

Spatial Patterns of Agricultural Development in Punjab and Haryana

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Abstract: Punjab and Haryana farmers have contributed a lot in making India food secure. These states witnessed tremendous agricultural development during Green Revolution. To measure this agricultural development composite index of development has been calculated following Narain et al. (2007) statistical method at district level. Six indicators have been used to analyze the patterns of agricultural development in the Punjab and Haryana states for the years 1970-71 and 2015-16. The results reveal an increase in agricultural development of study area from 1970-71 to 2015-16. But in long run maintaining this level of agricultural development is not going to be possible due to degradation of natural resources. There is dire need for making the intensive agriculture being practiced here sustainable.

Key words: Agricultural development, composite index of development, Green Revolution, agricultural intensification

Introduction: Agricultural development is critical in states like Punjab and Haryana, where agriculture is the primary source of revenue. Agricultural development measures how well established agricultural production systems are in the agro-ecosystems in consideration. With rise in agricultural productivity in Punjab and Haryana, the intensification of agriculture also increased. In the study area, agricultural intensification occurred mainly owing to the adoption of Green Revolution technology that were spread throughout the region to help enhance the region's agriculture. Different regions were able to adopt and reap the benefits of Green Revolution technology to differing degrees due to differences in geographic and environmental features. These advances had a significant impact on the states of Punjab and Haryana, transforming it into India's food basket.

In Punjab and Haryana, the agricultural development has led to adoption of new agricultural machinery, development of tube well and canal irrigation, chemical fertilizers, pesticides, insecticides and fungicides. This also resulted in adoption of new hybrid variety seeds of wheat and rice which later helped in establishing wheat-rice monoculture in large parts of these states. Prior to the Green Revolution, rice cultivation was limited to a few districts in Punjab, such as Amritsar and Tarn Taran, as these districts grew basmati rice. Later, at the expense of crops such as *bajra*, barley, and *Jowar*, its cultivation spread in large chunks of the states of Punjab and Haryana. Thus, agricultural development in Punjab and Haryana has not been able to bring about crop diversity, with the main contribution being a rise in food grain yields, which was critical for the nation's food security at the time.

Research Methodology: The composite index of agricultural development has been calculated for the years 1970-71 and 2015-16 from secondary data taken from Statistical Abstracts of respective state governments (S.A.P, 1971 and 2016, and S.A.H., 1971-72 and 2016-17) by utilising the statistical method given by Narain et. al (2007). There are five steps in this formula:

Step 1: Assume $[X_{ij}]$ is the actual value of an indicator (here referred to as j th) for a specific district (named i th). As all the selected indicators have different measurement units, they have been converted into Z scores to standardize them.

Convert X_{ij} to Z_{ij} :

$$[Z_{ij}] = \frac{X_{ij} - \bar{X}_j}{S_j}$$

where \bar{X}_j = mean of the jth indicator, S_j = standard deviation of the jth indicator and $[Z_{ij}]$ is the matrix of standardized indicators.

Step 2: From $[Z_{ij}]$, identify the optimal value of each indicator $[Z_{oj}]$, maximum value or minimum value based on the direction of the impact of indicator on the development. To obtain the Pattern of Development (P_{ij}), for particular indicator,

$$P_{ij} = (Z_{ij} - Z_{oj})^2$$

Where Z_{oj} is the maximum value from Z_{ij} values for the selected indicators.

Step 3: As seen below, the Pattern of Development (P_{ij}) is further standardised to a new parameter C_i :

$$C_i = \left[\sum_{j=1}^k P_{ij} / (C.V.)_j \right]^{1/2}$$

Where $(C.V.)_j$ is the coefficient of variation of the actual value of jth indicator.

Step 4: Composite Index D_i of an indicator is calculated as:

$$D_i = C_i / C$$

Here, C = Mean of $C_i + 3SD_i$

SD_i = Standard Deviation of C_i

Step 5: Composite Index of Agriculture Development of a district = (Sum of Composite Development Indices (D_i) of all Six Indicators)/6

It should be noted that a higher Composite Development Index (D_i) value indicates a low level of development while a smaller value indicates a high level. Maps illustrating the spatial variations in agricultural development have been created using the ARCGIS 10.1 software after the composite index of development for the states of Punjab and Haryana has been calculated.

