GROWTH OF CROP OUTPUT IN INDIA 1951–54 TO 1958–61

An Analysis by Component Elements

BY B. S. MINHAS* AND A. VAIDYANATHAN**

INTRODUCTION

FOR most practical purposes our knowledge in regard to consumption of and demand for agricultural products is fairly adequate. We have reasonably good estimates, for example, of expenditure elasticities and rough guesses about price elasticities. These elasticities together with the relevant information regarding the growth of population and incomes give us quite a good basis for projections of future demand for farm products; and they have, in fact, been extensively used for estimating the growth of demand for agricultural commodities.[1] It is these kinds of projections which heighten our awareness of the fact that the improvement in mass consumption standards in India depends almost entirely on the growth of agricultural output.

In comparison to our knowledge of demand we know far too little about the supply possibilities of agricultural output. Inadequate knowledge in regard to supply phenomena notwithstanding, in view of the overwhelming importance of agriculture in the Indian economy the need for scientific projections of agricultural output, in the context of planning, is fairly obvious. Effort in this direction, fortunately, has not entirely been lacking. The few projections that have so far been published, however, are either too aggregative and/or leave much to be desired in their methodological bases.[2] For the most part they

* Indian Statistical Institute, New Delhi. ** Planning Commission, New Delhi.

[1] There is an extensive literature, published and mimeographed, on demand projections. *See* in particular, *Studies in Consumer Behaviour*, Indian Statistical Institute Series 6 (Asia Publishing House, Bombay, 1960); National Council of Applied Economic Research, *Long-term Projection of Demand for and Supply of Selected Agricultural Commodities*, 1960–61 to 1975–76; and Ministry of Food and Agriculture, Directorate of Economics and Statistics, *Supply and Demand Projections*, papers presented at the meeting of experts on Agricultural Projections in Asia and the Far East, 1963 (Mimeo).

[2] *See*, for example, National Council of Applied Economic Research, *Long-term Projections of Demand and Supply...., op. cit.*; Perspective Planning Division, *Development of Agriculture, India*, 1960–61 *to* 1975–76, (Mimeo, 1964). There are also some studies (*e.g.*, Sukhatme, P. V., *Feeding India's Millions*) which attempt a general assessment of technical possibilities without going into detailed cropwise projection of area, output and input requirements.

reflect a measure of what is desirable and are not supported by a satisfactory assessment of possibilities or of concrete programmes and policies required to realise them. Moreover in a country marked by vast variations in climatic and soil conditions, projections of long-term production possibilities at the national level are of little value as a guide for detailed planning.

The assessment of production possibilities is not an easy matter: it raises a number of difficult problems both of methodology and of numerical estimation. Nevertheless, in principle, given the knowledge of production functions, firm forecasts of weather, and true prediction of the prices of different agricultural inputs and outputs, one can, under certain behaviouristic assumptions, completely specify production possibilities over time. But like all bills of requirements for ideal solutions, this one is almost impossible to fill.

One of the major difficulties is the lack of detailed and systematic knowledge of input-output relations in Indian agriculture. Until recently meaningful analysis was rendered difficult by the paucity of relevant information. Thanks to the work of Indian Council of Agricultural Research and, in particular, the Institute of Agricultural Research Statistics,[3] we are beginning to have data on crop responses to different inputs, individually and in combination, obtained from scientifically conducted experiments under actual field conditions in various parts of the country. The lack of statistical information will in course of time cease to be a major limitation on efforts at analysing input-output relations in agriculture.

A more serious problem, and one which has not received the attention it deserves, arises from the complex nature of input-output relations in agriculture: complementarity among inputs is just about as pervasive as the phenomenon of substitution. Extension of irrigation and fertilizer use, for instance, go together whereas human

[3] The Institute has undertaken a systematic compilation of the results of field experiments carried out in different parts of the country. The experiments which are being collated into a *National Index of Field Experiments*, provide valuable information on the response of crop yield to different inputs and combinations of them under varying soil and climatic conditions. Many of these volumes have already been published.

The Institute has also done pioneering work in analysing the data to evolve response functions. Some results of these studies are published. *See*, for example, Panse, V. G., Abraham, T. P., and Leelavathi, C. R., *Yardsticks of Additional Production of Certain Foodgrains, Commercial and Oilseed Crops*, I.A.R.S., I.C.A.R. (New Delhi, 1964).

labour and animal draft power can substitute for machinery. It is for this reason that indiscriminate fitting of the usual kind of production functions to agricultural data which one so often reads about (and gets bored with) in econometric literature, is not a very fruitful activity.

Faced with the deficiencies of basic data and the lack of knowledge regarding the nature and form of input-output relations in agriculture, not to speak of the difficulties of predicting future prices and farmers' response to them, how could one make meaningful judgements about future agricultural production? A purist most certainly will give counsel of despair; and the man of affairs will hardly have patience to listen to, what he may call, such academic excuses. Class loyalties aside, a practical approach to the problem of assessing future production potential might lie in two somewhat different but not mutually exclusive directions.

Starting with the present situation we might attempt to estimate the possibilities of increasing crop area through reclamation of new lands and extension of multiple cropping. The extent to which per acre yields of different crops could be increased by application of known and tested techniques can be assessed. One can throw in the possible and/or desirable changes in crop patterns and, in the end, arrive at an idea of the production potential of each crop and area for a weatherwise 'normal' year. The specification of this latter kind of 'normal' year may be difficult but it is not impossible.

