

A GEOGRAPHICAL ANALYSIS OF CROP DIVERSIFICATION IN PUNJAB WITH SPECIAL REFERENCE TO SUSTAINABLE AGRICULTURAL DEVELOPMENT

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Abstract

Due to its extensive production of rice and wheat, the northern Indian state of Punjab has long been referred to as the breadbasket of India. But the excessive reliance on these two crops has led to a number of ecological, economic, and social problems, including soil erosion, water scarcity, declining yields, and farmer dissatisfaction. Crop diversification has been identified as a crucial strategy for Punjab's sustainable agricultural development as a solution to these problems. In order to promote crop diversification for sustainable agricultural development, this paper will analyse the current state of crop diversification in Punjab, identify the factors that influence crop diversification, and suggest ways to promote crop diversification for sustainable agricultural development. The study uses secondary data, including analysis of government reports and statistical data between the years 1981–1982 and 2021–2022, in order to meet the objectives of the current study. The Herfindahl index has been used in the current study to calculate agricultural diversification. The study discovered that the status of crop diversification in Punjab is declining regularly since 1981's, with wheat and rice still predominating the pattern of crop production.

Keywords: Punjab, Sustainable Agricultural Development, Crop diversification, Herfindahl Index, Declining Trends.

Introduction

For a very long time, Punjab's economy, has been based mostly on agriculture. The state is renowned for producing large yields of wheat and rice, which have been made possible by the adoption of contemporary agricultural techniques, such as the use of chemical pesticides and fertilizers. 85% of the country's land is used for agriculture, which is the largest economic sector in Punjab. It has a cropping intensity of about 184%, and historically, the farmer used to cultivate the land in the maize-wheat or sugarcane-maize-wheat patterns. However, they changed to a wheat-rice farming pattern over the past 20 years, which raised the need for irrigation water and overused groundwater supplies. This change was mostly brought on by the relatively better returns and more consistent paddy and wheat yields. Water needs for producing one kilogramme of rice and one kilogramme of wheat are 3,000 litres and 1,350 litres, respectively. The state's land and water were degraded as a result of the prolonged implementation of this strategy. At a depth of 200 feet, tube wells have been set up to draw groundwater for irrigation. Heavy metal contamination makes the water from the lower aquifer unsuitable for consumption and agricultural use. Rice cultivation would require the use of submersible pumps, which are expensive and unlikely to be suitable for marginal and small landholding farmers, according to the Punjab Economic Survey (2020-21), which claimed that paddy cultivation had resulted in the overexploitation of ground water resources in the state. Crop diversification in Punjab, according to experts, has essentially failed because farmers are reluctant to adopt less water-intensive crops due to a lack of purchasing or marketing opportunities due to the open-ended rice and wheat procurement system used by Food Corporation of India (FCI) and state agencies.

Consequently, it is necessary to include new elements that concentrate on water source sustainability with the policy narrative in light of the threat that the water crisis provides to Punjab's agriculture sustainability. Depending on agroclimatic circumstances, crop diversification tries to replace water-intensive cropping patterns with less water-intensive crops. The availability of water is thought to be an effective way to lessen Punjab's Agri-water problems. Punjab has contributed more than 12.5 million tonne (MT) or 20% of the overall rice procurement of 56.81 MT to the central pool maintained by FCI during the current procurement season (October-September for 2021–2022). Punjab has provided more than 51% of the 18.77

MT of wheat that has so far been bought from farmers as part of the current rabi procurement exercise for wheat (2022-23).

