

An analysis of cropping pattern and crop diversification in district Bilaspur of Himachal Pradesh

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Background: Crop diversification is a practice of moving from a single crop to a wider variety of crops or from traditionally cultivated, less lucrative crops to more lucrative ones. Diversified cropping is important for sustainable agriculture. The present study, conducted in the district of Bilaspur of Himachal Pradesh, analyzes the existing cropping pattern, cropping system, and crop diversification.

Methods: The study was conducted in all four blocks of district Bilaspur, i.e., Ghumarwin, Bilaspur Sadar, Jhandutta, and Shri Naina Devi at Swarghat, using a random sampling technique. The data was collected from 60 respondents using personnel interview method, and the Herfindahl index was used to measure crop diversification.

Results: The results indicate that wheat and maize are the major cereals grown, and the cropping pattern of the district is progressively changing from a conventional cereal-based to a more diversified, high-value crops-based system. But there was a decline in area under pulses and rice cultivation, which can be attributed to climate change, low irrigation facilities, low labor availability, and wild animal menace. The wheat-maize cropping system was more prominent in the district. The major factors influencing crop diversification were increasing market demand for fruits and vegetables, government policies, and varying agroclimatic conditions. The crop diversification index for Ghumarwin, Bilaspur Sadar, Jhandutta, and Shri Naina Devi (Swarghat) is calculated as 0.783, 0.778, 0.813, and 0.762, respectively. The overall Crop diversification index value for the pooled sample of 60 respondents from the district Bilaspur as a whole is 0.7947. This indicates that crops are highly diversified in the study region. Market uncertainty, inadequate storage facilities, and pest/disease incidence were the main obstacles to diversification.

Conclusion: The study recommends the development of well-established markets in proximity to farmers, enhanced irrigation infrastructure, credit availability, agricultural trainings and storage facilities to support crop diversification.

Keywords: *Cropping pattern, cropping system, crop diversification, herfindahl index, bilaspur, sustainable agriculture*

Introduction

Agriculture is a broad term that refers to a wide range of methods used to cultivate crops and rear livestock to supply food and other beneficial goods to the world's population (Harris & Fuller, 2014). Despite decades of industrialization efforts, agriculture is the most important sector of the Indian economy (Wagh & Dongre, 2016; Nagpure et al., 2017). India's total domestic product is largely derived from the agricultural sector. India, which makes up only 2.3% of the world's land area, is home to 15% of the world's livestock and 18% of its human population (Nagpure et al., 2017). India remains a predominantly rural economy, with 66% of its population residing in rural areas. When it comes to the distribution of land, India's cropping pattern is biased toward food grains (Ghosh, 2011). During the Green Revolution period (1967-68 to 1977-78), the primary emphasis was on cereals, particularly rice and wheat. Our food basket has thankfully begun to diversify to some extent in recent years, but further improvement is needed (Paroda, R. (2022). Agriculture grew at a steady rate of roughly 5% annually between 2017-2023 and in the second quarter of 2024-2025, it grew by 3.5%, which is better than the previous financial year when growth was considerably slower (Economic survey 2024-2025). Cropping patterns have evolved primarily to include more lucrative crops like oilseeds, cotton, vegetables, fruits, sugarcane, legumes, and spices (Paroda et al., 2018). This recent improvement is probably due to improved weather, modern farming techniques, and supportive government programs (Economic Survey 2024-2025). Cropping pattern refers to the percentage of land covered by various crops at a given time (Bains & Atlas, 2022), and it can be identified by the way crops are arranged in a field. Cropping patterns in a region are influenced by various elements, including agro-climate, socioeconomics, culture, history, government policy, and innovation, which alter over time (Husain, 1996). A shift in cropping patterns suggests a shift in the percentage of land planted to various crops (Nagpure et al., 2017). In essence, during the late 1960s green revolution, there was a demand for a diversified agricultural system to revitalize the agricultural economy. To achieve this, it became essential to adjust cropping patterns to meet the nation's expanding demand and boost revenue by generating foreign exchange (Basu & Barman, 2014). The cropping pattern of a region affects the extent of crop diversification in the area. Diversification of agriculture is one of the many ways that can develop agriculture (Birthal et al., 2006). Crop diversification is defined as "the process of adding additional crops to a simplified cropping system to make it more diverse in time and space" (Hufnagel et al., 2020). Diversifying agriculture to include more high-value and economically viable enterprises is seen as a key tactic to increase farm revenue, create jobs, reduce poverty, and preserve valuable soil and water resources (Kumar et al., 2012). The local and international markets have seen a sharp rise in demand for high-value food items such as fruits and vegetables (Birthal et al., 2006). Globalization has led to a sharp increase in fruit and vegetable exports from developing to developed nations. As a result, Indian agriculture is progressively shifting toward high-value crops in order to satisfy the country's expanding internal demand and benefit from globalization (Kumar et al., 2012).

Estimated Percentage share of Major Crop Groups in Total MPCE

The distribution of major crop groups in the total Monthly Per Capita Expenditure (MPCE) showed different patterns across urban and rural households between 2011-12, 2022-23 and 2023-24. Cereals counted for a relatively higher share of MPCE in rural areas compared to urban areas throughout the study period. However, a substantial decline was observed in both, decreasing from 6.61% to 3.74% in urban households and from 10.69% to 4.97% in rural households. It indicates a gradual shift in consumption preferences away from staple foods. Expenditure on Gram remained minimal across all years, although a marginal increase was observed over time in both urban (0.11 to 0.18%) and rural (0.14 to 0.26%) populations. Similarly, the share of pulses and pulse products declined during the study period, decreasing from 1.93% to 1.22% in urban areas and from 2.76% to 1.78% in rural areas. In contrast, milk and milk products consistently constituted one of the largest components of MPCE. Their share increased slightly in rural households from 8.04% in 2011-12 to 8.44% in 2023-24, while remaining relatively stable in urban households (7.01%-7.22%). This trend reflects the sustained importance of dairy products in household consumption patterns. Vegetable expenditure demonstrated moderate fluctuations over time. Urban households recorded a decline from 4.63% in 2011-12 to 4.12% in 2023-24, whereas rural households showed a slight decrease from 6.62% to 6.03%. Fruit consumption exhibited a gradual increase in both regions, with urban households rising from 2.64% to 2.61% (after a slight dip in 2022-23) and rural households increasing from 2.25% to 2.66%.

Overall, the findings suggest a transition in dietary expenditure patterns characterized by a reduced share of cereals and pulses and a relatively greater emphasis on milk products, fruits, and vegetables. Rural households consistently allocated a higher proportion of MPCE toward essential food commodities than their urban counterparts, highlighting persistent differences in food consumption behaviour between the two population groups.

The structural breakdown of agricultural crop components in the total MPCE is distributed as in Table 1 and the same is represented in Figure 1.

Table 1. Percent share of major crops from Bilaspur in the total MPCE

Crops	Urban (%)			Rural (%)		
	2011-12	2022-23	2023-24	2011-12	2022-23	2023-24
Cereals	6.61	3.62	3.74	10.69	4.89	4.97
Gram	0.11	0.18	0.18	0.14	0.24	0.26
Pulses and Pulse products	1.93	1.21	1.22	2.76	1.77	1.78
Milk and Milk products	7.01	7.22	7.19	8.04	8.33	8.44
Vegetables	4.63	3.8	4.12	6.62	5.38	6.03
Fruits	2.64	2.5	2.61	2.25	2.54	2.66

Source: Household Consumption Survey: 2023-24, Ministry of Statistics and Programme Implementation, National Statistics Office, Government of India.