An alternative basis for future projections would reside in an analysis of the behaviour of agricultural production in the past and the factors responsible for the observed growth of output in different regions. Such analyses of past experience, and comparative studies of regions with different rates of growth in particular, could provide valuable insights into factors, other than purely technological desiderata, which help or impede the exploitation of known possibilities. These insights, in turn, might indicate changes in programmes and policies which could make agricultural planning more effective than it is at present.

In this paper we are *not* concerned with the question of agricultural supply projections *per se:* our aim is a more limited one. In the spirit of the latter of the two approaches mentioned above, we set out a framework of computations for assessing the contribution of different component elements to the growth of crop output in India for the period 1951–54 to 1958–61. Indices of aggregate output of 28 major

crops have been computed for all the 14 States and also for 268 districts belonging to 13 States. In each case, the observed increase in aggregate output has been decomposed into four component elements, *i.e.*, the contribution of (*a*) changes in area, (*b*) changes in per acre yields, (*c*) changes in cropping pattern, and (*d*) the interaction between the latter two elements. The methodological framework of this decomposition scheme and its relevance to supply projections, comprise Section I of this paper. In Section II, we discuss the sources and limitations of data used by us. Section III presents the numerical results of our computations and, finally, in Section IV we give resume of our findings and some suggestions for further research.

I. METHODOLOGY

A convenient notational representation of the data used in this study may be as follows:

Crop	Weight	Proportion of area in year		Yield in year	
		0	t	0	t
C_1	W_1	C_{10}	C_{1t}	Y_{10}	Y_{1t}
C_2	W_2	C_{20}	C_{2t}	Y_{20}	Y_{2t}
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
C_n	W_n	C_{n0}	C_{nt}	Y_{n0}	Y_{nt}

We confine our analysis to 28 crops, the C_i's; W_i's are constant price weights assigned to different crops and consists of three-year average all-India wholesale prices. C_{i0}'s and C_{it}'s are proportions of area occupied by different crops in years 0 and t, the representation of crop pattern which is a three-year average on either end. Y_{i0}'s and Y_{it}'s are base and final year yields—again these are three-year averages on each end.

We use the following symbols for ouput and area:

P_0 = Crop output in year 0.

P_t = Crop output in year t.

A_0 = Gross crop area in year 0.

A_t = Gross crop area in year t.

Definitions:

$$P_0 \equiv A_0 \sum_i W_i C_{i0} Y_{i0}$$

$$P_t \equiv A_t \sum_i W_i C_{it} Y_{it}$$

Assuming that every new gross crop acre is as good as an average acre already under cultivation,[4] we can split up the increases in crop production over the time period of our study into their component elements in the following manner:

$$\begin{aligned} P_t - P_0 = {} & (A_t - A_0) \sum_i W_i C_{i0} Y_{i0} \\ & + A_t \sum_i W_i C_{i0} (Y_{it} - Y_{i0}) \\ & + A_t \sum_i W_i Y_{i0} (C_{it} - C_{i0}) \\ & + A_t \sum_i W_i (Y_{it} - Y_{i0})(C_{it} - C_{i0}) \end{aligned}$$

In this additive scheme of decomposition,[5] the first element on right-hand side of the equation is the area effect. That is, an increase in

[4] During the period covered by our study, the gross irrigated and unirrigated acreage under 28 crops increased by 10 and 26 million acres respectively. The differential between irrigated and unirrigated yield varies a great deal from area to area. To assert that irrigated and unirrigated yields differ by a factor of about 2, on an average, might not be too far from truth; and this observation taken together with the respective increases in irrigated and unirrigated area should not do much violence to our assumption of every new gross crop acre being as good as one already under cultivation. However, if we had the necessary information, we can make our calculation just about the productivity of new acres. We have also assumed the absence of interaction between area and crop pattern.

[5] It is worth remarking that this is just one additive scheme of decomposition. Besides other additive schemes, one can decompose output into different component elements in a multiplicative fashion. In fact we have already experimented with one multiplicative scheme. The numerical results obtained from the multiplicative decomposition scheme, however, are not easy to interpret in a straightforward manner: we shall return to them at some subsequent occasion.

output of this magnitude could have taken place in the absence of any changes in per acre yields and the crop pattern. The second term in the equation is the effect of yield changes for a constant crop pattern. The third element portrays the effect of changes in crop patterns in the absence of any changes in per acre yields. The last element measures the effect on output which could be attributed to interaction between per acre yield changes and the changes in crop patterns.

At the back of this arbitrary scheme of decomposition, there is an analytical design: component elements are so chosen that their contributions to output growth are determined by more or less independent sets of factors. Each of these sets of factors can be separately analysed and these analyses should provide the building blocks for constructing output projections. Increases in gross sown area, for instance, are derived partly from extension of cultivation to new areas through reclamation of virgin lands or reduction of fallows and partly from increases in double cropped area made possible by the spread of irrigation, adoption of better crop rotations and moisture conservation practices. The extent of future accretions to gross crop acreages from the major sources can be exogenously estimated and this should serve our purpose for calculating the area effects as envisaged in our scheme. What happens to yields on the other hand depends entirely on the technological relations between inputs and outputs and the quantum of various inputs (including fertilizer, water, seeds and labour) used. We have not tried to estimate these technical production relations: analysis of factors responsible for past yield changes and assessment of technological possibilities of different areas will form a separate study. Here we have simply tried to measure the contribution of observed yield changes to the growth of agricultural output during 1951–54 to 1958–61. Aside from the availability of irrigation, shifts in crop patterns are a function of relative prices (profitability) of crops—a variable which traditionally has been the focal point of manipulation by government policy. We have provided a quantitative magnitude for this element's contribution to growth.

