Crop Diversification and Determinants: A Study of Himachal Pradesh

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Abstract
Crop diversification is a widely advocated means for agricultural and rural development. Crop diversification is a concept, which is opposite to crop specialization. It implies shift from subsistence farming to commercial farming or from low value food crop to high value food or noon-food crops. The level of diversification largely depends on the agro-climatic/ socio-economic condition and technological developments in a region. Also government support, institutional support and domestic demand play a significant role in diversification. For instance, the creation of the technology mission on oilseed by the government of India gave push to oilseeds production. The specific price related support also encourages crop area shifts. The article shows that in Himachal Pradesh diversification has taken place toward the high value crops i.e. fruits and vegetables and shows this occurs because of infrastructure development and other institutional development.
Key Words:

Introduction

Agriculture continues to be the mainstay of the people in Himachal Pradesh, because there are limited chances of development of secondary and tertiary sector due to geographical conditions prevail in the state. Due to the different agro-climatic condition, Himachal has comparative advantage in the horticulture crops such as off-season vegetables and fruits (like apple). Himachal Pradesh is situated in the high altitude of Himalayan region. It is impossible to implement the highly agricultural technology in this region, however it possible in some region which is adjournment to the plain area. As stated above the state has potential to off-season vegetables and other horticulture crops compatible with the prevailing climatic condition. Keeping in mind the limited scope of secondary and tertiary sector, there needed to be agriculture growth in the state. Like our country, in Himachal Pradesh most of the rural population is depend on the agriculture and it is the major source of income. Crop diversification will help the farmers in terms of increase in income, living standard, employment opportunity of all the agricultural labours, with incentivize remunerative. By taking in to account the potentiality of high horticulture crops in which state has comparative advantage the state government

implemented various programmes and schemes such as Accelerated Maize Development Programme, Vegetable Development Programme, Ginger Development Plan, for the development of agriculture in the state. The budgetary allocation toward the agriculture is high in all the planning period, due to all these efforts make by the government, the state agriculture has diversified toward the high value crops such as vegetables and off-season crops (Kumar, 2007a; b). But the magnitude of diversification is not same among the districts, hilly region is more developed and attributed it that the farmer in this region has more diversified from traditional crops to the highly cash crops, as compare to the lower region, the socio-economic condition of the middle hilly region is better than the other region, due to the high pace of diversification (Sharma 2007). The Himachal Pradesh has limited scope of the extension of cultivated area, because of their topographic feature; the only scope for the agriculture growth is increasing productivity of high cash crops and spread the pace of diversification with different agro climatic condition in the state. The air of present study is (i) to estimate the magnitude of crop diversification for each districts in Himachal Pradesh during the last three decades and (ii) to study the factors that determines crop diversification in the state and there implication

Data sources and methodology:

For the purpose of above mention objectives the data sources are Annual Season and Crop Report, Issued by the Directorate of Land Record, Government of Himachal Pradesh, Statistical outline of H.P, District Abstract, Directorate of Economics and Statistic Government of Himachal Pradesh, Directorate of Agriculture, Himachal Pradesh and census data. On the basis of above mention objectives the trends and nature of cropping pattern for the 1980 to 2004-05. To examine the crop diversification, various methods are available in the literature. The most commonly used methods are Herfindal index.

Herphindal index (Kumar 2007a, b) is defined as

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

pi = Proportion of area under i th crop

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

in which Ai = Area under i th crop and $\sum_{i=1}^{n} Ai$ = Total cropped area.

The value of HI-index varies between 0 to 1. It is one in case of perfect specialization and zero in case of perfect diversification.

To examine the determinants of crop diversification multiple OLS regression method have been applied by taking proportion of gross cropped area under horticulture, as dependent variable and road length per 100sq.km, bank per thousand population, cropping intensity, percentage of village electrified, rainfall index, fertilizer consumption kg/hectare and proportion of irrigated area as independent variables.

The functional form of the regression model is the log-linear of the following form:

$$\log Y = \beta_1 + \beta_2 Log X_2 + \beta_3 Log X_3 + \beta_4 Log X_4 + \beta_5 Log X_5 + \beta_6 Log X_6 + \beta_7 Log X_7 + \beta_8 Log X_8 + \mu_i$$

Where, Y= Proportion of area under horticulture crops to GCA, X_2 = Cropping Intensity, X_3 = Proportion of Irrigated Area to GCA, X_4 = Fertilizer Consumption kg/hectare, X_5 = Percentage of village electrified, X_6 = Bank branch per thousand populations, X_7 = Literacy Rate, X_8 = Road density per 100sq km. However, as per the Durbin-Watson "d" test a positive auto correlation was observed in the estimation in some districts. The Cocharine-Orcutt method, AR (1) has been applied to correct the same in the following form.

