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AGRICULTURAL TECHNOLOGIES AND ITS IMPACT ON AGRICULTURAL PRODUCTIVITY IN RAJASTHAN.

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ABSTRACT

India's two major problems of recent era are directly concerned with agriculture. The first on is to meet the growing demand for food and other agricultural produce by the increasing population. The second is to reduce the wide spread poverty in rural areas because it is inversely related to geographical product. Thus by increasing the level of agricultural productivity both purposes can be solved. The identification of productivity patterns and factors generating them can help to improve agricultural production through developmental programs. Much emphasis by laid on removing constraints which adversely affect productivity in high potential areas. During the decade of 1981's efforts were made to spur agricultural growth in low productivity and stagnant states and region. For this, special drives were launched to diffuse improved agricultural technology in hitherto under-development states. New crop varieties, technology and enterprises were developed for rainfall, dry-land and other ecological sittings to improve agricultural productivity and income in such region. In all 13 variables have been considered for the explanation of productivity variations in the state. The 13 indicator represent the three basic groups of factor of agriculture. The environmental component of crop production is being explained by mean annual rainfall of the respective years as water is the crucial factor in this part of the country. Irrigation, Pump sets and tractors represent the relationship with mechanical, technological factor, biological and chemical technology is considered in the form of area under high yielding varieties of crops and consumptions of chemical fertilizers, also known as the three basic components of green revolution.

Number of Figures:1 **Number of Tables :3** **Number of References :7**

INTRODUCTION

The Factor Productivity or the unit Productivity needs further explanation as to why it has spatial or regional variations. The answer to it is also lies in the very spatial patterns of productivity and others associated factors and input. Thus the productivity variations are explained with the help of some explanatory variables generated from the input and other factors for both the points of time. The environmental component of crop production is being explained by mean annual rainfall of the respective years as water is the crucial factor in this part of the country. Irrigation, Pump sets and tractors represent the relationship with mechanical, technological factor, biological and chemical technology is considered in the form of area under high yielding varieties of crops and consumptions of chemical fertilizers. these are also known as the three basic components of green revolution.

The relationship between the factors and productivity has been analysed Through showing the distribution of their respective constructed variable in the map calculating the category wise share and incidence of input and other factor and finally computing the coefficients of levels and there input and factor for both point of time separately.

Study Area:

The state of Rajasthan, as an abode of Rajput rulers, the princes and the heroic warriors, is located in the north western part of India. It's geographical location is between $23^0$3' to $30^0$12' North latitude and $69^0$30' to $78^0$17' East longitude with the tropic of cancer passing through the southernmost tip of the state.The length of Rajasthan state is 826 Km. from north to south. The land boundary of Rajasthan is about 5920 Km. long. It is the largest state of India from the view point of area.It's total area is 3, 42, 239 sq. Kms. Which is equivalent is about 10.41 % area of India.

Objective

The main objective of the present study is to attempt the Changes of Agricultural Technologies and its Impact on Agricultural Productivity in Rajasthan. And, to analysis the spatial temporal variation in productivity at Districts level.

Data and Methodology

Spatial analysis of productivity level is very important because it can highlight the structure and problems of production relations on which basis appropriate policies can be suggested by the policy farmers. The concept of productivity has been used extensively to explain the spatial organization of agriculture. Productivity is generally considered from two directions: Productivity of land; Productivity of infrastructure engaged in agriculture .Productivity of land is closely linked with the productivity of infrastructure. The present study is an attempt to analyses the inter district variations in agricultural productivity. The agricultural production is divided into four categories. i.e. cereals, pulses, oilseeds, and cash crops..

The productivity is measured by the output per hectare and is computed by using the fallowing formula-

$$Y = \frac{\sum_{I=1}^{n} Qi}{\sum_{I=1}^{n} Ai}$$

Y-Agricultural productivity

Q- Agricultural production of various crops.

A- Area under production of various crops.

For the study area, 13 indicators are selected. The basic data for this study are taken from statistical abstracts of rajasthan and District Census Handbooks. Various statistical techniques are applied to highlight the results. Ranking method is applied to rank the various districts in productivity level of different crops. Composite index of agricultural productivity is computed. Correlation coefficients are computed among agricultural infrastructure variables on witch productivity depends. Regression is run to show the casual relationship of its correlates.

