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REGION-WISE GAINS FROM AGRICULTURAL GROWTH : MEASUREMENT AND FACTOR ANALYSIS

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ABSTRACT

This paper examines the regional disparities among major states of India. It also identifies the factors responsible for these disparities. Between the triennia 1960-63 and 1982-85 North-Western India (the wheat belt) alone accounted for about 30 per cent of the output gains at all-India level. The other regions, in comparison, performed rather poorly. Technological factors such as HYV-seed, irrigation, fertiliser and mechanisation as well as technology supporting factors like infrastructure are responsible for the disparate growth of agriculture among states. The rank correlation coefficients between these two sets of factors, on one hand, and the output gains on the other are 0.56 and 0.68, respectively.

Introduction

Balanced regional development has been a long term objective of our polity. Several short and long term measures, such as special area programmes have been started from time to time to achieve this objective. Yet, even after nearly four decades of planned development we are no where near our goal, a fact to which many scholars have drawn attention (Rao, 1975; Mahendradev, 1985, Alagh, 1988; Bhalla and Tyagi, 1989). A common conclusion of their studies is one of near-stagnation in Eastern region in contrast to rapid growth in the wheat belt of North-Western India.

Both natural and man-made factors are responsible for the regional disparities. Natural factors include unfavourable soil, climate, topography, drought and flood-proneness. Man-made factors such as discriminatory investment on irrigation in favour of North-Western India and exploitative land tenurial arrangements in the Eastern India worked against regional

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parity in the pre-independence period. In the post-independence period, the regional disparities increased in the wake of (1) Intensive Agricultural District Programme (IADP) of the early 1960s, that covered only a few selected districts with good growth potential, and (2) introduction of HYV technology in the mid-1960s (Dantwala, 1977). Further, regional disparities in agricultural development have also been widened by the differential efforts put in by various state governments. Rao (1975) observes that interregional disparities derive 'partly, from the character of the technical change, and partly, from the regional differences in factor endowments, physical and institutional infrastructure, and entrepreneurship". Mukhopadhyay (1976) attributes a good amount of regional variation in agricultural performance to irrigation, land, fertilizer, tractor and literacy. Bhalla and Tyagi (1989) find fertilizer, tubewells and tractors as important explanatory factors.[1]

In view of the foregoing discussion the present paper aims to measure the extent of regional disparities in the country and to understand the factors responsible for it.

Methodology

A total of 19 principal crops are considered for computing state-wise and region-wise aggregate output. The diverse outputs of these crops are then aggregated using 'rice equivalent scale' evolved by Dhawan (1989). The 'rice equivalent scale' is based on five years (1980-85) minimum support prices of various crops, price of each crop being expressed as multiple of corresponding average support price of rice. These multiples are used as weights in aggregation (Appendix-I).

The major states studied are delineated into five major regions, as follows :

Region	*States included*
North-Western Region	Punjab, Haryana and Western U.P.
Western India	Gujarat, Maharashtra and Rajasthan
Central India	Madhya Pradesh and Central and Bundelkhand regions of U.P.
Southern India	Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.
Eastern India	Assam, Bihar, Orissa, West Bengal and Eastern U.P.

1. On a preliminary examination, Dantwala (1977) did not observe any association between the extent of irrigation (ratio of irrigated area to net cultivated area), land tenurial conditions and institutional credit on one hand and growth rate of agricultural output on the other. Rao (1975), however contends that increased public investment in irrigation in underdeveloped regions would lower the regional disparities.

The analysis was conducted both regionwise and statewise. For the statewise analysis Kerala and Assam were excluded due to data problems and domination of the plantation crops in their economies.

