00%), Bilaspur (27.36% to 38.36%) while minimum in Hamirpur (32.35% to 36.53%). The diversified area includes both replaced as well as non-cultivable where no vegetable cultivation was practiced prior to project implementation in the villages (Table 5).

Table 4. Actual and predicted area under different crop groups in Himachal Pradesh

Crops	2010-11		2020-21	
	Area (ha)	% Share	Area (ha)	% Share
Cereals	762.35	81.23	750.64	80.00
Pulses	31.62	3.37	9.03	0.96
Vegetables	80.13	8.56	101.82	11.52
Other crops (Mainly Fruits)	64.21	6.84	70.71	7.52

Source: Bharathi (2019)

Table 5. Performance of some selected HPCDP (JICA-ODA) sub-projects model in Himachal Pradesh

Target Districts	No. of model sub-projects studied	Range of gross income (INR/ ha)		% area brought under vegetable crops
		Before HPCDP	After HPCDP	
Bilaspur	3	40420-50441	272586-577355	27.36-38.36
Hamirpur	2	49775-74750	207835-280786	32.35-36.53
Kangra	10	50162-99366	258550-390275	22.98-68.75
Mandi	7	36762-77113	240750-378367	16.66-88.24
Una	3	58362-60822	354627-507269	29.32-58.00

Source: HPCDP Status Report of 25 Sub-Projects Model Vol. I, Department of Agriculture, HP, 2019

In other studies by Sharma *et al.* (2020) and Kumar *et al.* (2020), the extent of diversification on sample farms under project and non-project areas showed moderate to high degree of farm diversification in Kangra and Mandi districts of Himachal Pradesh (Table 6). These studies showed that 58 per cent and 73 per cent of the sample beneficiary farmers had more than 25 per cent of the total cropped area under vegetables in Kangra and Mandi districts, respectively. The area under vegetable crops due to diversification ranged from 32.17 per cent in Kangra to 49.63 per cent Mandi in project area as compared to 2.50 per cent and 17.57 per cent in non project area, respectively.

Impact of Crop Diversification Promotion (CDP) project on area, productivity and farm income has been summarized district-wise in particular and over all in general (Table 7). In general, the area under cereal crops decreased in target districts and increased under vegetable crops indicating diversification. Vegetable cultivation occurred on irrigated land through project interventions. Overall, kharif season cereal crops area decreased by 32.39 per cent from baseline 4034.25 ha to 2727.71 ha while rabi season crops by 31.25 per cent from baseline 3997.45 ha to 2748.38. Conversely, the area under vegetable crops increased by 91.38 per cent from baseline 121.22 ha to 1406.42 ha during kharif season and by 88.44 per cent from baseline 153.35 ha to 1326.39ha during rabi season. Impact of diversification interventions such as creating assured irrigation facilities and adoption of improved technological practices enhanced the productivity of both cereals and vegetable crops as shown in Fig. 3. Productivity of kharif cereal crops increased by 35.93 per cent from baseline 18.83 q/ ha to 29.39 q/ ha, rabi cereal crops by 35.03 per cent from baseline 18.36 q/ ha to 28.26 q/ ha, kharif vegetable crops by 30.78 per cent from baseline 13.18 t /ha to 19.04 t/ ha and rabi vegetable crops by 27.94 per cent from baseline 12.64 t/ha to 17.54 t/ha. On the whole, the productivity of cereals increased by about 33 per cent (over baseline) and that of vegetable crops by 42 per cent. As a result, the gross annual average farm income has risen by 348.82 per cent from baseline Rs. 52804/ ha to Rs. 236994/ ha. District-wise increase in gross-income (over baseline) was highest (378.89%) in Mandi followed by Kangra (370.40%), Bilaspur (303.94%), Una (255.04%) and Hamirpur (231.39%). The data thus revealed the vivid impact of crop diversification in raising income of the farmers to the tune of 3.0 to 3.5 times per hectare (Fig. 4). Besides diversification, the rise in income was attributed to higher production of food grains from reduced area under cereal crops and substantial marketed surplus of vegetable crops from enhanced area.