Agricultural productivity depends on the following agriculture technology and inputs. There are: Gross irrigated area to gross cropped area (in percentage);Gross irrigated area to net irrigated area (in percentage);Gross cropped area to net sown area; Total area under HYV to Gross Cropped Area (in percentage);Total Number of Livestock to Net Sown Area; Total number of agricultural laborers +cultivators to total number of workers; Total number of Pumps+ oil engines to Gross cropped area (in percentage);Total consumption of fertilizers to gross cropped area (in percentage);Total number of tractores to net sown area (I percentage);Number of electrified villages to total number of villages (in percentage);Rainfall variablity (in cm.);Literate Population to Total Population (in percentage),;Density of population.

Another group of eight districts fall under 0.6 to 1.2 tonnes productivity category. While six districts belong to1.2 to1.8 medium productivity category .The remaining two districts, Udaipur and Bundi, have high and very high productivity. Table-1 shows that the productivity of Rajasthan has increased in western districts of the state in last decade, due to developed irrigational facilities (Indira Gandhi Canal), use of high yield seeds, use of advanced agricultural implement etc.

Agricultural Productivity in 2011:

In Rajasthan, agricultural productivity is 0.95 tonnes per hectare, which is as high as 2011 productivity. Table-1 reveals the district wise productivity variation in 2011. The ranking coefficient values of very high, high, medium, low and very low productivity have been shown in figure also. The index number of area under all crops has decreased from 121.58 in 2010-11 to 116.25 in 2010-11. The increase was observed in the index of area under cereals, fibers, fruits & vegetables and tobacco, over the last area under cereals, fibers, fruits & vegetables and tobacco, over the last year, whereas the index of area under food grain, pulses, sugarcane, nonfood, year, whereas the index of area under food grain, pulses, sugarcane, nonfood, total oil seed, condiments & spices, and guar seed revealed

a decline over the previous year. The index number of production under different crop groups of last five. The index number of production under all crops decreased from 185.09 in 2009-10 to 138.83 in 20010-11. The decrease was observed in the index of production under food grain, cereals, pulses, non-food, total oil seed, condiments & spices, fruits & vegetables, sugarcane, and guarseed over the last year, whereas the index of area under fibers, and tobacco revealed an incline over previous year. The index number of productivity under all crops decreased from 152.24 in 2009-10 to 119.43 in 2010-11. The decrease was observed in the index of productivity under food grain, cereals, pulses, non-food, total oil seed, fibers, condiments & spices, fruits & vegetables, sugarcane, tobacco and guarseed over the last year.

Table 1: *Rajasthan: Agricultural Productivity Index (in tonnes/ hect.)-1981 and 2011*

Productivity	**1981**		**2011**	
Index/hectare	**No. of districts**	**% to total**	**No.of district**	**%to total**
Very low <	11	42.33	4	12.12
Low	3	11.53	11	33.33
Medium	4	15.38	6	18.18
High	4	15.38	4	12.12
Very high >	4	15.38	8	24.24
Total	26	100.0	33	100.0

Very low Productivity:

It may be observed from fig.1 that the very low agricultural productivity is found in the three Thar desert districts- Jaisalmer, Barmer, Bikaner,Churu. These districts have less agricultural land, unproductive sandy soil, lack of water and other agro-infrastructural facilities. The sand dunes of migrating character have a general southwest-northeast trend in the Jaisalmer-Barmer region, stone desert and wates occurring extensively as the final remnants of residual hills.Farmers practice grazing as a part of economy. The Indira Gandhi Canal has transformed the rural economy of Bikaner, Churu districts. With the help of irrigation, the farmers have brought more are under cultivation.

Low Productivity:

Out of total state districts, nine have low productivity range between 0.6 to1.2 tonnes per hectare. Most of this districts are located in western and north estern part of Rajasthan such as Jodhpur, jalore, Pali, Sirohi in western, jhunjhunu, Sikar in North- Eastern and Nagaur Bhilwara, Tonk, Ajmer districts in adjoining desert area.

Medium Productivity:

Seven districts, i.e., nearly 26 percent of state districts have 1.2 to 1.8 tonnes per hectare productivity. The state as a whole also has only 0.95 tonnes per hectare productivity.Central and south- eastern part of Rajasthan has medium productivity. The

underground water table is scanty and its utilization is constrained by the hard rock formations. The faemers diversify their cropping pattren to get some returns even under the adverse rainfall conditions.

