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AGRICULTURAL GROWTH, TECHNOLOGY AND EQUITY

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The outstanding contributions of Kendrick (8) and Solow (20) marked the beginning of a series of theoretical and empirical work on the role of technological change in economic development.¹ The results indicated that the "knowledge sector" was perhaps the most dominant contributor to growth. The technology-growth analysis with reference to agriculture has received relatively scant attention in India, particularly at the macro level. Studies by Tara Shukla for the 1921 to 1961 time period (18) and Bhattacharya for 1951 to 1958 (3) revealed practically no contribution of technological change to growth in Indian agriculture. Raj Krishna's analysis for the Punjab upto 1956-57 indicated (10) that during the inter-war period, technical progress did not contribute to output growth but in the post-war period, nearly 60 per cent of the (explained) output growth could be attributed to this factor. Evenson and Jha (6) inferred high rates of returns to investment in agricultural research. Hanumantha Rao (15) has estimated that between the pre- and post-green revolution periods, the contribution of technological change to growth of foodgrains output may be between 27 to 40 per cent or between 5-7 million tonnes.

A large number of micro level studies pertaining to the post-1965 period have highlighted the gains to farmers from new technology.² The positive contribution made by the other components of the knowledge sector, viz., education and extension, have been analysed by Chowdhari (5) and Mohan-Evenson (12).

This paper discusses the pattern and path of agricultural output growth in different States over the period 1953-1971. Some aspects of technological change and factorial distribution of income are analysed in the second section. Implications of these for agricultural research are indicated in the last section.

AGRICULTURAL GROWTH AND ITS PATTERN

Table I gives the growth rates of aggregate agricultural output and residual productivity for different States for three time periods. The table reveals the following trends :

* The paper embodies personal views of the author.

1. For excellent reviews in this area, see Nadiri (14) and Kennedy-Thirlwall (9).

2. See Abel (1) for a review and paper by Sidhu (19) for impact of change in wheat production technology.

TABLE I—ANNUAL LINEAR GROWTH RATES OF AGRICULTURAL OUTPUT AND RESIDUAL PRODUCTIVITY : 1953-54 TO 1970-71

State	1953-56 to 1958-61		1958-61 to 1963-65		1963-65 to 1969-71	
	Output	Residual productivity	Output	Residual productivity	Output	Residual productivity
1. Andhra Pradesh ..	2.42	0.85	2.63	0.11	-0.24	-1.05
2. Assam	1.22	-2.27	1.48	-0.18	5.45	3.98
3. Bihar	3.43	1.40	2.36	0.32	1.57	-0.82
4. Gujarat	3.00	0.74	4.71	2.81	7.13	4.78
5. Haryana	4.73	2.41	1.23	-0.70	20.40	16.10
6. Kerala	3.00	1.97	1.30	-1.25	2.15	-0.67
7. Madhya Pradesh ..	4.45	2.01	0.76	0.05	3.00	-1.52
8. Maharashtra	3.59	2.11	0.85	-0.93	0.08	-2.13
9. Mysore	3.97	1.03	2.96	0.69	1.93	0.27
10. Orissa	0.88	-1.34	4.80	1.93	3.15	1.30
11. Punjab	4.73	2.41	3.60	0.52	19.20	13.40
12. Rajasthan	3.51	0.09	0.06	-0.99	13.60	12.70
13. Tamil Nadu	4.48	1.49	1.77	-1.43	3.08	0.61
14. Uttar Pradesh	1.87	0.43	2.47	0.66	4.87	1.43
15. West Bengal	0.36	-2.12	4.66	2.67	2.18	-0.36

Source : R. E. Evenson and D. Jha, 1973 (6), *op. cit.*

1. During the first period, most of the States performed well in terms of growth and the rates were more or less comparable. The Eastern States of Assam, Orissa and West Bengal did not, however, perform so well and the residual productivity in these States recorded declines; for the others, it was positive and modest.

2. The uniform pattern observed in the first period started breaking up in the second period. The pace of growth in output slowed down and except for Gujarat, West Bengal and Orissa, residual productivity remained small or negative. This indicates that by the end of the second period, the "technological slack" around which the agricultural development strategy was built, almost disappeared.