Table 6. Extent of diversification on sample farms under project and non-project areas in Kangra and Mandi districts

Sr. No.	Degree of Diversification (% vegetable area)	Farmers (%)			
		Kangra		Mandi	
		Project area	Non-project area	Project area	Non-project Area
1.	Highly diversified (50-100%)	35.00	-	50.00	16.50
2.	Moderately diversified (25-50%)	22.50	-	22.50	3.00
3.	Less diversified (15-25%)	15.00	2.50	17.50	10.50
4.	Least diversified (<15%)	27.50	97.50	10.00	70.00
5.	Per cent area under vegetable crops	32.17	1.96	49.63	17.57

Source: Sharma *et al.* (2020) and Kumar *et al.* (2020)

Table 7. District wise impact of HPCDP project on area, productivity and farm income

District	CCA (ha)	Season	Baseline vs. present status	Cereal		Vegetables		Gross annual Average farm income (Rs./ ha)	
				Area (ha)	Productivity (q/ ha)	Area (ha)	Productivity (t/ha)	Baseline	Present
Bilaspur	319.36	Kharif	Baseline	262.1	17.68	2.72	12.4	50371	203471
			Present	221.71	26.18	61.34	22.31		
		Rabi	Baseline	266.7	17.68	2.3	11.85		
			Present	206.38	30.8	71.04	16.55		
Hamirpur	453.88	Kharif	Baseline	437.48	18.28	0.54	10.4	57842	191681
			Present	295.81	27.63	82.9	15.37		
		Rabi	Baseline	438.9	18.28	0.38	10.4		
			Present	277.85	26.56	103.36	15.2		
Kangra	2441.06	Kharif	Baseline	2155.13	19.27	65.2	11.85	46193	217291
			Present	1603.04	31.05	570.69	16.82		
		Rabi	Baseline	2108.66	18.7	86.73	12.92		
			Present	1544.25	29.99	569.95	18.64		
Mandi	1261.5	Kharif	Baseline	1024.21	18.77	49.11	15.21	63724	305165
			Present	478.92	24.71	652.41	21.55		
		Rabi	Baseline	1018.2	17.3	60.65	12.4		
			Present	610.45	22.3	487.18	17.75		
Una	194.84	Kharif	Baseline	155.33	16.57	3.65	10.63	57175	202993
			Present	128.23	35.77	39.08	12.21		
		Rabi	Baseline	164.99	21.89	3.29	10.28		
			Present	109.45	36.61	94.86	13.21		
Overall HPCDP Project	4670.6	Kharif	Baseline	4034.25	18.83	121.22	13.18	52804	236994
			Present	2727.71	29.39	1406.42	19.04		
		Rabi	Baseline	3997.45	18.36	153.35	12.64		
			Present	2748.38	28.26	1326.39	17.54		