It must be noted that the one factor whose effects span all the component elements of output growth is irrigation. Availability of water can open up virgin lands as well as extend gross crop area by making more extensive multiple cropping possible. Yields on irrigated lands will certainly be higher than the yields obtained under rainfed conditions. Varied and more remunerative crop patterns are a distinct

consequence of the availability of irrigation. The precise effects of irrigation on yields and cropping patterns are very important to know but, quantitatively speaking, they are a bit of a mystery at present. Nonetheless, the essential complementarity between the use of water and other inputs and the relationship between irrigation availability and cropping patterns should be firmly kept in view while the yield and crop pattern effects are assessed for their operational significance.

The interaction term in our scheme is essentially in the nature of a balancing entry. However, it is not altogether barren of interpretative significance. Though yields of certain crops in a region may go down, at given constant relative prices, farmers may leave the acreage allocations to different crops as they were—a distinct possibility in a region where an overall deterioration of soil fertility takes place—or they may switch acreages to crops whose yields have increased. This latter kind of response would be a rational one. We may, of course, get a perverse kind of crop pattern change. One can list all the different possible combinations of positive and negative yield changes and the crop pattern shifts. However, this is better left as an exercise for the interested reader. We have estimated the net effect of these interactions as one of the component elements of output growth.

II. Sources and Limitations of Data

This section provides a brief description of the sources and limitations of data relating to area, production and prices which form the basis for the estimates presented in Section III.

Area and production.—It is common knowledge that the absolute yearly figures of crop area and production suffer from a serious lack of intertemporal comparability. But, because of the progressive substitution of the traditional (subjective) method of estimation by the scientific crop-cutting method and the extension of reporting area, the quality of these statistics has improved from year to year. A natural consequence of this improvement process is that the absolute figures of area and production (both at the state and all-India level) for recent years are quite reliable. For the purpose of our study, however, we needed the absolute figures for earlier years which should be comparable (and as reliable) with the recent ones.

Assuming that the area and production statistics for the year 1960–61[6]—the ony absolute figures used in this study—are reasonably

[6] All figures of area and production for the year 1960–61 are taken from various publications of the Ministry of Food and Agriculture, Directorate of Economics and Statistics.

accurate, we have generated absolute figures for earlier years (going back to 1951–52) which, we believe, are more or less comparable over time. This task was facilitated by the appearance of the revised all-India and State-wise indices of area and production of different crops[7] which have been adjusted for changes in coverage and methods of estimation. These revised indices of area, however, go back to the year 1952–53 only. For some States, where revised production series are available, we have adjusted the absolute area figures of 1951–52 by using adjustment factors based on the comparable information for the years 1952–53 and 1953–54. For Mysore, Kerala and Rajasthan, the crop production indices go back only to 1952–53 and, consequently, our base estimates for these States are two-year (1952–53 and 1953–54) averages instead of the usual three-year averages for other States.

It is to be noted that at the State-level estimates of area (production) of some crops (mostly minor crops) were not available either for the base or the final year. We had to omit such crops from our State-wise computations. This is one of the reasons for the apparent differences between total area (production) under individual crops as reported for the country as a whole as against the respective aggregates obtained by summing up the State figures. For some minor crops the adjusted index numbers of area (production), at the State level, are not separately available: we have made use of the appropriate group indices in such cases.

The deficiencies of information at the district level[8] are even greater than at the State level. No adjusted data, either for production or area, are available. The problem of working out comparable series is difficult not only because of changes in coverage and estimation methods (which simply cannot be adjusted for at present), but also due to changes in district boundaries consequent upon reorganization of

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[7] These indices, among other places, are available in the statistical appendices of a study, *Growth Rates in Agriculture* (mimeographed Dec. 1964), by the Economic and Statistical Adviser, Ministry of Food and Agriculture.

[8] Except for Tea, Coffee and Rubber, which are covered in separate publications of the Directorate of Economics & Statistics, Ministry of Food and Agriculture (or the respective commodity boards), our source of district data for all crops for the years 1951–54 is the *Estimates of Area and Production of Principal Crops in India*, Vol. II (Detailed Tables), published by the Directorate of Economics and Statistics of the Ministry of Food and Agriculture. For data pertaining to the years 1958–61, we have made use of the various issues of *Agricultural Situation in India*.

States. We have, however, tried to adjust the total crop area estimates of districts affected by this latter change. This was done by increasing or decreasing the reported gross cropped area in the base year in proportion to changes in geographical area brought about by reorganization. As mentioned earlier, per acre yield figures are based on unadjusted data.

Apart from inter-temporal incomparability, the gaps in information regarding particular crops present a more serious difficulty at the district level. For instance, in the absence of data regarding the area under "all pulses", it was not possible to work out the area under "other pulses". District-wise estimates of area under some crops for some years were simply not available. The number of minor crops, with acreages which are small enough to be ignored, is naturally much larger at the level of individual districts than at the State or national levels. Quite apart from the incomparability of the State and district data, the larger number of data omissions at the district level warrant a great deal of caution in interpreting our district-wise results.

Prices.—Prices which have been used as the weights in computing indices of output are weighted all-India averages for the years 1956–57, 1957–58 and 1958–59. Prices for all crops (except small millets, castor seed, rubber, dry ginger and mesta) have been derived from the estimates of physical output of these crops and their respective values given by the Central Statistical Organisation.[9]

Prices of small millets have been assumed to be 90% of that of ragi as suggested in the Final Report of National Income Committee.[10]

The price of castor seed has been estimated by taking a weighted average of wholesale price of castor years as reported in *Agricultural Prices in India*.[11] The prices of each year and State have been weighted by the production of castor seed in the state and the year as given in the *Estimates of Area and Production of Principal Crops in India*.[12]

[9] Government of India, Central Statistical Organisation, Department of Statistics, *National Income Statistics: Proposal for a Revised Series of National Income Estimates for* 1955–56 *to* 1959–60 (1961).