Study Area: Punjab and Haryana (Figure 1), the northwestern states of India have been chosen as the study area. Prior to 1966, these two states were merged into a single state of Punjab. These two states are known for their agricultural prowess and are known as India's bread basket. This was made feasible by the fact that it is located in the lush Indo-Gangetic plains, which have plentiful surface and ground water supplies. Jammu and Kashmir in the northwest, Himachal Pradesh in the north and north east, Uttar Pradesh and the Union Territory of Delhi in the east, and Rajasthan in the west and south west encircle the study area. Punjab has a total area of 50,362 square kilometers and Haryana has a total area of 44,212 square kilometers. The study area extends between 27°37' North to 32°32' North latitude and from 73°55' East to 77°46' East longitudinally.

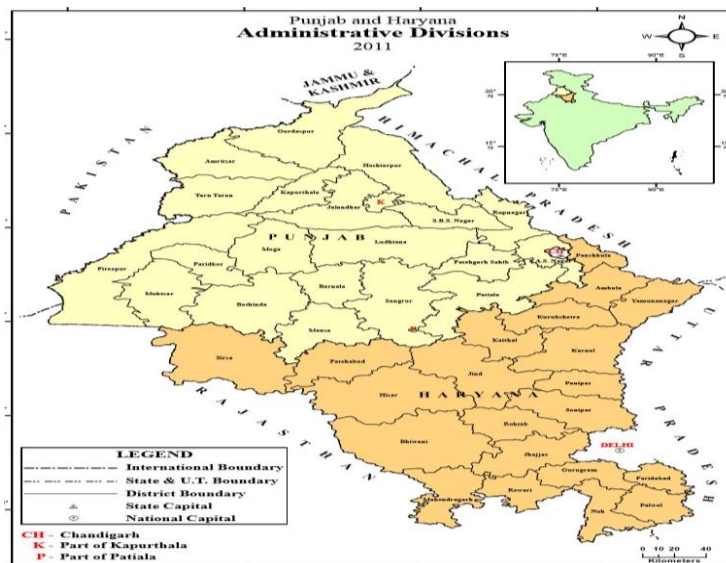


Figure 1. Study Area

Source: Census of India 2011 a and b

Selected Indicators: For the years 1970-71 and 2015-16, six major agricultural input and output variables were chosen to assess spatio-temporal changes in agricultural development patterns. The area under High Yielding Variety (H.Y.V.) of seeds as a proportion of Total Cropped Area (T.C.A), Gross Irrigated Area (G.I.A.) as a percentage of T.C.A., number of tube wells, fertilizer consumption in kilograms per hectare, number of tractors and yield per hectare are among the selected indicators.

Results and Discussions:

Apart from a few north eastern and south western districts falling into the moderate level of development category, the majority of Punjab showed very high and high levels of agricultural development. In contrast, only Karnal district of Haryana had a very high degree of agricultural development, Kaithal, Kurukshetra and Panipat districts had a high level, and the majority of the state had moderate to low levels of agricultural development in 1970–1971 (Figure 2).

