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Changes in Regional Disparities in Rice Productivity in Punjab During Post-Globalization Period

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Abstract-- The major objective of the present study is to evaluate the changes in regional disparities of rice productivity and factors responsible for achieving it. The study is of three folds. Firstly, spatial variations in regional disparities in rice productivity for the years 1990-91 and 2023-24 are explained. In second part the spatio-temporal changes in regional disparities are found. Finally, conclusions are drawn and suggestions are made. The study has observed that the patterns of rice productivity are not equally distributed, some districts have low rice productivity whereas others have noted recorded either moderate or high. The study has also identified that the physical environment like relief, nature of soil, rainfall, quality and depth of sub-soil water, degree of farm mechanisation, magnitude of farm mechanisation, government policies, marketing etc are the factors responsible for spatio-temporal changes. It is concluded that traditionally rice growing areas and areas with developed agricultural infrastructure have recorded high magnitude of rice productivity but the areas with physical hinderances and less developed agricultural infrastructure have low to moderate rice productivity during study period. It is further noted the high category of rice productivity has shifted from west to south east with the development of agricultural infrastructure. The study has also deduced that the gap between the regional disparities of rice productivity over time has minimized. It is suggested that 20 percent area from rice cultivation in Punjab should be diverted to crops like cotton, fodder, bajra etc, so that Punjab agriculture can become sustainable in times to come. The study is based on secondary sources of data and the unit of the study is district. Singh's modified technique is used for calculating the rice productivity and QGIS method is applied for mapping the results.

Keywords— Regional disparities, Productivity, Density of Tubewells, Farm Mechanisation, Sustainable.

I. INTRODUCTION

To understand the performance and development of agriculture in a region, agricultural productivity is an important indicator. In simple terms, it refers to amount of agricultural output obtained from a given quantity of agricultural resources, particularly land. Productivity is commonly expressed in terms of crop output per unit of cultivated area, such as kilograms or tonnes per hectare (Dayal, 1984). The crop productivity stands for to measure efficiency of an agricultural production system which use land, labour and capital (Sohal, 2004). It is observed that changes in physical factors and human factors directly affect the degree of crop productivity (Sohal, 1990).

Agricultural productivity is a function of the combined interplay of a variety of factors including physical, social, economic and technological; each acquiring its specificities as component in an interacting system over time. The combined effect of these factors manifest itself in per hectare productivity in given area (Bhatia, 1968). In fact, the level of agricultural productivity as a concept, means the degree to which the man-made framework is able to exploit the physical resources of an area for the purpose of agricultural 'product Kunde' (Sharma, 1965). However, among the physical factors which are comparatively static, relief, slope, soil and climate play a major role in determining the agricultural productivity of an area. Several empirical studies have proved that environmental factors provide a base and determine the agricultural productivity (Sharma, 1976; Vaidyanathan, 1978; and Tambad, 1965). But at the same time, the environmental factors impose constraints on increasing the level of productivity which man attempts to remove extent of competence by adopting a package of technology, farm inputs, crop rotation etc (Mohammad, 1981). Besides these, size of landholding, tenancy system, agricultural credit, market structure, cropping pattern, type of farming, density of population, supply of labour etc. play equally important role (Mohammad, 1981 and Hussain, 1976). Thus, agricultural productivity is a dynamic concept, because any change or improvement in physical or non-physical factors or in both imply increased agricultural production per hectare. Its study is also important for demarcating areas of high, moderate and low levels of crop/ agricultural productivity. Munir (1988) stated that there is direct relationship between higher levels of agricultural development and high magnitude of agricultural productivity and vice-versa (Chatterji and Maitreya, 1964).

II. STUDY AREA (FIG.1)

Punjab covers an area of 50,362 km², and is situated in the north-western part of India with an extension of 29°30'N to 32° 32'N latitudes and 73° 55'E to 76° 50'E longitudes. The state is bordered by Pakistan in the west direction, its boundary touches the state of Jammu and Kashmir, Himachal Pradesh, Haryana and Rajasthan. In 2011, the state has a population of 27,743,338 persons with a population density of about 500 persons per km².

