

Agricultural diversification in Himachal Pradesh: An economic analysis

Nisha Devi¹, R.S. Prasher²

*Department of Social Sciences, Dr. Y.S Parmar University of Horticulture and Forestry, Nauni Solan,
Himachal Pradesh – 173230, India
nishathakuroachghat@gmail.com¹, r.prasher@rediffmail.com²*

Abstract

Objective: The study about diversification in agriculture has been carried out to explain extent and trend of agriculture diversification and to know about the factors affecting the agriculture diversification in the State of Himachal Pradesh.

Methods: The present study explain the extent and trend of diversification using Simpson Index and percentage of area under non-food grain crops applied on the data collected from reliable sources throughout the State that widens the scope for improvement and development in agriculture. Step wise linear regression method was carried out for data collected from 1972-73 to 2011-12 to find out the drivers of crop diversification.

Findings: Kinnaur, Lahaul & Spiti, Shimla and Sirmour districts of Himachal Pradesh witnessed tendency towards diversified agriculture at varying extents. Diversification towards high value cash crops in most of the districts did take place but its intensity was quite pronounced in Lahaul & Spiti, Kinnaur, Shimla and Kullu where the increase in area under the non-food grains was varied from 17.18% in Kullu to 57.47% in Kinnaur over 1972-73.

Application: Average size of land holding, regulated market infrastructure and irrigated area were the important determinants, which were positively related with the crop diversification. Agriculture diversification is an option to stabilize and raise farm incomes of the farmers in the study area.

Keywords: Herfindahl Index, Simpson Index, Regression analysis, Vegetables, Agriculture diversification.

1. Introduction

The diversification of agriculture towards selective high-value cash crops including fruits and vegetables, compatible with the comparative advantage of the region, is suggested as a viable solution to stabilize and raise farm incomes, increase employment opportunities for small and marginal farmers, boost exports and conserve and enhance the natural resource base, principally land and water [1-5]. It achieves the stability of income because even if the return from one crop is low, the return from another will be high as it is famously quoted “never to put all your eggs in one basket” [6]. Crop diversification is one of the means to minimize the risk due to climate change and maximize the use of land. The diversification in agriculture is also adopted for avoiding or minimizing the adverse effects of the current system of crop specialization and monoculture for better use of resources, recycling of nutrients and regaining the soil fertility [7-9]. The diversification becomes necessary for developing countries since growing of basic staples such as cereals alone cannot support economic development, notwithstanding the need to ensure food security to the people. The performance of the Indian agricultural sector in terms of income generation and diversification has followed an unsteady path and showed huge variations between different geographical locations across the country at the disaggregated level [10].

Himachal Pradesh is now in the third phase of agricultural development where it is paying more attention to agricultural diversification and productivity enhancement. The state budgets proclaimed with reinforced vigour that “the agriculture sector occupies centre-stage to promote inclusive growth, enhance rural incomes and sustain food security and nutritional security. Therefore, the policy makers in the state have been focusing on the need for crop diversification in favour of higher value crops as major strategy of agricultural development.

This is because, with an increase in per capita income, the demand for food grains is likely to grow at also rate as compared to high value crops like horticultural commodities. The policy makers feel that the agriculture diversification not only provides opportunities for increasing farm incomes significantly, but also likely to put less pressure on natural resources which leads towards sustainable development of agriculture.

2. Methodology

All the secondary information at district and state levels were collected from State Department of Agriculture, National Horticulture Board, and Directorate of Land Records, Directorate of Economics and Statistics, State Agricultural Marketing Board and various other published sources of the government (Economic Survey, Annual Season and Crop Reports, Statistical Outlines and District Statistical Abstracts) for the period 1972-73 to 2011-12.

Herfindahl Index (H.I). Herfindahl Index is computed by taking sum of proportions of each activity in the economy. It ranges between 0 to1.

$$H.I. = \sum_{i=1}^N P_i^2$$

Where N is total number of crops and P_i represents acreage proportion of the i^{th} crop in total cropped area. With the increase in diversification, the Herfindahl Index would decrease. It ranges between 0 to1. HI assumes the value 0 at full diversification and 1 at full concentration. Simpson Index (1-H.I.): It is also used in the present study.

$$S.I. = 1 - \sum_{i=1}^N P_i^2$$

It ranges between 0 to 1. SI assumes the value 1 at full diversification and 0 at full concentration. To find out the determinants of diversification, the multiple step wise linear regression analysis was carried out by using the secondary data for the selected period from 1972-73 to 2011-12. Herfindahl Index of crop diversification was regressed on the selected explanatory variables as specified in the function below. The significance of coefficients of each of the variable from the estimated function were tested with the help of 't' statistics.

$$Y = a_0 + b_1X_1 + b_2X_2 + \dots + b_nX_n + u$$

Where:

Y = Herfindahl Index (D)

X_1 = Annual Rainfall (mm)

X_2 = Per cent area under high yielding cereals crops

X_3 = Fertilizer use (kg/ hectare)

X_4 = Per cent of gross irrigated area to gross cultivated area

X_5 = Road Length (Sq. Km/1000 hectares of gross cropped area)

X_6 = Mechanization (Number of tractors per 1000 ha of gross cropped area)

X_7 = Per cent of urban population

X_8 = Per capita Income (Rs.) at constant price

X_9 = Average size of land holding (ha/farm)

X_{10} = Number of regulated markets (per 1000ha of gross cropped area)

U = Error term

3. Results and Discussion

Extent of Diversification: The extent of crop diversification in Himachal Pradesh during 1972-73 to 2011-12 as measured by Simpson index has been presented in Table 1. It is clear from the table that agriculture in the state remained highly diversified over the years from 1972-73 and 2011-12 with marginal tendency towards specialization as denoted by the decreasing values of Simpson index. This implied that farmers in the state are still growing several crops instead of specialization in a few crops. Small size of operational holdings and fear from risk might be, among others, the main restraints to the specialization of agriculture in the state. However, analysis of Simpson indices over a period from 1972-73 to 2011-12 revealed that Kinnaur, Lahaul & Spiti, Shimla and Sirmour were the districts depicting a trend towards diversified agriculture at varying extents. The pace of specialization was observed to be the highest in Hamirpur and the lowest in Kullu during the study period. Likewise, the highest rate of diversification was recorded in Kinnaur and the lowest in Shimla over the study period. Low holding size and highly risky hill agriculture could be the factors hindering crop diversification in the state.

Table 1. Temporal and spatial extent of crop diversification in Himachal Pradesh: 1972-73 to 2011-12

| District/Index | Simpson Index (SI) | | | | |
|----------------|--------------------|---------|---------|---------|---------|
| | Periods | | | | |
| | 1972-73 | 1981-82 | 1991-92 | 2001-02 | 2011-12 |
| Bilaspur | 0.695 | 0.656 | 0.602 | 0.57 | 0.567 |
| Chamba | 0.747 | 0.726 | 0.691 | 0.718 | 0.714 |
| Hamirpur | 0.742 | 0.63 | 0.565 | 0.547 | 0.538 |
| Kangra | 0.747 | 0.741 | 0.72 | 0.71 | 0.697 |
| Kinnaur | 0.703 | 0.932 | 0.805 | 0.855 | 0.703 |
| Kullu | 0.787 | 0.792 | 0.77 | 0.775 | 0.78 |
| Lahaul&Spiti | 0.738 | 0.741 | 0.778 | 0.771 | 0.664 |
| Mandi | 0.76 | 0.888 | 0.713 | 0.714 | 0.696 |
| Shimla | 0.816 | 0.838 | 0.828 | 0.807 | 0.689 |
| Sirmour | 0.748 | 0.735 | 0.734 | 0.757 | 0.788 |
| Solan | 0.75 | 0.744 | 0.713 | 0.706 | 0.682 |
| Una | 0.718 | 0.642 | 0.615 | 0.634 | 0.604 |
| HP | 0.785 | 0.752 | 0.757 | 0.741 | 0.726 |

These indices were also worked out to examine diversification within different crop groups' viz., cereals, pulses, fruits, vegetables, non-food group and all crops together for the State at different periods of time and the results are presented in Table 2. Cereal group includes rice, wheat, barley, maize, common & minor millets and other cereals. Pulses group includes gram, green gram, red gram, black gram, horse gram, maser, other kharif pulses, other rabi pulses. Fruit group includes apple, peaches, pears, plum, litchi, kinnow and orange, other citrus fruits mangoes, guava, and other fresh fruits, walnut, almonds and other dry fruits. Vegetable group includes potato, brinjal, pea, sweet potato, tomato, lady finger, cauliflower & cabbage, turnip, radish, carrot, other winter vegetables and other summer vegetables.

Table 2. Simpson Index (SI) of different crop groups in HP

| Year | Crop groups and Simpson Index (SI) | | | | | |
|---------|------------------------------------|--------|--------|------------|----------------|-------------|
| | Cereals | Pulses | Fruits | Vegetables | Non-food crops | Total Crops |
| 1972-73 | 0.695 | 0.68 | 0.446 | 0.409 | 0.826 | 0.785 |
| 1981-82 | 0.658 | 0.725 | 0.451 | 0.496 | 0.802 | 0.752 |
| 1991-92 | 0.632 | 0.669 | 0.413 | 0.517 | 0.788 | 0.757 |
| 2001-02 | 0.625 | 0.625 | 0.442 | 0.738 | 0.774 | 0.741 |
| 2011-12 | 0.616 | 0.585 | 0.317 | 0.795 | 0.773 | 0.726 |

It is evident from table that situation with regard to cereals has remained almost same as shown by the values of Simpson index for this crop group which ranges from 0.695 to 0.616. Similar trend was observed in case of pulses and non-food crops, though the value of Simpson index differs between these crop groups. The table reflects some definite trend of diversification in the vegetable group where the Simpson index value has shown an increasing trend from 0.409 in 1972-73 to 0.795 in 2011-12 indicating thereby the clear trend of diversification.