3. For Andhra, Bihar, Kerala, Madhya Pradesh, Maharashtra, Mysore, Orissa and West Bengal, there was a further deceleration in output growth in the third period and residual productivity declined further. Disparities between these States and others like Assam, Gujarat, Haryana, Punjab,

Rajasthan, Tamil Nadu and Uttar Pradesh tended to increase. The latter group of States also recorded fair to substantial gains in total factor productivity.

The general picture that emerges from the above table confirms the view that inter-State disparities were accentuated during the period analysed. It also demonstrates that the blanket development strategy adopted in the 'fifties resulted in uniform growth patterns in the earlier years, but soon enough the technological slack was exhausted and output growth suffered in the early 'sixties. Then came the "new strategy" which resulted in outstanding gains in some States, mostly wheat producing. Apart from Assam and Tamil Nadu, other rice growing States did not record any gains. The other group of States which have not fared well are predominantly dryland agriculture regions of Maharashtra, Madhya Pradesh, Andhra Pradesh and Mysore.

India is characterized by extreme diversities in resource endowments and relative factor scarcities. As a logical consequence of this, following Hayami and Ruttan (7), the growth pattern obtaining in different parts of the country differs—not only with respect to absolute rates but also with respect to the source of growth. Figures 1 illustrates the changes in output per hectare (O/H) and output per worker (O/W) between 1959-61 and 1969-71 for different States.³ The estimates are tentative because States are fairly heterogeneous with respect to resource endowments and what is relevant is a comparison of different resource endowment regions. Nevertheless, the trend observed here is illustrative.

The figure reveals that there is a category of States—Tamil Nadu, Kerala, Andhra Pradesh, Assam and Bihar, which is characterized by increases in O/H and relative declines in O/W between 1961 and 1971. In more or less the same category are Uttar Pradesh, West Bengal, Mysore and Orissa, which have recorded increases in both O/H and O/W, the former rising relatively more. It follows that output growth in these States has largely followed the land-augmenting, bio-chemical technological path.

In the other category fall the States of Punjab, Haryana, Rajasthan and Gujarat, where O/W has increased more as compared to O/H. This implies that these States have been following a mixed strategy—the labour-saving dimension being the more dominant. Finally, there is the case of Maharashtra and Madhya Pradesh. Both these States have recorded absolute declines in O/H as well as O/W. Maharashtra is already in the news, Madhya Pradesh will, in all probabilities, make news shortly.

3. These are not based on the data reported in Table I, hence some differences are apparent. Aggregate agricultural output has been evaluated at constant (1969-71) prices. The 1971 Census proportion of agricultural workers to rural population has been imposed on the 1961 Census to arrive at the number of workers in each State in 1961.

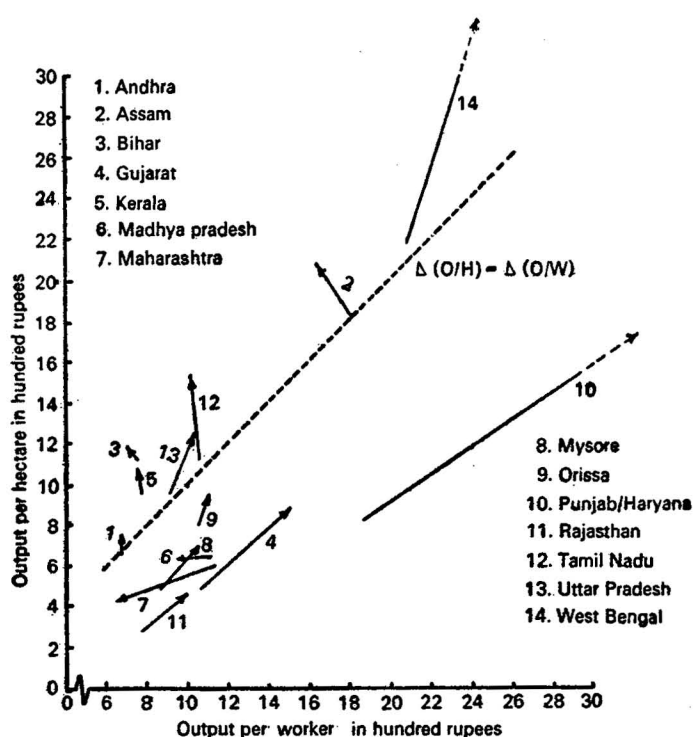


Figure-1. Changes in Output/Worker and Output/Hectare 1961-1971

A look at the land-worker ratios for different States (data not presented here) reveals that those States which have recorded high growth of O/W, are also blessed with a relatively favourable land-man ratio. The most important exceptions being Madhya Pradesh and Maharashtra. Mysore is another State which is favourably placed in this respect and it seems to be very close to the 45° line. States which have low land-worker ratios have followed the other path.