$$Log(Y_t - \rho Y_{t-1}) = \beta_1(1 - \rho) + \beta_2 Log(X_t - \rho X_{t-1}) + \beta_3 Log(X_t - \rho X_{t-1}) + \cdots + e_t$$

Where, t and t_{-1} shows the current and lagged value of the variable, respectively. It assumes error term follows AR (1) scheme, namely,

$$U_t = \rho U_{t-1} + et \quad \text{which means et} = \quad (U_t - \rho U_{t-1}), \ (-1 < \rho < 1).$$

Magnitude of Diversification

This section focuses on the magnitude of diversification in all districts of Himachal Pradesh (Table 1). To see the extent of diversification in the state the herfindal index has used. As it is clear from the table that, in the state crop diversification has taken place and the value of index is decreasing all over the period. The value of crop diversification in first period was 0.25, which shows crop diversification and over a period of time its value is decreasing all the period reached to 0.23 in the last period. It shows that diversification has taken place in the state as a whole. But when the district level data analysis takes place, the mixed result has been found in the diversification index. The result has been given in Table No.1.District-wise crop diversification from 1980 to 2004-05 can also from the Figure 1.

It is clear from the figure that crop specialization has taken place in the Kinnaur in recent years, which is one of the tribal area of Himachal Pradesh that is situated in the high altitude where the agro-climatic condition is different, and is not suitable to grow all crops as compared to other districts. Except Lahual and Spiti, Shimla and Sirmaur district

all other districts show high diversification in 80s and a trend towards crop specialization in recent years as the diversification index is moving towards one in these districts. In Lahual and Spiti district diversification was taken place in 90s and started moving towards specialization in recent years. The districts lie in mid hill region such as Shimla, Solan and Sirmaur are moving towards diversification in recent years. The herfhindal index in all other districts is increasing over time. It reveals that crop specialization is taking place in these districts. However the pace of specialization is slow.

Table No. 1 Crop Diversification Index of all Districts in Himachal Pradesh: 1980-81 to 2004-05

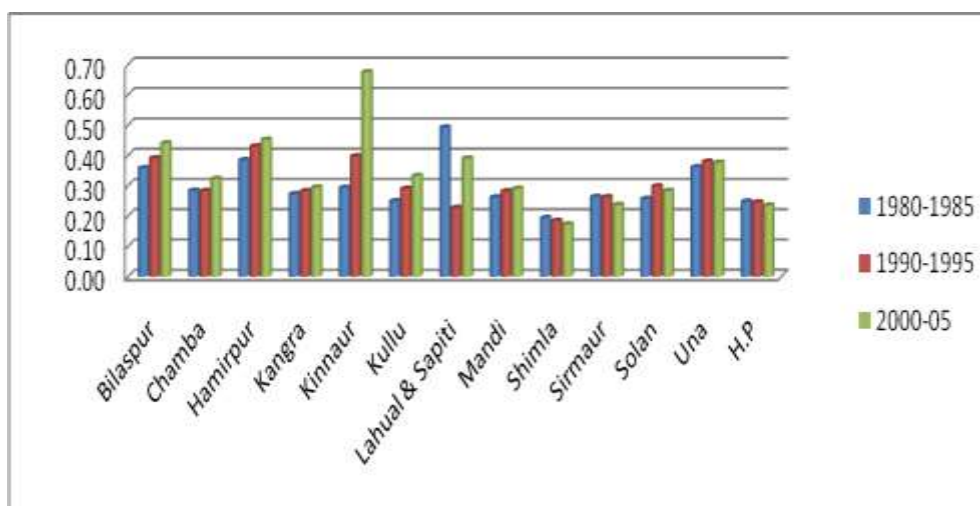| Districts	H.I				
	1980-1985	1985-90	1990-1995	1995-00	2000-05
Bilaspur	0.36	0.38	0.39	0.42	0.44
Chamba	0.28	0.28	0.28	0.30	0.32
Hamirpur	0.38	0.42	0.43	0.44	0.45
Kangra	0.27	0.28	0.28	0.29	0.29
Kinnaur	0.29	0.31	0.40	0.47	0.67
Kullu	0.25	0.26	0.29	0.32	0.33
Lahual & Sapiti	0.49	0.19	0.23	0.26	0.39
Mandi	0.26	0.26	0.28	0.29	0.29
Shimla	0.19	0.18	0.18	0.19	0.17
Sirmaur	0.26	0.26	0.26	0.25	0.24
Solan	0.26	0.26	0.30	0.28	0.28
Una	0.36	0.36	0.38	0.38	0.38
H.P	0.25	0.24	0.24	0.23	0.23