In so far as changes in the process of crop diversification at the state level are concerned, the area share of food grains has shown a declining trend between 1972-73 and 2011-12 (Table 3). Within cereal group, the area under paddy declined in the initial stages but stabilised at around 8% thereafter. The shift in the acreage under paddy could not make much headway, because of slow growth in irrigation base and due to shift of irrigated area towards high value vegetable crops in the state. However, maize and wheat has shown an increasing share in the gross cropped area but barley, other cereals, oilseeds and pulses declined by varying degrees, during this period.

Table 3. Temporal changes in cropping pattern in Himachal Pradesh from 1972-73 to 2011-12

| Crops/ Year | 1972-73 | 1977-78 | 1982-83 | 1987-88 | 1992-93 | 1997-98 | 2002-03 | 2007-08 | 2011-12 |
|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Rice | 10.50 | 10.9 | 9.45 | 9.25 | 8.42 | 8.73 | 8.81 | 8.16 | 8.05 |
| Maize | 28.16 | 29.11 | 30.1 | 30.78 | 31.91 | 31.62 | 30.98 | 31.15 | 31.54 |
| Wheat | 34.30 | 34.30 | 39.20 | 38.50 | 38.90 | 38.26 | 38.03 | 38.05 | 38.19 |
| Barley | 4.55 | 4.04 | 3.94 | 3.23 | 2.79 | 2.81 | 2.5 | 2.44 | 2.21 |
| Other cereals | 5.90 | 4.13 | 3.40 | 2.85 | 2.08 | 1.19 | 2.17 | 0.77 | 0.76 |
| Pulses | 7.76 | 8.66 | 4.48 | 4.52 | 4.22 | 3.64 | 3.19 | 3.52 | 2.37 |
| Total food grains | 91.17 | 91.14 | 90.57 | 89.13 | 88.32 | 86.74 | 85.67 | 84.28 | 83.38 |
| Fruits | 1.79 | 2.17 | 3.00 | 3.69 | 4.78 | 5.63 | 6.51 | 7.01 | 8.54 |
| Vegetables | 2.10 | 2.17 | 2.22 | 2.85 | 2.61 | 3.42 | 3.63 | 3.71 | 4.09 |
| Oilseeds | 2.58 | 2.43 | 2.33 | 2.38 | 2.35 | 2.04 | 1.47 | 1.63 | 1.70 |
| Others | 2.36 | 2.09 | 1.88 | 1.95 | 1.94 | 2.17 | 2.72 | 3.37 | 2.29 |

Table 4. Temporal changes in the area under non-foodgrains crops across districts in Himachal Pradesh 1972-73 to 2011-12

| Districts | 1972-73 | 1982-83 | 1992-93 | 2002-03 | 2011-12 |
|-----------|---------|---------|---------|---------|---------|
| Bilaspur | 3.01 | 3.3 | 3.24 | 2.83 | 3.38 |
| Chamba | 6.36 | 7.49 | 7.49 | 9.13 | 8.46 |
| Hamirpur | 1.38 | 1.28 | 1.28 | 1.02 | 1.22 |
| Kangra | 11.21 | 9.34 | 9.34 | 9.83 | 8.45 |
| Kinnaur | 8.09 | 14.45 | 14.45 | 33.87 | 60.80 |
| Kullu | 6.83 | 11.9 | 11.9 | 22.68 | 24.01 |
| L& S | 24.7 | 46.97 | 46.97 | 71.96 | 82.17 |
| Mandi | 5.89 | 6.8 | 6.8 | 9.42 | 9.00 |
| Shimla | 17.16 | 20.76 | 20.76 | 48.83 | 64.66 |
| Sirmaur | 9.99 | 10.75 | 10.75 | 17.48 | 23.63 |
| Solan | 9.73 | 8.25 | 8.25 | 13.96 | 12.87 |
| Una | 7.79 | 7.83 | 7.83 | 8.18 | 9.11 |
| HP | 8.81 | 9.38 | 9.38 | 14.69 | 16.62 |

To capture diversification in terms of increase in acreage under high value crops, changing level of area under non-food grains, was considered for the purpose. It was assumed that all crops which are not classified as food grains are more remunerative crops. By simply eyeballing the Table 4, it can be realized that area under non-food grains (fruits and vegetable crops) increased continuously in the state from 8.81% of total cropped area in triennium ending 1972-73 to 16.62% in triennium ending 2011-12 i.e. it almost doubled. An analysis of area under non-food grains at the district level showed that it increased at varying rates in most of the district (nine) while a marginal decline was observed in Bilaspur, Hamirpur and Kangra. Diversification towards high value cash crops in most of the districts did take place during the study period but its intensity was quite pronounced in Lahaul & Spiti, Shimla, Kinnaur and Kullu where the increase in area under the non-food grains was varied from 17.18% in Kullu to 57.47% in Kinnaur over 1972-73.