Punjab is an agricultural state, having fertile alluvial plains and extensive irrigation which leads to the

expansion of cereal- based cropping system. There are twenty-three districts for administrative purposes.



Fig. 1. Administrative Divisions of Punjab

Source: Remote Sensing Centre Ludhiana, Punjab



III. OBJECTIVES

To reveal the regional disparities in rice productivity and changes during study period.

To find out the factors responsible for changes in rice productivity

To know whether the regional disparities in rice productivity have increased or decreased during 1990-91 to 2023-24

To make suggestions

IV. METHODOLOGY

The present study is based on secondary sources of data. The district is taken as unit of study. Two time periods are selected for the present study i.e. 1990-91 and 2023-24. The QGIS technique is applied for mapping the results. The present researcher has used improved Singh's (1976), for calculating the index of rice productivity. The technique is as follow:

$$Cp_i = \frac{C_i + Y_i}{2}$$

Cp_i = Stands for Crop Productivity Index

C_i = Stands for Concentration Index

Y_i = Stands for Yield Index

The crop concentration index of rice is calculated by using the following formula:

$$C_i = \frac{C_{pe}}{C_{pr}} \times 100$$

C_i = Concentration index.

C_{pe} = Percent area of crop in an enumeration unit.

C_{pr} = Percent area of crop in the entire region.

The formula for calculating the Rice yield index is as follows:

$$Y_i = \frac{Y_{ae}}{Y_{ar}} \times 100$$

Y_i = Rice yield index.

Y_{ae} = yield in an enumeration unit.

