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INVESTIGATING THE PATTERN AND DETERMINANTS OF CROP DIVERSIFICATION: POLICY RECOMMENDATIONS FOR SUSTAINABLE DIVERSIFIED FARMING IN PUNJAB, PAKISTAN

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ABSTRACT

Crop diversification is a crucial approach for promoting sustainable agriculture by allowing farmers to optimize yields, reduce inputs, conserve resources, and mitigate ecological and environmental risks. The main objectives of this study were to investigate the pattern and determinants of crop diversification in Punjab Pakistan. This research was carried out in four districts of mixed cropping zone of Punjab i.e. Faisalabad, Chiniot, Toba Tek Singh, and Jhang. A multistage sampling method was used to collect data from 200 farmers. Inferential statistics techniques such as the Tobit model and Simpson Diversity Index were employed to analyze the study objectives. The mean diversification index across the districts was 0.73, 0.75, 0.69, and 0.66 for Faisalabad, Chiniot, Toba Tek Singh, and Jhang. The mean diversification index for all the diversified farmers was 0.71. Tobit model analysis revealed that the age of farmers, education attainment, access to inputs, extension services, irrigation, and membership of farmers' associations have a major impact on the promotion of diversification of crops in the study area. This study suggests that there is a dire need to educate farmers about the production technologies of emerging crops, proper markets for fruits and vegetables, and easy availability of cheap interest loans.

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INTRODUCTION

The presence of a wide range of crop species is critical for developing strong and sustainable farming systems. This involves implementing strategies such as crop rotation, multiple cropping, or intercropping instead of relying on specialized farming practices in order to enhance crop yields, maintain soil stability, and promote ecological services (Rosa-Schleich, 2023). When combined with a coherent set of crops, agroecological practices have been shown to reduce disease and pest pressure in the field (Storkey et al., 2019), regulate biogeochemical cycles more effectively (Dwivedi et al., 2017), control weed populations better and promote the reduction of economic risks at the farm level (Weisberger et al., 2019). A viable alternative to modern industrial farming is the implementation of varied crop systems, which are founded on agroecological principles and operate within a systems framework (Puech and Stark, 2023). It is crucial to comprehend the relationship between crop diversification and the income sources of farmers in emerging nations since they rapidly diversify their income sources (Davis et al., 2012).

The cropping patterns of subsistence farmers in Punjab districts in Pakistan underwent substantial changes with the advent of agricultural commercialization in developing countries. This resulted in a higher concentration of crop cultivation in places that exhibited greater and increasing productivity (Rani et al., 2021). Although the agriculture industry is the second greatest contributor to Pakistan's economy, its share has been consistently decreasing. Since 2014, there has been a significant decline; this decline was further exacerbated in 2019 and 2020 as a result of the COVID-19 pandemic. Although its proportion is decreasing, agriculture still employs 43.5 percent of the country's workforce (Raza et al., 2018).

Agriculture constitutes a substantial portion of the income for the ordinary farm household in Pakistan (Chaiya et al., 2023). The agricultural industry of Pakistan is confronted with a range of challenges, including extreme weather events, insect infestations, and volatility in market prices (Abbas et al., 2023). Shifting from low-value crops to high-value crops might be a practical approach for farmers to sustain and potentially enhance their income, particularly considering Pakistan's growing population and the resulting need for food products (Horst and Watkins, 2022).

However, the implementation of diversification measures is seldom due to the necessity for additional investments in machinery, infrastructure skills, and research evidence (Meynard et al., 2018). Nevertheless, crop diversification is widely acknowledged as a highly successful method for managing risks, which can safeguard farm businesses against the uncertainties of climate and commodity markets (Nazir and Lohano, 2022).

Singh et al. (2021) found that a survey revealed that decreased crop diversification has negative effects on the environment, increases the financial risk for farmers, and contributes to the excessive utilization of natural resources. The primary concerns in the districts currently encompass the overutilization of chemical pesticides and fertilizers, pollution, a declining water table, increasing water logging, soil salinity, and various other challenges (Jabbar et al., 2021). Furthermore, the ability to enter and operate in the market poses a substantial obstacle to expanding the range of crops cultivated by small-scale farmers (Curtin et al., 2024).