[10] Government of India, Ministry of Finance, *National Income Committee, Final Report*, 1954, p. 34.

[11] Government of India, Ministry of Food and Agriculture, Directorate of Economics and Statistics, *Agricultural Prices in India*, 1960.

[12] Government of India, Ministry of Food and Agriculture, Directorate of Economics and Statistics, *Estimates of Area and Production of Principal Crops in India*, Vol. I (1960).

Price of rubber has been assumed to be the same as that at Kottayam (Kerala) and relates to calendar years.

Price of dry ginger has been taken from the statistical bulletins of different states. Average price of mesta in 1956–59 has been estimated by applying the ratio of the prices of mesta to that of jute as obtained in 1949. Average unit prices of different crops for the year 1956–59 are given in Appendix I.

III. Results

Rates of growth.—A striking feature of agricultural development in recent years is the wide variation in the rate of growth of output in different regions. During the period 1951–54 to 1958–61, total crop output in India is estimated to have increased by 27·8%, that is, a compound annual rate of 3·57%. In seven out of the fourteen States for which indices were calculated, the rate of growth was higher than the national average (*vide* Table I).

The Punjab (5·14%) and Madras (5·12%) achieved high rates of growth. If we are to stick to the three-year-average rule for the base (which is a good device for ironing out yearly abnormalities in production), the growth rate for Gujarat works out to be the highest (6·50%) in India (*See* † in Table I).[13] From among the remaining seven States, which were below the national average, three did very poorly. West Bengal (0·21 %) recorded the lowest rate of increase in crop output, followed by Orissa (1·05%) and Assam (1·24 %).

The variations in growth experience at the district level are even more marked. Of the 268 districts (belonging to 13 States) for which estimates have so far been made, 67 seem to have achieved an average annual increase of 7·5% or more. In 114 districts, covering an area of 122 million acres, crop output has grown at better than 5% per year. Another 59 districts have grown at rates between 2·5 and 5% per a year. In all, therefore, about 65% of the

[13] It has been pointed out that Gujarat had poor crops both in 1951–52 and 1952–53 particularly in the earlier year. By dropping 1951–52 from the base, the average growth rate between 1952–54 and 1958–61 work out to only 4·53%. This arbitrary manner of dropping years for some States is objectionable on methodological grounds. If a three-year average is not sufficient to iron out annual fluctuations, the proper course would be to take a four or five-year average. But whatever time period is chosen, it should be adopted uniformly for all States.

TABLE I

Growth of crop output in different States, 1951–54 to 1958–61

Sl. No.	State	Index of total output 1958–61 (1951–54 = 100)	Annual rate of increase
	1	2	3
1	Punjab ..	142·0	5·14
2	Madras ..	141·9	5·12
3	Gujarat* ..	133·1	4·53
	,, ..	(155·4)	(6·50)
4	Mysore* ..	131·7	4·36
5	Rajasthan* ..	130·4	4·20
6	Kerala* ..	129·5	4·08
7	Madhya Pradesh	132·1	4·07
8	Maharashtra ..	123·6	3·07
9	Andhra Pradesh	123·4	3·05
10	Bihar ..	118·2	2·42
11	Uttar Pradesh ..	116·4	2·20
12	Assam ..	109·0	1·24
13	Orissa ..	107·6	1·05
14	West Bengal ..	101·5	0·21
	All India ..	127·8	3·57

* Base year: 1952–54.

districts studied by us (and covering an area of 186 million acres) have achieved rates of growth of crop production significantly higher than the average rate of growth of population in the country. However the annual increase in output was less than 2·5% in 95 districts

and in 24 of these, crop production, in fact, fell during this period. A frequency distribution of districts by growth rates is given in Appendix II.

Although defects in basic data at the district level warrant caution, it is nonetheless heartening knowledge that over as large an area as 122 million acres, out of a total of 285 million acres analysed in this study, crop output has been rising at better than 5% a year. Intensive search for factors which made such high rates of growth possible in these areas, should help us a great deal in understanding the puzzle of agricultural growth.

Components of increase in output.—Using our additive decomposition scheme, we find that of the 3·57% compound rate of growth of aggregate crop output in India during 1951–54 to 1958–61, approximately 45% (or 1·62 percentage points) could be attributed to area growth, 46% (or 1·64 percentage points) to yield increases, a little over 8% (or 0·29 percentage points) to crop pattern changes, and less than 1% to interaction between yield and crop pattern changes. In other words for the country as a whole about nine-tenths of additions to output were obtained through extension of crop area and increases in per acre yields.

The relative contributions of component elements to the growth of crop output in different States are presented in Table II. The numbers in top line against each State stand for the proportion of additional output that can be attributed to changes in area, yields, crop pattern and the interaction between the latter two elements; whereas the corresponding numbers in brackets express the respective contributions of each of these elements in terms of percentage points in the overall growth rate.

It is quite clear that the relative contributions of component elements vary a great deal from region to region.