Y_{ar} = yield of crop under the entire region

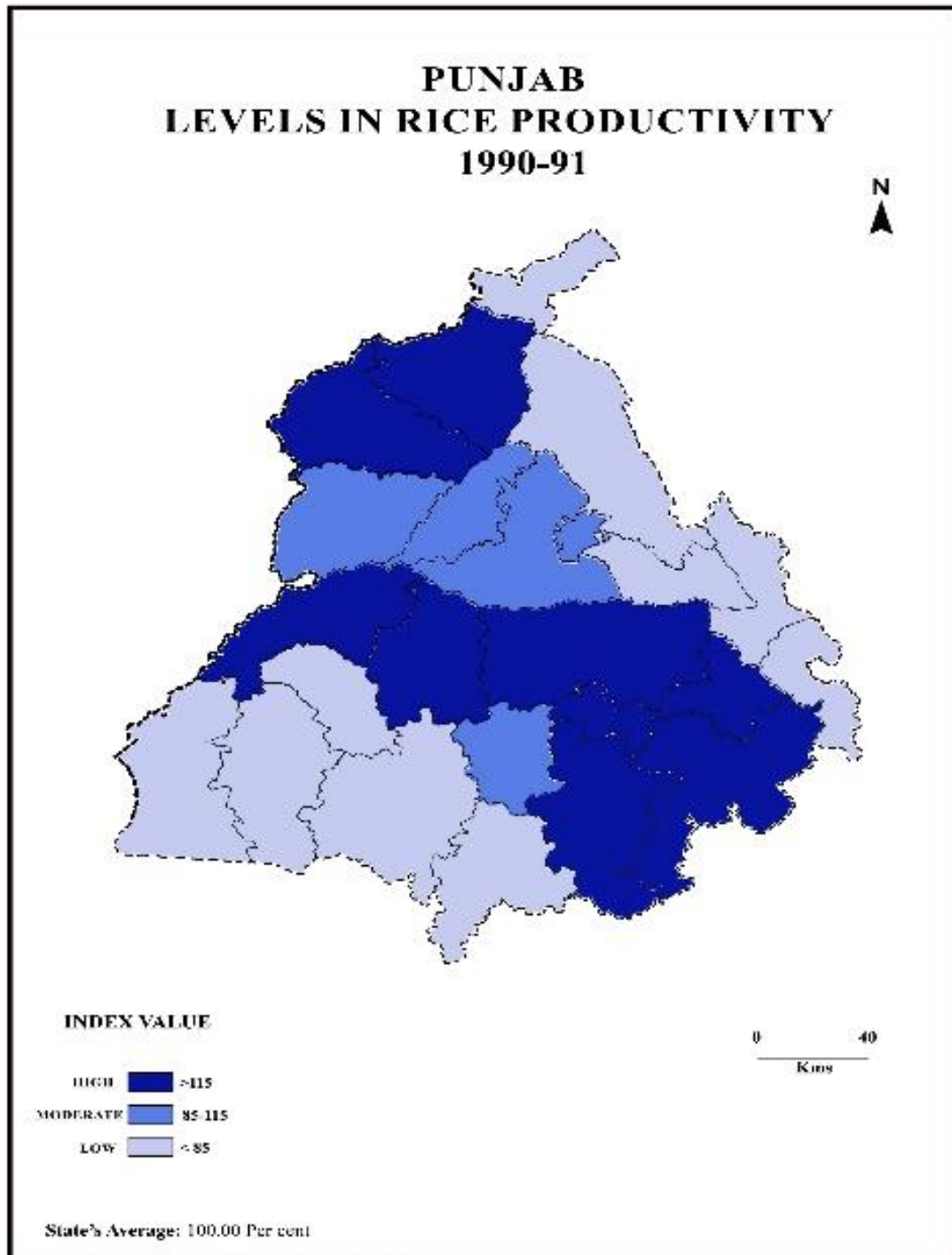
V. DISCUSSION

Patterns of Rice Productivity in Punjab: 1990-91

The levels of rice productivity vary greatly in the state which was noted between 43.46 in Fazilka district to 129.72 in Malerkotla district during 1990-91. These levels are shown in fig. 2 which yield the following three categories: -

High levels of Rice Productivity (> 115 index value)

Nine districts formed this category, mostly, laid in the central and north western parts. It had two belts. Reasons for high levels of rice productivity in the first belt including Gurdaspur and Amritsar districts were, the traditional rice growing areas, the occurrence of flood plains, adequate irrigation, loamy to clayey fertile soils, well versed farmers with rice cultivation, high use of agricultural inputs, easy marketing etc. The second belt of this category which is largest in size had seven districts such as Ferozpur, Moga, Ludhiana, Fatehgarh Sahib, Malerkotla, Sangrur and Patiala. These were not the traditionally rice growing areas with exception of some parts of Ferozpur district. Here, the levelled sand-dunes, reclamation of bet areas of Satluj river, Loamy soils, introduction of green revolution technology like mechanised farming, use of chemical fertilizers, HVY seeds of rice, the agricultural research and extension services provided by Punjab Agricultural University Ludhiana, remunerative prices, assured marketing etc which had made rice popular among farms and consequently rice replaced groundnut, cotton, maize, bajra crops. All these areas were captured by rice crop which yield high. Thus, this category had noted high levels of rice productivity.



Source: Director, Land Records, Punjab, Jalandhar

Fig. 2. Levels of Rice Productivity in Punjab, 1990-91



Moderate Levels of Rice Productivity (85-115 index value)

Four districts found in this category which forms one belt and one patch. The belt laid between the high category and low category, including districts of Tarn Taran, Kapurthala and Jalandhar. Here, the index value of rice productivity varies between 99.28 in Tarn Taran and 114.07 in Barnala district. The district of Tarn Taran, Kapurthala and Jalandhar had moderate levels of rice productivity because of extension of irrigation facilities by sinking tubewells, the assured and higher economic returns from rice had attracted the farmers for rice cultivation which were the traditionally Maize, Groundnut and Cotton growing areas especially Patti Tehsil of Tarn Taran district.

Thus, rice had captured more area under its cultivation which led to high rice concentration index value and moderately yield index value and combinedly resulted into moderate levels of rice productivity. In case of Barnala district, which was traditionally cotton and bajra growing areas. Increase in extent of irrigation, introduction of mechanised farming which helped in reclaim the sand-dunes. Introduction of HYV of rice seeds and development of agricultural infrastructure had enthused the farmers to left bajra and cotton cultivation for rice crop which become responsible for moderate index value of rice productivity.