According to officials, the Punjab government is encouraging direct planting of rice (DSR), which uses less water, enhances percolation, and lessens reliance on agricultural labour, beginning with the current kharif season (2022-23). Farmers who use the DRS technique are given a reward of Rs 1,500 per acre, and a budget of Rs 450 crore has been set out for it. The state government is also urging farmers to grow short-duration rice varieties like PAU 126, 127, and 128 so that transplanting may be done during the July monsoon rains (which mature in 125 days as opposed to traditional varieties, which require 135-145 days). According to a statement made by the agriculture ministry in Parliament in April (2022), the Rashtriya Krishi Vikas Yojana's crop diversification programme, which was launched in 2013-14 in Green Revolution states like Punjab, Haryana, and western Uttar Pradesh, has only resulted in the demonstration of 0.63 MH of alternative crops at farmers' fields. Nevertheless, between 1980-1981 and 1990-1991 there was a halt in agricultural growth and a collapse of Punjab's economy (Singh et al., 2019). The variety of cropping techniques decreased, and rice-wheat specialisation evolved in agriculture. In Punjab, mono-cropping culture with the wheat-paddy dominating system began to emerge as a result of a quantitative fall in crop diversification. This led to ecological issues such as excessive groundwater and resource use, soil degradation, and a decline in agricultural employment (Sidhu & Johl, 2002). Groundwater levels decreased due to misuse between 1973 and 2003 at a rate of 24 cm per year (Hira et al., 2004) and between 2000 and 2013 at a rate of 43 cm (Srivastava et al., 2017).

As Punjab is the bread basket in terms of food grain of India, Economists and policymakers face a significant Problem in determining the best cropping pattern for Punjab. Several economists hypothesized that the phenomenon may be resolved by switching from wheat and paddy to alternate crops. Urbanization together with economic expansion causes an increase in the demand for foods that are rich in nutrition, and crop diversification offers consumers a variety of food options while also increasing farmer revenue. It also gives agriculture sustainability and lowers associated risk and migration (Mruthyunjaya & Chauhan, 2003) Therefore, Crop diversification is becoming more popular as a strategy for advancing sustainable agricultural development in recent years. For an agriculturally oriented economy like Punjab, crop diversification is crucial. Due to price response, market infrastructure, resource availability, government involvement (pricing and credit policies, R&D, and globalization of agriculture), crop diversification is also attracting a lot of attention. A wise crop mix has enabled the use of underutilized resources, which has decreased seasonal and underemployment of labour, increased farm earnings, and reduced risks and uncertainties in crop yields caused by climatic and biological whims. To address these issues, crop diversification has been highlighted as a key approach for Punjab's sustainable agricultural growth.

Studies have been carried out to examine agricultural diversification. Singh & Sidhu (2004) examined how the shifting cropping patterns and growing specialisation of wheat and rice in Punjab led to a decrease in crop diversification. The ecology, farmers' incomes, and the overuse of natural resources were all affected by the decreased crop diversification. Moreover, it increases manufacturing variety. Several studies, including Chand & Chauhan (2002), Joshi et al. (2004), Sharma (2011), and Kaur et al. (2015), have documented the "findings of agricultural diversification" and highlighted the change in crop output to high-value food crops as a result of shifting consumption patterns. Wheat and paddy were identified as the two primary crop specialities in the districts of Punjab by Singh et al. (2013) who did research on crop diversification. Nevertheless, the Malwa area produced more American cotton, while the districts of Jalandhar, Hoshiarpur, Kapurthala, and Gurdaspur produced sugarcane and moong. Diversifying the crops by growing things like fruits and vegetables, soyabeans, and maize was advised. In Punjab, Sarkar (2014) proposed crop diversification as a solution to the groundwater-energy issue. It was suggested that the pattern of cultivation be changed from wheat and rice to wheat and maize, which uses less water.