TECHNOLOGICAL CHANGE AND INCOME DISTRIBUTION

The decade of 'sixties has two important lessons to offer in this regard. The first is that gains from technology have been maximum in the north-western States of Punjab, Haryana, Gujarat, Rajasthan and perhaps western Uttar Pradesh. The gains have been more or less confined to wheat crop. Isolated rice areas have done well but areas dominated by other cereals, have not made much headway. It follows, as argued above, that inter-regional disparities have increased.

Coming next to factorial distribution of income, an attempt has been made to examine the changes in shares of land and labour—the two most important inputs, between 1961 and 1971. Table II presents estimates of

factor shares at these two points of time for different States, as well as the index of real wages.

TABLE II—ESTIMATED FACTOR SHARES : 1960-61 AND 1970-71 AND INDEX OF REAL WAGES: STATEWISE

State	Land*		Labour		Index of real wage in 1969-70 (1961-62 = 100)
	1960-61	1970-71	1960-61	1970-71	
1. Andhra Pradesh	0.397	0.465	0.451	0.407	86 (F)
2. Assam	0.185	0.316	0.683	0.570	85 (F)
3. Bihar	0.266	0.361	0.569	0.510	104 (P)
4. Gujarat	0.330	0.381	0.574	0.539	77 (F)
5. Haryana	0.339	0.395	0.516	0.530	..
6. Kerala	0.306	0.438	0.595	0.478	114 (F)
7. Madhya Pradesh	0.366	0.438	0.457	0.425	82 (P)
8. Maharashtra	0.387	0.425	0.441	0.453	98 (F)
9. Mysore	0.387	0.432	0.501	0.390	74 (F)
10. Orissa	0.539	0.641	0.319	0.197	87 (F)@
11. Punjab	0.380	0.384	0.430	0.489	115 (P)
12. Rajasthan	0.468	0.578	0.430	0.342	..
13. Tamil Nadu	0.331	0.396	0.497	0.443	95 (P)
14. Uttar Pradesh	0.309	0.388	0.479	0.404	102 (P)
15. West Bengal	0.255	0.348	0.589	0.525	88 (F) @

* Includes irrigation which is in fact land-augmenting.

@ Wage figures for Orissa and West Bengal relate to 1968-69 and 1967-68 respectively.

Source : (1) R. E. Evenson and D. Jha, 1973(6) for factor shares data. Details on calculations are mentioned in the Appendix to the paper.

(2) Absolute wage rates data were taken from C. H. Hanumantha Rao, 1974 (15). These have been deflated by index of all agricultural commodity prices index.

P and F refer to the ploughman and field labourer categories respectively.

The figures presented suggest that in all States the share of land has gone up, implying relatively larger gains for landowners. The share of labour has gone down in all States except Haryana, Maharashtra and Punjab; the increase being modest in Haryana and Maharashtra, but sizable in Punjab. Rao's analysis (15) reveals a decline in the share of both land and labour in the post-green revolution period accompanied by a sizable increase in the share of entrepreneurial factors. The conclusions are not substantially different, however. The land owning large cultivators have gained and the agricultural labourers have lost their relative share. The data on real wages also reveal this tendency—all States except Punjab and Kerala have recorded

either a decline in real wages or at best, stagnation. This does not mean that no additional employment has been created. It simply implies that this additional demand has not found its expression in terms of an increase in real wages.

It is important to mention that it would be improper to infer that this increase in disparities is a consequence of some inherent characteristic of the kind of technological change the decade of 'sixties has witnessed. It has been demonstrated that the biological-chemical technological change, in a pure sense, biases (in a Hicksian sense) the functional distribution of income in favour of labour, even in the 'surplus' labour case. Since it is truly land-augmenting the share of land should also fall. In reality, because of imperfections in factor markets and the advantageous position of large landowners in terms of access to the critical inputs of credit, information and education, this does not come about, as has been shown by the above data.