High and very high Productivity:

Remaining eight districts are having high and very high productivity range between 1.8 to 2.4 tonnes but Bundi has the highest productivity .i.e., 2.93 tonnes per hectare in Rajasthan. Mostly these districts are situated in Southern Rajasthan. Agriculture in this region is largely dependent on the timely arrival, distribution of rainfall and irrigational facilities. In this area, the farmers grow at least two crops in a year and the same piece of land is sown season after season. The dominated crops are rice, whest, maize, pulses etc.

This table that productivity is positively and significantly linked with some agriculture infrastructure indicators, while with others, though it is positively correlated, but insignificantly. The correlation of productivity with cropping itensity (R3) is +0.75, improved seeds (R4) +0.39, irrigational intensity (R2) +0.47 etc. But factors like literacy rate (R12), percent of electrified villages (R10), and pump +oil engines (R7) do not have much influence on increase of productivity in Rajasthan, The correlation with these factors is insignificant.

Correlates of Productivity:

Though the same correlates are considered for the explanation in the spatial variation of crop productivity in 2011s they have been computed on the basis of 2011s.information and do not provide the same results as of 1981s.suggests that the relative importance and relevance of same attributes have changed, partly, If not wholly. To more attributes of HYV and chemical fertilizer have also been includes in the analysis. The Agriculture index of farm harvest price, area, production, productivity, net area sown, gross area sown, cropping intensity and irrigation intensity are given in table 15 to 18 .These indices are based on Triennium ending1993-94=100.In all 38 crops are covered for this purpose which are divided into two main groups which in turn are sub-grouped. Approximately 98 percent area of the total area is covered by these crops.

Table 2: *Correlation Coefficientes of Total Productivity and Agricultural Techonology factors*

Total	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**	**R12**	**R13**
Productivity	.67	.41	.75	.39	.28	.17	.14	.37	.53	.28	.52	.31	.41

1. Rainfall Rainfall is one of the dominant factors responsible for crop Production. The prime source of water in the State is confined only to 3 to 4 months under south-west monsoon .The behavior of monsoon in Rajasthan is usually south-west monsoon .The behavior of monsoon in Rajasthan is usually erratic and uncertain. Its erratic behavior has been presented in the chart as below. The weather and rainfall can be set in motion favorable or unfavorable factors which considerably influence the harvest

from the fields. During the year 2010-11 an average rainfall of 413.8 M.M. as recorded against the normal of 575.1 M.M. and thereby showing the deficient of 28 %. The quantum of Rainfall over the last 5 years has been presented in the Table and chart below.

The average rainfall during the years 2010-11 was 46.91 cm. relatively less than the average of the 1981 which has resulted into a negative growth of output in central districts. The spatial variability in the rainfall has also increased from 41.5 percent in 1981s.to 57.9 cm. in 2011s.The spatial distribution as shown in figures no 3.6. The pattern of the rainfall remained as the same and the average annual rainfall decreases from South- East, East to north-west, west.

The coefficient of correlation between the productivity and rainfall comes to 0.52 and is significant at 0.01 level of signficance further proves that productivity is dependent upon rainfall. The R2 suggests that 30.3 percent variatiom in the productivity are associated that of rainfall.

2. **Irrigation Intensity and Extent**: The index of Net Irrigated Area was 130.85 during 2010-11 as against139.69 in 2009-10, showing a decrease of 6.33 percent. The index of Gross Irrigated Area was 134.14 during 2010-11 as against145.17 in 2009-10, showing a decrease of 7.60 percent. The irrigation intensity is the ratio of gross irrigated area to net irrigated area. It was 124.94 in 2010-11 compared to 126.66 in 2009-10, showing a decrease of 1.36 percent. The Index of irrigation intensity has slightly decreased to 102.51 in 2010-11 from 103.92 in 2009-10, showing a decrease of 1.36 percent.