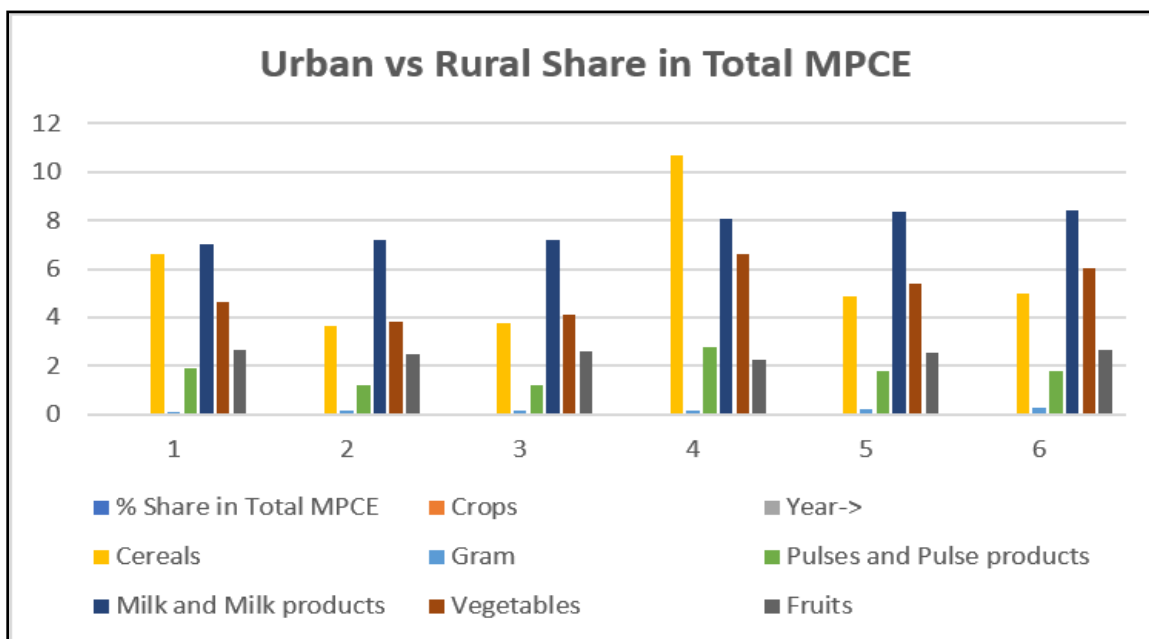


Figure 1. Percent share of major crops from Bilaspur in the total MPCE

Over the past few years, crop diversification in Himachal Pradesh has rapidly expanded towards high-value commodities such as fruits and vegetables, particularly off-season vegetables (Chaudhary & Singh, 2020). To a certain degree, this change in consumption patterns led to a shift towards high-value commodities, changes in customers' tastes, preferences, and income (Mittal, 2007; Reddy, 2009). Several studies about cropping patterns and crop diversification have been conducted in other districts of Himachal Pradesh, but at present, there are limited studies that are particularly focused on the district of Bilaspur. So, in this context, the present study was conducted in all four blocks, namely Ghumarwin, Sadar Bilaspur, Jhandutta, and Shri Naina Devi (Swarghat) of the district of Bilaspur. In the district of Bilaspur more than 70% of population is actively engaged in agriculture and allied sector. The major crop grown in the Rabi season is wheat, whereas in the Kharif season it is maize. The farmers are also growing vegetables, to some extent pulses, and fruits in their fields. Therefore, the research was conducted to study the cropping pattern and extent of diversification in the district of Bilaspur

Materials and Methods

Study area

The present study was conducted in the district of Bilaspur, Himachal Pradesh with a latitude of 31° 12' 30" to 31° 35' 45" N, a longitude of 76° 23' 45" to 76° 55' 40" E, and elevations ranging between 290 to 1980. The district Bilaspur is located in Himachal Pradesh's agro climatic zone I; sub-mountain and low hills, sub-tropical (HP-1) zone (Figure 2).

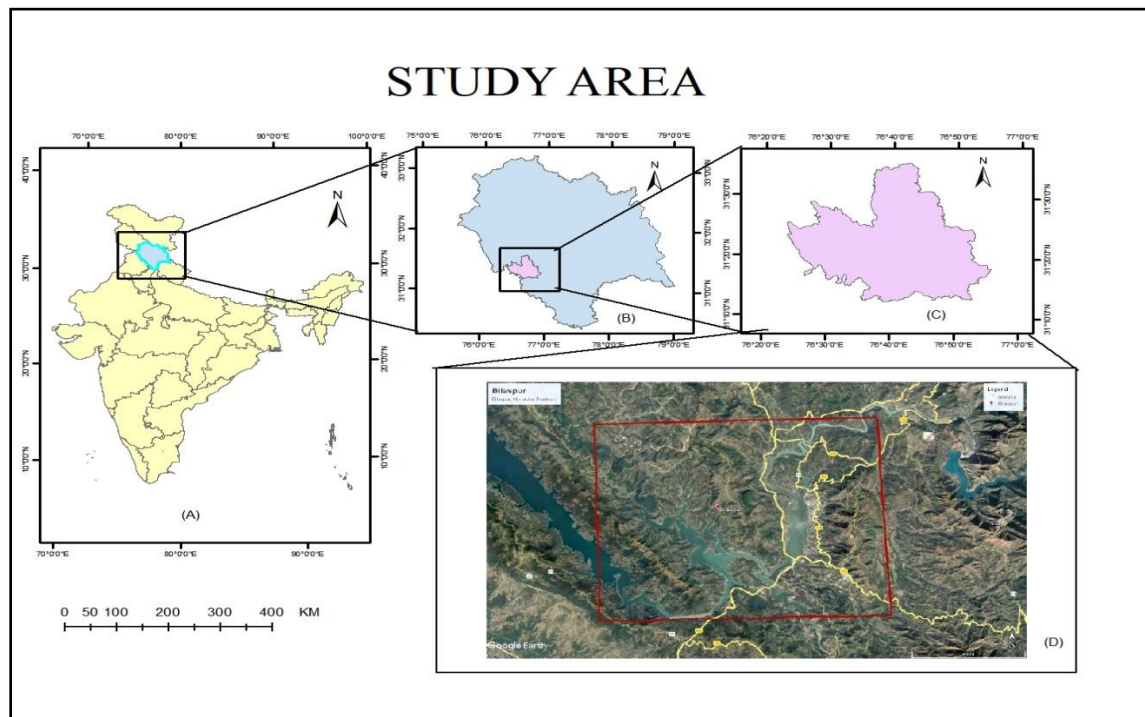


Figure 2. Map of the study area (District Bilaspur of H.P.)

Topographic classification

During the survey, the geographic coordinates of one representative location from each of the 12 surveyed villages were recorded using GPS. Elevation data of these locations were extracted from a Digital Elevation Model (DEM) using QGIS. To assess the landholding pattern, mean landholding size for each village was calculated based on data from five respondents per village. The relationship between topography (represented by elevation) and mean landholding size was analyzed using Simple linear regression and Pearson's correlation coefficient.