The case of mechanical innovations is relatively simple. Their prime role is labour-saving and cost-reducing. These, therefore, invariably lead to reduction in labour share. It may be argued that for those mechanical innovations which are primarily land-augmenting, *viz.*, irrigation pumps, this does not apply and these, in fact, lead to increased labour use. This again fails in reality. Because of the high investment and indivisibility implicit in such innovation, only affluent farmers can afford to take advantage—the same conclusion is reached and labour loses. Therefore, private investments in mechanical inputs always favour the large landowners. Public investments on such inputs could, however, be free of such bias.

The essence of the argument is that given the type of agrarian structure that we have, large landowners will grab most of the gains from technological advance—biological or mechanical.⁴ In this context Bieri, *et. al.* observe :

“... the relatively easy generation of technological advances has all too often been performed at the neglect of the arduous task of managing structural changes. Unless this is done, the small farmers and farm workers tend to be the prime losers in the structural readjustments of agriculture that follows the spread of technological advance.” (4, p. 807.)⁵

Ladejinsky (11) has very aptly remarked :

“It is not... the new technology which is the primary cause of the accentuated imbalances in the countryside. It is not the fault of the new technology that the credit service does not serve those for whom it was originally intended; that the extension services are not living up

4. For significantly differing empirical results, see Satyanarayana (16).

5. See also Schmitz and Seckler (17), Ayer and Schuh (2).

to expectations; that the panchayats are political rather than development bodies; that security of tenure is a luxury of the few; that rents are exorbitant; that ceilings on agricultural land are notional; that for the greater part tenurial legislation is deliberately miscarried; or that wage scales are hardly sufficient to keep soul and body together."

IMPLICATIONS FOR AGRICULTURAL RESEARCH

With reference to the technological basis of agricultural growth, the Indian experience provides some valuable lessons. The first is that it is dangerous to presume that at any point of time, the stock of available know-how is adequate. The second is the extremely limited scope of importing "blue prints" from other, particularly developed countries.

These are the lessons of the 'fifties. The third lesson is that substantial decentralisation of agricultural research will have to take place. The talk about 'location-specificity' of research will have to be translated to reality. Fourth, we have now come to recognize that technology transfer in agriculture is an extremely complicated process. Finally, it is now realised that technology interacts with economic and social parameters and that this interaction could be quite upsetting.

1. The analysis of inter-State growth patterns demonstrated that the non-wheat producing States are now falling behind. The Indian agricultural research system has responded by strengthening the research programme for rice, millets, pulses, dryland agriculture and other such areas.

2. The fact that different States have followed at least two distinct paths of growth—one through increases in output per hectare and the other through gains in labour productivity, indicates that relative resource endowments are crucial. Maximum advantage of technological change can be taken only when the technological packages for each region are specifically designed to maximize returns to the relatively scarce resources. This can be achieved only through reorganization of research programmes on the basis of natural resource regions.

3. It has been demonstrated that growth in residual factor productivity and investment in agricultural research are highly correlated (6). Table III presents estimates of agricultural research expenditures for different States over the quinquennium ending 1965, and the changes in proportion of State agricultural output to the total production in the country.

The pervasive nature of agricultural research limits the validity of State-wise comparisons. Nevertheless, the table reveals some interesting trends. First of all, research investment during this period did not bear any relationship with either the area of the State or its contribution to aggregate national

TABLE III—AGRICULTURAL RESEARCH INVESTMENTS (1961-65) AND RELATIVE SHARE OF DIFFERENT STATES IN GROSS AGRICULTURAL OUTPUT