Irrigation in the state expanded with the extension and completion of many irrigation projects and installation of pump sets and tube wells. This has resulted into 22.56 per cent irrigated area in the 2011. It is significant to note that in three very high productivity districts the percentage of irrigated productivity area is 47.66 percent in high productivity district it is 32.41 percent and it gradually decreased towards low productivity district and in extremely low productivity districts. It is only 3.46 percent of the total cropped area. The spatial distribution of irrigated area is fig. 3.7 shown a highly coinciding pattern of irrigated with productivity pattern. The very high productivity districts with only 15.86 per cent gross cropped area process more than one third irrigated area of the state. On the other five extremely low productivity districts with about 28.01 percent area have only 4.3 percent irrigated area. This indicates the inequality in the distribution of irrigated area though it has decreased in comparison to 1981s. The coefficient of correlation with productivity is very high 0.47 and significant even at 0.001. The R2 indicated that 75.5 percent variations in the productivity can be explained with the help of variations in irrigated area.

Table 3: *Regression Results*

Variable	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
Reg. Coeff.	23.01	19.11	11.12	8.10	7.30	5.21	7.01	3.12	4.32	11.34	12.01	8.60	6.28

R2 = 0.99, Constant = -8.4562

The figures in the parenthesis are't' values.

3. Tractors: The average number of tractors in the state during the 1981s.was 35.5 per ten thousand hectares registering a compound growth of 13.48 per cent annum. The ratio tractors to net area sown in the very high productivity category is 91.77 whereas it is only 14.02 in the extremely low productivity districts, but in the remaining districts of high productivity to very low productivity the ratio varies between 29.22 to 36.5 it suggests that tractors have highly skewed distribution during 2011s.. 38.4 percent tractors of the state are concentrated in three districts with only 15.86 percent gross cropped area, the spatial distribution of tractors as evident from, has a 94.68 percent variation bility. Its ratio is very high in Bharatpur, Alwar and Ganganagr districts, whereas in Churu, Dungarpur, Answer and Shallower it is less than five. The coefficient of correlation between tractors and productivity is 0.89 significant at 0.01 level of significant.

4. Intensity of Cropping – The index of Net Area Sown was 104.65 during 2010-11 as against 108.21 in 2009-10, showing a decrease of 3.29 percent. The index of Gross Area Sown was 113.42 during 2010-11 as against118.77 in 2009-10, showing a decrease of 4.50 percent. Cropping intensity is one of the indices for assessing the efficiency of the agriculture sector. The cropping intensity is the ratio of gross area sown to net area sown. It was 128.10 in 2010-11 compared to 129.74 in 2000-10, showing a decrease of 1.26 percent. The Index of Cropping Intensity has slightly decreased to 108.38 in 2010-11 from 109.76 in 2009-10, showing a decrease of 1.26 percent.

Intensity of average cropping has increased to 114.84 percent during 1981s.except the very high productivity districts it trends yo decreased with the decreased of productivity levels. The intensity cropping is very high in Alwar, Chittoreghar, Answer, Udaipur, Bundi,Bhilwara and very low in western district. The coefficient of correlation with productivity is 0.53 significant as 0.01 percent level of significant and the R2 indicates that as 48.1 percent variation in productivity are associated with that of intensity of cropping.

5. Area under High Yielding Variety Crops – during 1981s.it was negligible, but in 1981s.area under high yielding variety crops H.Y.V.) Increased to16percent.The high yielding varieties of seeds and chemical fertilizers have revolutionized the agricultural practices and output growth and because of these we could have achieved the gains of green revolutions. However, the achieved the gain benefits of these new innovation where not equally spread and

benefited the people and regions (Bhalla and tyagi 1989). It is also significant to note that HYV seeds of Bajra and Maize have not been grown with greater success. It is for this region that though. The HYV seeds have been applied over 18 to 28 percent cropped area in very high productivity districts to medium productivity districts but the impact of it not much evident in the cash of western Rajasthan. The coefficient of correlation with the productivity comes to 0.39 significant. It is also evident from the R2 that 13.5 percent variation in productivity is association with expansion of area under HYV crops. The Distribution of HYV area also proves a significant relationship between HYV and productivity.

6. Chemical Fertilizers – The use of chemical fertilizer along with HYV seeds and sufficient irrigation lead the increase in productivity, During 2011s. The consum-ption of chemical fertilizers increased to11.41 kg./ha. From a negligible base in 1981s however. It is very low in comparison to other state of the country. In very high and high productivity districts the consumption of fertilizer is around 21.5 to 24.2 kg/hectare and in the lower productivity districts it decreased with the decrease in yield level. In extremely low productivity districts it is only 1.7 kg./ha.