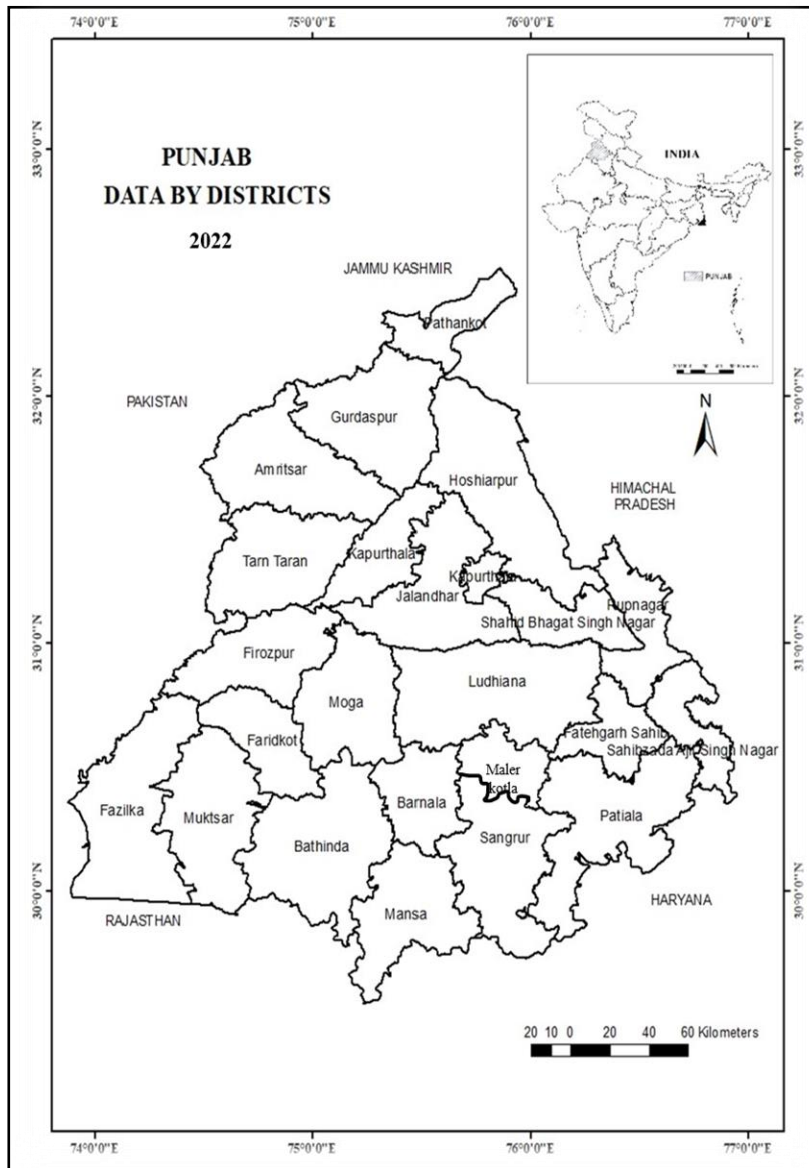
Study Area

Punjab is a landlocked state that borders Pakistan, Jammu and Kashmir, Himachal Pradesh, Rajasthan, Haryana, and other states. Majha, Doaba, and Malwa are the three primary Geographical regions of Punjab, and each has its own terrain, climatic conditions, and agricultural techniques. With a population density of 550 people per square kilometre, the region is located between 29 degrees 30 minutes north and 32 degrees 32 minutes north latitude and 73 degrees 55 minutes east and 76 degrees 50 minutes east longitude. It covers an area of 50,362 square kilometres (1.53 percent of India's total geographical area) and is home to 2,77,04,236 people (2.29 percent of the nation's total population) (Census of India, 2011).

Punjab had 12 districts at the time of the 1981 census, but five more districts were added in 2001, bringing the total to 17 (Moga, Muktsar, Mansa, SBS Nagar and Rupnagar). Nevertheless, as of June 2, 2021, Malerkotla was officially recognised by the Punjab government as the 23rd district in the province. Hence, the total number of districts rose to 23 by 2023. The state of Punjab renowned for its thriving culture, it has a lengthy history that spans many different eras. Several empires and dynasties, including the Maurya’s, Kushans, Mughals, and British, have reigned over it. Punjab, dubbed as the "Granary of India," is a state whose economy is heavily based on agriculture. Many industries, such as those producing textiles, sporting products, and medicines, are also located there. Despite recent strong economic progress, the state continues to face issues including unemployment, poverty, and income inequality.

Map of Study Area

Map: 1.1



Source: Census of India (2011) and Statistical Abstract of Punjab, 2022.

Research Objectives

- To analyse the current state of crop diversification in Punjab.
- To identify the factors that influence crop diversification.
- To suggest ways to promote crop diversification for sustainable agricultural development.

Research Methodology

For the fulfilment of the research objectives, the study uses secondary data, including analysis of government reports, Economic Survey of Punjab and data from statistical abstract of Punjab data between the years 1981–1982 and 2021–2022. District is taken as a unit of the study. For the Analysis of the data, famous statistical techniques known as Herfindahl index has been evaluated for twenty important crops, including potatoes, rice, wheat, moong, massar, mash, sugarcane, linseeds, cotton (desi), cotton (American), bajra, barley, mustard, sesame, and a variety of dry-chili crops (as ninety-five percent of the state's to cropped area of the state is occupied by these crops) to calculate agricultural diversification. In this way at first HI values has been calculated for the concerned districts according to the respective census.