Sampling procedure

A random sampling technique was used to select the respondents. The four blocks of the district are, namely Ghumarwin, Jhandutta, Bilaspur Sadar, and Shri Naina Devi (Swarghat). A total of 60 respondents (15 respondents from each block) were selected from all four blocks of the district, while from each block, 3 locations were randomly selected (Figure 3).

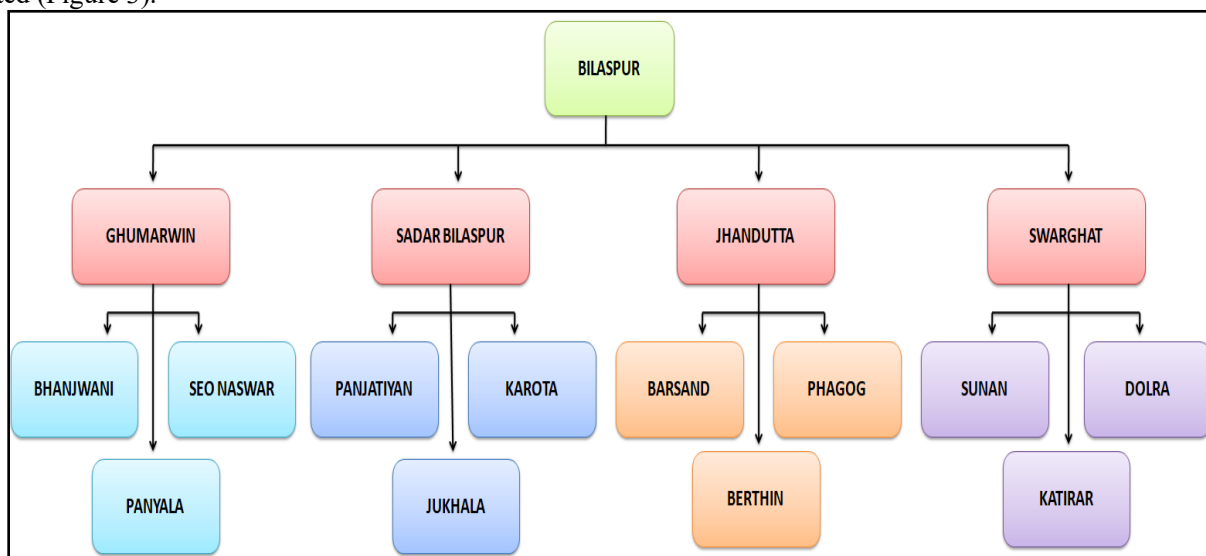


Figure 3. Schematic representation of the sampling procedure

The present study was based on both primary and secondary data. The primary data for this study were systematically collected through a personal interviewing technique and a carefully designed questionnaire. To conduct a thorough study, secondary data were also collected from various sources such as government websites and publications, the Department of Agriculture, Himachal Pradesh, the Department of Horticulture, Himachal Pradesh, and the Directorate of Land Records.

Descriptive analysis

Descriptive statistics provide summaries of sample data and deal with describing the characteristics of known data. It is beneficial to identify and examine the dataset's essential features without drawing broad conclusions or presumptions about the whole collection. Therefore, a simple descriptive statistical tool, i.e., percentage, was used to summarize the frequency distributions of the complete dataset, which can be seen or understood in the form of tables, graphs, and charts.

Index to measure crop diversification in the study region: (Malik & Singh, 2002). To measure the crop diversification index, the Herfindahl index was used.

Herfindahl index of crop diversification (HI) = $\sum_{i=1}^n P_i^2$

$P_i = A_i / \sum_{i=1}^n A_i$

Where, P_i = proportion under the i^{th} crop,

A_i = area under the i^{th} crop (hectares)

$\sum_{i=1}^n A_i$ = total cropped area (hectares)

$i = 1, 2, 3, \dots, n$, number of crops

Crop diversification in the area proportion is calculated using this method. "HI" has a value between 0 and 1. If the HI value is 1, there is total concentration, and if the value is approaching 0, there is significant diversification in the region. However, for the easy interpretation of findings, an index of crop diversification was calculated as:

CD = 1-HI

The CDI directly relates to diversification. A value of zero indicates specialization, while a value of one indicates that more crops are grown in the region. The proportion of the area also measures it. In simple terms, CDI shows how diverse or specialized the crops are in an area.

Results

Bilaspur is one of the 12 districts of Himachal Pradesh. At present, it is the second smallest district of Himachal Pradesh. The total geographical area of the district is 1167 Sq. Kms, which comprises about 2.1% of the state. It is located on the outer slopes of the lower Satluj valley at latitudes of 31° 12' 30" to 31° 35' 45" N and longitude of 76° 23' 45" to 76° 55' 40" E. Bilaspur district shares boundaries with districts Mandi, Hamirpur, Una, and Solan, and also with Roopnagar district of Punjab. The region is divided into about equal sections by the main river, the Satluj, which flows through its center. There are four subdivisions, i.e., Bilaspur Sadar, Ghumarwin, Jhandutta, and Shri Naina Devi Ji; four tehsils, namely Sadar, Ghumarwin, Jhandutta, and Shri Naina Devi Ji, and three sub-tehsils, namely Bharari, Kalol, and Namhol. The district consists of four urban centers, 151 Gram Panchayats, and 1061 villages. The total population of the district is 3, 81,956 out of which 3, 56,827 is the rural population and 25,129 is urban. About 80.72 percent of the total populations are males and 69.78 percent are females. The literacy rate of the district is 84.59 percent (Table 2).

Table 2. Demographic Features of District Bilaspur vis-à-vis Himachal Pradesh

Sr. No.	Particulars	Bilaspur	H.P.
1	Geographical area	1,167 km ²	55,673
2	Total population	3,81,956	68,64,602
3	Male population	192764	3481873
4	Female population	189192	3382729
5	Rural population	356827	6176050
6	Urban population	25129	688552
7	Literacy rate	84.59%	82.80%

Source: Statistical Abstract of Himachal Pradesh 2023-24.

Socio-economic profile of respondents

The socio-economic profile of selected respondents was prepared using a structured questionnaire which included age, gender, landholding size, educational qualification, occupation, and farming experience of respondents.

Age group and gender

Table 3 and Figure 4 represent that among 60 respondents in all four blocks, 9 (15%) were in the age group 30-40, 15 (25%) respondents fell within the age group 40-50, 19 (31.66%) respondents were categorized within the age group 50-60, and 17 (28.33%) respondents were of the age above 60 years.