The dependent variable is the agricultural output gains per net sown hectare. This equals the difference between the aggregate output of terminal period (triennium 1982-85 in this case) and the initial period (triennium 1960-63) divided by the net sown area during the initial period. Two sets of explanatory variables are studied : technological factors and technology supporting factors. Technological factors are those which in themselves are capable of enhancing crop output and thus include irrigation, extent of adoption of high yielding varieties, fertilisers and mechanisation. Technology supporting factors, on the other hand, help in the adoption and then expression of potential of the technological factors. Thus, they include marketing facilities, credit availability, power and roads. The definition of these variable as used in the study are explained in Table 1. The net sown area during 1960-63 triennium is used as the numeraire throughout. Coefficients of linear correlation and rank correlation are used to derive qualitative inferences about the relationships between dependent and independent variables. The required data are compiled from various statistical publications.[2]

Results

Regional disparities in gains

Between triennia 1960-63 and 1982-85, aggregate output of all states taken together rose by about 73 million tonnes of rice equivalent units (Table 2). Of this step-up, about 30 per cent is shared by North-Western India (the wheat belt), as against mere 11 per cent share of Central India. When expressed per net sown hectare, the North-Western region records 1.61 tonnes per hectare which is three times the national average (0.53

2. They are : *Area and Production of Principal Crops in India* (Directorate of Econ. and Stat. Ministry of Agriculture, Govt. of India), *Statistical Abstracts of India* (Central Statistical Organisation, Govt. of India) *Currency and Finance Report* (Reserve Bank of India, Bombay) *Statistical Statements Relating to Cooperative Movement in India* (Reserve Bank of India and later on by National Bank for Agriculture and Rural Development (NABARD) since its inception), *Statistical Outline of India* (Tata Services Ltd., Bombay), *Basic Statistics Relating to Indian Economy* (Centre for Monitoring Indian Economy, 1985), *District-wise Indicators of Development* (State Planning Institute, Government of Uttar Pradesh. 1983), *Social and Economic Atlas of India* (Oxford and IBH, Delhi, 1988) and *Statistical Abstracts* of various states (respective State Directorates of Economics and Statistics), *Indian Agriculture in Brief* (Govt. of India, 22nd edition).

Table 1. Definitions of the variables used in the study

Variable Name		Description
1. dOPT/NSA	:	Expansion in aggregate crop output between 1960-63 to 1982-85 per NSA;
2. dGIA/NSA	:	Expansion in irrigation ratio i.e. change in gross irrigated area between 1960-63 and 1982-85 as per cent of NSA;
3. dNPK/NSA	:	Expansion in fertilizer intensity (=ratio of fertilizer used to NSA, in percentages) between 1959-61 and 1982-85.
4. dHYV/NSA	:	Expansion in HYV intensity (=ratio of crop area under HYV of crops to net sown area in percentages) between 1969-70 and 1983-84.
5. dTRAC/NSA	:	Expansion in tractor intensity (=number of tractors per 1000 ha of NSA) between 1961 and 1981.
6. dCREDN/NSA	:	Expansion in institutional short term credit per NSA between 1962-63 and 1983-84 both in nominal terms.
7. dCREDR/NSA	:	Expansion in institutional short term credit per NSA between 1962-63 and 1983-84 at constant prices.
8. dPOWR/NSA	:	Expansion in electricity consumption per NSA between 1959-60 and 1983-84;
9. d%ELECT	:	Proportion of additional villages electrified between 1961 and 1984, to the total number of inhabited villages as per 1971 census;
10. dROD/NSA	:	Expansion in the length of surfaced roads between 1960-61 and 1980-81 per NSA;
11. d%PUCRD	:	Proportion of additional villages linked through pucca roads, between 1970-71 and 1979-80;
12. dRGMKT/NSA	:	Expansion in the number of regulated markets per NSA between 1966 and 1984.

NSA=Net sown area relating to 1960-63 triennium, in ha.

tonnes/ha) and four times the estimate for Central India (0.39 tonnes/ha) (Table 3).

State-wise picture shows that Punjab with an aggregate all crops output gain of 2587 kgs per net sown hectare is at the top. Bihar with a gain or 166 kgs/ha only is at the bottom. Haryana, U.P. and West

Table 2. Region-wise distribution of incremental crop output in India between 1960-63 and 1982-85

(Percentages)

Region	Foodgrains	Non-foodgrains	All Crops
North-Western India	34.07	20.44	33.26
Western	14.88	28.29	18.63
Central	13.88	4.73	11.33
Southern	12.99	26.91	16.89
Eastern	19.47	17.40	18.88
All India	100.00	100.00	100.00
	(52.26)	(20.26)	(72.51)

Note : 1. Figures in brackets are incremental outputs in million tonnes of rice equivalents.