Herfindahl index

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

where, $P_i = A_i / \sum_{i=1}^n A_i$ is the proportion of the i^{th} activity in acreage.

Crop Diversification Index

$$CDI = 1 - HI$$

Where, HI = Herfindahl index

CDI = Crop Diversification Index

The CDI has direct relationship with diversification. It varies between 0 to 1. The zero value of C.D.I. indicates specialization and moving towards one showing increase in number of enterprises. It is also measured on acreage proportion. After calculating the crop diversification index for all districts, data has been analyzed using excel sheet and GIS based maps has been prepared to interpret the data.

Major Findings and Discussion

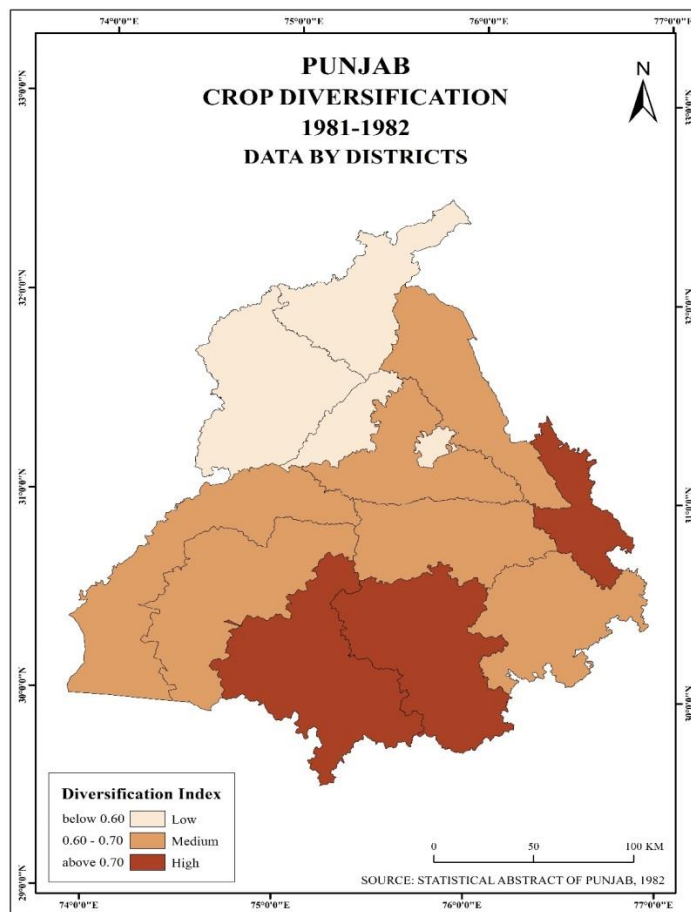
After the analysis of the data, it has been observed that the trend of crop diversification is regularly declining in Punjab since 1981.

Table: 1.1
Punjab: District wise Crop Diversification Index Values

Sr. No.	Name of the district	CDI Value for 1981-1982
1	Amritsar	0.593
2	Gurdaspur	0.598
3	Kapurthala	0.60
4	Patiala	0.637
5	Ludhiana	0.648
6	Jalandhar	0.660
7	Firozpur	0.66
8	Hoshiarpur	0.680
9	Faridkot	0.696
10	Sangrur	0.716
11	Bathinda	0.75
12	Rupnagar	0.76
13	Barnala	-
14	Fatehgarh sahib	-
15	Fazilka	-
16	Malerkotla	-
17	Mansa	-
18	Moga	-
19	Muktsar	-
20	Pathankot	-
21	SAS Nagar	-
22	SBS Nagar	-
23	Tarn Taran	-
Punjab		0.666

Source: Crop diversification Index calculated from the crop wise data given in Statistical Abstract of Punjab, 1982. The value of Punjab's crop diversification index was (0.666) in the years 1981–1982, (0.607) in 2001–2002, and (0.579) in the years 2021–2022, indicating that the province's agriculture is more focused on the production of wheat and rice, even though some districts are trying to diversify their cropping patterns and pursue sustainable agricultural development at the local level. The values of the crop diversification index for the years 1981–1982 are shown in table 1.1.