Table 3. Representation of age category of respondents

Age group	Ghumarwin	Bilaspur Sadar	Jhandutta	Shri Naina Devi (Swarghat)	Total
30-40	2	4	0	3	9
40-50	4	3	4	4	15
50-60	2	3	8	6	19
Above 60	7	5	3	2	17
Total	15	15	15	15	60

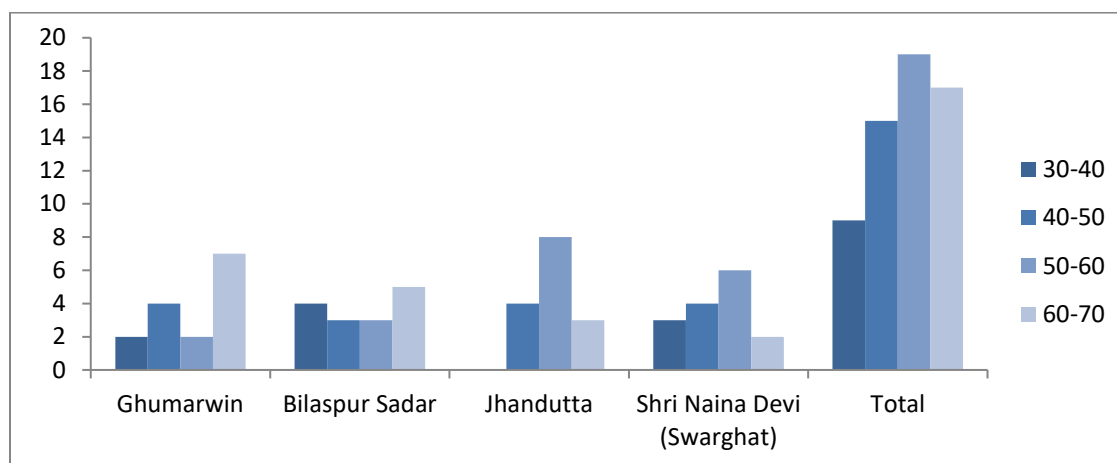


Figure 4. Age-wise distribution of respondents

Overall, the majority of respondents were 50-60 years old. This age group makes up 31.66% of all responders, while the age group above 60 was the second largest, making up 28.33% of the total. About 60% of respondents were of the age group above 50 years showing that elderly population makes up the majority of farming population in study area. The relatively lower percentage of younger respondents may suggest that young generation is not as actively engaged in farming practices.

The information collected also reveals that among 60 respondents, 13 (21.66%) were female respondents, while 47 (78.33%) were male respondents (Figure 5).

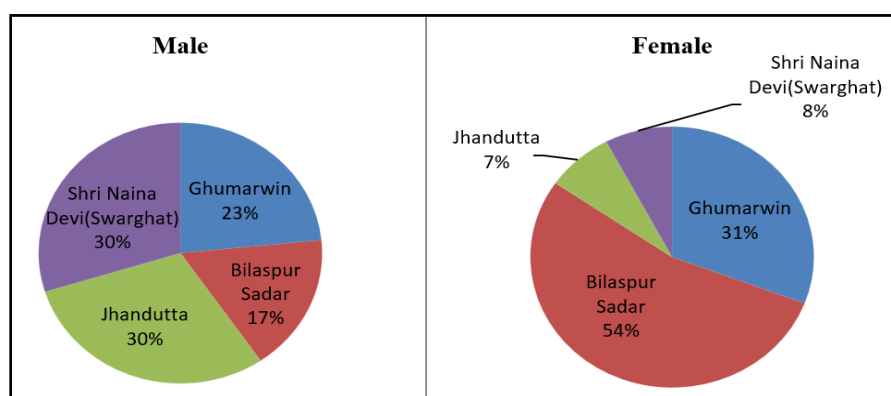


Figure 5. Distribution of male and female respondents in the surveyed area

Educational profile of respondents

Educational qualification can affect the use of scientific technologies and their knowledge about various aspects of agriculture, like the type of variety grown, insecticides or pesticides used in pest and weed management, and the type, quality, and quantity of fertilizer to be used, etc. Therefore, the educational profile of all interviewed participants was recorded (Figure 6). 6.66% (4) of total respondents received no formal education, 1.66% (1) attended primary school, 25% (15) received education up to middle school, 30% (18) completed high school education and around 16.66% (10) of participants acquired education up to senior secondary or a diploma, while 20% (12) were graduates or had received further higher education.

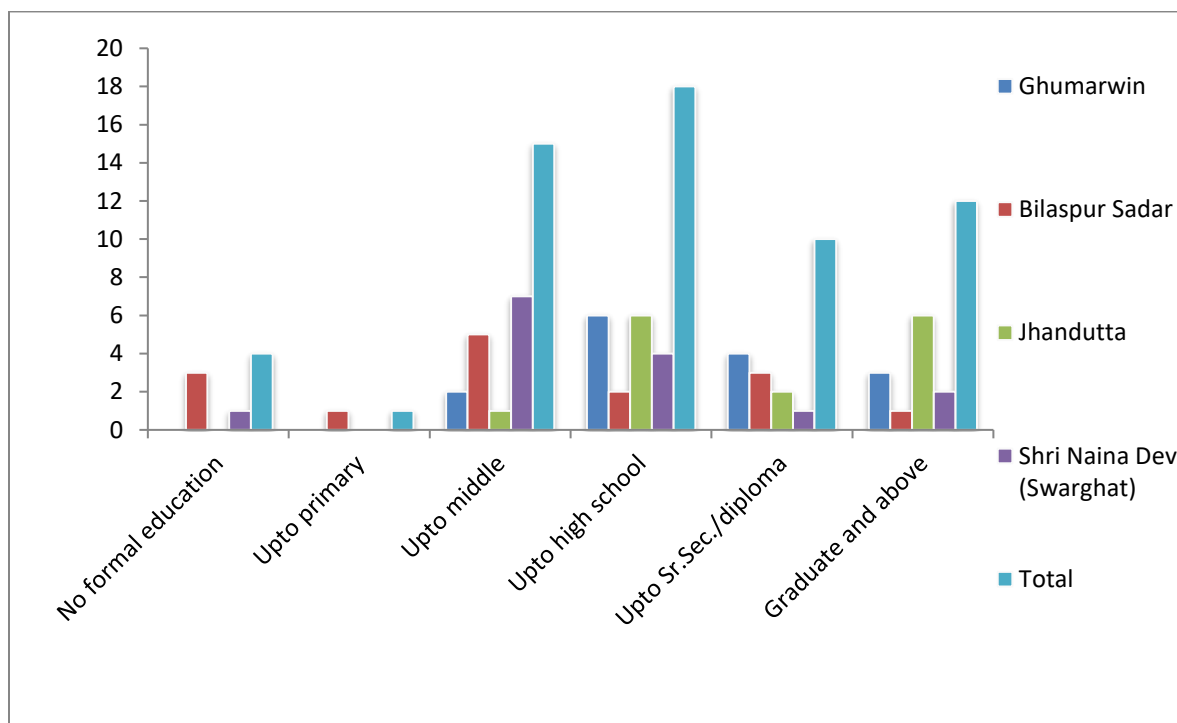


Figure 6. Educational profile of respondents

Landholdings and Occupational Pattern

The landholding size of farmers was also recorded. Table 4 shows the distribution of landholding sizes across different blocks of the district, which reveals that small to semi-medium holdings predominate in the distribution of landholdings across four blocks of the district Bilaspur. The largest share of landholdings is in the 0.809-1.618 hectares. category, i.e. total of 28 out of 60 respondents have land size 0.809-1.618 (hectares), which included 5 landholders in Ghumarwin block, 10 in Bilaspur Sadar, 7 in Jhandutta, and 6 respondents in Shri Naina Devi (Swarghat) block. The next largest group is less than 0.809 hectares which represents 26 landholders (3 in Bilaspur Sadar, 7 in Jhandutta, 9 in Ghumarwin and 7 in Shri Naina Devi (Swarghat) block). There were a lot of marginal farmers, especially in the Ghumarwin block. On the other hand, larger holdings (more than 1.618 hectares category) were less prevalent; these include six landholders in all blocks. Further, it is noteworthy that in comparison to other blocks, Bilaspur Sadar block continuously reports a higher number of landholders in size class 0.809-1.618 (hects). With bigger landholders being relatively uncommon, particularly in Ghumarwin and Jhandutta block, where only one landholder owns land in more than 1.618 hectares, statistics indicate that land fragmentation is a prevalent aspect of the district.