A major part of output increases in some rapidly growing States is attributable to growth of gross crop area alone. In the Punjab, for instance, 3·59 percentage points out of a total growth rate of 5·14% can be attributed to this factor. Rajasthan's growth rate of 4·20% is not even commensurate with the (4·28 percentage points) increase in area. Growth of crop output in Assam (1·24%) and West Bengal (0·21%) has hardly kept up with gross crop acreage expansion. In Mysore and Madhya Pradesh, with growth rates of 4·36% and

TABLE II

Relative contributions of different elements to the growth of crop otuput—all-India and States 1951–54 *to* 1958–61

	Per cent. increase attributed to					Overall rate of growth
	Area	Yield	Crop pattern	Inter-action	Total	
1	2	3	4	5	6	7
1. Punjab ..	69·93 (3·59)	7·98 (0·41)	22·38 (1·15)	−0·29 (−0·01)	100·00	5·14
2. Madras ..	19·70 (1·01)	52·70 (2·70)	25·00 (1·28)	2·60 (0·13)	100·00	5·12
3. Gujarat*	22·16 (1·00)	21·29 (0·97)	68·21 (3·09)	−11·66 −(0·53)	100·00	4·53
4. Mysore*	37·29 (1·63)	48·71 (2·12)	11·32 (0·49)	2·68 (0·12)	100·00	4·36
5. Rajasthan*	102·00 (4·28)	−18·37 (−0·77)	6·90 (0·29)	9·47 (0·40)	100·00	4·20
6. Kerala* ..	21·42 (0·87)	74·57 (3·04)	6·41 (0·27)	−2·40 (−0·10)	100·00	4·08
7. Madhya Pradesh	40·44 (1·65)	53·32 (2·17)	6·45 (0·26)	−0·21 (−0·01)	100·00	4·07
8. Maha-rashtra	31·92 (0·98)	42·60 (1·31)	46·43 (0·81)	−0·95 (−0·03)	100·00	3·07
9. Andhra Pradesh	9·74 (0·30)	48·75 (1·48)	36·61 (1·12)	4·90 (0·15)	100·00	3·05
10. Bihar ..	17·73 (0·43)	76·51 (1·85)	16·72 (0·40)	−10·96 (−0·26)	100·00	2·42
11. Uttar Pradesh	45·98 (1·01)	34·12 (0·75)	19·39 (0·43)	0·51 (0·01)	100·00	2·20
12. Assam ..	99·27 (1·23)	15·89 (0·20)	−14·23 (−0·18)	−0·93 (−0·01)	100·00	1·24
13. Orissa ..	32·34 (0·34)	61·87 (0·65)	7·33 (0·08)	−1·54 (−0·02)	100·00	1·05
14. West Bengal	83·96 (0·18)	−54·02 (−0·11)	74·92 (0·15)	−4·86 (−0·01)	100·00	0·21
All-India ..	45·38 (1·62)	45·83 (1·64)	8·16 (0·29)	0·63 (0·02)	100·00	3·57

* Base is two-year (1952–54) average.

4·07% respectively, the contribution of area (1·63 and 1·65 percentage points) has been quite significant.

In five States, the contribution due to improvements in yields was substantially higher than the national average. Kerala seems to have done very well in regard to yields: out of growth rate of 4·08% per annum, 3·04 percentage points can be attributed to yield improvements. Madras (2·70 percentage points in 5·12%), Madhya Pradesh (2·17 percentage points in 4·07%), and Mysore (2·12 percentage points in 4·36%) have experienced significant yield rises. Bihar's rate of growth of 2·42% per year, though low, is largely a consequence of creditable yield (1·85 percentage points) improvements. In Rajasthan and West Bengal yields actually fell. In the Punjab, the most rapidly growing State in India, yields have shown no significant improvement.

At the all-India level the contribution of crop pattern change to the growth of output during 1951–54 to 1958–61 has been very small —approximately 0·29 percentage points in the overall growth rate of 3·57%. The proportion of area covered by cereals has gone down. Share of rice has fallen from 24·35% in 1951–54 to 23·79% in 1958–61, "other cereals" (excluding rice and wheat) from 33·84% to 31·23%. However, wheat has registered a significant gain from 7·99% to 9·22%. Pulses have gained from 16·08% to 17·11%; oil-seeds from 9·04% to 9·58%; sugarcane from 1·36% to 1·52% and cotton from 5·30% to 5·42%.

In the absence of a marked change in the composition of agricultural exports, one should not expect significant changes in the cropping pattern of a big agricultural country considered as one whole. One cannot, however, maintain this expectation for each of the individual regions. Different regions of a big developing country derive irrigation and other benefits of development in different measures. They have greater flexibility in the exploitation of their comparative advantage in production of different crops in response to changes in their relative prices. Our findings confirm these *a priori* expectations: changes in crop pattern did not contribute much to the output growth at the national level; they were, however, a significant source of growth in a number of States. In Gujarat, for instance, crop pattern change alone contributed 3·09 percentage points to an overall growth rate of 4·53%. There has been a very large shift of area away from millets to higher value crops (*see* Appendix III). The proportion of area under "other cereals" fell from 54·6% to 37·4% while oil-seeds

(mostly groundnut) increased from a little over 12% to 22% and cotton from 14·1% to 19·1%.

Madras, Punjab and Andhra Pradesh are other States where changes in crop pattern have contributed significantly to output growth. In the Punjab, the area under "other cereals" has fallen (from 32·4% to 23·2%) whereas area under rice (from 3·75% to 4·70%) and wheat (from 25·05% to 25·46%) has increased. Pulses (mainly gram) have gone up from 25·5% to 32·7%; sugarcane and cotton have also gained. In Madras and Andhra Pradesh the shifts have been mostly from "other cereals" to rice and, to a smaller extent, sugarcane.

The contribution of the interaction element—negative in some and positive in other States—has been very small. Except for Gujarat, Rajasthan and Bihar, its contribution, for all practical purposes, can be neglected.

IV. Some Concluding Remarks

In this section we content ourselves with a brief resume of some of our findings, some speculation about others, and some indications about the direction of our future research in this field.