Map: 1.2



From the table 1.1 and map 1.2 it is very clear that at the time of 1981-1982 the districts of Sangrur (0.716), Bathinda (0.75) and Rupnagar (0.76) were the most diversifying districts in terms of crop diversification as their districts lies in the fertile plains of Sutlej River. Rest of the districts were in the middle and low category of crop diversification index.

Table: 1.2
Punjab: District wise Crop Diversification Index Values

Sr. No.	Name of the district	CDI Value for 2001-2002
1	Patiala	0.536
2	Fatehgarh sahib	0.544
3	Ludhiana	0.55
4	Amritsar	0.55
5	Sangrur	0.553
6	Moga	0.562
7	Kapurthala	0.571
8	Gurdaspur	0.582
9	Faridkot	0.592
10	Jalandhar	0.623
11	Firozpur	0.642
12	SBS Nagar	0.661
13	Muktsar	0.663
14	Rupnagar	0.665

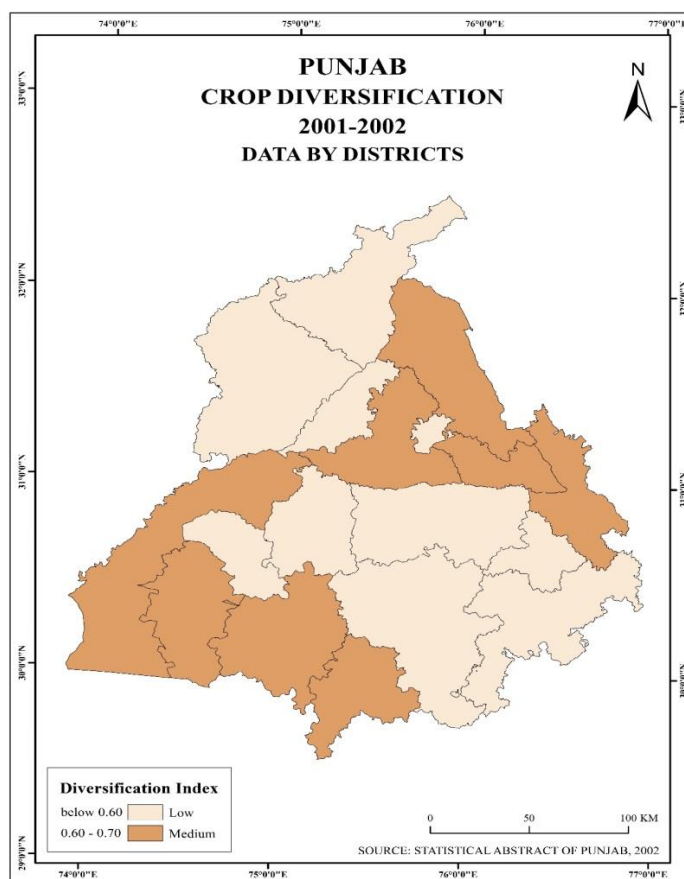
15	Mansa	0.66
16	Bathinda	0.678
17	Hoshiarpur	0.699
18	Barnala	-
19	Fazilka	-
20	Pathankot	-
21	SAS Nagar	-
22	Tarn Taran	-
23	Malerkotla	-
Punjab		0.6077

Source: Crop Index the crop wise Statistical Punjab, 2002.

diversification calculated from data given in Abstract of

The districts of Sangrur (0.716), Bathinda (0.75), and Rupnagar (0.76), which had the highest degree of crop specialisation in 1981–1982, fell into the middle level category during the period of 2001–2002, as shown in table 1.2 and map 1.3. This high-level category of districts then collapsed as a result of crop specialisation. Due to the farmers' primary concentration on cash, wheat, and rice crops, districts of the intermediate level category were moved into the low-level category, while districts of the high level category were moved into the middle level category.