Multiple studies have been undertaken by researchers to examine the environmental and social advantages of diversifying farming practices (Shahbaz et al., 2017; Delgado and Siamwalla, 2018; Tamburini et al., 2020). However, it is crucial to take into account the factors that affect the acceptance of farm diversification. Farmers have several constraints in their daily activities, and despite the aforementioned benefits, they may require additional resources or chances to adopt, safeguard, or enhance crop diversity. This study seeks to explore crop diversity and identify the main factors that promote and limit crop diversification in Punjab, Pakistan, and analyses the policy implications of these findings.

METHODOLOGY

Description of the Study Area

The current research was conducted in the Punjab province of Pakistan because of its significant crop production, which accounts for over half of the country's gross domestic product (GOP, 2022). Pakistan benefits from the presence of fertile soil in this region, which is crucial for agricultural activities (Ali and Rose, 2021). Pakistan's agriculture sector contributes about 75% of the country's overall exports, with the province of Punjab accounting for 60% of this share. The Punjab province is geographically segregated into three distinct zones: the rice-wheat farming zone, the mixed cropping zone, and the cotton-wheat cropping zone. Punjab province encompasses over sixty percent of the nation's diversified cropping zones, characterized by diverse temperatures, topography, and agriculture, which provide an ecological environment conducive to cultivating various crops. The location is highly conducive for cultivating rice, fruits, wheat, sugarcane, and vegetables.

Data Collection and Analysis

The Punjab province and its four districts (Faisalabad, Chiniot, Toba Tek Singh, and Jhang) were purposefully chosen because of their significant percentage of cropped area and the occurrence of mixed cropping zones. Figure 1 shows the map of the study area, comprising four districts of mixed cropping zone. A proportional selection technique was employed to choose villages from different districts. Specifically, 7 villages were selected from Faisalabad District, 4 villages from Chiniot District, 6 villages from Toba Tek Singh, and 3 villages from Jhang District, resulting in a total of 20 settlements.

A straightforward random selection procedure was utilized to select ten (10) respondents from each hamlet, resulting in a sample size of 200 homes belonging to diverse crop producers. A comprehensive analysis was conducted on farmers in the four districts who had recently expanded their agricultural activities by incorporating cash crops, in order to investigate their farming methods in detail. In order to choose these farms, a purposive sampling method was employed, followed by a snowball sampling strategy. This involved obtaining the names of the initial diversified farmers in each district from local agricultural extension professionals. Following the first interviews, the farmers were subsequently requested to furnish the names of other farmers in their community who had lately engaged in crop diversification.

The study collected data by administering a semi-structured questionnaire. The sample size was determined following the formula prescribed by Adam (2021), taking into account the known number of diverse crop growers.

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

n= sample size; N = target population; e = level of precision (0.05)

Descriptive statistics like mean, frequency, and percentages were used to capture the diversified cropping patterns according to respective growing seasons:

$$\bar{X}= \frac{\sum fx}{N} \quad (2)$$

$$\bar{X}= \frac{\sum fx}{N} *100 \quad (3)$$

$\bar{X}$ = mean; $\sum$= summation; f = frequency; x =variable; N = total frequency; $\bar{X}$*100 = Percentage

$$Pi \ \frac{A_i}{\sum_{i=1}^{n} A_i} \quad (4)$$

$$SDI = \sum_{i=1}^{n} P_i^2 \quad (5)$$

$$CDI = 1 - \sum_{i=1}^{n} P_i^2 = 1 - Hi \quad (6)$$

SDI = Simpson diversification index; CDI = crop diversification index; Pi= share of the i^{th} crop cultivated; Ai = Area under i^{th} Crop; $\sum_{i-1}^{n} A_i$ = Total cropped Area and i = 1,2,3…n (number of crops grown)

Tobit model is used to examine the factors that lead to farmers' choice of crop diversification:

$$y_i^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + U \quad (7)$$

y_i^* = Crop diversification index; β_0 = Constant; β_1, β_2,…β_k = the regression coefficients; X_1, X_2…X_k = predictor variables; K = number of predictor variables; U = Stochastic error; X_1 = Age of the farmer; X_2 = Farming experience; X_3 = years of formal schooling; X_4 = Family labor ; X_5 = Hired labor; X_6 = Household size; X_7 = Membership of farmers association; X_8 = Access to information; X_9= whether agricultural graduate; X_{10} = Extension Contact frequency; X_{11} = Farm size (acre); X_{12} = Irrigation services; X_{13} = Number of parcels; X_{14} = Distance from farm to market (Km); X_{15} = Access to credit and X_{16}= On-farm income (PKR).