We have tried to present a fairly complete picture of the observed growth of crop output by States and a summary of our results at the district level. Instead of the usual two-factor breakdown of growth into area and productivity changes, we have suggested a method for splitting the growth rates into 4 component elements. These contributory elements are so arranged that their individual effects can be additively aggregated. The interaction between yield and crop pattern change, the only element in the four-fold break-up which is multiplicative in nature and bears a little complex interpretation, has been found to be quantitatively insignificant. The net contribution of crop pattern change (which has been a significant source of growth in some States) has been disentangled from the effects of the other two factors, namely, area and yields.

Preliminary results of our experiments with alternative sets of constant weights, based on average prices prevailing in 1948–51, 1956–59 and 1960–63, point to a remarkable stability in the numerical magnitudes of the overall growth rates as well as the percentage contributions of component elements. This is a very desirable feature of this additive scheme of decomposition. Even very sharp difference

(among different constant price sets) in the prices of crops, which are of minor significance in a region, would not be enough to upset this stability. The crops experiencing large price shifts must not only cover a large proportion of the area of the region to start with but should also experience significant change in the crop pattern (or yields per acre) in favour of them. The experience of Gujarat seems to be the only exception to this stability property claimed of the additive scheme and is largely explained by the drastic price and area shifts pertaining to groundnuts alone.[14]

One drawback of this decomposition scheme is that, although it involves heavy (but simple) computational work, it is wasteful of information: it does not use all of it. Instead of using only six time points out of a total of ten, we could have taken five-year averages on both ends and made full use of the information. This, however, would have added considerably to the computational burden and, possibly, without changing the nature of results in any significant manner.

We are aware of some of the obvious theoretical sanctions which our decomposition scheme lacks; and purists can certainly point out many more. Nonetheless, we (somewhat unguardedly) think that our way of decomposing the agricultural output growth can provide a framework for reflective speculation on some meaningful policy alternatives of the following kind: Given an outside expert judgement about accretions to gross cropped area and knowing the technological yield possibilities of different crops, one can suggest alternative crop patterns and pattern of land use which could help balance supplies and demands for different agricultural products. Or, assuming certain alternative crop patterns on given areas of land, one can get alternative targets of production, and, from the knowledge of input-output relations, derive implicit targets of input demands. Useful exercises

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[14] Using the 1948–51 and 1960–63 average prices as constant weights, the growth rate for Gujarat works out to 5·07% and 4·91% respectively. In comparison, the corresponding growth rate, in terms of 1956–59 price weights, is 4·53% of which 3·09 percentage points is the contribution of crop pattern change. Evaluated in 1948–51 and 1960–63 prices, the crop pattern changes accounted for 4·00 and 3·62 percentage points in growth rates of 5·07% and 4·91% respectively.

In 1951–54, groundnuts accounted for about 8% of the gross sown area in Gujarat which increased to approximately 20% in 1958–61. The groundnut prices both in 1948–51 and 1960–63 were higher than 1956–59 by about 30%. Further details of this price sensitivity exercise will be discussed at some later occasion.

on the patterns of price stresses that different targets imply could also be made.

All said and done, the break-up of the increase in output into its component elements is no more than a convenient starting point for analysis. The really difficult problem is to explain the difference in their respective contribution to output growth in different regions.

In the search for factors responsible for variation in growth of output as a whole and in its component elements, a necessary first step is to eliminate the effects of differences in soil and climatic conditions. For this purpose the districts will have to be reclassified into regions, more or less homogeneous in respect of soil and climate. It would then be possible to attempt a meaningful analysis of the factors accounting for changes in crop area, shifts in crop patterns and changes in per acre yields within each region.

It is relatively easy (from published statistics) to separate out the increase in total crop area due to additions to net sown area and to extension of double cropping. What is lacking and needs research is an assessment of the relative importance of reclamation of virgin land, deforestation, reduction of fallows and other elements in extending the crop area, and, more importantly, the factors responsible for the spread of multiple cropping. The relationship between irrigation and double cropping needs to be analysed.

As regards crop pattern the aim is to assess the impact of irrigation and of changes in relative prices on the allocation of area among different crops. Given the base year crop pattern on unirrigated and irrigated areas of each region and given further the growth of total irrigated and unirrigated areas, the allocation of crop area corresponding to the relative price prevailing in the base year can be estimated. The residual would then measure the contribution of relative price changes and other factors. Some good exploratory work on the responsiveness of area allocations among crops to changes in their relative prices is already available. This work needs to be extended to cover all major crops on a region-wise basis.

Most attempts at explanation of yield changes fail because of the lack of relevant data on inputs. About the only inputs for which we can get region-wise time series are irrigation and, hopefuily, fertilisers. In the absence of time series data, analysis of cross-sectional information within homogeneous regions holds some promise of yielding useful results. In order to have a firm grip on input-output

relations, we are already engaged in analysing experimental data on individual crops by regions. Much work in this direction has already been done by the I.A.R.S.; our effort will be to extend this work in the direction of appropriate functional forms of production functions which can handle complementarity and substitution among inputs simultaneously.

The foregoing types of analysis will give us some idea of the contribution of physical factors to the growth of output in different regions. This would still not explain why farmers in some regions absorb these inputs and techniques associated with them at much faster rates than other regions. Statistical analysis of interregional cross-section and time series data could be usefully supplemented by detailed studies in depth of a few selected regions. In particular, comparative studies of the experience of districts which have achieved high rates of growth and those which have done poorly should be illuminating.

