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A spatiotemporal analysis of Punjab's agricultural diversification

Un análisis espaciotemporal de la diversificación agrícola de Punjab

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ABSTRACT

The Indian state of Punjab is well known for its prosperous agrarian position. The amount of different sorts of crops a farmer is cultivating on a specific plot of land is indicated by crop diversification. We have attempted to assess crop diversification for the various agro-climatic zones of Punjab in the current study. We measured the degree of agricultural diversification using the Herfindahl Index and the Entropy Index for the various years, and we then charted the pattern over time. The findings for both indexes show that farmers are shifting their focus away from other crops and towards wheat, paddy, and vegetables. This suggests monoculture, which suggests that farmers are switching from crop diversity to crop specialization. We have also made an effort to draw attention to the issue of the state's declining water level and deteriorating situation. Wheat, paddy, and vegetables are grown specifically because they use more water and have a negative impact on biodiversity in Punjab, where farmers are highly dependent on groundwater levels.

Keywords: Agriculture, Punjab, Crop-Diversification

RESUMEN

El estado indio de Punjab es bien conocido por su próspera posición agraria. La diversificación de cultivos indica la cantidad de diferentes tipos de cultivos que un agricultor cultiva en una parcela de tierra específica. Hemos intentado evaluar la diversificación de cultivos para las diversas zonas agroclimáticas de Punjab en el estudio actual. Medimos el grado de diversificación agrícola utilizando el índice Herfindahl y el índice de entropía para los distintos años, y luego trazamos el patrón a lo largo del tiempo. Los resultados de ambos índices muestran que los agricultores están desviando su atención de otros cultivos hacia el trigo, el arroz y las hortalizas. Esto sugiere monocultivo, lo que sugiere que los agricultores están pasando de la diversidad de cultivos a la especialización de cultivos. También nos hemos esforzado por llamar la atención sobre la cuestión del descenso del nivel del agua y el deterioro de la situación en el estado. El trigo, el arroz y las hortalizas se cultivan específicamente porque utilizan más agua y tienen un impacto negativo en la biodiversidad en Punjab, donde los agricultores dependen en gran medida de los niveles de agua subterránea.

Palabras clave: agricultura, Punjab, diversificación de cultivos

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INTRODUCTION

Agriculture has long been a significant part of the Indian economy. In terms of attaining economic growth in terms of eradicating poverty and ensuring food security, the agriculture sector serves as a pillar. Since independence, agriculture has a smaller percentage of India's GDP, although rural areas in India still rely on it for employment and a means of subsistence. Even during COVID-19, out of the other two sectors—manufacturing and services—agriculture was the one least affected by the epidemic and displayed positive development. In 2020–21, India produced 3087 lakh tonnes of food grains overall.

India has seen rapid expansion in the agricultural sector as a result of the green revolution technologies in the 1960s and has achieved food grain self-sufficiency. The agriculture industry faces a difficulty in maintaining the food supply needed to feed the world's second-most populous nation. However, the increase in agricultural activity has also led to a number of environmental issues, such as biodiversity loss, land degradation, excessive irrigation, etc., that pose a threat to the agriculture sector's future at the regional level.

Crop diversification offers a wide range of crop options in a specific location and helps to increase productivity and reduce risk. Generally speaking, crop diversification is the process through which a farmer switches from historically low-yielding crops to high-yielding ones. Crop diversification may be caused by a number of factors. One of the causes could be the market price; farmers are more likely to choose to cultivate the crop that has higher market price. The elements affecting infrastructure, profitability, weather, governmental policies, etc., are what determine agricultural diversification.

Punjab: Rich Agrarian State in the Country

A state called Punjab is located in northern India and borders the states of Jammu & Kashmir, Rajasthan, and Haryana. Its square area is 50,362 km. The Himalayas and the Thar Desert have the biggest impacts on Punjab's climate. Sutlej, Ravi, and Beas rivers all pass through the state. Punjab typically receives 61.9 cm of rain per year, 75% of which falls during the monsoon season. The agriculture industry makes up a large portion of the state's economy and uses 85% of the state's total water use. Due to farmers' excessive usage of tube wells, the state is experiencing a ground water shortage.

