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DETERMINATION OF AGRICULTURAL PRODUCTIVITY IN A DEVELOPING REGION : A CASE OF WESTERN UTTAR PRADESH

Mahabir Chand Thakur, New Delhi

ABSTRACT : The results of regression analysis establish that agricultural productivity is determined by the use of modern capital inputs and yield augmenting biological inputs. Mechanization representing tracters, oil engines and electric pumpsets emerged as an important factor but the addition of variables like gross cropped area and chemical fertilizers contributes significant increase in the explanation of variation in land productivity. Further, the role of mechanization and biological inputs in determining productivity has enhanced during the years 1962-65 and 1978-81.

INTRODUCTION

Spatial patterns of agricultural productivity is an enterplay of multifareous environmental, technological and institutional factors. Physical environment such as soil climate and relief impose certain broad limits within which a particular crop may be successfully cultivated, but that the scale, intensity and extent of production within these physical limits is determined by economic considerations, levels of technological innovations and prevailing social institutions. Physical environment alone does not adequately explain patterns of agricultural productivity. It is the interaction between physical and techno-economic factors that determine overall variations in the levels of productivity.

In the past, the tendency of the most of geographical studies of agricultural patterns has been to stress on the role of physical environment. The emphasis on economic considerations is relatively, a recent trend (Shafi 1960, Singh 1972, Raza 1981, Mohammad 1981 and Casetti et. al 1981). This paper is different in its emphasis mainly in two ways. Firstly, it attempts to examine spatial patterns of composite agricultural productivity per hectare of land by taking as much as eighteen crops into account. Secondly, the paper tries to observe the relative importance of selected physical as well as economic variables in determining the levels of agricultural land productivity. Moreover, the study also places emphasis on changes in spatial variation in agricultural productivity and the role of influencing variables over the selected years.

Thus, the main objectives of the study are :

(1) To work out spatial patterns of agricultural productivity in terms of money value.

(2) To examine the relative contribution of explanatory variables in determining the levels of productivity.

(3) To observe changes in spatial pattern and the strength of influence exerted by explanatory variables over the years.

THE STUDY AREA

Western part of Uttar Pradesh comprising nineteen districts of the state has been selected for the present investigation. The region lies between 26° 21′ and 30° 23′ N latitude and 77° 4′ and 80° 26′E longitude covering an area of 82189 sq.km. with a population of 3,93,56,803 as per 1981 census. It constitutes the part of upper Ganga plain characterized by almost a monotonous relief showing little geomorphological variations. The soil of the region is fine grained both in ' Kahadar ' (i.e. new alluvial) and

'Bhangar' (i.e. old alluvial). It receives an average annual rainfall of 83 centimeter.

This agro-economic region of the state is placed on part with Punjab and Haryana with respect to diffusion of green revolution (Bhalla and Alagh, 1979). This parity seems to be quite appropriate as substantiated by the proportional share of western Uttar Pradesh in the state's agricultural production as well as adoption of high yielding variety of seeds, chemical fertilizer, mechanization of agriculture and development of irrigational facilities. It accounts for 36.90 per cent of the total cropped area shares as much as 61.50 per cent of gross agricultural production and almost half (i.e. 49.20 per cent) of gross irrigated area. It also concentrates 60.66 per cent of the total tractors, 51.95 per cent of the irrigational pumpsets, 38.48 per cent of the area under high yielding variety of seeds and 45.05 per cent of the total fertilizer consumption of the state. On the contrary, its proportional share to the total geographical area comes to only 27.92 per cent. This reflects significant headway the region has made in the field of agricultural development.

METHODOLOGY

The study is based on secondary informations collected from government publications like 'Estimates of Area and Production', 'Agricultural Situations in India', 'Farm (Harvest) Prices of Principal Crops in India' and 'Uttar Pradesh ke Krishi Ankare'. The unit of the study is district. At present there are nineteen districts in the region. The district of Gaziabad was carved out of Hapur and Gaziabad Tehsils of district Meerut during late seventies. Since the study includes the years of sixties, the informations of Gaziabad have been clubbed together with that of Meerut so as to avoid splitting of data. Thus, the analysis is carried out for old eighteen districts.