Table No 1: Index Value of Rice Productivity in Punjab: 1990-91 To 2023-24

Sr. No.	Crops	1990-91	2023-24
1	Pathankot	74.04	81.76
2	Gurdaspur	118.00	105.22
3	Amritsar	117.33	106.94
4	Tarn Taran	99.28	107.60
5	Hoshiarpur	71.11	79.40
6	Kapurthala	109.21	117.71
7	Jalandhar	111.70	116.12
8	S.B.S. Nagar	80.33	88.67
9	Rupnagar	82.70	86.37
10	S.A.S. Nagar	65.57	76.93
11	Fatehgarh Sahib	120.78	122.17
12	Patiala	119.37	120.57
13	Ludhiana	124.10	125.77
14	Malerkotla	120.72	121.25
15	Sangrur	120.33	120.67
16	Barnala	114.07	120.24
17	Ferozpur	116.21	114.95
18	Moga	116.96	118.02
19	Faridkot	78.41	112.18
20	Bathinda	67.45	98.58

Sr. No.	Crops	1990-91	2023-24
21	Mansa	64.65	98.68
22	Muktsar	43.46	99.59
23	Fazilka	57.61	70.77
#	Punjab	100.00	100.00

Source: Director, Land Records, Punjab, Jalandhar.

Low levels of Rice Productivity (< 85 index value)

This category also comprised of two belts. One lying along the Shiwaliks and second covered the south-western parts of the state. In the first belt, which had districts of Pathankot, Hoshiarpur, S.B.S. Nagar, Rupnagar, and Mohali, had the presence of Shiwaliks, dissected undulating topography, comparatively infertile soils, high rainfall, less developed irrigation, comparatively low magnitude of farm mechanization, etc. These factors were favourable for maize cultivation as compared to rice, but with the levelling of some lands by the farmers, low lying areas across the rivers and seasonal streams etc attracted the farmers to sow rice crop as compared to maize. Thus, both low concentration index and low yield index had resulted into low levels of rice productivity. Second belt which comprised south-western districts were traditionally known as cotton growing areas because of the occurrence of sand-dunes, saline and alkaline sub-soil water, low rainfall, availability of enough canal water but with the introduction of HYV seeds of rice, its assured market, higher economic returns, etc some awakened farmers had brought some land from cotton, gaur and bajra to rice cultivation which consequently led to low magnitude of rice productivity. Moreover, these were traditionally non-rice growing areas.

The study has deduced that central areas of Punjab had noted moderate to high magnitude of rice productivity because of favourable physical environment followed by developing and developed agricultural infrastructure. While districts with less favourable natural environment and less developed agricultural infrastructure, traditionally either maize or cotton or bajra growing areas had low magnitude of rice productivity.

Existing Patterns of Rice Productivity in Punjab 2023-24

The magnitude of rice productivity has striking variations in its spatial distribution in the state in 2023-24 which is visible from fig and table 1 because it is noted lowest of 70.77 in Fazilka district, which it enjoys highest index value of 124.77 in Ludhiana district followed by Malerkotla with 121.25. All these results are mapped in fig.3 which portrays the following categories:

Districts with High Magnitude of Rice Productivity (>115 index value)

Eight districts form this high category which covers central parts of the state in a contagious belt. Factors identified for high levels of rice productivity are land with gentle gradient, predominance of loamy soil, though soil varies from silty clay to sandy-loam which are best for rice cultivation. High extent of irrigation, moderate rainfall of about 60 cm, high density of tractors, high density of tubewells, high consumption of chemicals and fertilizers, high efficiency of regulated markets, efficient agricultural researches, extension services provided to the farmers by Punjab Agricultural University, Ludhiana and State Agricultural Department, well awakened farmers etc. All these factors combinedly resulted into high magnitude of rice productivity in this category.