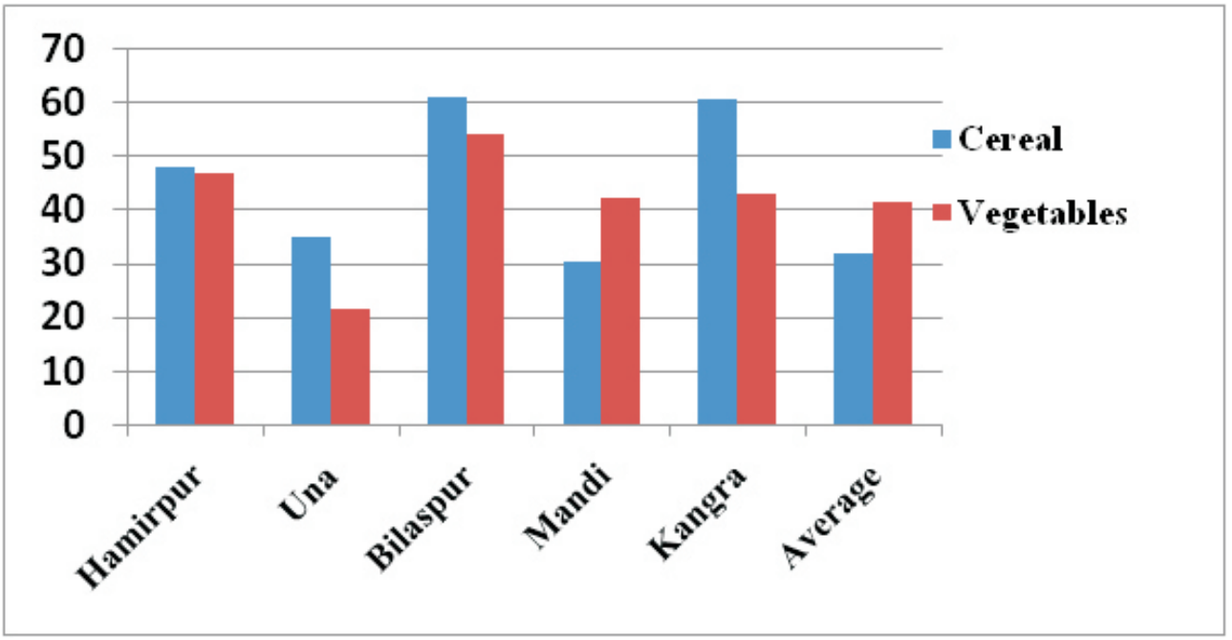

Fig.3. Productivity (%) increase of cereals and vegetables

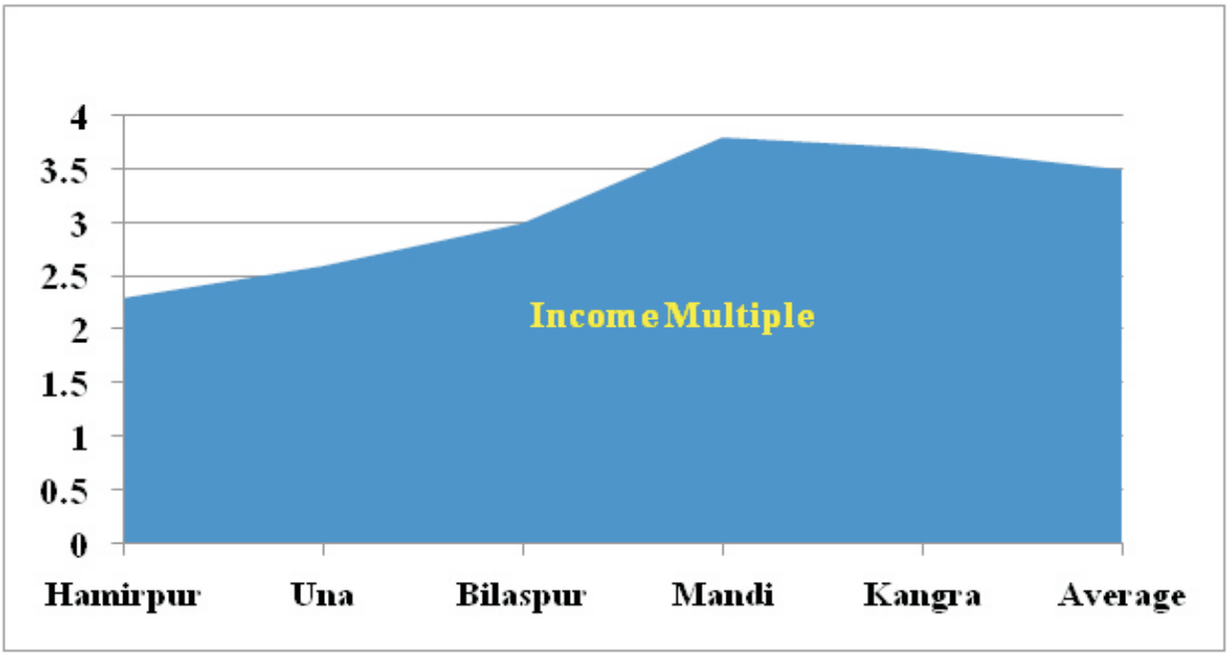

Fig. 4. Gross annual average increase in farm income

Impact of diversification on efficiency

In a study conducted by the Department Agriculture Economics, CSK HPKV, Palampur, 71 per cent of the beneficiaries reported rise in their income, 57 per cent had improved household assets through enhanced income, 43 per cent utilized enhanced income for better education of children, 73 per cent admitted rise in social status, 52 per cent in nutritional security, 35 per cent turned job seekers to job providers, 11 per cent empowered to supply seed and planting material while 33 per cent adopted to grow vegetable crops in 30 to 50 per cent area. In general, the extent of diversification was 9.69 per cent for vegetables crops in Mid & Low Hills under HPCDP-JICA project (Chauhan *et al*. 2017).

Kumar *et al.* (2018) reported that the use of power tiller in land preparation and sowing operations resulted in time saving to the tune of 340 per cent over bullocks, cost to the tune of 95 per cent over hired bullock and 208 per cent over owned pair of bullock (Table 8). Similarly, the use of power operated spray pumps for weed, insect- pest and disease management reduced the cost to the extent of 233 per cent over manual spray pumps. Hence, this calls for more incentives towards farm mechanization so as to boost commercial farming in the state by laying more stress on high tech, precision, labour saving, farm machinery and tools.

Factors contributing rise in crop productivity and farm income

In CDP project the rise in crop productivity and farm income has been attributed to several factors and interventions. Assured irrigation facility created under the project contributed 30 to 90 per cent, capacity building through knowledge and expertise with respect to selection of varieties and improved cultivation practices 10 to 70 per cent and corrective measures such as reduced use of urea, balanced use of nutrients and application of recommended fertilizers doze 10 to 80 per cent. Operational efficiency in farm operation due to mechanization with improved tools and implements had accomplished four mandays work in one mandays while labour cost scale down from INR 600 to INR 100. Plant protection measures to control insect-pests had 30 to 70 per cent increase in the productivity of both cereals and vegetable crops. In addition, growing of more number of crops per unit area and time enhanced cropping intensity (Table 9). All this had been possible due to concerted efforts of the field functionaries, facilitation services and technical guidance to the farmers enabling them to take up commercial cultivation of vegetable crops on a large scale.