State	Research expenditure as per cent of total	Research expenditure per hectare of sown area (Rs.)	Per cent of gross value of agricultural output in	
			1959-61	1969-71
1. Maharashtra	6.24	1.65	10.32	5.67
2. Madhya Pradesh	4.92	1.43	9.95	8.42
3. Andhra Pradesh	6.58	2.87	6.92	6.30
4. Bihar	5.81	3.41	8.83	7.31
5. Kerala	1.16	2.85	1.80	1.69
6. West Bengal	3.72	3.23	11.43	12.87
7. Mysore	5.33	2.45	4.73	5.26
8. Tamil Nadu	9.59	7.55	7.75	6.82
9. Orissa	5.56	4.68	4.39	4.29
10. Uttar Pradesh	19.32	5.30	16.00	16.15
11. Assam	1.29	2.74	3.94	3.37
12. Gujarat	7.72	3.89	4.43	6.12
13. Rajasthan	10.92	3.92	3.56	4.38
14. Punjab/Haryana	11.79	7.49	5.90	11.35

* Source : R. Mohan, D. Jha and R. E. Evenson (13). Research expenditures on special crops like plantation, etc., are excluded. Research expenditures for Delhi has been allocated to the States of Punjab, Haryana, Rajasthan, Gujarat and Uttar Pradesh on the basis of sown area. The States have been arranged in ascending order of productivity.

output, the exception being Uttar Pradesh. The other large States (in terms of output) of West Bengal, Maharashtra, Madhya Pradesh, Bihar and Andhra Pradesh contributed nearly 50 per cent of the aggregate output in 1959-61; only about 26 per cent of the national investment in research from 1961 to 1965 went to these States. These, along with Kerala, make the six States which recorded negative total factor productivity growth in the 1965-71 period and all of them, except West Bengal, registered declines in their respective contributions to total output in 1969-71.

The other four States which recorded moderate productivity gains, namely, Mysore, Tamil Nadu, Orissa and Uttar Pradesh, got nearly 40 per cent of research investments. The last group of Rajasthan, Assam, Gujarat and Punjab/Haryana, registered high to very high productivity gains; they accounted for about 32 per cent of research investment. Excluding Assam, the other three got more than 30 per cent while their contribution to gross output in 1959-61 was a bare 14 per cent. This rose to nearly 22 per cent in 1969-71.

4. The per hectare research investment gives a rough idea of research effort vis-a-vis research needs. In the first group of five States mentioned above, Maharashtra, Madhya Pradesh and perhaps Kerala and Andhra are not spending enough on research. West Bengal and Bihar seem to be spending a fair amount but without commensurate results—in the form of productivity gains. The research programmes for these States need looking into in terms of relevance and appropriateness. In the second group (moderate productivity States), Mysore spends the least on research and Tamil Nadu the maximum, the latter perhaps again calls for some scrutiny. In the third group of high productivity States, Assam's performance is difficult to explain.

The above analysis highlights the disparities that exist in the research efforts of different States. It also reveals under-investment in the first group of States.

5. The implications for agricultural research of the equity problem is not easy to assess. It has been argued above that the existing bias in our social and economic institutions will inevitably lead to unfavourable impact on the poor. This calls for remedial action on political-administrative front. Theoretically speaking, the main emphasis in agricultural research should be on generating biological-chemical technology. Research on mechanical innovations needs careful handling. By promoting research on labour-saving mechanization, we only serve the prosperous farmers at the cost of the poor. It is particularly important to guard against this danger today because the short-term profits from agro-biological technological change has practically disappeared now, particularly in the progressive areas. The large farmers in these areas know that further cost reductions can only come from labour-displacing machines. Hence the pressure. A public supported research system, however, cannot afford to succumb to this pressure.

This does not, however, mean that all research on mechanical innovations should cease. On the contrary, in some areas it affords real promise through its land-augmenting dimension, *viz.*, irrigation, land reclamation, etc. Even in these instances, it is important to see that gains are not monopolised by the prosperous farmers, as has been the case so far. Perhaps what is needed is a set of deliberate public policy measures which make private investment in such innovations exorbitantly expensive. The public sector could, on the other hand, make use of these and ensure that the benefits are evenly shared.

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AN OPERATIONAL APPROACH TO AGRICULTURAL GROWTH AND EQUITY

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Growth and development are often used synonymously in economic discussions and this usage is entirely acceptable. But where both the words exist, there is point in drawing a distinction between them. Implicit in usage, and explicit in what follows, economic growth means more output, and economic development implies both more output and changes in the technical and institutional arrangements by which it is produced (17).* The process

* Numbers in brackets refer to the list of references at the end of this article.