Map: 1.3



The index value ranged from 0.6 to 0.76 in the years 1981–1982, but it decreased to 0.536–0.699 in 2001–2002 and again to 0.51-0.684 in the years 2021–2022, indicating a significant fall in Punjab's agricultural diversity and specialisation in wheat and rice from 1981 to 2022.

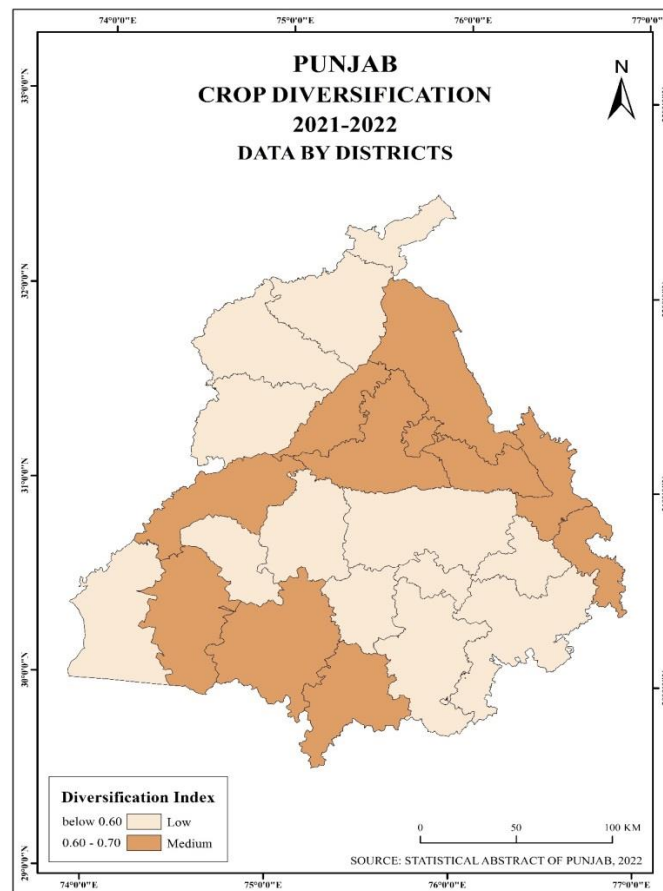
Table: 1.3
Punjab: District wise Crop Diversification Index Values

Sr. No.	Name of the district	CDI Value for 2021-2022
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1	Malerkotla	0.51
2	Tarn Taran	0.52
3	Patiala	0.53
4	Amritsar	0.535
5	Moga	0.536
6	Ludhiana	0.538
7	Pathankot	0.54
8	Sangrur	0.54
9	Fatehgarh sahib	0.549
10	Barnala	0.55
11	Fazilka	0.55
12	Gurdaspur	0.57
13	Faridkot	0.58
14	Kapurthala	0.601
15	Jalandhar	0.604
16	SAS Nagar	0.613
17	Muktsar	0.62
18	Mansa	0.622
19	Firozpur	0.625
20	Bathinda	0.635
21	Rupnagar	0.639
22	SBS Nagar	0.64
23	Hoshiarpur	0.684
Punjab		0.579

Source: Crop diversification Index calculated from the crop wise data given in Statistical Abstract of Punjab, 2002. The table 1.3 and map 1.4 make it abundantly clear that many middle-level districts were shifted into low-level districts in 2021–2022, leaving the middle-level category of districts with just 10 districts. This shift from middle to low level districts demonstrates the sharp decline in Punjab's crop diversification. But on the other hand, district Kapurthala which was earlier in low category in 2002 moved to middle category in 2022, which shows that farmers of the district adopting crop diversification strategies.

Map: 1.4



Key Suggestion for Crop Diversification and Sustainable Agricultural Development

- In Punjab farmers should Establish dairy businesses that would deliver milk and milk products to metropolitan centres in north India for diversifying Punjab's crop base.
- Another economically effective way to diversify the agricultural base is to construct processing facilities for dairy, poultry, and vegetables. making excellent crop plans that might offer various cropping techniques.
- Crops should be chosen based on the geography, soil composition, and water availability. Making excellent crop plans that might offer various cropping techniques. Net earnings will rise as a result, while water use and greenhouse gas emissions will be significantly reduced.
- Mandating public-private purchases for less water-intensive crops at present prices and ensuring ruminative pricing, or MSP. Building a golden triangle with the farmer, Agro industry, and banker as its corners is necessary to increase crop diversity and Agro industrialization.
- Encouraging neighbourhood groups like cooperative societies, NGOs, and Gram Panchayats to use local farming methods that are appropriate for the area's soil and climate. ensuring the use of alternative crops by producers.
- Supporting the use of subsidised micro irrigation for agricultural diversification in places with limited water resources by ensuring that there is a minimum amount of financial support available for crop diversification.
- Offering comprehensive crop diversification education and training programmes for farmers. Identifying and improving supply and value chains to increase the market for alternative crops.