Districts with Moderate Magnitude of Rice Productivity (85-115 index value)

Moderate category of rice productivity is lying between high and low categories. It comprises one belt and one patch. The belt has eight districts and out of eight, four are traditionally rice growing areas i.e. Gurdaspur, Amritsar, Tarn Taran and Firozpur. River Ravi, Beas and Satluj flow through these districts and upper Bari-doab canal irrigates the land. Here, suitable relief, fertile soils, high to moderate rainfall, high extent of irrigation, high density of tubewells, tractors, moderate size of landholdings, well versed farmers with rice cultivation, well developed network of market, soils of the river flood plains are highly suitable for Basmati variety of rice which yield comparatively low though returns are high, are responsible for moderate yield index value and high concentration index value which resulted into moderate magnitude of rice productivity in these districts.

The remaining four districts like Faridkot, Muktsar, Bathinda and Mansa are non-traditionally rice growing areas but with the emergence of water logging, frequent cotton failure owing to whitefly disease, high extent of irrigation, well developed agricultural infrastructure, higher and assured economic returns from rice as compare to cotton, etc have enthused the farmers to shift from cotton to rice.



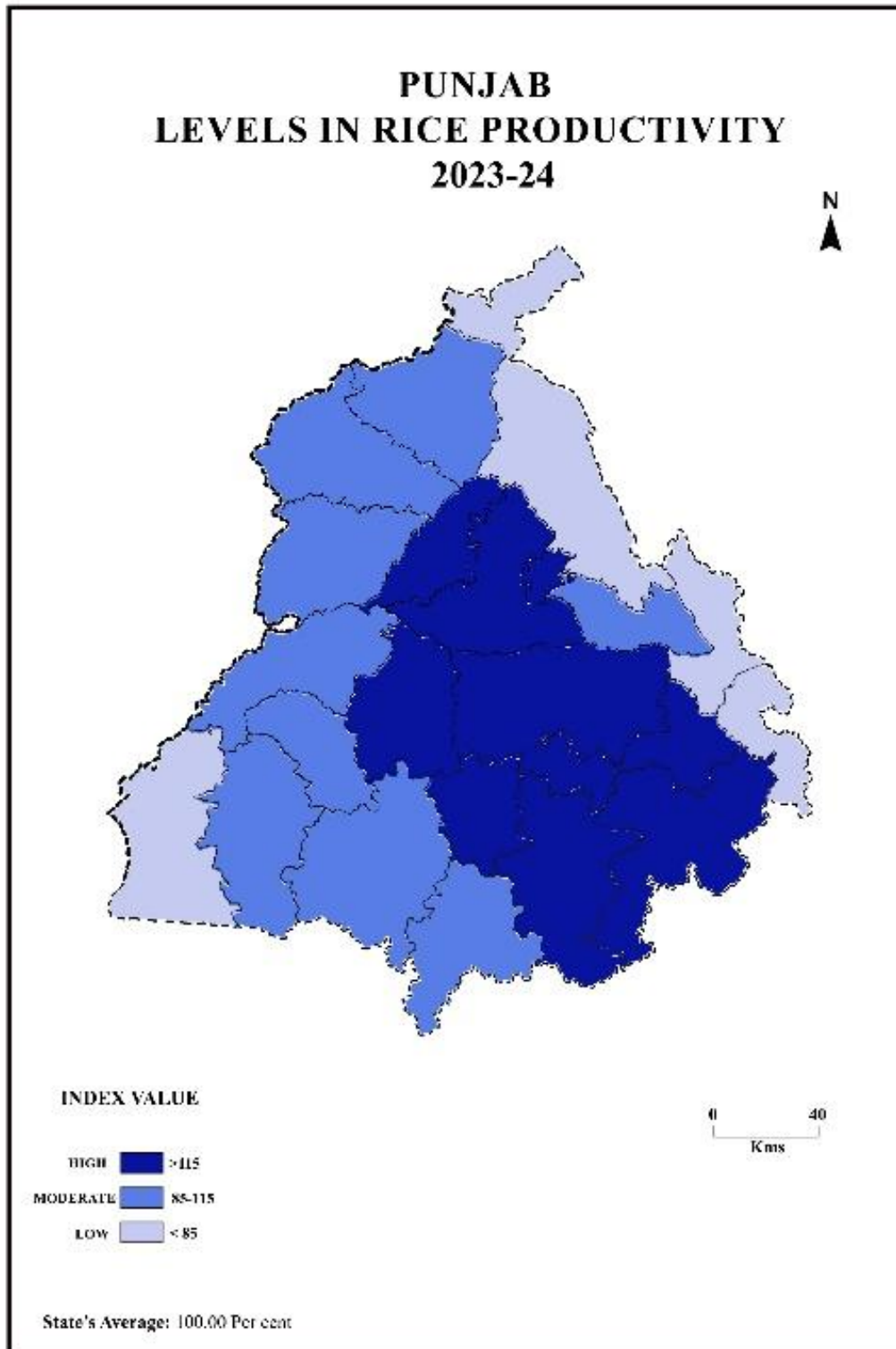
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Thus, all these factors become responsible for moderate magnitude of rice productivity. The patch of this category includes S.B.S. Nagar district only. Here, the main factor for moderate rice productivity is the pre-dominance of rice in Nawasher tehsil and maize in Balachaur tehsil which combinedly resulted into moderate level of rice productivity.