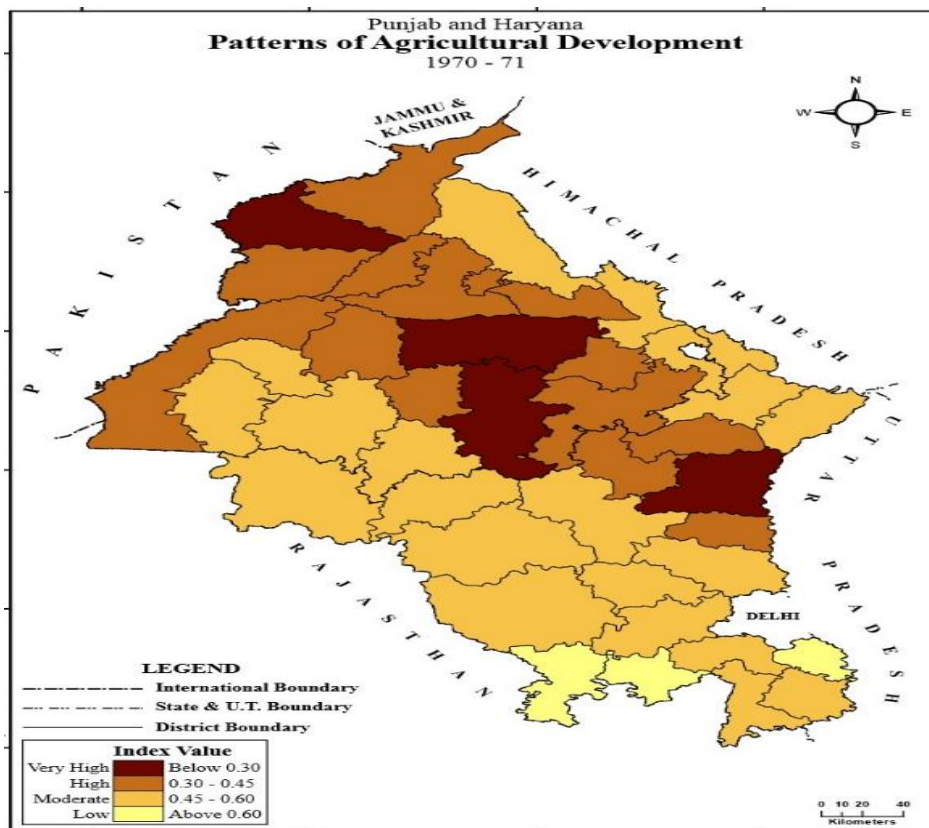


Figure 2.

Source: Researcher’s Own Calculations

Table 1 Composite Index of Agriculture Development of Punjab and Haryana at District Level

District	1970-71	2015-16	Changes From 1970-71 to 2015-16	
Gurdaspur	0.41	0.32	-0.10	Increase
Amritsar	0.24	0.29	0.05	Decrease
Tarn Taran	0.34	0.39	0.05	Decrease
Kapurthala	0.34	0.31	-0.03	Increase
Jalandhar	0.31	0.25	-0.06	Increase
S.B.S Nagar	0.38	0.39	0.01	Decrease
Hoshiarpur	0.51	0.32	-0.19	Increase

Rupnagar	0.56	0.37	-0.18	Increase
S.A.S Nagar	0.53	0.41	-0.13	Increase
Ludhiana	0.05	0.17	0.12	Decrease
Firozpur	0.36	0.27	-0.09	Increase
Faridkot	0.49	0.32	-0.17	Increase
Muktsar	0.45	0.45	0.00	No Change
Moga	0.41	0.38	-0.03	Increase
Bathinda	0.46	0.32	-0.15	Increase
Mansa	0.58	0.43	-0.16	Increase
Sangrur	0.27	0.14	-0.13	Increase
Barnala	0.36	0.34	-0.03	Increase
Patiala	0.31	0.19	-0.12	Increase
Fatehgarh Sahib	0.41	0.31	-0.09	Increase
Ambala	0.50	0.41	-0.09	Increase
Panchkula	0.52	0.51	-0.01	Increase
Yamunanagar	0.47	0.39	-0.08	Increase
Kurukshetra	0.36	0.38	0.01	Decrease
Kaithal	0.35	0.36	0.01	Decrease
Karnal	0.25	0.33	0.08	Decrease
Panipat	0.39	0.42	0.03	Decrease
Sonipat	0.48	0.37	-0.11	Increase
Rohtak	0.50	0.48	-0.02	Increase
Jhajjar	0.50	0.46	-0.04	Increase
Faridabad	0.61	0.43	-0.17	Increase
Palwal	0.59	0.46	-0.14	Increase
Gurugram	0.58	0.51	-0.07	Increase
Nuh	0.58	0.64	0.06	Decrease
Rewari	0.66	0.57	-0.09	Increase
Mahendragarh	0.73	0.76	0.02	Decrease
Bhiwani	0.54	0.58	0.04	Decrease
Jind	0.49	0.39	-0.10	Increase
Hisar	0.48	0.47	-0.02	Increase
Fatehabad	0.51	0.40	-0.12	Increase
Sirsa	0.48	0.45	-0.04	Increase
Punjab and Haryana Average	0.45	0.39	-0.06	Increase

Source: Researcher's Own Calculations

In 2015-16, the areas of high level of agricultural development are placed in northern and southern parts of Punjab and north eastern parts of Haryana primarily, whereas moderate and low developed areas are limited

typically to the central and southern parts of Haryana (Figure 3). Infact, the agricultural development is low in the two districts of namely Nuh (0.64), and Mahendragarh (0.76) in Haryana as shown in table 1.