2. For partitioning Uttar Pradesh data for sub-regions the shares observed in 1970s are used. They are 44.7, 26.7, 6.7, 16.7 and 5.2 per cent respectively for West U.P., East U.P., Bundelkhand, Central U.P. and U.P. Hills.

Bengal are among the next high ranking states. The spatial disparity in output gains is, thus, very high as indicated by high coefficient of variation of 95 per cent. This indicates that the growth performance of agriculture has been highly uneven across states. It is also noted, that the regional disparity in the level of aggregate output per net sown area has increased in early eighties compared to early sixties.

Analysis of factors

Technology and technology supporting factors are analysed in relation to output gains. (Table 3 and 4).

Technological factors

Irrigation

The development of irrigation has been quite uneven across states ever since organised efforts to harness the water resources started in the country. Between the early sixties and the early eighties, the gross irrigated area rose by about 24 million ha (m ha) from an initial level of 29 m ha. The maximum rise has taken place in North-Western India, which accounted for about 40 per cent of the nation-wide expansion in irrigation. The expansion of irrigated area has been sluggish in Southern India amounting to 1.6 m ha over a period of over 20 years. All the other three regions are in between these two extremes. In other words, in North-

Western India the irrigation coverage (measured as proportion of gross irrigated area to net sown area) increased by about 68 percentage points between the early sixties and the early eighties. During the same time Southern India witnessed an increment by about 5 percentage points in the irrigation ratio. In Western, Eastern and Central regions, the increment is in the range of 13 to 16 percentage points compared to the national level step-up of 18 percentage points. The expansion of irrigated area has been at varying rates across states as indicated by the differential increments in irrigation ratio. Ranging from 84 percentage points in Punjab to negligible amount in Tamil Nadu, the increments in irrigation ratio show a high coefficient of variation of about 108 per cent.

Expansion of irrigation ratio has positive and significant influence on output gains per net sown hectare and explains about 81 per cent of the inter-state variation in the latter. An interstate difference in incremental irrigation ratio of 10 percentage points led to difference in output gains per net sown hectare of two quintals[3]. However, there are certain exceptions in the relationship. The irrigation ratio, for example, expanded by the same magnitude in Rajasthan and Bihar as against the output gains of about 318 kg and 166 kg per net sown hectare, respectively. Output gain in Bihar is much less than what it is in Andhra Pradesh though the expansion in irrigation ratio is comparatively greater. Such exceptions are understandable because of the differential yield impact of irrigation across states. Further, there are other factors that influence the output gains in a state. Some of these factors are discussed below.

Fertilizer

Fertilizer use is complementary to irrigation facility. Hence, the pattern of growth in fertilizer use will be more or less similar to that of irrigation variable, of course, with a few possible exceptions, like Gujarat, Tamil Nadu and Andhra Pradesh. At all India level, the fertilizer use per net sown hectare rose from 2.2 kgs in early sixties to about 55 kgs in early eighties. Punjab recorded maximum step-up in fertilizer intensity of 236

3. The equation is :

$$dOPT/NSA = 0.14 + 0.02^{*}\ dGIA/NSA \qquad R^2 = 0.81$$
$$(0.113)\quad (0.003) \qquad\qquad n = 13$$

where, dOPT/NSA=output gains between 1960-63 and 1982-85 per net sown area (tonnes of rice equivalents per ha). dGIA/NSA=increment in irrigation ratio, (percentage points).

Note : Bracketed figures are standard errors and '*' denotes significance at 1 per cent level.