Input use efficiency

Input use efficiency in project and non project area of project district Mandi and Kangra was compared (Table 10) by Sharma *et al.* (2020) and Kumar *et al.* (2020). In Kangra input use efficiency (output-input ratio) was remarkably greater in project area ranging from 1.23 to 2.65 than in non project area which varied from 0.86 to 1.63. Input use efficiency among cereal crops was greater in project area which ranged from 1.49 to 2.07 than in non project area varying from 1.12 to 1.63. In Mandi input use efficiency was also greater in project area ranging from 1.02 to 6.89 than in non project area which varied from 0.56 to 7.97. Input use efficiency among cereal crops was greater in project area which ranged from 1.73 to 3.46 than in non project area varying from 1.28 to 2.11. In both the districts majority of the vegetable crops had 1.52 to 2 times higher input use efficiency in project area over non-project area. Thus crop diversification in the project area not only raised productivity and production but improved input use efficiency too due to various technological interventions.

Table 8. Financial efficiency of farm machinery and cost saving

Farm operations	Amount (INR /ha)	Cost saving over owned bullocks (%)
A. Ploughing operation		
Owned bullocks		
Cost of maintenance of bullocks	37734	
Human labour	7500	-
Total	50805	
Hired bullocks		
Bullocks charges	18570	94.88
Human labour	7500	
Total	26070	
Hired power tiller		
Power tiller hiring charges	13504	207.83
Human labour	3000	
Total	16504	
B. Interculture and spraying	**Amount (INR/ha)**	**Saving in cost over manual sprayer (%)**
Labour use with manual sprayer	1500	-
Labour use with power operated sprayer	450	233.33

Source: Kumar *et al.* (2018)

Table 9. Factors contributing rise in crop productivity and farm income

Factor	Contribution
Assured irrigation facility	30% to 90%
Enhancement in knowledge and expertise w.r.t. cultivation and type of varieties to be grown	10 to 70%
Corrective measures w.r.t. use of fertilizers (reducing use of urea and application of recommended fertilizers)	10 to 80%
Efficient use of farm power machinery, tools and implements in farm operations	4 days work done in 1 day
Reduction in costs of labour for farm operations	Rs. 600 to Rs. 100
Controlling insect pest attack	20/30% to 70%
Growing more number of commercial crops (Sugarcane & potato to radish, cauliflower, peas, tomato, etc.)	Four crops of radish and three crops of cauliflower

Source: HPCDP Report, 2018

Table 10. Relative output-input ratio of different crops in project and non-project area

Crops	Kangra		Mandi	
	Project area	Non-Project Area	Project area	Non-Project area
Cereal crops				
Maize	1.49	1.12	1.73	1.28
Paddy	1.51	1.36	1.84	1.59
Wheat	1.66	1.39	1.82	1.28
Barley	2.07	1.63	3.46	2.11
Summer vegetables				
Lady finger	1.98	1.10	3.76	3.15
Bitter and bottlegourd	1.94	1.05	-	-
Frenchbean	1.37	0.91	1.72	2.96
Cucumber	2.65	1.10	3.85	-
Potato	-	-	1.02	0.56
Cauliflower	-	-	3.51	-
Peas	-	-	6.89	7.97
Winter vegetables				
Cauliflower	2.38	1.23	4.27	2.26
Potato	2.71	1.07	2.13	1.09
Peas	2.02	1.75	3.98	4.5
Tomato	-	-	6.04	-
Onion	1.48	1.17	2.75	1.91
Garlic	1.23	0.86	3.39	1.32

Source: Sharma *et al.* (2020) and Kumar *et al.* (2020)

Conclusion

Impact of HPCDP project has been quite successful in improving the socio-economic status of farm families across project sites. There has been increase in the irrigated area and the area under vegetable crops. Cropping pattern changed resulting into 35-50 per cent of the farms highly diversified with 50 per cent of the area under vegetable crops. The farm productivity of vegetable crops increased by about 42 per cent while income increased by more than 3-5 times over the baseline income. The increase in income was attributed to several contributing factors and interventions carried out under HPCDP initiatives. Operational farm efficiency also registered improvement due to the use of improved tools and machinery provided under the project. Overall, the project enhanced the cropping intensity, productivity, production and marketed surplus. Therefore, considering the impact on raising productivity and income, project operational area should be expanded to cover farm families in all districts of Himachal Pradesh to realize the benefits of tested technology and endeavors of the project.

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