The years under question are 1962–63, 63–64 and 64–65 during sixties, 1970–71, 71–72 and 72–73 during seventies and 1978–79, 79–80 and 1980–81 for the last triennium of 1978–81. Three years average has been worked out to eliminate climatic anomalies. The years are so selected as to capture the situations before green revolution, immediately after green revolution and relatively recent patterns.

In order to compute agricultural productivity eighteen crops namely rice, jowar-bajra, maize, ragi, wheat, barley, gram, tur, groundnut, seasamum, rapeseed and mustard, lineseed, cotton, jute, potato, sugarcane, and tobacco have been selected keeping in view the availability of farm harvest prices for the crops concerned. Moreover, these crops account for as much as 85 per cent of gross cropped area and about 99 per cent of gross production. The productivity is computed in terms of money value by taking farm harvest prices of the year 1970–71 for converting physical value of production. The procedure of computation is expressed in the following notation (Sharma, 1966).

$$Y = \frac{\sum_{i}^{n} = 1\, Q_i P_i}{\sum_{i}^{n} = 1\, A_i}$$

Where

- Y = per hectare gross value composite productivity (18 crops)
- Q_i = Physical production of a particular crop during a particular year
- P_i = Farm harvest price for that particular crop kept constant over the year
- A_i = Area under that crop.

Besides mean and standard deviation, coefficient of variation has also been calculated for all selected points of time. In order to trace out changes, percentage of annual compound growth rates has been worked out.

The second aspect of study involves the analysis of stepwise linear regression so as to establish functional relationships between agricultural productivity and its determinants. The co-efficient of determinants (R^2) and adjusted co-efficient ($\bar{R}^2$) are obtained at each step of the regression analysis. Besides, the value of 't' has also been computed for testing the significance level of regression co-efficient.

VARIABLES

The following explanatory variables of agricultural productivity were tried in regression function :

(1) Amount of average annual rainfall in mm.

(2) Mechanization Index–this composite index was worked out by taking into account the number of oil engines, electric pumpsets and tractors per 1000 hectares of gross cropped area.

(3) Gross irrigated area as percentage to gross cropped area.

(4) Use of chemical fertilizers per 1000 hectare of gross cropped area.

(5) Number of agricultural worker per hectare of gross cropped area. Agricultural workers include both male cultivators and agricultural labourers.

(6) Gross cropped area

(7) Cropping intensity–gross cropped area as percentage to net sown area.

(8) Percentage area under high yielding variety of seeds. This variable was included only in 1970–73 and 1978–81 because HYV seeds were introduced after mid–sixities.

SPATIAL PATTERNS AND GROWTH OF LAND PRODUCTIVITY

Table I depicts districtwise agricultural productivity as well as percentage of growth

TABLE I

Spatial Patterns and Growth of Agricultural Productivity in Western Uttar Pradesh

S. No.	DISTRICTS	Productivity in Rs. per Hectare			Annual Compound Growth Rates in %	
		1962–65	1970–73	1978–81	1970–73 over 1962–65	1978–81 over 1970–73
1.	Saharanpur ..	1111.46	1369.83	1671.80	2.65	2.52
2.	Muzaffarnagar ..	1457.96	1892.28	2209.37	3.31	1.95
3.	Meerut ..	1228.30	1655.53	1976.76	3.80	2.24
4.	Buland Shahar ..	607.41	1211.42	1472.06	9.01	2.47
5.	Aligarh ..	686.59	1030.68	1247.88	5.21	2.42
6.	Mathura ..	637.42	919.64	1091.83	4.68	2.17
7.	Agra ..	612.33	704.01	912.11	1.76	3.29
8.	Mainpuri ..	721.88	887.62	1047.94	2.62	2.10
9.	Etah ..	723.45	873.65	944.58	2.39	0.98
10.	Bareily ..	860.88	937.11	1211.18	1.07	3.26
11.	Bijnor ..	1093.17	1382.65	1753.53	2.98	3.02