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APPENDIX I

Average unit price of different crops India: 1956–59

Sl. No.	Crops	Unit	Price per Unit Rupees
1	Rice	Metric Tonne	524
2	Wheat	,,	450
3	Jowar	,,	345
4	Bajra	,,	385
5	Barley	,,	317
6	Maize	,,	344
7	Ragi	,,	331
8	Small Millets	,,	297
9	Gram	,,	373
10	Tur or Arhar	,,	429
11	Other pulses	,,	415
12	Sugarcane (Gur)	,,	382
13	Groundnuts	,,	470
14	Castor seed	,,	563
15	Sesamum	,,	865
16	Rape and Mustard	,,	695
17	Linseed	,,	565
18	Cotton	Bale of 392 lb.	363
19	Jute	Bale of 400 lb.	119
20	Tobacco	Quintal	204
21	Mesta	Bale of 400 lb.	113

APPENDIX I (*Contd.*)

Sl. No.	Crops	Unit	Price per Unit Rupees
22	Tea	Quintal	224*
23	Coffee	,,	356
24	Rubber	,,	333
25	Potatoes	Metric Tonne	305
26	Chillies (dry)	,,	1,752
27	Ginger (dry)	,,	1,083
28	Pepper (Black)	Quintal	175

* Price is of raw tea leaves.

APPENDIX

Proportion of (i) *cropped area and* (ii) *value of total output* (1958–61)

State	Total No. of districts in the State	No. of districts considered	7·5% and above					5·0% and above but less than 7·5%				
			No. of districts	Cropped area		Value of output		No. of districts	Cropped area		Value of output	
				In million acres	As % of total	In 10 million rupees	As % of total		In million acres	As % of total	In 10 million rupees	As % of total
1	2	3	4	5	6	7	8	9	10	11	12	13
1. Gujarat ..	17	17	9	10·30	52·1	83·78	45·2	5	6·38	32·2	73·03	39·4
2. Punjab ..	19	17	4	6·61	32·9	91·64	28·3	3	4·89	24·2	79·66	24·6
3. Madras ..	13	11	1	1·50	10·2	38·95	12·1	3	4·13	28·3	89·48	27·8
4. Mysore ..	19	16	4	2·11	11·9	32·80	20·2	5	4·13	23·3	52·61	32·4
5. Kerala ..	9	2†	0	..	..	..	..	2	2·75	100·0	73·66	100·0
6. Rajasthan ..	26	23	13	11·86	55·0	120·46	66·1	3	2·75	12·7	24·78	13·6
7. Madhya Pradesh	43	40	18	13·72	36·7	145·64	33·1	6	4·13	11·0	50·60	11·5
8. Andhra Pradesh	20	19	4	4·15	17·5	42·71	11·7	3	3·54	15·0	55·13	15·1
9. Maharashtra	26	25	7	11·23	30·9	124·51	33·6	6	9·65	26·6	91·90	24·8
10. Bihar ..	17	16	3	3·86	17·7	51·47	15·3	5	6·00	27·5	92·51	27·5
11. Uttar Pradesh	54	48	1	0·48	1·1	9·10	1·4	5	4·46	10·5	63·73	9·8
12. Assam ..	11‡	8	0	..	..	..	..	0	..	..	..	..
13. Orissa ..	13	13	3	2·48	22·7	42·79	23·6	2	2·48	22·7	46·06	25·4
14. West Bengal	15	15	0	..	..	..	..	1	0·56	4·3	12·53	4·1
State-total ..	302	270	67	68·30	23·7	783·85	19·4	49	55·85	19·4	805·68	19·9
States-total* ..	293	268	67	68·30	24·0	783·85	19·8	47	53·10	18·6	732·02	18·4

* Excludes Kerala District, data not being available for base year.

Details for districts are not available.

II

accounted by districts classified according to growth rate of total output

2·5% and above but less than 5·0%					Below 2·5%					Cropped area (in million acres)			Value of output (in 10 million rupees)		
No. of districts	Cropped area: In million acres	Cropped area: As % of total	Value of output: In 10 million rupees	Value of output: As % of total	No. of districts	Cropped area: In million acres	Cropped area: As % of total	Value of output: In 10 million rupees	Value of output: As % of total	Total for the districts considered	Total for the State	Districts total as % of State total	Total for the districts considered	Total for the State	Districts total as % of State total
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	1·18	5·9	13·90	7·5	2	1·94	9·8	14·65	7·9	19·80	20·76	95·4	185·36	199·01	93·1
5	6·73	33·4	116·89	36·1	5	1·92	9·5	35·62	11·0	20·15	21·02	95·9	323·81	330·22	98·1
7	9·00	61·5	193·45	60·1	0	..	..	..	..	14·63	15·59	93·8	321·88	343·91	93·6
0	..	..	..	..	7	11·48	64·8	76·96	47·4	17·72	23·04	76·9	162·37	235·77	68·9
0	..	..	..	..	0	..	..	..	..	2·75	2·75	100·0	73·66	82·16	89·7
5	4·60	21·3	28·79	15·8	2	2·37	11·0	8·20	4·5	21·58	29·88	72·2	182·23	213·52	85·3
9	12·18	32·6	155·33	35·3	7	7·35	19·7	88·44	20·1	37·38	43·40	86·1	440·01	473·52	92·9
4	3·25	13·7	42·35	11·6	8	12·72	53·8	224·88	61·6	23·66	26·50	89·3	365·07	402·16	90·8
2	3·17	8·7	37·80	10·2	10	12·29	33·8	116·36	31·4	36·34	41·22	88·2	370·57	398·68	92·9
4	6·20	28·4	109·66	32·6	4	5·76	26·4	82·75	24·6	21·82	25·77	84·7	336·39	387·83	86·7
15	13·47	31·6	231·50	35·6	27	24·22	56·8	345·95	53·2	42·63	56·79	75·1	650·28	865·86	75·1
0	..	..	..	..	8	5·28	100·0	143·24	100·0	5·28	5·75	91·8	143·24	150·11	95·4
5	4·20	38·4	66·01	36·4	3	1·77	16·2	26·47	14·6	10·93	12·12	90·2	181·33	210·02	86·3
2	0·93	7·2	41·25	13·5	12	11·44	88·5	251·79	82·4	12·93	14·84	87·1	305·57	336·16	90·9
59	64·91	22·6	1036·93	25·7	95	98·54	34·3	1415·31	35·0	287·60	339·43	84·7	4041·77	4628·93	87·3
59	64·91	22·8	1036·93	26·1	95	98·54	34·6	1415·31	35·7	284·85	336·68	84·6	3968·11	4546·77	87·3