Table 4. Landholding size of respondents [in bigha (hectares)]

Landholding size bigha (hectares)	Ghumarwin	Bilaspur Sadar	Jhandutta	Shri Naina Devi (Swarghat)	Total
Less than 10 bigha (0.809)	9	3	7	7	26
10-20 bigha (0.809-1.618)	5	10	7	6	28
More than 20 bigha (1.618)	1	2	1	2	6

Table 5. Village-wise geographic coordinates, elevation and mean landholding size of surveyed villages in district Bilaspur.

S.No.	Village	Latitude	Longitude	Elevation	Mean landholding size
1.	Karota	31.339787	76.826164	700.87	1.52
2.	Panjatiyan	31.292056	76.819287	781.41	1.06
3.	Jukhala	31.287667	76.82179	800.6	0.9
4.	Sunan	31.275235	76.700967	630.42	0.76
5.	Katirar	31.247816	76.650476	631.75	1.02
6.	Dolra	31.241021	76.6538	848.73	0.61
7.	Barsand	31.363698	76.701786	761.24	0.79
8.	Berthin	31.4187669	76.6427082	653.7	1.08
9.	Phagog	31.402406	76.622421	605.65	1.03
10.	Bhanjwani	31.369438	76.723916	523.39	0.71
11.	Seo Naswar	31.476669	76.681526	683.3	0.58
12.	Panyala	31.483554	76.72595	767.61	0.92

Note: Simple linear regression; $R^2 = 0.0003$, $\beta = -0.00015$, $p = 0.864$. Relationship not statistically significant

A simple linear regression, conducted to examine the relationship between topography (represented by elevation) and landholding size showed a very faint negative trend ($R^2 = 0.003$; $\beta = -0.00015$) indicating negligible decline in mean landholding as elevation increased. The lack of statistical significance in the association ($p = 0.864$) suggests that elevation did not substantially influenced landholding size across the villages (Table 5)

The family's income is directly determined by the occupation of the head of the family. Along with agriculture, some interviewed participants were working in private organizations, and some others were government employees. However, the dependence on agriculture was high compared to others. About 35 (58.33%) respondents were directly dependent on agriculture for employment. The government sector was the second most important employment sector, with 21.66% of the participants working in the government sector in addition to being engaged in agriculture. About 20% of participants were also working in a private organization. Further, the dependency on agriculture alone was higher in the Bilaspur Sadar block, with about 93.33% of the workforce depending on it.

Farming Experience of Workforce

The period a farmer has spent being actively engaged in agricultural activities, such as growing crops, raising livestock, or performing other related activities helps the farmer to have better knowledge about the cropping season *i.e.*, which season is best suited to grow different types of crops; it helps the farmer to get familiarized with evolving techniques and machines being used in agriculture with time. Further, it helps the farmer to know about different crop disease patterns in different seasons and to analyze and develop possible strategies to mitigate their effects. Table 6 highlights the farming experience of farmers in the study area. From the data, it is clear that among all 60 respondents, the majority of farmers (30%) had farming experience of more than 40 years. The information further reveals that farmers with farming experience of more than 40 years were more in the Bilaspur Sadar block (53.33%) as compared to other blocks. The lowest percentage is observed in category 5-10 years, *i.e.* 6.66 percent. The categories 10-20 years and 20-30 years observed a similar trend *i.e.* 21.66% of respondents.

Table 6. Farming experience of respondents in the study area

Farming Experience	Ghumarwin	Bilaspur Sadar	Jhandutta	Shri Naina Devi (Swarghat)	Total
5-10 years	2 (13.33%)	1 (6.66%)	0	1 (6.66%)	4 (6.66%)
10-20 years	1 (6.66%)	4 (26.66%)	5 (33.33%)	3 (20%)	13 (21.66%)
20-30 years	3 (20%)	1 (6.66%)	3 (20%)	6 (40%)	13 (21.66%)
30-40 years	3 (20%)	1 (6.66%)	4 (26.66%)	4 (26.66%)	12 (20%)
More than 40 years	6 (40%)	8 (53.33%)	3 (20%)	1 (6.66%)	(30%)

Cropping pattern in the study area

The cropping pattern of the study area was recorded in order to determine how different types of crops are grown in the region. Cropping pattern simply indicates the amount of land as a percentage of total land area, being cultivated under various crops at a time. It provides details regarding the total area under crop cultivation, the percentage of land taken up by different crops, the intensity of cropping, and the sequence of crops being grown. It also illustrates the diversity of crops within a given area. Therefore, in order to analyze the cropping intensity and type of crops being grown, the farmers were asked about the crops they were growing. The information revealed that the major crop grown in the Rabi season was wheat, whereas in the Kharif season it was maize, which implies that the maize-wheat cropping system was prevalent in the study area. The farmers were also growing vegetables, to some extent pulses, and fruits, also in their fields. The major vegetables grown in the Rabi season were potato, cabbage, cauliflower, broccoli, radish, carrot, turnip, beetroot, onion, and different varieties of garlic, whereas in the Kharif season majority of farmers were growing tomato, capsicum, brinjal, okra, cucurbits, arbi, adrak, and jimikand. The farmers in the surveyed area also grew fruits like mango, litchi, pear, plum, peach, pomegranate, kiwi, persimmon, lemon, orange, mosambi, papaya, apple, guava, grapes, chikoo, walnut, avocado, and khumani, etc. Some farmers were also growing flowers such as marigolds, carnations, roses, and gerberas.

Table 7 and Figure 7 show the distribution of different crops in the study area of all four blocks of the district Bilaspur. It is clear that although a majority of farmers grow wheat as their staple crop, vegetable and fruit cultivation was also prominent in the district. The majority of the net sown area was occupied by wheat, *i.e.* 28% (15.458 hectares). The area under maize cultivation is 22% (12.383 hectares), vegetable cultivation is 24% (13.354 hectares), whereas fruits, pulses, and other crops occupy 12% (6.960 hectares), 6% (3.318 hectares), and 7% (3.642 hectares) of the total cropped area, respectively. Rice cultivation occupied only 1% (0.566 hectares) of the total area. Among all four blocks, vegetable and fruit cultivation were more prominent in Bilaspur Sadar and Jhandutta blocks, respectively, whereas vegetable cultivation was least in Ghumarwin, and fruit cultivation was least in Shri Naina Devi (Swarghat) block. There was a considerable decrease in the area under rice cultivation, owing to production constraints and crop diversification with other horticulture crops. The area under pulses is significantly less as compared to other crops. This indicates a dramatic change in the region's agricultural trends and a substantial shift in farmers' crop preferences. Additionally, the findings indicate that although the majority of farmers grew wheat and maize as major crops, horticultural crops like vegetable and fruit cultivation in the region are also prominent, indicating possible crop diversification in the region.