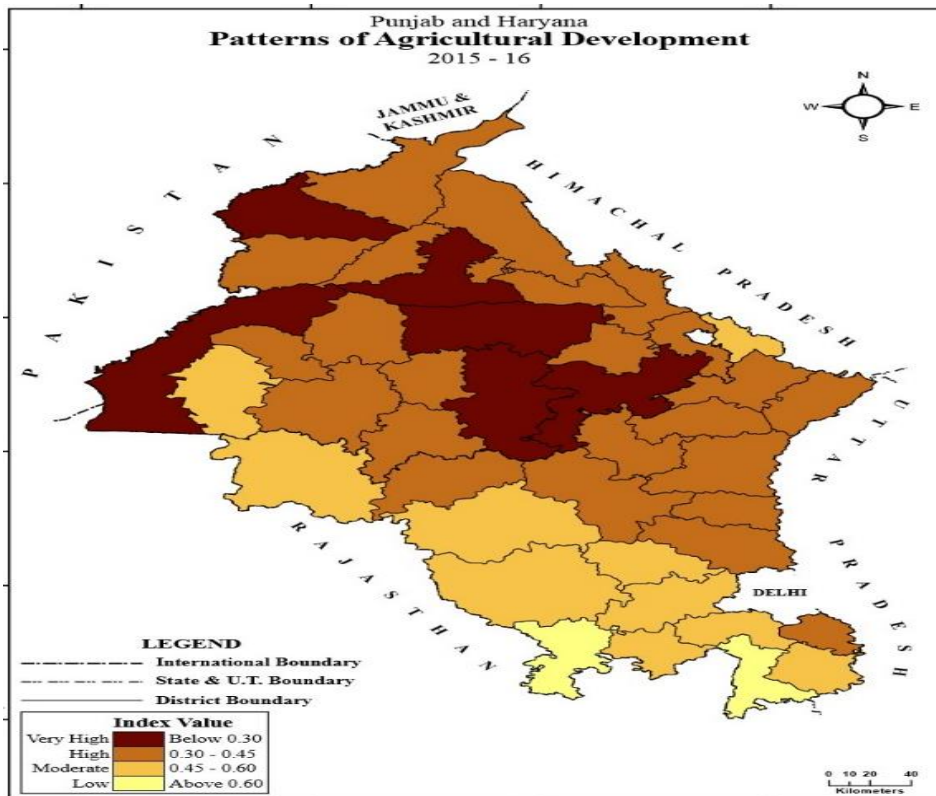


Figure 3.

Source: Researcher's Own Calculations

Change in Composite Index of Agricultural Development: 1970-71 to 2015-16

From 1970-71 to 2015-16, the composite index of agricultural development in the study area has improved, with the index value falling by 0.6. This was made feasible by the fact that the majority of districts in the moderate category improved in chosen parameters and transitioned to the high level of agricultural development category in 2015-16. These variations in changes in the spatial patterns of agricultural development has been shown through Figure 4 and category wise details are discussed below:

- i. **Increase in Agricultural Development (Decrease in Composite Index):** Hoshiarpur, Rupnagar, S.A.S. Nagar, Patiala, Sangrur, Fatehabad, Bathinda, Mansa Faridkot, Gurdaspur, Kapurthala, Jalandhar, Firozpur, Moga, Barnala, and Fatehgarh Sahib are among the listed districts of Punjab. Sonipat, Faridabad, Palwal, Panchkula, Ambala, Yamunanagar, Sirsa, Hisar, Jind, Rohtak, Jhajjar, Rewari, and Gurugram are among the Haryana districts that fall within this group. The extent of irrigation, the volume of high yielding seeds cultivated, the amount of fertilisers used, and the subsequent rise in crop output have all raised the level of agricultural development in these districts.