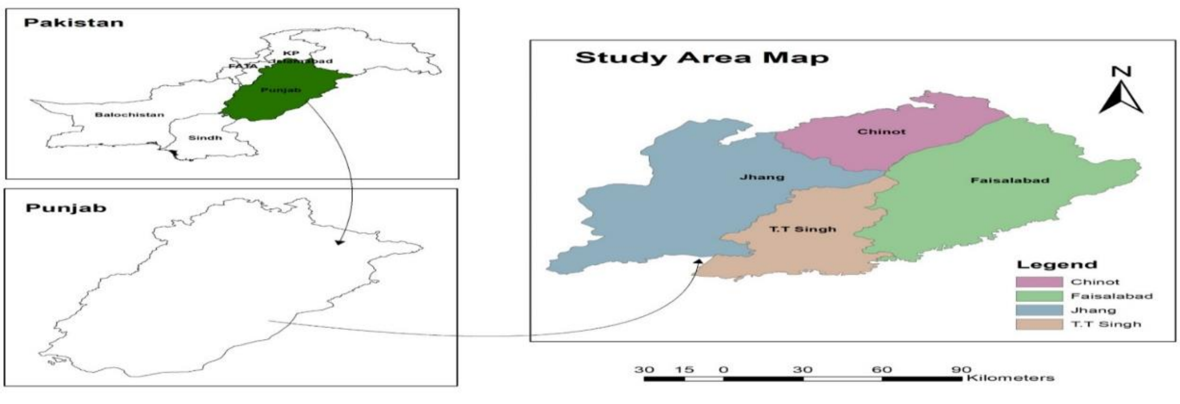

Figure 1. Study area map.

RESULTS AND DISCUSSION

Cropping Pattern of Diversified Farmers

The cropping pattern, which illustrates the regional distribution of crop diversification among the diversified farmers, is displayed in Tables 1 and 2. The crops are classified according to the season, such as summer and winter crops. Summer crops are cultivated during the initiation of the monsoon season and are typically harvested between September and November. Conversely, winter crops in Pakistan are sown between November and December and reaped between March and April.

Summer Crops

Table 1 illustrates the list of primary crops grown by the diverse farmers over the summer season. According to the survey statistics, rice, sugarcane, and maize are the primary and noteworthy crops cultivated by 62.5%, 48%, and 39% of the farmers, respectively. The combined rice cultivation area amounted to 362.5 acres, accounting for 21.85% of the total cultivated area reported by the respondents. The average and maximum size of the rice farms were 4.51 acres and 10 acres, respectively. In the same manner, the overall area dedicated to growing sugarcane amounted to 297 acres, which accounted for 17.90% of the entire cultivated land area. The average cultivated area dedicated to sugar cane growing was 4.05 acres, while the largest area seen was 20 acres. Cotton is another summer crop planted by 94 diversifiers, which accounts for 47% of the respondents. The cotton production encompassed a total farm area of 172 acres, accounting for 10.37% of the overall farm area. The average farm size for cotton production was 4.91 acres, with a maximum size of 10 acres.

Moreover, the findings in Table 1 demonstrate that diversifiers engage in the cultivation of a wide range of vegetables, fruits, and oil seeds during the summer season. Cucumbers, okra, bitter melon, and watermelons are the most crucial veggies. The table clearly indicates that the proportion of farmers involved in different vegetable cultivations is as follows: watermelon (11%), lady finger (9%), bitter gourd (7.5%), and cucumber (6.5%). Sesame is the sole oil seed crop cultivated throughout the summer season. The average cropped area was 3.86 acres.