The nine very high and productivity districts combined use 70.25 percent fertilizers of the state. In 15.86 to 34.90 percent gross-cropped area. The spatial distribution as shown in fig. 2.5 indicates that much consumption of fertilizer is concentrated in the south- eastern districts of Rajasthan. The significant coefficient of correlates 0.37 and R2 suggest that 50.3 percent variation in productivity can be explained by the variation in the use of chemical fertilizers.

7. Density of Population – Population density in the very high and high productivity districts is less than in the medium and low productivity districts**,** howereit is below average in the very low and extremely low productivity districts. The relationship between population density and productivity levels is also significant can be explained by the spatial variation in density of population. The visual comparison with productivity levels also suggest the same kind of relationship.

8. Pump– Sets- Pump sets in the state have increased the compound rate of 21.03 percent per annum. The average number of pump sets during 1981s.Was 80.65 per ten thousand hectares, except the very high productivity districts in which canal irrigation is the major source of irrigation, the ratio of pump sets decreases with the decrease of productivity levels from 620.7 for the high productivity districts to 28.6 for the extremely low productivity districts. This indicates that pump sets can explain the productivity variations the concentration of pump sets is shown in which indicates that maximum concentration of pump set is in high and medium productivity districts. The spatial distribution of the pump sets indicates that its ratio to net area soen decreases towards west, the coefficient of correlation between pump sets and productivity levels is 0.14 and significant at 0.05 level of significant. The R2 value has decreases from 0.397 to 0.161. This shown that now only 16.1 percent variation in productivity are explained by variation in pump sets.

Changing Pattern of Productivity: The crops classification of districts by productivity levels of 1981 and 2011 are presented in it bring out of the movement of district among productivity level 1981 to 2011. Three districts have attained the very high productivity level during the period. These are Gangarnagar, Bharatpur and bundi. It is significant to note that Ganganagar has shifted from high productivity to very high productivity level and Bharatpur from medium productivity level.Wheres Bundi has crossed over the low productivity level to join the very high productivity level.

Alwar, Chittirgarh and S. Madhopur districts moved from medium level to high productivity level and Kota district moved from low productivity to high productivity level. Jaipur, Sirohi and Tonk districts to moved away from the low productivity level but could attain only the medium productivity level.

In western Rajasthan two districts of the northern part of it, Sikar and Jhunjhunu moved from very low level of productivity to low level of productivity level could find it possible to cross their barriers to join the upper level. These four districts of western Rajasthan are Barmer, Bikaner, Churu and Jaisalmer.Other districts which remained in their 1981s.level even in 2011 are Bhilwara and Udaipur of high productivity level, Jhalawar of medium, Ajmer and Pail of low and Jalore and Nagaur of very low productivity levels.

There are also districts which have moved backward due to their negative growth rate of productivity. These are Answer and Dungarpur, Tribal districts of southern Rajasthan which related to medium from the high level and Jhodhpur districts which has even loosed his very low level of productivity and fall into the level of extremely low productivity.

CONCLUSIONS:

The productivity in the state has increased from during the study period of 28 years with growth of 0.715 percent, is quiet low in comparison to the 1.648 percent of the national average (Bhalla & tyagi 1989).The productivity variations during the period has further increased the inequality in the distribution of output which has increased from 0.27 to 0.44 this proves that the development is not leading to egalitarian distribution. Much of the productivity variations in fifties as well as eighties can be explained in relation to rainfall irrigated areas, pump sets, tractors, others but during eighties more significant relationship has been observed between irrigation and productivity and HYV& fertilizer also explained & greater part of the variation in productivity. The distribution of many crucial input are not space natural and concentrated only in few districts

The study thus concludes that a balanced development of the state is fundamental to the growth of output and development of agriculture. The balanced development requires natural constraints. However the benefits of the even development strategy is the only answer for long term objective of development. An analysis of total Productivity also highlight the low productivity of the state and the spatial variation. To increase the total productivity of the state, gross cropped area, net irrigated, gross irrigated area, use of fertilizers,

improved seeds and modernization of agriculture are the crucial factors. The policy farmers should consider these factors while farming the policies.

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