Districts with Low Magnitude of Rice Productivity (< 85 index value)

There are one belt and one patch in this category. The belt is lying along the Shiwalik foothills, covering the

districts of Pathankot, Hoshiarpur, Rupnagar, and S.A.S. Nagar. Here, pre-dominance of hills, undulating and dissected topography, high land gradient, occurrence of numerous seasonal torrents which are locally called choes, infertile soils with a mixture of sand, silt, clay, pebbles, high rainfall, moderate to low extent of irrigation, nearly absence of canal irrigation, moderate density of tubewells, small to medium size of landholdings, poor economic conditions of farmers and labourers, low mechanisation, pre-dominance of maize cultivation etc.



Source: Director, Land Records, Punjab, Jalandhar

Fig. 3. Levels of Rice Productivity in Punjab, 2023-24



Thus, in these conditions the concentration index as well as the yield index are both low which give birth to low magnitude of rice productivity. The patch of this category i.e. Fazilka district is found in the extreme south-western parts which is part of semi-arid zone, here low rainfall, sandy to sandy loam soil, moderate to high extent of irrigation, low mechanisation, pre-dominance of kinnow orchards, cotton, bajra crops etc. In such geo-climatic and socio-economic environment, the levels of rice productivity is noted low.

To sum up, the study has deduced that districts with gentle gradient, fertile loamy soils, moderate rainfall, high extent of irrigation, moderate to high size of landholdings, existence of Punjab Agricultural University, Ludhiana, high farm mechanisation, well developed marketing network, awakened farmers etc have registered high magnitude of rice productivity. But the areas with harsh physical environment like undulating and dissected topography, soil erosion, low extent of irrigation, infertile soils, non-traditionally rice growing areas, low degree of farm mechanisation etc have embraced low magnitude of rice productivity. Whereas old agricultural colonised areas, traditionally rice growing areas with moderate to high fertile soils, well developed agricultural infrastructure, high extent of irrigation, pre-dominance of basmati variety of rice which yield low etc, have noted to moderate magnitude of rice productivity.

Changes in levels of Rice Productivity in Punjab 1990-91 to 2023-24

Punjab has experienced revolutionary changes in its cropping pattern and yield of individual crops during the period under present study. The main factors for these striking changes are the levelling of sand-dunes in south-western parts of the state, land reclamation along the shiwaliks hills, draining out of water logging areas especially in Muktsar, Faridkot, Fazilka and Bathinda district reclamation of kallar (Saline and Alkaline) soils, extension of irrigation particularly through sinking of tubewells and pumping sets, increase in density of tubewells and density of tractors, increasing use of chemical fertilizers, adoption of HYV of rice seeds which yield higher and assured economic returns, easy marketing of rice, well developed marketing network and road network, emergence of water logging that destroyed the cotton crop which requires less quantity of water followed by whitefly disease which affected cotton crop etc. All these factors together enthused the farmers to cultivate rice crop in place of cotton or Bajra. Hence, it affected both concentration index and yield index of rice which are the main indicators for measuring the index value of rice productivity. But the differences in physical environment in various parts of Punjab followed by variations in development of socio-economic environment have resulted into under regional disparities in rice cultivation as well as rice productivity.