The state's irrigation is carried out using a system of canals. However, due to increased pressure on groundwater resources, the state's surface water supplies are completely utilised but unable to meet the demand for water for irrigation in agriculture. The quantity and quality of surface water are declining as a result of climate change and global warming. Punjab has a net irrigation area of 11,69,000 hectares from canals and 29,07,000 hectares from tube wells. It suggests that farmers rely on the level of ground water for irrigation. The following fig 1 shows the exploitation of ground water in different regions of Punjab. Majority of the regions shows that there is an over-exploitation of ground water level that has deteriorated the ground water table and is negatively affecting the biodiversity.

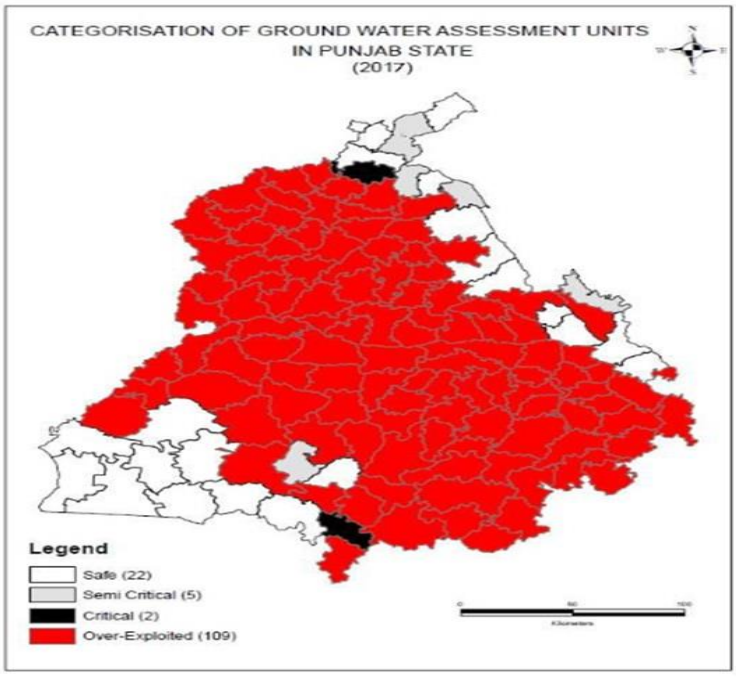

Figure 1: Regions showing Over-exploitation of ground water in Punjab
Source: Website of Punjab, Environment Information System

Literature Review

According to Sood et al. (2009), the area planted with wheat and paddy has expanded as a result of the availability of subsidised inputs with high prices for the output thanks to the minimum support prices provided by the Indian government.

A study on the level of ground water was conducted by Krishan et al. (2014) for many districts in Punjab between 2006 and 2013. According to the findings, Patiala experienced the greatest decline in ground water level, followed by Bhatinda and Jalandhar.

The importance of crop diversification, from conventional low-valued crops to high-valued pursuits like horticulture and cattle, was highlighted by Deogharia (2018). This will increase farmers' incomes and generate more employment in the rural economy.

According to a spatiotemporal analysis of ground water levels in Punjab between 2000 and 2019, the average depletion is 8.91 metres, with the Barnala district of Punjab experiencing the largest depletion at 20.38 metres. (Sidhu et al. 2019)

The need of crop diversification for a state like Punjab was discussed by Kumar, R. (2019), who also highlighted the many causes of the increase in the area planted to wheat and paddy. It is due to the government's pledge to purchase wheat and paddy at MSP as well as the market's low prices for other commodities.

Due to the state's dependency on paddy, its water resources are being used excessively. Kaur & Cheema used the Simpson Index and Punjab's gross cultivated area for their study on crop diversification from 1970 to 2011. According to the findings, Punjab has switched from growing food grains to high-value crops.

Objectives

To determine the degree of crop diversification in Punjab according to the various agro-climatic zones.