TABLE I—*Contd.*

S. No. DISTRICTS	Productivity in Rs. per Hectare			Annual Compound Growth Rates in %	
	1962–65	1970–73	1978–81	1970–73 over 1962–65	1978–81 over 1970–73
12. Badaun ..	684.92	955.65	936.48	4.25	–0.25
13. Moradabad ..	825.76	992.87	1388.56	2.33	4.28
14. Shahjahanpur ..	707.60	897.47	1175.63	3.02	3.43
15. Pilibhit ..	894.51	1052.67	1443.49	2.06	4.02
16. Rampur ..	822.08	987.86	1417.96	2.32	4.62
17. Farrukhabad ..	822.48	968.06	1323.48	2.06	4.00
18. Etawah ..	722.19	964.39	1060.81	2.82	1.20
Mean ..	847.80	1110 02	1366.25	3.42	2.63
S. D. ..	225.78	293.12	354.52		
C. V. ..	26.63	26 40	25.94		

Productivity Group	No. of Districts		
	1962-65	1970-73	1978-81
Low—below mean—0.5, S. D. ..	9	7	7
Medium—Mean $\pm$ 0.5, S. D. ..	5	7	7
High—above + 0.5. S. D. ..	4	4	4
Total ..	18	18	18

rate. While classifying districts in three groups of low, medium and high productivity on the basis of dispersion from mean productivity, two main characteristics became apparent. Firstly, the number of districts falling in high productivity group remained constant in all three points of time. The districts of Saharanpur, Muzaffarnagar, Bulandshahar and Bijnor retained their status of high productivity all through. Secondly, inter district variations in the levels of productivity has tended to decline after the breakthrough of new technology. The number of districts having low productivity has come down to seven in 1970–73 from nine in 1962–65. This trend is also evident from co-efficient of variations which decreased, though marginally, from 26.63 per cent in 1962–65 to 25.94 per cent in 1978–81.

The changes in inter district disparities can further be explained through rhe percentage of annual compound growth rates. The average productivity of the region was estimated to Rs. 847.80 in 1962–65 which

increased to Rs. 1110.02 in 1970–73 and Rs. 1366.25 in 1978–81. This grew at an annual compound rate of 3.42 per cent during 1962–65 and 1970–73 and 2.63 per cent during the second period i.e. 1970–73 to 1978–81. The performance of growth during first period has been conspicuous at district level also; the highest percentage being as much as 9.01 in Bulandshahar district. The lowest was recorded by district of Barielly (1.07 per cent). As many as seven districts registered above 3 per cent of growth rate. On the contrary, the second period is marked by negative changes in productivity recorded by Badaun district (−0.25 per cent) in particular and a slowing down tendency of growth in general. The plausible explanation of higher growth rates during first period may be the computation of growth rates from a lower production base in 1962–65 while the growth rates for second period were worked out against an already sound base obtained in 1970–73 as a result of new technology introduced during later half of sixties. It may also be attributed to gradually slackening of impact of green revolution. It is also noteworthy that the districts with low productivity, barring a few exceptions, have recorded higher growth rates during sixties as well as seventies. This helped decrease in inter-district variations in agricultural productivity over the years.

RESULTS OF REGRESSION ANALYSIS

The discussion so far has related to average characteristics and inter-district variations in agricultural productivity and its growth rates. The analysis of regression has been attempted to reveal the factors responsible for high or low agricultural productivity. The analysis also tests the hypothesis that the intensity of use of mechanical inputs like chemical fertilizers coupled with better irrigational facilities would augment yield levels. Regression equations have been fitted for all three points of time. The yearwise results are presented in Table II.