Table 7. Total area in bigha (hectares) under different crops in the studied area of four blocks

Crop	Ghumarwin	Bilaspur Sadar	Jhandutta	Shri Naina Devi (Swarghat)	Total
Wheat	43 (3.480)	52 (4.208)	49 (3.965)	47 (3.804)	191 (15.458)
Maize	35 (2.832)	37 (2.994)	38 (3.075)	43 (3.480)	153 (12.383)
Rice	0	7 (0.566)	0	0	7 (0.566)
Pulses	9 (0.728)	11 (0.890)	15 (1.214)	6 (0.485)	41 (3.318)
Vegetables	29 (2.347)	74 (5.989)	31 (2.590)	31 (2.509)	165 (13.354)
Fruits	15 (1.214)	28 (2.266)	29 (2.347)	14 (1.133)	86 (6.960)
Others	7 (0.566)	11 (0.890)	20 (1.618)	7 (0.566)	45 (3.642)
Total	138 (11.167)	220 (17.803)	182 (14.728)	148 (11.977)	688 (55.675)

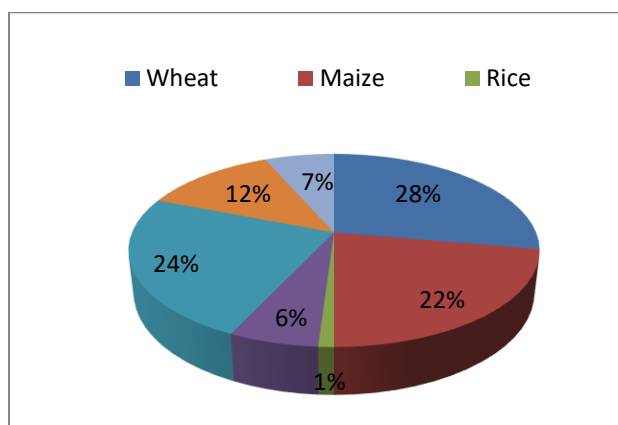


Figure 7. Percentage of total area under different crops grown in the study area

Shifts in cropping patterns and factors influencing the change in the studied area over the past five years

The data collected from respondents revealed that the majority of respondents (75%) have changed their cropping patterns over the past five years. This change in cropping pattern may be attributed to various factors such as market demand, soil health, climate change, pest/disease problems, government policies, and labor. As shown in the Figure 8, market demand strongly influences farmers' cropping decisions. Approximately 36% of respondents have changed their cropping pattern owing to variations in market demand, whether due to lower pricing or greater prospects.

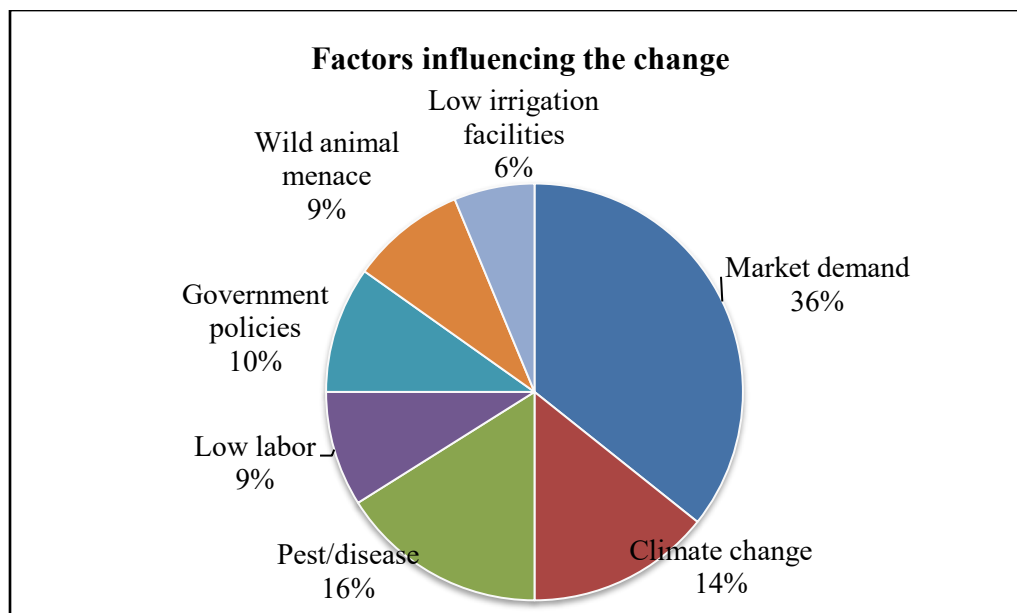


Figure 8. Percentage of major factors influencing changes in cropping patterns over the past 5 years

Further, pest/disease prevalence and climate change were major influencing factors for 16 percent and 14% of respondents, respectively, while other factors such as government policies, low irrigation facilities, wild animal menace, and low labor availability were main influencing factors for 10%, 6%, 9%, and 9 % of respondents, respectively. The information gathered from farmers further revealed that some farmers used to grow pulses and also rice, but owing to damage caused by wild animals they discontinued cultivation of pulses whereas rice cultivation was aborted mainly because there were insufficient irrigation facilities. As a result, many farmers shifted to bulb and rhizome crops like turmeric, ginger, jimikand, garlic and onion which the respondents believed were less vulnerable to harm from wild animals because the harvestable part grows beneath the soil surface. Additionally, farmers used fences and other preventive techniques to safeguard vegetable crops, making their cultivation beneficial even in presence of wild animals. Due to government policies such as the HPSHIVA project and various other schemes, some farmers were now cultivating fruits in the area where they used to grow traditional crops. Some farmers previously growing major vegetables crops discontinued vegetable cultivation due to increased insect-pest/disease incidence; however, in some regions where protected cultivation practices were prominent and irrigation facilities were available, farmers were still cultivating vegetables on a very large scale, considering the high market demand for cash crops.

Practice of mixed cropping and crop rotation

Mixed cropping and crop rotations are key practices in crop diversification, helping farmers to increase yields, reduce pests and diseases, and improve soil fertility. These strategies can improve diversification, resource usage efficiency, and farm resilience. Table 8 and Figure 9 show that about 87% of the total respondents in the study area practice mixed cropping and crop rotation.

Table 8. Respondents practicing mixed cropping/crop rotation

Response	Ghumarwin	Sadar	Jhandutta	Swarghat	Total
YES	12	15	13	12	52
NO	3	0	2	3	8