To propose alternative, varied development ideas.

Research Question

How has the degree of crop diversification varied over time in the various agro-climatic zones of Punjab?

Data Sources

The information for the three time periods 2000-01, 2010-11, and 2015-16 for cropped area for various crops like Wheat, Maize, Paddy, Sugarcane, Jowar, Barley, Vegetables, Gramme, and Bajra in Punjab state was obtained from the website of Agriculture Census, Department of Agriculture & Farmers Welfare, Government of India.

METHODOLOGY

According to their agroclimatic characteristics, the state of Punjab has been divided into five zones. The first zone is a sub-mountain undulating zone with the districts of Hoshiarpur, Pathankot, and Gurdaspur. Mohali, Ropar, and Nawanshahr are located in the second zone, which is an undulating plain zone. Amritsar, Tarn Taran, Kapurthala, Jalandhar, Ludhiana, Fatehgarh Sahib, and Patiala districts are located in the Central Plane Zone. Districts Firozepur and Faridkot are located in the western plain zone. Mogha, Bathinda, Mansa, Muktsar, Sangrur, and Barnala districts are located in the final western zone. The various agro-climatic zones in the map of Punjab state are depicted in figure 2 below.

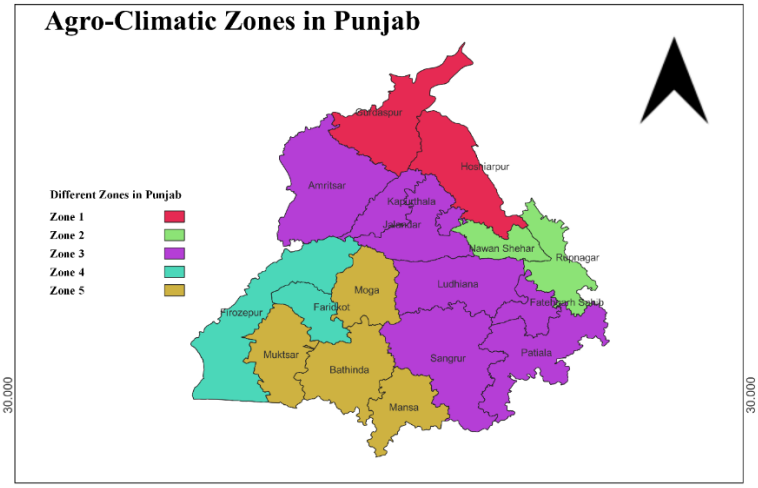

Figure 2: Agro-Climatic Zones in Punjab. Source: Author’s Computation

To make the study more worthwhile, it is necessary to have a fundamental understanding of these zones before studying them in detail. There are distinct characteristics in each of these five agro-climatic zones. Table 1 displays a list of the many features. The rainfall, climatic conditions, type of soil, and appropriate crops for each zone are shown in the following table.

Table 1: Features of Agro-Climatic Zones in Punjab

Sub Region	Rainfall (in mm)	Climate	Soil	Most suitable Crops
AGROCLIMATIC FEATURES OF ZONE I & II				
High altitude temperate	165	Humid to cold arid	Hill soils, Mountain, Meadow Skeletal, Tarai	Wheat, Maize, Rice, Jowar.
Hill temperate	2000	Humid	Brown Hill	Rice, Maize, Wheat, Rapeseed
Valley temperate	400	Sub-humid	Sub-mountain, Mountain Skeletal, Meadow	Wheat, Maize, Rice, Sugarcane.
Sub-tropical	1030	Semi-arid to humid	Alluvial (Recent), Brown hills.	Wheat, Barley, Potato.
Average rain fall	900			
AGRO CLIMATIC FEATURES OF ZONE III, IV & V				
Plains – Zone III	561	Semi-arid to Dry sub-humid	Alluvial (Recent)	Wheat, Rice, Maize, Sugarcane
Scarce Rainfall arid region -Zone IV and V	360	Arid & Extreme Arid	Calcareous, Sierozemic, Alluvial (Recent), Desert	Wheat, Cotton, Gram, Bajra, Rice

Source: Environment Information System: Punjab, Government of India

Measures of Crop diversification levels

There are numerous ways to gauge the degree of agricultural variety in the literature. We have chosen two techniques to assess Punjab's various agroclimatic zones' crop diversification.