TABLE II

Determinants of Agricultural Productivity : Stepwise Linear Regression Function

Steps	Variables	Intercept	Coefficient	't' Value	R^2	R^{-2}
	1962-65—					
1	Mechanization	633.38	72.79	4.16**	0.5199	0.5199
2	Mechanization		86.59	4.33**	0.5703	0.5130
	Gross cropped area	847.15	0.001	1.33		
3	Mechanization		79.32	3.87**		
	Gross cropped area		0.001	1.32		
	Agricultural worker	1150.18	-422 20	1.24	0.6127	0.5297
4	Mechanization		81.81	4.11**		
	Gross cropped area		0.001	1.37		
	Agricultural worker		-509.44	1.52		
	Rainfall	1157.68	0.037	1.41	0.6641	0.5608

TABLE II—*Contd.*

Steps	Variables	Intercept	Coefficient	't' Value	R^2	R^{-2}
	1970–73—					
1	Mechanization	646.53	148.72	6.65**	0.7341	0.7341
2	Mechanization		148.73	6.93**		
	Rainfall	363.62	0.34	1.55	0.7707	0.7401
3	Mechanization		139.39	6.53**		
	Rainfall		0.39	1.83 +		
	Gross cropped area	113.89	0.001	1.55	0.8043	0.7624
	1978-81—					
1	Mechanization	596.92	243.10	6.94**	0.7505	0.7505
2	Mechanization		167.57	4.31**		
	Fertilizer	309.71	9.78	2.91*	0.8407	0.8194

** Significant at 0.01 level. * Significant at 0.05 level. + Significant at 0.10 level.

In 1962–65, mechanization in agriculture has emerged as the main determinants of productivity as fairly a large percentage of variation in land productivity is explained by it. The addition of factors like gross cropped area, agricultural worker per hectare and rainfall to mechanization, though their coefficient was insignificant, raised the coefficient of multiple correlation from 51.99 per cent to 56.08 per cent. The position of mechanization as an explanatory variable further consolidated in 1970–73. It alone explained as much as 73.41 per cent of variation in productivity per hectare of land. Rainfall and gross cropped area marginally contribute to over all explanation of variation. The intensity of use of modern technology represented by mechanization and chemical fertilizers appeared still more important in 1978–81. Mechanization together with fertilizers explained as much as 81.94 per cent variation. Three fourth of the variation is explained by mechanization alone. The direct and significant relationship of mechanization and fertilizers with land productivity emphasizes the increasing importance of mechanical and biological inputs in modern agriculture.

The emergence of mechanization as the most pronouncing determinants in 1970–73 and afterwards is primarily because the intensity of tractor use has increased markedly after the advent of the Green Revolution. Moreover, the addition of tubewells to tractors while computing composite mechanization index has also increased the explanatory power of the model in all three periods. The role of mechanization in increasing efficiency and thereby promoting multiple cropping, use of HYV seeds, chemical fertilizers is quite obvious. This ultimately leads to increased per hectare land productivity.

RESUME

Recapitulation of observations made in the context of Green Revolution establishes

that inter-district variations in the levels of agricultural productivity in Western Uttar Pradesh has started declining. The rate of change in productivity during 1962–65 and 1970–73 has been substantial while it tended to slow down during 1970–73 and 1978–81. It may be due either to computation of growth rates against an already improved situations in 1970–73 or to declining tempo of green revolution with the passage of time. Confirming the postulated hypothesis the results of regression analysis establish that productivity in modern agriculture depends on the intensity of use of both mechanical and biological inputs. This became more apparent in 1978–81 when as much as 81.94 per cent of variation was explained by mechanization and chemical fertilizers. This indicates towards a capital intensive agricultural structure coming up in a green revolution region.

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Address of the Author

Dr. M. C. Thakur
Centre for the Study of Regional Development
Jawaharlal Nehru University,
New Delhi.

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