Table 3. Factors associated with inter-State disparities

	Technological Factors				
	dOPT/ NSA tonnes of Rice equivalent units ha.	dGIA/NSA % points	dNPK/ NSA Kg/ha	dHYV/ NSA % points	dTRAC/ NSA No./ lakh ha.
1 2	3	4	5	6	7
States :					
1. Punjab	2.587	84.3	234.8	74.15	20.54
2. Haryana	1.193	72.1	86.1	58.63	13.15
3. Uttar Pradesh	0.952	38.1	88.9	38.44	4.17
4. Gujarat	0.488	19.1	45.6	20.70	2.45
5. Maharashtra	0.248	8.0	29.9	30.82	1.19
6. Rajasthan	0.318	16.2	14.0	19.11	1.96
7. Madhya Pradesh	0.261	11.2	18.8	23.22	1.03
8. Andhra Pradesh	0.570	9.6	70.4	29.82	1.48
9. Karnataka	0.362	8.4	44.9	15.06	1.19
10. Tamil Nadu	0.261	—4.0	88.0	5.64	1.80
11. Bihar	0.166	15.7	33.3	43.93	1.51
12. Orissa	0.506	13.9	18.3	23.85	0.40
13. West Bengal	0.668	9.9	59.8	34.49	0.42
Regions :					
1. North-Western	1.61	67.6	143.0	56.08	12.92
2. Western	0.33	13.3	28.0	24.57	1.74
3. Central	0.39	16.1	27.4	24.61	2.01
4. Southern	0.40	5.3	61.3	17.59	1.42
5. Eastern	0.49	14.5	43.2	37.84	1.12
All-India	0.53	17.9	52.6	29.29	2.81
Coefficient of variation (for 13 states)	94.7	108.3	87.2	55.3	146.0
Correlation coefficient with output gains	1.00	0.90	0.93	0.82	0.94

kgs during this period, as against a minimum 14 kgs in the case of Rajasthan. In seven states out of 13 the step-up in fertilizer intensity is below the national average step-up of 53 kgs/ha. On the whole, the

in output gains

Technology Supporting Factors						
dCREDR/ NSA Rs./ha.	dCREDG/ NSA Rs./ha.	dPOWR NSA KWH/ ha	d%ELECT % points	dROD/ NSA Kms lakh ha	d%PUCRD	dRGMKT/ NSA No./mha.
8	9	10	11	12	13	14
112.10	794.99	506.10	84.0	650.4	53.33	135.7
74.75	497.40	376.29	93.0	433.0	36.86	38.6
0.35	123.76	187.38	46.7	196.0	21.78	36.0
1.82	158.19	142.86	78.0	277.2	29.85	23.4
—0.84	144.59	129.76	85.7	268.2	19.95	19.1
11.25	84.07	85.75	54.6	159.3	14.16	21.7
3.75	81.86	35.78	51.4	198.4	7.05	17.5
38.54	362.62	121.31	69.0	293.2	33.28	37.2
26.63	220.18	43.56	67.0	295.4	30.76	16.8
15.82	384.33	352.30	61.0	1080.4	24.80	29.7
0.92	24.69	71.46	48.6	166.1	18.80	74.8
16.13	150.99	12.48	46.7	111.7	10.95	10.1
6.02	87.19	17.28	59.2	100.1	32.96	58.8
55.1	420.2	380	68.8	375.4	—	69.9
3.8	127.3	118	73.3	233.6	—	10.9
2.4	87.0	45	47.0	188.6	—	21.5
49.9	415.3	136	66.9	472.3	—	16.1
3.9	85.0	66	49.6	141.1	—	42.8
18.4	207.1	125	55.3	293.6	20.63	31.0
137.8	87.1	93.5	23.5	79.8	46.2	81.7
0.87	0.82	0.75	0.45	0.29	0.78	0.78

regional disparities in expansion of fertilizer intensity is less than that in irrigation expansion as shown by lower coefficient of variation of 87 per cent. The expansion in fertilizer intensity explained about 86 per cent of