(a) Herfindahl Index: The Herfindahl Index is determined by summing the squares of the acreage proportion of each crop in the overall cultivated area, as shown below:

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

where N is total number of crops and P_i represents acreage proportion of the i-th crop in total cropped area.

The Herfindahl Index would fall as diversification increased.

When there is complete specialisation, this index has a value of 1, and as N increases, its value decreases until it reaches zero. assuming diversification is "perfect".

(b) Entropy Index: Entropy Index is regarded as an inverse measure of concentration having logarithmic character.

$$\text{E. I.} = \sum_{i=1}^{N} P_i * Log(\frac{1}{P_i})$$

where N is total number of crops and P_i represents acreage proportion of the i-th crop in total cropped area.

The index would rise as diversification increased, and it would become close to zero when there was perfect concentration.

RESULTS

We have shown the zone-by-zone percentage change in the area under various crops in Punjab from 2000-01 to 2015-16 prior to computing the indices to quantify the amount of crop diversification. It's shown in Table 3.

Only the area planted in wheat, paddy, and vegetables has increased in percentage across all zones between 2000-01 and 2015-16, while the area planted in other crops has drastically declined. The data in the table show that farmers are converting to monoculture and that crop diversification is declining in Punjabi regions. The market's high pricing for these products relative to other crops, high local and foreign demand, and the government's easy purchase of wheat and paddy at minimum support prices may all be contributing factors.

Since the website does not have any data for zone 4, it was not possible to determine the percentage change for the area planted with sugarcane.

Table 2: Zone wise percentage area under different crops from 2000-01 to 2015-16

Zone Wise percentage change in the area under different crops in Punjab, 2000-01 to 2015-16

Crops	Zone 1 (in %)	Zone 2 (in %)	Zone 3 (in %)	Zone 4 (in %)	Zone 5 (in %)	Overall Percentage Change in Punjab
Wheat	-6.77	79.38	-10.71	-25.68	37.73	5.53
Maize	-40.61	-40.90	-4.19	-75.89	-50.17	-31.03
Paddy	6.58	134.63	-6.01	3.14	88.28	18.88
Sugarcane	28.92	-30.55	-47.71	N.A.	-92.93	-30.18
Jowar	-91.36	-77.85	-69.40	-95.94	-17.61	-45.49
Barley	-86.13	-40.51	-60.81	-95.83	-70.67	-75.01
Vegetables	-21.70	102.7	80.01	-5.19	8.01	42.80
Gram	-42.16	-75.42	-90.51	-99.77	-90.28	-80.32
Bajra	-49.17	-68.93	-87.40	-99.91	-42.33	-70.78

Source: Author’s Computation

The state of Punjab's overall percentage change in the area planted with various crops is shown in the final column of Table 3. We can see that the percentage change in the area under crop has gone up for wheat by 5.53%, paddy by 18.88%, and vegetables by 42.80%. While the acreage for other crops has decreased in terms of percentage change.

After observing the percentage change in the area planted with various crops in Punjab's various agroclimatic zones, we can now examine the agricultural diversification indexes. To examine the degree of crop diversification, I calculated the Herfindahl Index (H.I.) and Entropy Index (E.I.) for each of the five zones. We generated the index value for the three time periods—2000–01, 2010–11, and 2015–16—to observe the trend in the indices. Table 4 presents the findings.

Zone 1 shows an increasing H.I. value over time, indicating a decline in crop diversification from 2000–01 to 2015–16, which is also supported by table 3. However, the value of E.I. has remained constant over time, indicating that cropping patterns have not changed.