Conclusion

Punjab's agricultural diversification has been on the decline from 1981–1982 to 2021–2022. The analyses' findings indicate that Punjab's agriculture is becoming more specialised, with the exception of the Malwa area, which crops American cotton rather than rice and wheat. The primary factors that contribute to the

fall in diversification include the use of fertilisers, irrigation systems, and mechanisation in agriculture, constant output, and high returns. Crop diversification has a number of advantages, including the preservation of groundwater, revitalization of the soil, improved productivity, effective resource use and sustainable agricultural development. Punjab has to adopt a new manufacturing profile. Farmers in Punjab must diversify their existing crop mix to include fruits, vegetables, soy, and maize. High crop diversification should receive specific attention for better crop patterns and sustainable agricultural growth.

References and Bibliography

1. Acharya S. P., Basavaraja H., Kunnal L. B., Mahajanashetti S. B., Bhat A. R. (2011). Crop diversification in Karnataka: An economic analysis. *Agricultural Economics Research Review*, 24, 351–358.
2. Birthal P. S., Joshi P. K., Roy D., Thorat A. (2013). Diversification in Indian agriculture toward high-value crops: The role of small farmers. *Canadian Journal of Agricultural Economics/Revue Canadienne agroéconomique*, 61(1), 61–91.
3. Chauhan, S. (2003). Crop Diversification in Indian Agriculture: Silent Revolution Towards
4. Agribusiness. *Agricultural Situation in India*, 60(5), 289-296.
5. Economic Survey. (2020–21). Economic and Statistical Organization, Government of Punjab.
6. Gupta R. P., Tewari S. K. (1985). Factors effecting crop diversification: An empirical analysis. *Indian Journal of Agricultural Economics*, 40(902–2018–2395), 304–309.
7. Hira, G.S., Jalota, S.K. & Arora, V.K. (2004). Efficient Management of Water Resources for Sustainable Cropping in Punjab. *Research Bulletin*, Department of Soils, Punjab Agricultural University, Ludhiana, 4-5.
8. Johl, S. S. (1996). Future of agriculture in Punjab: Some policy issues. *Journal of Agricultural Development and Policy*, 7(1), 1–21.
9. Joshi P. K., Gulati A., Birthal P. S., Tewari L. (2004). Agriculture diversification in South Asia: Patterns, determinants and policy implications. *Economic and Political Weekly*, 39(24), 2457–2468.
10. Joshi, P.K., Gulati, A., Birthal, P.S., & Rao, P.P. (2005). Agricultural Diversification and Vertical Integration in India: Will Smallholders Participate? MTID. International Food Policy Research Institute Washington DC(Memo).
11. Khatun D., Roy B. C. (2015). Crop diversification in West Bengal: Nature and constraints. In *Diversification of Agriculture in Eastern India* (pp. 141–153). New Delhi, Springer.
12. Kumar S., Gupta S. (2015). Crop diversification towards high-value crops in India: A state level empirical analysis. *Agricultural Economics Research Review*, 28(2), 339–350.
13. Kaur, A.P., Singh, J., & Raju, S.S. (2015). Crop Diversification and its Determinants: State-Wise Analysis. *Food security and sustainable rural development*. Mangalam Publications, 163-178.
15. Kumar, S., Kumar, S., Chahal, V.P. & Singh, D.R. (2018). Trends and Determinants of Crop Diversification in Uttar Pradesh. *Indian Journal of Agricultural Sciences*, 88(11), 56-60.
16. Sarkar, A., & Das, A. (2014). Groundwater Irrigation-Electricity-Crop Diversification Nexus in Punjab: Trends, Turning Points, and Policy Initiatives. *Economic and Political Weekly*, 49(52), 64-73.
17. Mahajan G. (2004). Crop diversification: An empirical analysis of Kangra farms of Himachal Pradesh. *Agricultural Economics Research Review*, 17(2), 199–217.
18. Nayak C., Kumar C. R. (2019). Crop diversification in Odisha: An analysis based on panel data. *Agricultural Economics Research Review*, 32(1), 67–80.
19. Rani, P., & Sahoo, A. K. (2021). Assessment of Productivity and Crop Diversification Pattern in Punjab Agriculture. *Arthaniti: Journal of Economic Theory and Practice*, 0(0).
20. Sajjad H., Prasad S. (2014). Analysing spatial-temporal pattern of crop diversification in Jalandhar district of Punjab, India. *Asian Journal of Agriculture and Rural Development*, 4(3), 242–256.
21. Shiyani R. L., Pandya H. R. (1998). Diversification of agriculture in Gujarat: A spatial-temporal analysis. *Indian Journal of Agricultural Economics*, 53(4), 627.
22. Singh J., Sidhu R. S. (2004). Factors in declining crop diversification: Case study of Punjab. *Economic and Political Weekly*, 39(52), 5607–5610.
23. Singh J., Sidhu R. S. (2006). Accounting for impact of environmental degradation in agriculture of Indian Punjab. *Agricultural Economics Research Review*, 19(conf), 37–48.