Table 4. Correlation matrix of the variables under study

Sl. No.	Name of the Variables	Coefficient of Variation	Variable No.										
			2	3	4	5	6	7	8	9	10	11	12
1.	dOPT/NSA	94.7	0.90	0.93	0.82	0.94	0.87	0.82	0.75	0.45	0.29	0.78	0.78
2.	dGIA/NSA	108.2		0.75	0.89	0.95	0.82	0.71	0.73	0.50	0.16	0.64	0.65
3.	dNPK/NSA	87.2			0.70	0.87	0.83	0.88	0.85	0.44	0.56	0.84	0.83
4.	dHYV/NSA	55.3				0.84	0.72	0.58	0.57	0.43	—0.01	0.62	0.80
5.	dTRAC/NSA	146.0					0.92	0.87	0.86	0.59	0.40	0.74	9.74
6.	dCREDN/NSA	137.8						0.94	0.77	0.60	0.43	0.78	0.66
7.	dCREDR/NSA	87.1							0.80	0.64	0.67	0.81	0.61
8.	dPOWR/NSA	93.5								0.59	0.77	0.69	0.59
9.	d%ELECT	23.5									0.35	0.68	0.24
10.	dROD/NSA	79.8										0.42	0.26
11.	d%PUCRD	46.2											0.70
12.	dRGMKT/NSA	81.7											1.00

the output gains (r=0.93). Equal magnitudes of expansion of fertilizer intensity obtained in two states, is not followed by output gains of the comparable magnitude. Such situation can be seen in the case of Haryana, Uttar Pradesh on one hand and Tamil Nadu on the other. Thus the impact of fertilizer on output gains differs across different states.

High Yielding Varieties (HYV)

At all-India level the HYV intensity expanded by about 30 percentage points between 1969-70 and 1983-84, from initial level of about 39.4 per cent. Interestingly, the inter-state disparity in expansion in HYV intensity is less than in the case of any other technological variable as shown by coefficient of variation of only 55 per cent. And the association of the expansion in HYV intensity and the output gains per ha also is less stronger (r=0.83).

Mechanisation

The number of tractors rose from 23 per one lakh ha of net sown area in early sixties to about 304 in early eighties. Against the average expansion in the tractor intensity of about 281, Punjab and Haryana have an expansion of 2050 and 1320 tractors, respectively. The lowest expansion in tractor intensity can be seen in Orissa and West Bengal where there are about 40 tractors. Thus, the interstate variation in expansion of tractor intensity is very high (coefficient of variation is 146 per cent). Similarly, the degree of its association with the output gains also is high (r=0.94).

Technology supporting factors

Credit

Thanks to several institutional innovations in the rural credit sector, farm credit is now more readily available through cooperatives, commercial banks and regional rural banks than ever before. However, the credit supply has been more or less uneven and biased towards developed regions/states (Rao, 1975; Desai, 1988). Between 1962-63 and 1983-84, the availability of short term credit, together from cooperatives and commereial banks increased from Rs. 21 to Rs. 228 per net sown hectare. This enhancement in credit supply of the order of 10 to 11 times comes down to slightly less than two times in real terms. North-Western and Southern regions are in the first two positions recording a step-up in real credit supply of Rs. 55 and Rs. 50 per net sown hectare, respectively. The least increment of Rs. 2.4 took place in Central region. The other two regions, of course, do not show much progress too, the step-up there being a little less than Rs. 4 against the all-India average step-up of

Rs. 18.4 per net sown area. Further in North-Western and Southern States the credit available has met comparatively large proportion of the credit requirements (Desai, 1988). Output gains and increment in short-term credit supply, are positively and strongly (r=0.87) related.

Rural electrification

In the country as a whole, the electrification has progressed well. The proportion of electrified villages in the total (as per 1971 estimates of number of villages) rose from a little less than 5 per cent in 1961 to about 60 per cent in 1984. By 1961, the proportion of electrified villages was the highest in South India (18 per cent) followed by North-Western India (9 per cent). In the remaining regions, the extent was negligible. During the next two decades about two thirds to three-fourths of the villages in Southern, North-Western and Western regions are added to the stock of electrified villages. Notably, Punjab and Haryana of North-Western India and Kerala, Tamil Nadu and Andhra Pradesh of the South, achieved hundred per cent electrification. On the other hand, the electrification is rather slow in Eastern and Central regions. Between early 1960s and 1980s, at all-India level, the power consumption in agriculture rose by about 125 KWH per net sown hectare (Govt. of India, *Indian Agriculture in Brief*, 22nd Edn.). The level and the growth of power consumption for irrigation is concentrated in North-Western and Southern regions. There is fairly strong relationship between output gains and progress in power consumption per hectare (r=0.75).