It is further noted that the index of rice productivity in Punjab varied from 57.61 in Fazilka district to 124.10 in Ludhiana district in 1990-91 which has increased to minimum value of 70.77 index value in Fazilka district and 129.25 in Malerkotla district in 2023-24 which shows that minimum as well as maximum index value of rice have increased during study period. District wise in 1990-91 the index value of rice productivity was recorded high in nine districts which were found in two belts. First belt comprised of the districts of Gurdaspur and Amritsar which were traditionally rice growing areas even before independence. Here, the suitable physical environment and enough irrigation facilities supplemented by farmers positive attitude towards rice cultivation had resulted into high magnitude of rice productivity, while in the second belt which were well known for either maize cultivation or cotton or Bajra have also experienced high rice productivity because of the agricultural extension services provided by Punjab Agricultural University, Ludhiana and Punjab government which had trained the farmers to adopt rice crop which gave higher economic returns. Supplement by increased in the irrigation facilities. Moreover, the HVY of seeds, mechanised farming developed road and transport network, etc. had also enthused and compelled the farmers to brought more land under rice which resulted into high magnitude of rice productivity in 1990-91 but in 2023-24 this category had shifted towards central parts of a state leaving behind Amritsar, Tarn Taran and Ferozpur districts but only these districts have moderate rice productivity in 2023-24 are the cultivation of basmati rice which yield low though it attracts higher prices per ton as compared to dwarf variety of rice like IR8 etc. But districts of Kapurthala and Jalandhar have experienced increase in irrigation facilities, levelling of sand-dunes at some places even lifting of sand from the fields because underneath the sand dunes there are loamy soils which are highly suitable for rice cultivation with adequate irrigation facilities. Thus, these are the reasons for shifting of this category from north-west to south-east. During 1990-91 to 2023-24 the moderate category of rice productivity has expanded its rice because there were four districts in 1990-91 of high this category which have increased to nine districts in 2023-24. The districts of Gurdaspur, Amritsar and Ferozpur have shifted from high to moderate not because of decline in area or yield but owing to increase in total area under rice cultivation in the districts of high category because these are new areas which have brought more area under its cultivation as well as with increased use of farm mechanisation and agricultural inputs and consequently both area and yield have witnessed increase. It is worth mentioning that Barnala district has also shifted from moderate category of 1990-91 to high category of rice productivity in 2023-24 owing to above mentioned reasons.

The category of low magnitude of rice productivity has witnessed decline in its number of districts as a result it has shrunk from eleven districts in 1990-91 to five districts in 2023-24.

In 1990-91 the belt of this category along shiwaliks which with shiwalik hills, piedmont plains with undulating and dissected topography, high rainfall, comparatively less fertile soil, low extent of irrigation, low magnitude of farm mechanisation, pre-dominance of maize cultivation had experienced low level of rice productivity but in 2023-24 only one district out of five districts namely S.B.S Nagar has shifted to moderate category because of more

socio-economic development of Nawanshahr tehsil of this district which lead to increase in rice productivity and consequently this district joins moderate category. But in case of second belt which was confined to south-western parts of the state has experienced revolutionary changes in draining out of water- logging areas, levelling of sand dunes, increase in density of tube wells and other agricultural inputs have become responsible to increase the index value of rice productivity and consequently this belt with exception of Fazilka district join moderate category in 2023-24.