Zones 2, 3, 4, and 5 show an increase in the value of H.I. with time, indicating a decline in agricultural diversification as farmers concentrate on fewer crops and lessen the area planted in others. Zones 2 and 4's E.I. index has a declining tendency over time, which denotes a decline in crop diversification.

The E.I. for zones 3 and 5 for 2015–16 is greater than the value for 2010–11 but lower than the value for 2000–01, indicating a decline in crop diversification.

The findings clearly show that farmers in the regions are shifting their attention to certain crops, including wheat, paddy, and vegetables.

Table 4: Crop Diversification indices for different zones from 2000-01 to 2015-16

Crop Diversification Indices for different Agro-Climatic Zones of Punjab, 2000-01 to 2015-16				
Zone	Index	2000-01	2010-11	2015-16
1	H.I.	0.26704	0.28085	0.2961653
	E.I.	0.5211	0.5211	0.5211042
2	H.I.	0.26184	0.27997	0.3213385
	E.I.	0.59227	0.48622	0.4581247
3	H.I.	0.35961	0.39157	0.394768
	E.I.	0.40133	0.37971	0.3966982
4	H.I.	0.26662	0.3196	0.4398944
	E.I.	0.38278	0.34866	0.3260207
5	H.I.	0.25107	0.30219	0.3685537
	E.I.	0.38522	0.33574	0.3481629

Source: Author’s Computation

CONCLUSION

The results displayed in tables 3 and 4 reveal that farmers in various agro-climatic zones are shifting their focus exclusively to growing vegetables, wheat, and paddy, whereas the Punjab has seen a notable decline in the area under cultivation. This suggests that Punjabi farmers are turning to monoculture.

We also know that farmers rely on tube wells for irrigation because of the underdeveloped canal system, and a crop like rice requires a lot of water. Zone 2 has seen the largest percentage rise in the area planted to paddy, therefore zones are urged by the literature to switch from paddy to other crops because paddy benefits the eastern Indian states and requires relatively little water. Punjabi farmers should concentrate more on less water-intensive crops like sugarcane, cotton, and maize.

Farmers in other zones are also able to switch to different horticultural crops and benefit from favourable production environments. To enhance employment and income levels in rural Punjab, the state can also develop the non-farm sector. To establish significant agro-based food processors in the various zones of Punjab, the state must entice significant investments from private firms.

On the other side, the state must offer the farmers substantial incentives and infrastructure so they can switch to other crops. They also require additional agricultural education.

In addition, the government must make sure that the canal system in Punjab's several agroclimatic zones is properly restructured and expanded so that farmers can rely less on groundwater. The government can also encourage people to use drip irrigation systems, collect rainwater, protect surface water, and steer clear of flood irrigation methods.

The transition is challenging since it requires cooperation from the government, farmers, and the commercial sector.

REFERENCES

Deogharia, P. C. (2018). Diversification of agriculture: a review. J Econ Soc Develop, 15(1), 46-59.

Kumar, R. (2019). Economic Viability of Crop Diversification in Punjab. Journal of Krishi Vigyan, 8(1), 55-62.

Krishan, G., Rao, M. S., Loyal, R. S., Lohani, A. K., Tuli, N. K., Takshi, K. S., ... & Kumar, S. (2014). Groundwater level analyses of Punjab, India: A quantitative approach. Octa Journal of Environmental Research, 2(3).

Sidhu, B. S., Sharda, R., & Singh, S. (2021). Spatio-temporal assessment of groundwater depletion in Punjab, India. Groundwater for Sustainable Development, 12, 100498.

Sood, A. N. I. L., Choudhury, B. U., & Sharma, P. K. (2009). Crop Diversification: A Viable Means to Sustain Agricultural Production in the State of Punjab.

Kaur, R., & Cheema, S. S. The Role of Crop Diversification towards High-Value Crops in Punjab.

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http://dx.doi.org/10.7770/safer-V11N1-art712

Kumar, R. (2019). Economic Viability of Crop Diversification in Punjab. Journal of Krishi Vigyan, 8(1), 55-62.

Web Link: https://agcensus.dacnet.nic.in/DistCharacteristic.aspx

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