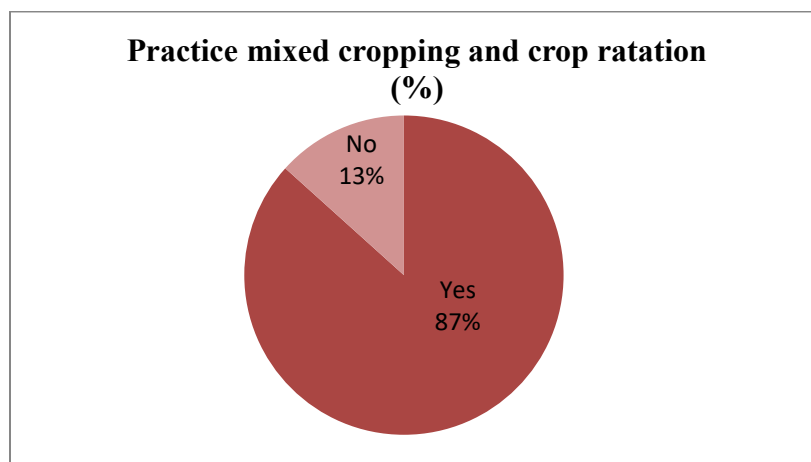


Figure 9. Percentage of respondents practicing mixed cropping and crop rotation

Extent of crop diversification

Crop diversification means shifting from less profitable to more profitable crops. The extent of crop diversification within blocks and also for the total sample of 60 respondents as a whole was computed based on the proportion of area under the crops using the Herfindahl index of crop diversification. Tables 9 depicts the values of HI for Ghumarwin and Bilaspur Sadar blocks. Similarly, Table 10 depicts the values of HI for Jhandutta and Shri Naina Devi (Swarghat) blocks. As mentioned earlier, the crop diversification from the Herfindahl index can be calculated by subtracting the value of HI from one. Therefore, the calculated crop diversification index for these blocks was 0.783, 0.778, 0.813, and 0.762, respectively. According to Malik & Singh (2002), the CDI directly relates to diversification. A value of zero indicates specialization, while a value of one indicates that more crops are grown in the region. In simple terms, the CDI shows how diverse or specialized the crops are in an area. The values of CDI of all four blocks (n=15 each) are approaching one. It means the diversification was high within all four blocks, and farmers have adopted a diversified cropping system instead of monoculture. This shows that the farmers use land more efficiently and have better risk management strategies.

Table 9. Extent of crop diversification in Ghumarwin and Bilaspur Sadar block (n=15 each)

Crop	Area (hectares)	Pi	Pi ²	Crop	Area (hectares)	Pi	Pi ²
Wheat	3.480	0.311	0.097	Wheat	4.208	0.236	0.055
Maize	2.832	0.253	0.064	Maize	2.994	0.168	0.028
Rice	0	0	0	Rice	0.566	0.031	0.001
Pulses	0.728	0.065	0.004	Pulses	0.890	0.05	0.002
Vegetables	2.347	0.21	0.044	Vegetables	5.989	0.336	0.113
Fruits	1.214	0.1	0.011	Fruits	2.266	0.127	0.016
Others	0.566	0.05	0.002	Others	0.890	0.05	0.002
Total	11.167	0.989	0.222	Total	17.803	0.998	0.217
CDI (Ghumarwin) = 0.783				CDI (Bilaspur Sadar) = 0.778			

Table 10. Crop diversification in the studied area of Jhandutta and Shri Naina Devi (Swarghat) blocks (n=15 each)

Crop	Area (hectares)	Pi	Pi ²	Crop	Area (hectares)	Pi	Pi ²
Wheat	3.965	0.269	0.072	Wheat	3.804	0.317	0.1
Maize	3.075	0.208	0.043	Maize	3.480	0.29	0.084
Rice	0	0	0	Rice	0	0	0
Pulses	1.214	0.082	0.006	Pulses	0.485	0.04	0.001
Vegetables	2.509	0.17	0.029	Vegetables	2.509	0.209	0.043
Fruits	2.347	0.159	0.025	Fruits	1.133	0.094	0.008
Others	1.618	0.109	0.012	Others	0.566	0.047	0.002
Total	14.728	0.997	0.187	Total	14.8	0.997	0.238
CDI (Jhandutta) = 0.813				CDI (Shri Naina Devi (Swarghat)) = 0.778			

Similarly, when the crop diversification was computed for 60 respondents from the whole district, the value came to 0.7947, which shows a higher degree of diversification in the cropping pattern (Table 11).

Table 11. Crop diversification in the study area from all four blocks of the district Bilaspur as a whole (n=60)

Crop	Area (hectares)	Pi	Pi ²
Wheat	15.458	0.277	0.077
Maize	12.383	0.222	0.049
Rice	0.566	0.01	0.0001
Pulses	3.318	0.059	0.003
Vegetables	13.354	0.239	0.057
Fruits	6.960	0.125	0.015
Others	3.642	0.065	0.0042
Net area	55.675	0.997	0.2053
CDI (n=60) = 0.7947			

The major diseases and pathogens affecting crops, and changes in disease patterns with crop diversification

The farmers in the study area were mostly growing cereals (such as wheat and maize), vegetables, and fruits. The major diseases affecting their crops were rust, blight, bacterial wilt, and insect pests, which also cause major harm to their produce. The major diseases reported in wheat were yellow rust, black rust, and kernel bunt, and maize is susceptible to stem borer. Similarly, vegetables were more prone to insect pests, mites, thrips, canker, blight, powdery mildew, downy mildew, alternaria leaf spot, brown spot, flies, and yellow vein mosaic virus. The major diseases reported in fruits were apple scab, white root rot, and canker. Table 12 represents respondents' perspectives on disease patterns with the cultivation of different crops. The majority of respondents (23) noticed an increased incidence of diseases with changing cropping patterns and diversification. The number of respondents observing a decreased incidence of diseases was 17, whereas 20 respondents had observed no change in disease occurrence patterns.

Table 12. Disease pattern with crop diversification

Sr. No.	Pattern	No. of Respondents
1.	Increased disease incidence	23
2.	Decreased disease incidence	17
3.	No change observed	20

Advisory services for disease management and the control measures used

Table 13. Number of respondents receiving advice for disease management

Block	Yes	No
Ghumarwin	9	6
Sadar	13	2
Jhandutta	12	3
Swarghat	13	2
Total	47	13

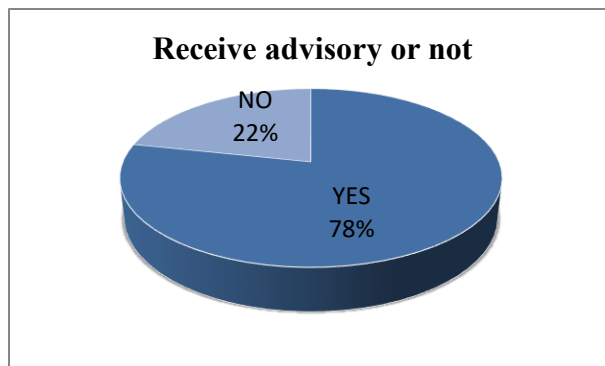


Figure 10. Percentage of respondents receiving advice or not

Figure 10 and Table 13 show that about 78% of respondents receive advice from the agriculture department for the management of diseases occurring in their crops, which may be helpful to farmers for the early detection of diseases and to take preventive measures. This, in return, reduces yield losses and increases agricultural productivity. While about 22% of the respondents do not receive any kind of advice. The details of the pest/disease management practices adopted by the respondents are summarized in Table 13.

Table 14. Management practices adopted by respondents

S. No.	Practice followed / adopted	No. of respondents knowing management practice	No. of respondents adopted the practice
1	Chemical fungicides, bactericides, insecticides, pesticides	60	50
2	Biological control	1	1
3	Cultural practices	42	31
4	Mechanical and physical control	40	33
5	Indigenous practices	46	36

The information from Table 14 further reveals that farmers mostly use fungicides, bactericides, insecticides, and pesticides to control the diseases of their crops. However, it was also seen that most farmers use a mix of traditional and modern methods to control crop diseases. They often rely on homemade remedies made from natural ingredients like garlic, neem, and cow urine. These methods are not only cost-effective but also eco-friendly and safer for the environment. This approach shows farmers' resourcefulness and adaptability, especially when access to chemicals or expert advice is limited. It also aligns with the growing trend towards sustainable and organic farming. The survey also revealed that all respondents (100%) show considerable interest in adopting new disease-resistant crop varieties and techniques.