Rural road network

An effective linking of the rural areas with the urban market centres is *sine qua non* for agricultural (rural) development. Such linkage facilitates greater mobility and hence the availability of farm inputs, when and where needed. The condition as well as extent of road network is extremely poor in Eastern states (especially Orissa) and Madhya Pradesh. About three-forths of the villages in Eastern India have no roads connecting them to the nearest highway. (*Social and Economic Atlas of India*, Oxford and IBH, New Delhi, 1987). No wonder then that development administration, Food Corporation of India and other marketing agencies are unable to reach such villages. Field studies by the Jorhat Agro-Economic Research Centre clearly bring out the impact of roads on agricultural development (quoted in Rath, 1988). In our analysis, proportion of additional villages provided access through pucca roads showed a positive and significant relation with output gains (r=0.78).

Marketing facilities

A good network of efficient markets for farmers' produce is essential. In India, the efforts towards this aim resulted in establishing regulated markets in the country. Between early sixties and eighties, the rise in number of regulated markets was 31 per million ha of net sown area from an initial level of 10. In the wheat belt the expansion took at a faster pace of 70 markets per million ha of net sown area during 23 years. Western India lagged behind in this respect by registering an increase of only 11 markets per million ha net sown area during this period. Interestingly, Eastern India, especially Bihar and West Bengal showed a performance above national average. The association between expansion of regulated markets and output gains is positive, the correlation coefficient being 0.78.

Index of Infrastructural Facilities vs. Output Gains

A composite ranking of the progress in the development of different factors is deduced by ranking the state-wise sums of ranks across different factors. Its association with output gains i.e. rank correlation coefficients is as follows :

Composite Ranking	*Rank Correlation with output Gains in Agriculture*
1. Technological Factors	0.56
2. Technology Supporting Factors	0.68
3. All Factors	0.69

The result shows that the combined influence of the progress in various technology supporting factors on output gains seems to be stronger than that of the technological factors.

Summary and Conclusions

The disparities in development of technological and technology supporting factors reflected ultimately in disparities in output gains from agricultural development. The regions with fast expanding irrigation ratio, short term credit supply, rural electrification, regulated markets, rural roads tend to be those which have shown larger aggregate output gains per net sown hectare. Therefore, sound infrastructural base should be expanded in the states lagging behind, to reduce disparities in output gains. But the disparities are inevitable at least in the short run (Rao, 1975). Because, the natural endowments which are more or less fixed in nature pose certain constraints. For instance, irrigation potential is

largely concentrated in Eastern India. Out of the total irrigation potential yet to be exploited (from all sources) of about 46 m ha about 46 per cent is in this region (Rao *et al.*, 1988). That is, this region has a potential to grow in near future. On the other hand, in the low and medium rainfal areas like Western India, there is less scope of further expansion in irrigated area as the exploitable potential is low. In such areas, deficient in endowments, the strategy as suggested by Dantwala (1977) should (a) help remove the natural constraints, and (b) cause shifts in land use towards silviculture, animal husbandry, etc. Further, the policy shift should be towards development of non-agricultural sector.

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Appendix I. Crop.wise weights in the rice equivalent scale

Crop	Weight	Crop	Weight
Rice	1.00	Cotton	2.00
Wheat	0.80	Groundnut	1.60
Other cereals	0.66	Mustard	1.80
(Jowar, Bajra, Maize		Soyabean	1.25
Ragi Barley)		Potatoes/ onions	0.40
		Chillies	4.00
Gram	1.25	Sugarcane	0.10
Other pulses	1.30	Tobacco	4.00

Source : Table 1 (p. 178) from Dhawan (1989)