24. Singh S. (2004). Crisis and diversification in Punjab agriculture: Role of state and agribusiness. *Economic and Political Weekly*, 39(52), 5583–5590.
25. Singh, J., Singh, N. (2013). Crop Diversification in Punjab Agriculture: A Temporal Analysis. *Journal of Environmental Science, Computer Science and Engineering & Technology*. 22(22):200-205
26. Sarkar, A., Sen, S., & Kumar, A. (2009). Rice–Wheat Cropping Cycle in Punjab: A Comparative Analysis of Sustainability Status in different Irrigation Systems. *Environment, Development and Sustainability*, 11(4), 751-763.
27. Sharma, H.R. (2011). Crop Diversification in Himachal Pradesh: Patterns, Determinants and Challenges. *Indian Journal of Agricultural Economics*, 66(1), 97-114.
30. Shergill, H. (2005). Wheat and Paddy Cultivation and the question of Optimal Cropping Pattern for Punjab. *Journal of Punjab Studies*, 12(2), 239-250.
31. Sidhu, R.S., & Johl, S.S. (2002). Three Decades of Intensive Agriculture in Punjab: Socio-Economic and Environmental Consequences. *Future of Punjab Agriculture*, Johl, SS and SS Ray (Eds.), Centre for Research in Rural and Industrial Development, Chandigarh, India.
32. Singh, J., & Sidhu, R.S. (2004). Factors in Declining Crop Diversification: Case Study of Punjab. *Economic and Political Weekly*, 39(52), 5607-5610.
33. Singh, J., Yadav, H.S., & Singh, N. (2013). Crop Diversification in Punjab Agriculture: A Temporal Analysis. *Journal of Environmental Science, Computer Science and Engineering & Technology*, 2(2), 200-205.
35. Singh, J., Kaur, A.P. & Singh, A. (2016). Empirical Analysis of Area Response in Crop Production of Punjab: Determinants of Crop Area Allocation. *Agricultural Situation in India*, 73(8), 10-15.
37. Singh, J., Singh, A., Tomar, T.S., & Sachdeva, H. (2019). “Agricultural growth performance of Punjab: Challenges and way forward”, Edt. Ravinder Singh in *Emerging Issues in India*. Sapatrishi Publication, Chandigarh, 17.
38. Srivastava, S.K., Chand, R., Singh, J., Kaur, A.P., Jain, R., Kingsley, I., & Raju, S.S. (2017). Revisiting Groundwater Depletion and its Implications on Farm Economics in Punjab, India. *Current Science*, 113(3), 422-429.
41. Singh, J., Kapor, S., Datta, T., Singh, N. (2021). What Drives the Crop Diversification? A Case Study of Punjab State. *Agricultural Economics* 78(9):35-45