Winter Crops

Table 2 shows that diversified farmers plant a total of 16 crops throughout the winter season. The primary crops include wheat, canola, mustard, citrus, tomato, cabbage, and potato. Diversified farmers primarily cultivate wheat during the winter season, accounting for 93% of their crop cultivation and occupying 38% of the total cropped area. On average, each farmer cultivates 4.92 acres of wheat, with a maximum of 15 acres. The diversifiers mostly cultivate potato (13%), garlic (11%), spinach (8%), onion (6%), peas (6%), turnips (5.5%), and Phalia (4%) as their main winter vegetable crops. The findings indicate that, despite farmers expanding their production to include vegetables, there is still a need to increase the rate of involvement.

Table 1. Cropping pattern in the summer season (diversified farmers, n=200).

Variables	Number of farmers	Land Area Sown (acres)	% of the total cropped area	Mean cropped area	Max	SD
Rice	125 (62.5)	362.5	21.85	4.51	10	2.4
Sugarcane	96(48)	297	17.90	4.05	25	3.6
Maize	78(39)	197	11.88	4.04	10	2.3
Bajra	11(5.5)	133.5	8.05	4.05	15	2.7
Ladyfinger	18(9)	25.2	1.52	2.1	5	1.4
Bitter gourd	15(7.5)	29	1.75	2.9	7	1.9
Cucumber	13(6.5)	19.5	1.18	2.79	12	1.6
Sesame	16(8)	313	18.87	3.86	4	2
Cotton	94(47)	172	10.37	4.91	10	2.6
Watermelons	22(11)	47	2.83	4.7	10	2.6
Sunflower	18(9)	35	2.11	4.38	10	2.5
Ridged Guard	19(9.5)	13.2	0.80	2.2	5	1.6
Guava	16(8)	15	0.90	2.5	4	1.1
crop area	200(100)	1345.9	100.00	3.59		

Note: Figures in parenthesis are % to the number of farmers; Source: Authors' computation, 2024.

Table 2. Cropping pattern in the winter season (diversified farmers, n=200).

Variables	Number of farmers	Area Sown (Acres)	% to the total crop area	Mean crop area	Max	SD
Wheat	186(93)	1021	38.00	4.92	15	2.5
Cabbage	29(14.5)	40.5	1.51	2.53	6	1.6
Tomato	28(14)	99	3.68	2.83	10	1.3
Brinjal	16(8)	18	0.67	2.25	6	1.03
Canola	72(36)	275	10.23	3.67	10	1.8
Mustard	68(34)	251	9.34	3.98	10	1.7
Spinach	16(8)	266	9.90	3.55	10	1.7
Peas	12(6)	162	6.03	3.45	8	1.6
Potato	26(13)	23	0.86	2.88	5	1.3
Turnip	11(5.5)	204	7.59	3.24	10	1.7
Phaliya	8(4)	72	2.68	3.27	6	1.6
Citrus	33(16.5)	191	7.11	4.06	20	2.8
Tobacco	9(4.5)	13	0.48	2.6	5	1.5
Onion	12(6)	43	1.60	3.58	10	2.3
Garlic	22(11)	8.65	0.32	1.44	3	1.1
Total		2687.15	100.00			

Note: Figures in parenthesis are % to the number of farmers; Source: Authors' computation, 2024.

Furthermore, the findings revealed that a significant proportion of the farmers are engaged in cultivating oilseed crops, specifically Canola and Mustard. According to the findings, 36% of the farmers engage in canola cultivation, which accounts for 10.23% of the entire planted area. The average size of the crop area dedicated to canola was 3.67 acres, with a maximum size of 10 acres. Mustard is cultivated by 34% of the farmers, covering a land area of 251 acres, which represents 9.34% of the total cropped area. Additionally, citrus was cultivated by 33 farmers, accounting for 16.5% of the total number of farmers. The citrus cultivation encompassed a total land area of 191 acres, with an average size of 4.06 acres and a maximum extent of 20 acres. The findings suggest that citrus cultivation is of moderate scale among farmers in the studied locations.