Figure 1 District-wise Crop diversification in HP, 1980-81 to 2000-05

Broad findings indicate that diversification has taken place towards horticulture crops in the state over a period of time. The magnitude of diversification was high in1980s in all districts of Himachal Pradesh. Only in Kinnaur district crop specialization has taken place in favour of apple that too in recent period. The districts falling under the plain area like Hamirpur, Bilaspur and Una are moving towards specialization in cereals. In these districts area under cereals i.e. wheat and maize constitutes more than seventy percent and is increasing over a period of time. The district falling in hilly region namely Kinnaur, Lahual and Spiti and Kullu districts are moving towards specialization in terms of horticulture crops, but diversification index of Solan and Shimla districts is more or less same over a period of time.

Determinants of Crop Diversification in Himachal Pradesh

It is clear from literature that both demand and supply side factors influence crop diversification. The process of diversification out of staple food production is triggered by rapid technological change, improved rural infrastructure and diversification in food demand pattern (Joshi, Gulati, Brithal 2004). Market availability and price are equally important for diversification. The agronomic condition in a given region such as physical and geographical feature, climatic factors etc. are also important factors which influence the cropping decisions of producers (Vayas 1996). The delivery system of inputs, proper information, credit facilities and institutional arrangement also facilitate the process crop diversification.

In the case of Himachal Pradesh, literature on diversification reveals that it has taken place in favor of horticulture crops in early 1980s. District level analysis shows that area under horticulture crops in all the districts is increasing over a period of time except some lower plain district where specialization towards the food grain is taking place. The implementation of many development strategies, along with improvement in road connectivity, rural electrification, health and education has been playing a major role in the diversification process. Secondly a network of institution was created in Himachal Pradesh and in turn that facilitated the process of crop diversification such as Himachal Pradesh. For instance, the set up of Himachal Pradesh horticulture Produce Marketing and Processing corporation in 1971 with the help of Word Bank provides post-harvest infrastructure facilities. Along with HPMC, various other institutions were also created as Research and Development institutions, co-operative societies, food grower societies in Kullu and Shimla districts and market facilities are also playing a prominent role.

An attempt has been made to examine the determinants of crop diversification at the district level from 1980-81 to 2004-05 in the state. The extent of crop diversification, measured by proportion of gross cropped area under horticulture, has been taken as dependent variable, and road length per 100sq.km, Bank branches per thousand population/ number of Bank, cropping intensity, percentage of village electrified, rainfall index, fertilizer consumption kg/hectare and proportion of irrigated area to GCA as independent variables. Crop prices are not taken due to non- availability of time series data on farm prices of many crops in the districts. Alternative regression model have been

tried to address the problem of multicollinearity among the independent variables. The regression is run in by- log form.

Table 2 presents the estimated results. In Bilaspur district, first model implies that cropping intensity and irrigated area are positively related to area under horticulture crops, which means that one percent increase in irrigated area and fertilizer consumption per hectare will increase area under horticulture crops to 2.83 percent and .46 percent respectively. In second model, percentage of village electrified and road density is positively related to area under horticulture crops with elasticity of 1.21 percent and 1.19 percent respectively.

In Chamba district percentage of irrigated area, fertilizer consumption per hectare and percentage of village electrified are positively related to area under horticulture crops with elasticity at .837 percent, .484 percent and .982 percent respectively. Cropping intensity is positively related, but statistically insignificant. In model two, Bank branch per thousand population and road density is positively related to area under horticulture crops with elasticity at 1.05 percent and 2.13 percent respectively.

In Hamirpur district first model implies that cropping intensity, irrigated area and fertilizer consumption per hectare is positively related to area under horticulture crops. It reveals that one percent change in cropping intensity, irrigated area and fertilizer consumption would increase area under horticulture crops by 9.28 percent, 1.36 percent and .83 percent respectively. Percentage of village electrified and road density have positive coefficient with elasticity at 1.70 percent and 1.86 percent respectively.

In Kangra district cropping intensity, irrigated area, fertilizer consumption per hectare and number of bank is positively related to the area under horticulture crops, implies that one percent increase in all these variables will increase area under horticulture crops to 1.02 percent, 1.97 percent, .392 percent, .464 percent and .932 percent respectively. In Kinnaur, first model reveals that irrigated area and road density is positively related to area under horticulture crops with elasticity at 1.04 percent and 2.06 percent respectively, fertilizer consumption and number of bank positively related, but statistically insignificant. According to second model, percentage of village electrified and literacy rate is positively related.