Challenges faced by farmers in Crop Diversification:

Crop diversification has several benefits, but farmers face a number of obstacles that prevent its spread. The information about challenges faced by farmers in crop diversification revealed that about 41.66% of farmers face the challenge of insect pests and diseases as a major obstacle to crop diversification. Lack of fair pricing and guaranteed market was also observed as the main challenge to crop diversification (about 25%). The lack of established markets deterred farmers from moving from conventional crops like maize and wheat. In areas where a variety of crops require a steady supply of water, inadequate irrigation facilities were observed as a challenge to crop diversification by 18.33% of farmers. Climate change and labor shortage are also the main obstacles to 16.66% of farmers.

Discussion

This study aimed to examine the level of crop diversification and the existing cropping system in the district of Bilaspur. According to the results obtained, horticultural commodities like fruits and vegetables are replacing traditional cereal-based farming. In areas with better access to markets and irrigation facilities, this shift is more noticeable. [Akanksha \(2024\)](#) reported that in district Bilaspur, the area planted to vegetables accounted for 25.23% and 23.8% of total cultivated area during kharif and Rabi season respectively, which coincides with the study's findings that vegetables occupy 24% of total area under cultivation. The research findings support the goals of Himachal Pradesh State Agriculture Policy and the National Mission on Sustainable Agriculture (NMSA), which aims to promote market-driven and climate-resilient cropping systems. Initiatives like Himachal Pradesh Horticulture Development Project and the Prakritik Kheti Khushhal Kisan Yojana are driving agricultural diversification in Bilaspur, encouraging low-input, high-output farming methods with greater returns, particularly in vegetable cultivation. The study shows that 75% of farmers have diversified their cropping pattern over the past 5 years, which aligns with the study of [Sarial et al. \(2020\)](#), which shows that 35-50% of farms in Bilaspur, Mandi, Hamirpur, Kangra, and Unna districts are diversified as a result of HPCDP – JICA project. The value of the Herfindahl index calculated for crop acreage from the whole district was 0.2053, indicating higher diversification, which coincides with findings of [Sharma \(2018\)](#), which was found to be 0.28 in small farms and 0.22 in large farms of Mandi district, indicating more diversification in large farms as compared to small farms. Further, the Market uncertainty, inadequate storage facilities, and pest/disease incidence are major constraints to crop diversification in the district. These findings align with the study of [Kumar \(2022\)](#). Although there is encouraging potential for crop diversification in district Bilaspur, persistent obstacles must be overcome. A more successful agriculture can be achieved by combining efforts with policy support.

Conclusion

The main objectives of the present study were to assess the existing cropping pattern and level of crop diversification in the district of Bilaspur of Himachal Pradesh, using primary data from a survey and secondary data sources. The findings show that wheat-maize is the prominent cropping system followed in the district, and cropping patterns vary significantly amongst blocks, mostly due to agro climatic factors, irrigation systems, market accessibility, and institutional assistance. Even though traditional cereals are still the mainstay in some regions, others are clearly moving towards high-value crops, including fruits, vegetables, and off-season crops. The analysis of topography represented by elevation with mean landholding size showed very weak, non significant relationship ($\beta = -0.00015$; $R^2 = 0.003$; $p = 0.864$) indicating that elevation does not explain variations in landholding. The Herfindahl index, used to calculate crop diversification, showed that among the surveyed blocks Jhandutta had highest CDI. The crop diversification values for blocks, namely Ghumarwin, Bilaspur Sadar, Jhandutta, and Shri Naina Devi (Swarghat), were 0.783, 0.778, 0.813, and 0.762, respectively. The higher diversification can be attributed to increasing market demand for lucrative crops, variation in cropping practices etc. Further study related to factors such as market accessibility, irrigation facilities and socioeconomic factors is needed to understand the causes of the variation. Market uncertainty, inadequate storage facilities, and pest/disease incidence were the main obstacles to diversification. Despite these constraints, farmers recognized that diversity may help manage climate risk, which might result in crop failure, improve soil health, and increase agricultural profitability. Further, the impact of crop diversification on disease prevalence was analyzed. The majority of farmers, i.e., 38.33%, reported increased incidence of diseases with crop diversification, and 28.33% farmers reported decreased disease incidence; 33.33% farmers observed no change. The disease management practices of farmers were also recorded, which shows that the majority of farmers use chemical pesticides, insecticides, fungicides, and bactericides to control pests/diseases. However, they also adopted cultural practices, physical and mechanical control measures to prevent disease incidence. In addition, they also practice indigenous methods like spraying neem oil, stale lassi, ash, and cow urine to manage diseases and pests, which indicate farmers are adopting organic farming. The positive response of respondents on the use of new or improved resistant varieties can indicate their awareness about the benefits of those varieties and their willingness to adopt sustainable agricultural practices and to reduce dependency on chemical sprays. The resistant varieties plays major role in guaranteeing consistent and increased yields. The study's conclusion emphasizes the necessity of the development of well-established markets in proximity to farmers, enhanced irrigation infrastructure, credit availability, agricultural trainings and storage facilities to support crop diversification. Farmers might be further encouraged to adopt a more resilient and diverse farming system by providing institutional support and ensuring price guarantees for diversified crops. The knowledge gained from this district-level study can be a useful tool for developing policies and planning regional agriculture in a way that promotes sustainable and equitable rural development.

Limitations of the study

The present study has certain limitations, particularly with respect to statistical analysis. The study was based on a relatively small sample of 60 respondents from four blocks, namely Ghumarwin, Bilaspur Sadar, Jhandutta, and Shri Naina Devi at Swarghat. Therefore, the use of inferential statistical approaches like multiple regression or hypothesis testing, which depend on larger datasets to produce accurate and significant results, was limited by this extremely small sample size. It may limit the generalizability of the findings to the broader farming community in the district, despite efforts to include diverse farm sizes and occupations. Furthermore, the study's methodology limited the analysis as socio-economic variables like age, landholding size, education, and occupation, etc. were compiled in frequency distributions rather than individual household data. Therefore, it was not possible to directly correlate these variables with CDI statistically. Consequently, this study's findings are mostly descriptive and comparative in nature. Although patterns and variances have been highlighted using block-wise averages and distributions, no statistical significance can be deduced. It is important to exercise caution when interpreting these findings and to avoid extrapolating them outside of the study area. The use of sophisticated statistical methods and more thorough investigation of the relationships between socio-economic determinants and CDI would be made possible by future studies with a bigger sample size and comprehensive household-level data.

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Author contributions

Conceptualization, data collection and data curation, software, writing original draft; Sharma S.; review and editing; Sharma P.; Kumari N.; data analysis and editing; review, editing, and supervision; Upmanyu S. All authors have agreed to the final version of the manuscript

Conflicts of Interest

The authors declare that they have no conflict of interest.

Ethics approval

The study involved questionnaire-based surveys and personal interviews with farmers. Prior informed consent was obtained from all participants, and the research did not involve any loss of biodiversity.

AI tool usage declaration

Artificial intelligence tools were used only for language refinement and grammatical improvement of the manuscript. The scientific content, data analysis, interpretation, and conclusions were entirely developed by the authors.

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