Acreage Allotted under Various Crops by Diversified Farmers

According to the data shown in Figure 2, wheat was grown on 1,021 acres, which accounted for 34.02% of the total area used for winter season crops by the diversified farmers. The cultivation of sugarcane covered a total of 297 acres, accounting for 22.07% of the total area used for summer season crops. Winter crops, primarily vegetables, accounted for 22.44% of the total cultivated land, encompassing both winter and summer crops. Oilseed crops came in a close second, occupying 20.96% of the farmed area. The diversifiers allocated a smaller proportion of land, less than 6.5%, specifically 253 acres, for fruit cultivation. Spices and stimulants account for a mere 1.11% of the cultivated land. The farmers' limited capacity to engage in fruit cultivation is likely due to the fact that, unlike vegetables and oil crops, most fruits are perennial plants. Additionally, the farmers' tiny land holdings restrict their ability to pursue such agricultural endeavors.

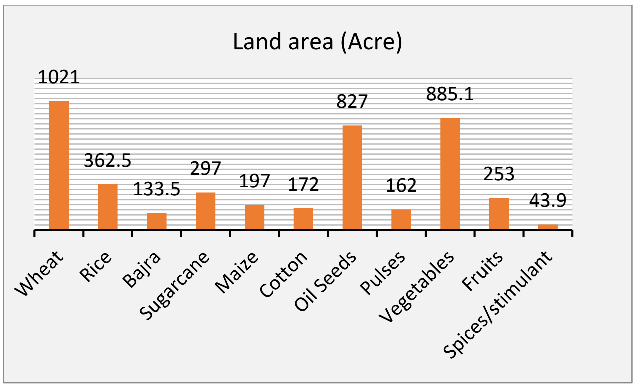

Figure 2. Average land area under cultivation; Source: Authors' computation, 2024.

Extent of Crop Diversification in Study Area

Diversification of cropping pattern was assessed using the Simpson Diversification Index (SDI) which ranges from 0 to 1. A value below 0.5 is classified as low diversity, while values of 0.5 or more than it classified as high diversity as defined by Umar et al. (2020) and Mamman et al. (2022).

Table 3. Extent of crop diversification in the Punjab province.

Variables	Frequency	Percentage
High diversify (≥0.5)	170	82.36
Low diversify (< 0.5)	30	17.64
Total	100.00	100
Mean	0.71	

Source: Authors' computation, 2024.

This index was used by Agyeman et al. (2014) and Batool et al. (2017). Table 3 explains the overall crop diversification index of the study area. The results indicated that 82.36% of farmers manifested a high diversity index and 17.36% manifested a low diversity index. The average crop diversity index was 0.71. Results concluded that there is a significant amount of crop diversification among farmers in the study area, as exhibited by the high value of the crop diversification index.

Extent of Crop Diversification (District Wise)

According to the estimation from Table 4, 88.06% of the farmers in the Faisalabad district had a high crop diversity index. By comparison, 11.04% of the sample had low crop diversity scores. The average, minimum, and maximum levels of diversification were 0.75, 0.26, and 0.89, respectively. In the Chiniot district, the findings showed that the majority of respondents (84.62%) had a high crop diversification index. The average, highest, and lowest indexes were 0.75, 0.31, and 0.89, respectively. 84.62% of the participants in Toba Tek Singh exhibited a high variety index. The average, highest, and lowest diversity scores in Toba Tek Singh were determined to be 0.69, 0.23, and 0.87, respectively. Furthermore, the findings in the Jhang district revealed that 81.48% of the area exhibited a high diversity index, with an average, minimum, and maximum diversity index of 0.66, 0.21, and 0.84 respectively.

Table 4. Degree of crop diversification (district-wise).

Location	Frequency	Percentage
Faisalabad		
High diversity (≥0.5)	59	88.06
Low diversify (< 0.5)	8	11.94
Total	67	100
Mean	0.73	
Chiniot		
High diversity (≥0.5)	33	84.62
Low diversify (< 0.5)	06	15.38
Total	39	100
Mean	0.75	
Toba Tek Singh		
High diversify (≥0.5)	56	83.58
Low diversify (< 0.5)	11	16.42
Total	67	100.00
Mean	0.69	
Jhang		
High diversify (≥0.5)	22	81.48
Low diversify (< 0.5)	5	18.52
Total	27	100.00
Mean	0.66	

Source: Authors' computation, 2024.