In Kullu district, first model implies that cropping intensity and fertilizer consumption is positively related to area under horticulture crops with elasticity at 1.11 percent and 0.224 percent respectively. In second model, percentage of village electrified and road density is positively related with elasticity at 0.409 percent and 0.909 percent respectively. In Lahual and Spiti districts percentage of village electrified is positively related to area under horticulture crops with elasticity at 0.801 percent, other variables such as cropping intensity, irrigated area and fertilizer consumption per hectare show positive result, but are statistically insignificant in first model. In second model number of bank, literacy rate and road density are positively related to area under horticulture crops and are statistically significant with elasticity at 0.30 percent, 0.60 percent, and 0.77 percent respectively.

Table 2 Determinants of Crop Diversification at District Level from 1980-81 to 2004-05

Village		Cropping Intensity	Total Irrigated Area	Fertilizer Consumption	Village Electrified	Bank Branch	Literacy Rate	Road Density	Constant	Adj. R^2	D.W.
Bilaspur	I	1.56 (0.64)	2.83 (3.95)*	0.46 (3.96)*					-13.80 (-1.11)	0.76	1.51
	II				1.21 (7.57)*			1.19 (9.50)*	-8.43 (-17.28)	0.95	1.96
Chamba	I	1.84 (1.26)	0.837 (2.32)***	0.484 (2.51)**	0.982 (2.82)*				-13.87 (-1.79)	0.62	1.84
	II					1.05 (4.63)*		2.13 (3.36)**	-2.45 (-0.91)	0.87	1.03
Hamirpur	I	9.28 (2.93)*	1.36 (2.50)***	0.843 (4.40)*					-52.18 (-3.19)	0.71	0.94
	II				1.70 (4.5)*			1.86 (8.43)*	-14.61 (-9.48)	0.86	0.5
Kangra	I	1.02 (24.74)*	1.97 (4.41)*	0.392 (2.35)**	0.464 (2.04)**	0.932 (5.61)*			-10.64 (-5.62)	0.97	2.49
	II										
Kinnaur	I		1.04 (2.78)*	0.031 (1.08)		0.106 (1.37)		2.06 (10.89)*	-4.93 (-4.37)	0.95	2.39
	II				0.119 (2.15)**		1.55 (8.0)*		-2.35 (-3.95)	0.94	1.41
Kullu	I	1.11 (2.34)**	0.099 (0.67)	0.224 (3.98)*					-2.46 (-1.03)	0.63	0.64
	II				0.409 (4.20)*			0.909 (11.06)*	-.085 (-0.47)	0.93	1.85
Lahual	I	0.94 (1.08)	6.10 (1.59)	0.020 (0.15)	0.801 (5.78)*				28.31 (.98)	0.61	2.14
	II					0.303 (-1.28)	0.608 (2.88)*	0.778 (2.14)**	-.077 (-0.08)	0.72	2.09
Mandi	I	3.41 (3.24)**	0.241 (0.23)	0.884 (5.92)					-18.23 (-3.26)	0.81	1.33
	II						2.00 (2.96)**	0.068 (2.28)*	-3.00 (-4.98)	0.91	2.21
Shimla	I	.496 (1.35)	0.011 (2.09)**	0.119 (2.22)**	0.963 (9.22)*				-2.096 (-1.04)	0.89	1.54
	II					0.335 (2.31)**		0.629 (2.20)**	.867 (1.11)	0.83	2.25
Sirmaur	I	1.43 (2.31)**	0.018 (2.04)**	0.041 (0.75)			0.884 (5.92)*		-12.97 (-2.77)	0.96	1.84
	II				0.063 (1.05)			0.964 (2.15)**	-6.04 (-7.14)	0.91	2.24
Solan	I	2.65 (3.57)*	2.59 (2.99)*			1.20 (2.16)**			-4.52 (-1.50)	0.46	1.91
	II										
Una	I	0.844 (3.36)	0.447 (5.91)*	0.314 (4.64)*		0.446 (3.39)*			-4.24 (-2.41)	0.97	2.08
	II				0.794 (3.12)*			1.36 (4.79)*	-7.61 (-15.16)	0.93	0.85

In Mandi district, cropping intensity and fertilizer consumption are positively related to area under horticulture crops with elasticity at 3.41 percent and 0.88 percent respectively, and is statistically significant. In second model literacy rate and road density are positively related to area under horticulture crops with elasticity at 2.00 percent and 0.068 percent respectively.