Table No.2 Changes in Rice Productivity in Punjab: 1990-91 to 2023-24

Sr. No.	Districts	Percent
1	Pathankot	+7.72
2	Gurdaspur	-12.78
3	Amritsar	-10.39
4	Tarn Taran	+8.32
5	Hoshiarpur	+8.29
6	Kapurthala	+8.50
7	Jalandhar	+4.42
8	S.B.S. Nagar	+11.66
9	Rupnagar	+3.67
10	S.A.S. Nagar	+11.37
11	Fatehgarh Sahib	+1.39
12	Patiala	+1.20
13	Ludhiana	+1.67
14	Malerkotla	+0.53
15	Sangrur	+0.34
16	Barnala	+6.18
17	Ferozpur	-1.26
18	Moga	+1.07
19	Faridkot	+33.77
20	Bathinda	+31.13
21	Mansa	+34.04



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Sr. No.	Districts	Percent
22	Muktsar	+56.14
23	Fazilka	+13.17

Source: Director, Land Records, Punjab, Jalandhar.

The reasons for low productivity in Fazilka district in 2023-24 are mainly due to the popularity of kinnow orchard farming in this district. Though, rice is the predominant crop in one tehsil namely Jalalabad of this district is but overall this district has recorded low levels of rice productivity.

Thus, the study has observed that the central parts of the state with favourable physical environment and well-developed agricultural infrastructure have enjoyed the high levels in rice productivity followed by western districts with exception of Pathankot and Fazilka districts have moderate magnitude of rice productivity. But the area along the shiwaliks which are not highly suitable from physical environment point of view for rice crop, low extent of irrigation and poor agricultural infrastructure development have remained the areas with low rice productivity. It is also noted that three districts out of twenty-three have recorded negative volume of change during study period in rice productivity, while the remaining districts have gained in index value of rice productivity. It is also deduced that the regional disparities in levels of rice productivity have narrowed down during study period because the minimum of rice productivity value has increased from 57.61 to 70.77 and highest value of 124.10 to 129.25. Thus, the gap between the minimum and highest value was 66.49 in 1990-91 and 58.48 in 2023-24.

VI. CONCLUSION

During study period Punjab has undergone important changes in its socio-economic, technological and institutional factors which have affected the levels of rice productivity in the state because significant increase in the extent of irrigation, farm mechanisation, consumption of chemical fertilizers, improvements in the HYV of seeds of rice, efficient marketing and road network systems, remunerative prices of rice and assure marketing. The agricultural research and extension services provided by Punjab Agricultural University, Ludhiana and Director Punjab agriculture, Chandigarh. All these factors have combinedly affected the rice productivity in areas with favourable relief, fertile soils, enough rainfall, well developed agricultural infrastructure, etc and as result their districts recorded moderate to high rice productivity. But areas with less favourable physio-socio-economic-technological-organisational factors are lagging behind in rice productivity.

These factors have affected the same way in 1990-91 as well as in 2023-24. It is further noted that with the development in socio-economic environment, the areas of moderate rice productivity in 1990-91 have transformed into high rice productivity areas.

Some low productivity areas especially in south-western Punjab have shifted from low productivity because of the levelling of sand-dunes, reclamation of saline and alkaline soils, draining out of water-logging areas followed by the improvements in socio-economic environment, introduction of HYV seeds of rice which yield higher and assured economic returns than cotton crop. It is also observed that the gap between areas with low rice productivity and high productivity areas have minimized during study period in Punjab.

VII. SUGGESTIONS

The study has suggested that more agricultural infrastructure should be developed in areas with low magnitude of rice productivity. Secondly, in high productivity areas where there are hardly any scope for increase in rice productivity. Thus, Government should give special emphasis to maintain that rice productivity level in the coming times to come in these districts. No doubt, increase in rice productivity has enhanced rice production in the state which make it Rice Bowl of India and this increased production of rice has made India not only self-sufficient but surplus in rice production. It is also suggested that the rice crop has severely affected the land and water resources of the state. Thus, to overcome this strain on environment there is a need to minimize rice area by diverting atleast 20 percent area to other crops like cotton, fodder for dairy development, agro- forestry among oilseeds, pulses etc. Though, the physical environment is degraded but at the same time to meet the increasing demand of food the country requires to continue rice cultivation in the state. Thus, it is suggested that ecological obligation and national interest should walk hand in hand.

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