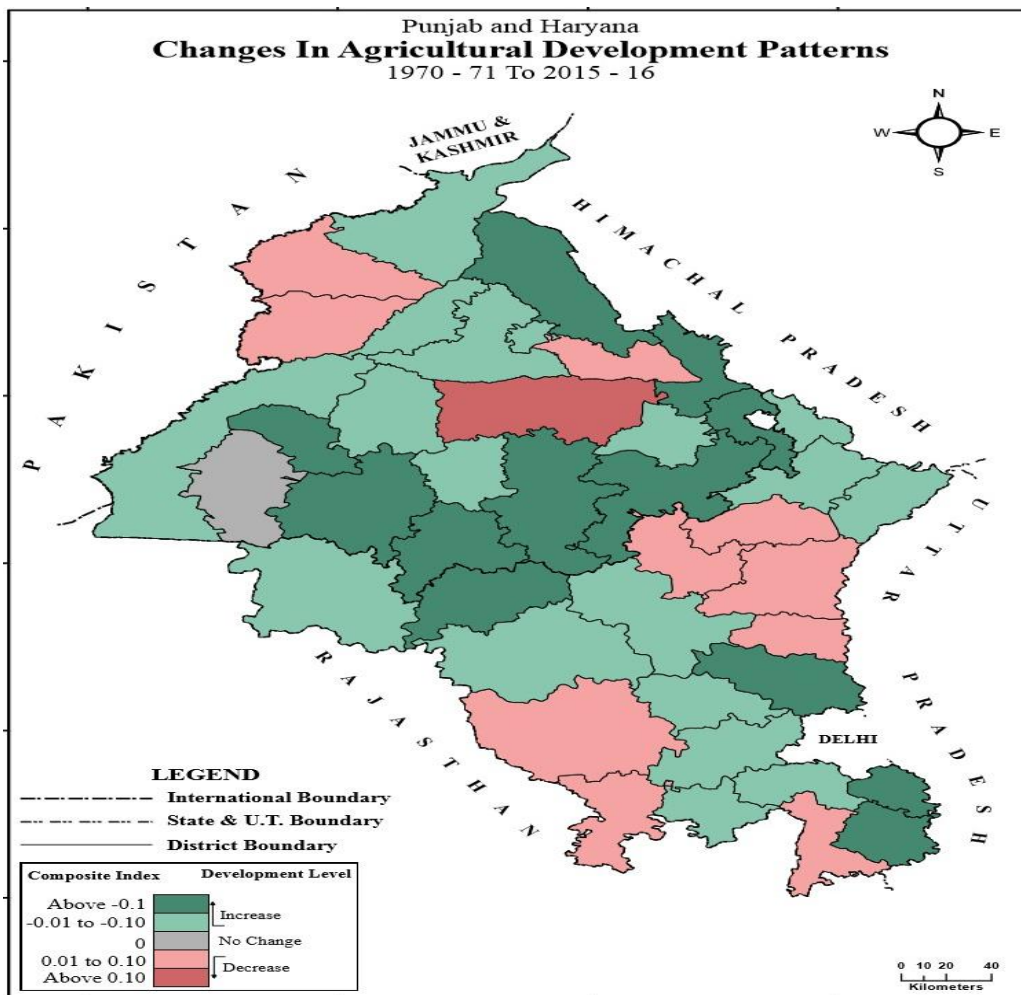


Figure 4.

Source: Researcher's Own Calculations

- ii. **Decrease in Agricultural Development (Increase in Composite Index):** The agricultural development in the districts of Amritsar, Tarn Taran, S.B.S. Nagar, Ludhiana, Kurukshetra, Kaithal, Karnal, Panipat, Bhiwani, Mahendragarh, and Nuh has declined. Many of the aforementioned districts were able to achieve maximum development during the Green Revolution era. This also shows that while other lagging districts have shown significant improvements in agriculture development, their performance has been mediocre because they have already reached their peak and are now approaching a point of stagnation.
- iii. **No Change in Agricultural Development (The Value of Composite Index has Remained Same):** The composite indicator for the Muktsar district has the same value between 1970–1971 and 2015–16, yielding an index value of 0.45. As a result, there have been no significant changes to this area, which continues to have a moderate level of agricultural development.

Conclusion: Punjab and Haryana farmers have made a considerable contribution to India's food security, having played a key part in achieving it. This was made feasible by the study area's successful adoption of Green Revolution technology. The average composite index of development in the study area has improved from 1970-71 to 2015-16. With greater adoption of technology and improvements in selected indicators for the current study, the majority of moderately agriculturally developed districts have shown an improvement in level of agricultural development. Sangrur, Firozpur, Ambala, Rewari, Faridabad, Palwal, and Jind are among the districts where agricultural growth has improved. Others, like as Amritsar, Tarn Taran, Ludhiana, Karnal, and Mahendragarh, have seen their agricultural development diminished as their index values have risen. However, a small proportion of districts are still lagging behind and require to be agriculturally developed in order for this region's agriculture to be viable in the future.

To sum up, the word 'agricultural development' is frequently used around the world to describe the growth in productivity of agricultural land. As a result of this development, agriculture has become increasingly commercialised, however in the case of Punjab and Haryana, this development has had significant ecological ramifications and there is need to make agriculture more sustainable in the study area.

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