In Shimla district first model reveals that irrigated area, fertilizer consumption and percentage of villages electrified are positively related to area under horticulture crops with elasticity at .011 percent, 0.119 percent and 0.963 percent respectively. Cropping intensity positively related to area under horticulture crops, but is statistically insignificant. Bank branch and road density is positively related to area under horticulture crops with elasticity at 0.335 percent and 0.629 percent respectively.

In Sirmaur district cropping intensity, irrigated area and literacy rate are positively related to area under horticulture crops with elasticity at 1.43 percent, 0.018 percent and 0.884 percent respectively. Fertilizer consumption is also positive, but is statistically insignificant. In second model, percentage of village electrified and road density is positive with elasticity at 0.063 percent and 0.964 percent respectively, but the former variable is statistically insignificant.

In Solan district, cropping intensity, irrigated area and Bank branch per thousand populations are positively related to area under horticulture crops with elasticity of 2.65 percent, 2.59 percent and 1.20 percent respectively. In Una district cropping intensity, irrigated area, and fertilizer consumption per hectare and Bank branch per thousand populations are positive with elasticity of 0.844 percent, 0.447 percent, 0.314 percent and 0.446 percent respectively. In second model, percentage of village electrified and road density are positively related to area under horticulture crops with elasticity of 0.794 percent and 1.36 percent respectively.

From the above discussion, it may be concluded, that agricultural variables like cropping intensity, irrigation facility and availability of fertilizer have played a major role in diversification towards high value horticulture crops in all the districts except few where cropping intensity is low due to harsh climatic conditions which makes impossible to grow crops more than once in a year. Besides the infrastructure development has also equally played a major role in the agriculture diversification in Himachal Pradesh as is revealed in most of the studies. Road connectivity is extremely important in this hilly region to facilitate the diversification towards high value horticulture crops, because of road connectivity farmers are easily carrying out their product to market and getting better price of their product, which incentivize them to produce more of high value crops. Infrastructure development which has taken place in Himachal Pradesh has also positively facilitated crop diversification towards high value horticulture crops.

Conclusion

The analysis of crop diversification reveals that diversification has taken place towards high value horticulture crops at the cost of coarse cereals in Himachal Pradesh. The district level analysis indicates that crop specialization in favour of apple has taken place

only in Kinnaur in recent years, which is one of tribal area, situated at high altitude where the agro-climatic condition is different, and is not suitable to grow all crops as compared to other districts. Except Lahual and Spiti, Shimla and Sirmaur district all other districts were highly diversified in 80s and have moved towards specialization in recent years. In Lahual and Spiti district diversification took place in 90s and started moving towards specialization in recent years in favour of horticulture crops. The districts lie in mid hill region such as Shimla, Solan and Sirmaur, the magnitude of diversification is very high as compared to other districts. Most of districts which lie in plain regions, crop specialization towards cereals have taken place. However the pace of specialization is slow. The inter crop diversification reveals that in Himachal Pradesh, among the cereals the diversification has taken place toward the wheat and maize at the cost of millet and barely. Pulses are perfectly diversified. Horticulture crops are also perfectly diversified in the state, but moving towards specialization in favor of apple and other sub-temperate fruits at the cost of area under the other temperate fruits.

Among the districts Hamirpur, Bilsapur, Chamba and Una are moving towards specialization in favor of maize and wheat among cereals, while all other districts present diversification in cereals. Horticulture crops are perfectly diversified in majority of districts. Only Kinnaur district is moving towards specialization in favour of apple at the cost of other horticulture crops. In three districts, namely Bilaspur, Hamirpur and Una where apple is not produced, area under other sub-temperate fruits has increased more than other horticulture crops. In Lahaul and Spiti district too, area under potato and other pulses which include green pea, are increasing more than all other horticulture crops. It may be concluded from the finding that in Himachal Pradesh/ districts crop diversification has taken place in favour of horticulture crops. The magnitude of diversification was high in the 80s in most of districts except a few districts in high and mid hill region which gathered pace of diversification in nineties and early 2000. However, some districts in hilly region are showing specialization in favour of horticulture crops, while districts in the plain regions are moving towards specialization in favour of cereals.

Empirical evidence on the determinants of crop diversification in each district reveals that road connectivity; rural electrification, education facilities, availability of low cost inputs, irrigation facilities, and institutional arrangement have played a major role in crop diversification in Himachal Pradesh. Secondly cropping intensity has also contributed in diversification towards high value horticulture crops in all the districts except a few where cropping intensity is low due to unfavourable climatic condition which makes impossible to grow crops more than once in a year.

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