Mean Comparison of the Crop Diversity Scores across the Selected Districts

A t-test was used to see if there was a significant difference in the mean diversity scores among the districts. Table 5 showed that there were no significant variations in the average diversity ratings between the districts of Faisalabad and Chiniot. The average diversity score of the two districts was statistically equivalent. The findings also demonstrated that the average diversity index values between Jhang and Toba Tek Singh were statistically comparable. The results in Table 5 indicate that there was a statistically significant difference in the mean diversity scores between Faisalabad and Toba Tek Singh at a 10% probability level. One possible interpretation is that farmers in Faisalabad are engaging in more diversification compared to farmers in other areas. At a 1% probability level, there were notable variations in the average diversity scores of diversifiers in Chiniot and Jhang. The study also showed that the average diversity score between Faisalabad and Jhang was statistically significant at a 5% confidence level.

Table 5. Mean Comparison of the crop diversity scores across the selected districts.

Paired	Paired Difference			95% confidence interval		
	Mean	Std. Dev	Std. Err	Lower	Upper	T-value
Faisalabad - Toba Tek Singh	-.0512	.1927	.0272	-.1060	.0036	-1.88*
Faisalabad- Chiniot	.0404	.2243	.0317	-.0234	.1042	1.27NS
Faisalabad- Jhang	.1006	.3201	.0453	.0096	.1916	2.22**
Chiniot – Toba Tek Singh	.0916	.2348	.0332	.0249	.1583	2.76**
Chiniot – Jhang	.1518	.3026	.0428	.0658	.2378	3.55***
Jhang – Toba Tek Singh	-.0602	.3260	.0461	-.1528	.0324	-1.31NS

Note: *** Significant at 1%, **significant at 5%, * significant at 10%; Source: Authors' computation, 2024.

Table 5 illustrates the differences in crop diversification levels across the districts in the research area. While the statistical analysis indicated that the significance of diversification between Faisalabad and Chiniot is comparable to that of Jhang and Toba Tek Singh, the findings demonstrate a shift in Punjab agriculture from traditional subsistence farming to high-value agriculture, as evidenced by the trends in area growth. Nevertheless, this transition is not consistent across different regions.

Determinants of Crop Diversification

The Tobit model results, presented in Table 6, identified the elements that influence crop diversification. The SDI index is considered the dependent variable, whereas the estimated independent variables are the socio-demographic characteristics of the farmers. The study revealed a negative and statistically significant correlation between the age of the respondents and their inclination towards innovation and risk-taking in farm activities. This suggests that younger farmers are more likely to be inventive and willing to take risks. This finding is consistent with that of Sichoongwe et al. (2014), who reported that the age of the farmers positively affects farmers' crop diversification decisions

On the other hand, older farmers tend to be predominantly traditional in their farming methods. Similarly, the results showed that the education and farming experience of the participants had a significant and favorable effect on crop diversification. The findings indicated a positive correlation between farm size and the probability of crop diversification. Various previous studies (Benin et al., 2004; Culas and Mahendrarajah, 2005; Mwangi et al., 2011) have illustrated a positive correlation between farm size and crop diversity. As the number of extension delivery services increased, there was a corresponding increase in the likelihood of farmers diversifying their produce. Extension services are vital mechanisms for the dissemination of new ideas and policies from the government to farmers. The findings indicated that the distance from the market had a negative impact on crop diversification, and this impact was statistically significant. This suggests that agricultural families located further away from the primary market tend to have a lower level of output diversification. The presence of a negative sign on the distance to markets indicates that as farmers get closer to the market, their likelihood of diversifying increases. The study revealed that access to credit had a favorable and statistically significant impact on diversification, with a probability of less than 0.05. Therefore, farmers who have the ability to obtain financing are more likely to engage in diversification compared to farmers who have little or no access to credit facilities.

The findings also showed that, despite being positive, the coefficient of irrigation service is not statistically significant. Furthermore, it was noted that in areas where building irrigation systems is difficult, small-scale farmers with land sizes below 0.5 ha and between 0.5 and 1 ha concentrate their efforts on growing crops such as fruits, oilseeds, jute, and fibers. This action was undertaken to meet their financial needs, in contrast to farmers in districts that have access to irrigation infrastructure. The data revealed that a drop in land size by 1 acre resulted in a proportional fall of 15.8% in the likelihood of adopting crop diversity.