4. Drivers/ Facilitating factors of crop diversification

In order to identify the major determinants of diversification in the State (Table 5), a step wise regression analysis with Herfindahl index as the dependent variable was carried out in the present study using time series data for the selected explanatory variables from 1972-73 to 2011-12. As pointed out earlier the independent factors considered for this analysis were as under; X_1 = Annual Rainfall (mm), X_2 = Per cent area under high yielding cereals crops, X_3 = Fertilizer use (kg/ hectare), X_4 = Per cent of gross irrigated area to gross cultivated area, X_5 = Road Length (Sq. Km/1000 hectares of grossed cropped area), X_6 = Mechanization (Number of tractors per 1000 ha of gross cropped area), X_7 = Per cent of urban population, X_8 = Per capita Income (Rs.) at constant price, X_9 = Average size of land holding (ha/farm) and X_{10} = Number of regulated markets (per 1000 ha of gross cropped area).

Agricultural crops were categorized into some major groups like cereals, pulses, food crops, non-food crops and all crops. Cereal includes rice, wheat, barley, maize, ragi and other cereals. Pulse group includes gram, black gram, horse gram, maser and other pulses. Food crops group includes sugarcane, apple, potatoes, fruits and vegetables, chillies, ginger and other food crops.

Table 5. Factors affecting crop diversification in Himachal Pradesh

| Factors | Crop Groups and Regression coefficients | | | | | |
|--|---|--------------------|---------------------|--------------------|----------------|---------------------|
| | | Cereals | Pulses | Food Crops | Non Food Crops | All Crops |
| | R ² | .948 | .718 | .927 | .841 | .687 |
| Constant | .402 | .042 | .628 | .144 | .470 | |
| Rainfall (X_1) | - | - | .09** (0.00) | .023* (0.00) | - | - |
| High Yielding Varieties (X_2) | - | - | - | - | - | - |
| Fertilizer Consumption (X_3) | - | - | - | -3.00** (1.00) | 2.00** (0.00) | - |
| Irrigated area (X_4) | - | - | - | - | - | -6.00** (2.00) |
| Road length (X_5) | - | 2.00** (1.00) | - | - | - | - |
| Mechanisation (X_6) | - | - | - | - | - | - |
| Urban Population (X_7) | - | - | - | - | - | - |
| Per Capita Income (X_8) | - | -.0007** (0.00) | .013** (0.00) | .0052** (0.00) | - | - |
| Average Size of Land Holding (X_9) | - | -65.0** (18.0) | - | - | - | -92.00** (15.00) |
| Regulated Markets (X_{10}) | - | - | -60.00** (13.00) | -18.00** (7.00) | - | - |

** Significant at 1%, * at 5%

b values and standard error are multiplied by 1000, because of small size of the values

Non-food crops include cotton, ground nut, sesamum, rape-mustard, linseed, tea, fodder crops and other non-food crops. All crops include all the cereals, pulses, food crops and Non-Food crops. As is evident from the table, the situation for agriculture in the state, in general, shows the importance of the average size of land holding, regulated market infrastructure and irrigated area in promoting crop diversification. These factors are positively related with the agricultural diversification. Mechanisation, urban population and high yielding varieties are three important factors which have not turned out to be significant in any of the crop group even though their importance cannot be minimized.

5. Conclusion

The study has examined extent of crop diversification at the state and districts level along with identification of major factors determining crop diversification. The extent of diversification as measured by SI (Simpson Index) at State level have shown that agriculture in the state remained highly diversified over the years during 1972-73 and 2011-12 with marginal tendency towards specialization. Small size of operational holdings and fear from risk might be, among others, the main restraints to specialization of agriculture in the state. Among the different crop groups some definite trend of diversification in the vegetable group was found where the SI value has shown a decreasing trend from 0.409 in 1972-73 to 0.795 in 2011-12. The trends in area growth under High Value Crops (Non-food grain crops) have increased in nine districts of Himachal Pradesh means that agriculture is transforming from traditional subsistence agriculture to high-value agriculture. However, this transformation was not evenly distributed cross states/regions. The results of regression analysis have revealed that average size of land holding, regulated market infrastructure, irrigated area and per capita income were the important factors in promoting crop diversification. Former three factors were positively while; the per capita income was negatively related with the crop diversification at the state level.

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