† Travancore-Cochin and Malabar are two regions for which analysis has been carried out,

‡ Excludes districts under N.E.F.A.

APPENDIX III

Percentage distribution of crop area by major crops—India and States, 1951–54 *and* 1958–61

Sl. No.	States	Year	Rice	Wheat	Other cereals	Pulses	Sugar-cane	Oil-seeds	Cotton	Other fibres	Tobacco	Potato	Plantation crops	Other crops	Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Gujarat ..	1952–54	5·80	5·70	54·57	6·81	0·08	12·08	14·13	..	0·80	0·03	..	..	100·00
		1958–61	6·00	6·32	37·38	7·97	0·16	22·06	19·10	..	0·98	0·03	..	..	100·00
2	Punjab ..	1951–54	3·75	25·05	32·45	25·50	2·66	4·83	5·19	..	0·04	0·10	0·06	0·37	100·00
		1958–61	4·70	25·46	23·19	32·71	2·78	4·07	6·61	..	0·02	0·13	0·05	0·28	100·00
3	Madras ..	1951–54	30·70	0·02	38·77	7·72	0·61	14·19	5·93	..	0·29	0·14	0·91	0·72	100·00
		1958–61	35·69	0·02	33·14	6·60	0·96	14·83	6·45	..	0·27	0·17	0·91	0·96	100·00
4	Mysore ..	1952–54	9·80	3·27	49·27	12·75	0·45	11·01	10·96	..	0·52	0·06	0·81	1·10	100·00
		1958–61	10·12	3·14	48·11	12·81	0·60	11·14	11·77	..	0·42	0·08	0·82	0·99	100·00
5	Kerala ..	1952–54	71·85	..	1·05	0·74	0·66	3·02	0·66	..	..	..	13·62	8·40	100·00
		1958–61	69·45	..	1·13	0·80	0·80	2·80	0·80	..	..	..	15·19	9·03	100·00
6	Rajasthan ..	1952–54	0·74	8·74	60·98	20·88	0·20	6·46	1·74	..	0·08	0·01	..	0·17	100·00
		1958–61	0·76	9·62	53·50	26·32	0·24	7·39	1·89	..	0·05	0·01	..	0·22	100·00
7	Madhya Pradesh	1951–54	24·43	13·05	27·36	21·85	0·21	7·66	5·16	..	0·04	0·05	..	0·19	100·00
		1958–61	23·21	17·21	24·40	21·40	0·24	8·81	4·44	..	0·02	0·06	..	0·21	100·00
8	Andhra Pradesh	1951–54	20·75	0·14	41·54	13·01	0·53	17·56	3·81	..	1·31	..	..	1·35	100·00
		1958–61	26·34	0·17	41·99	12·23	0·65	13·44	2·76	..	1·39	..	..	1·03	100·00
9	Maharashtra	1951–54	6·96	4·36	47·84	15·78	0·44	8·33	15·41	..	0·21	0·05	..	0·62	100·00
		1958–61	7·35	5·53	46·51	14·41	0·65	9·19	15·38	..	0·15	0·06	..	0·77	100·00
10	Bihar ..	1951–54	52·23	5·89	15·48	19·68	1·33	2·82	0·06	1·68	0·15	0·38	..	0·30	100·00
		1958–61	49·40	6·13	16·27	21·37	1·69	2·30	0·02	1·57	0·16	0·69	..	0·40	100·00
11	Uttar Pradesh	1951–54	16·74	16·38	27·19	19·76	4·79	14·21	0·34	0·06	0·10	0·42	0·01	..	100·00
		1958–61	18·08	16·95	25·02	19·90	5·27	13·83	0·30	0·06	0·08	0·50	0·01	..	100·00
12	Assam ..	1951–54	74·43	0·11	0·84	2·82	1·10	5·65	0·62	5·40	0·39	1·19	7·34	0·11	100·00
		1958–61	74·30	0·16	0·88	3·41	1·08	5·45	0·56	5·30	0·42	1·30	6·90	0·24	100·00
13	Orissa ..	1951–54	80·30	0·10	3·79	9·27	0·48	4·60	0·22	0·80	0·14	0·17	..	0·22	100·00
		1958–61	81·11	0·13	2·97	10·15	0·45	3·88	0·16	0·64	0·14	0·20	..	0·17	100·00
14	West Bengal	1951–54	74·24	0·89	2·14	12·67	0·33	2·00	..	5·27	0·27	0·85	1·34	..	100·00
		1958–61	73·75	0·66	2·10	12·46	0·55	2·48	..	5·44	0·27	0·92	1·37	..	100·00
15	All-India ..	1951–54	24·35	7·99	33·84	16·08	1·36	9·04	5·30	0·70	0·27	0·20	0·37	0·50	100·00
		1958–61	23·79	9·22	31·23	17·11	1·52	9·58	5·42	0·70	0·28	0·25	0·40	0·50	100·00