Table 6. Determinants of crop diversification.

Variables	Coeff.	Std. error.	T-value
Age of the farmer (Years)	-0.0223	0.0073	-3.05***
Farming experience (Years)	0.0456	0.0088	5.19***
Formal schooling (Years)	0.0048	0.0018	2.60**
Family labor (Mandays)	0.1230	0.6570	0.19NS
Hired labor (Man-days)	0.0053	0.0059	0.89NS
Household size (Numbers)	0.2460	0.0876	2.81**
Membership of Farmers Association (Dummy)	0.0118	0.0057	2.09
Access to information (Dummy)	0.0033	0.0023	1.41NS
Whether agricultural graduate (Dummy)	0.5820	0.6850	0.85NS
Extension Contacts frequency	0.0987	0.0369	2.67**
Farm size (acre)	0.0035	0.0011	3.20***
Availability of Irrigation services	0.0256	0.0157	1.63NS
Number of Parcels	-0.0432	0.0220	-1.96*
Distance from farm to market (Kms)	-0.0576	0.0451	-1.28NS
Access to credit (Dummy)	0.0021	0.0008	2.68**
On-farm income (Rs./Annum)	0.0245	0.0119	2.06*
Constant	1.8530	0.2340	

Note: ***, **, and * = significant at 1%, 5%, and 10% respectively; Source: Authors' computation, 2024.

The correlation between farm income and diversification is positive and statistically significant, indicating that as farm revenue rises, farmers are more likely to engage in diversification. This finding aligns with the results reported by Makate et al. (2016) in Zimbabwe, Bravo-Ureta et al. (2006) in El Salvador and Honduras, and Perz (2004) in the Brazilian Amazon. Bravo-Ureta et al. (2006) reported a mean gain of 21% in agricultural income for farmers who diversify their cropping pattern. Correspondingly, Perz (2004) also reported a positive correlation between the extent of crop diversification and farm income.

CONCLUSIONS

The study demonstrates that Punjab is transitioning from mono-cropping to crop diversification. Having a common conceptual understanding of crop diversification, improving cropping systems, establishing new value chains and sustainable ecological systems, and providing additional socioeconomic advantages are crucial. Nevertheless, this study aims to assess the primary factors and scope of crop diversification. The study's findings suggest that enhancing the crop diversity of small farming households, which are abundant, might be more effectively achieved by cultivating a broader range of crops and building more diverse local commodities marketplaces. Various factors, including the socioeconomic circumstances of farmers such as their age, level of education, access to agricultural resources, irrigation, extension services, participation in farmers' associations, and the amount of land dedicated to cropping, can have a substantial and meaningful impact on the long-term viability of crop diversity. This is especially true for small-scale farmers who actively cultivate a diverse range of crops.

The study paved the way for policy assistance through the improvement of marketing infrastructure, accessible agricultural credit, the establishment of irrigation systems, farm mechanization, crop insurance, and the provision of suitable technologies to farming communities to promote crop diversity for a more sustainable environment and improved livelihoods. Similarly, in order to enhance crop diversity production, it is imperative to streamline the participation of the private sector in facilitating lending, providing technical help, ensuring timely distribution of inputs, and disseminating knowledge through organized events such as farmers' days or demonstration plots.

There is a dire need of farmers' training and awareness about production technologies of emerging and diversified crops. Farmers should be informed regarding the profitability of these crops and boost their morale to diversify their cropping patterns. It is recommended that credit loans with lGOPow interest rates should be given to farmers by the government and commercial banks so that credit will enable farmers to get high quality inputs at the right time to get optimum yield.

Research focused on specific crops, such as increasing yield potential, improving quality characteristics, developing shorter-duration varieties, and enhancing tolerance to pests and climate stresses, is being conducted. Additionally, efforts are being made to study the overall farming system, including water and land management, to assist farmers in adapting their crop choices based on changing incentives and to accommodate a diverse range of crops within a given season.

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