Vol XXXV
No. 2

APRIL-
JUNE
1980

ISSN 0019-5014

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

GROWTH RATES AND CROPPING PATTERN CHANGES IN AGRICULTURE IN SIX STATES: 1950 TO 1975*

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All-India aggregate growth rates in agriculture offer no clue to the disparate performance of agriculture in different States or regions in India. Estimations of growth rates by crops for different regions and States followed by explanations on why they differ are crucial for an insight into the agricultural development process.

This paper estimates and analyses the growth rates in area, yield and output of major crops in six States, *viz.*, Punjab (including Haryana), Rajasthan, Uttar Pradesh, Bihar, Maharashtra and Andhra Pradesh in the period 1950-51 to 1974-75 and studies the impact of disparate growth rates of crops on cropping pattern in these States.[1] It also attempts through 'decomposition method' to study the area, yield and cropping pattern effects on crop output growth in these States in the period under reference.

The present study differs from earlier related studies on crop output growth rates and cropping pattern in two important respects. Firstly, by relating the disparate rates of growth in individual crops to the changes in cropping pattern, it attempts to offer a plausible explanation for the macro State level changes in the cropping pattern witnessed in the six States during the reference period. Secondly, it suggests a method of measuring the 'aggregate' change in the cropping pattern of a State in terms of 'substitution' and 'expansion' effects by comparing the area growth rates of individual crops with the corresponding growth rate in gross cropped area.

The analysis in the paper is divided into five sections. A brief review of changes in the cropping pattern in the six States during the period 1950-75 is presented in section I. Section II deals with an analysis of the growth rates in area, yield and output of major crops and the impact of the disparate growth rates on the cropping pattern in each of the six States. Section III analyses through decomposition method the contributions of area, yield, etc., to crop output growth. Section IV concerns itself with the method of measuring the total change in the cropping pattern in each State in terms of substitution and expansion effects. In the last section, we present the summary and conclusion of our study.

Relevant data, Statewise, for the analysis in this paper are drawn from the official sources.[2]

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* This paper is based on two studies prepared earlier by the authors: "Study of Cropping Pattern Changes in Punjab, Rajasthan, Uttar Pradesh, Bihar and Maharashtra in the Period 1950-70", Institute for Social and Economic Change, Bangalore (mimeo.), and "Study of Cropping Pattern Changes in Andhra Pradesh during 1950-75", *Indian Economic Review*, Vol. XIII (New Series), No. 2, October 1978.

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1. The selection of States for the study may seem to be somewhat arbitrary in nature. But the fact that these States do represent different agricultural situations and levels of agricultural development in the country is worth noting.

2. For details, see (*i*) Venkataramanan and Prahladachar, "Study of Cropping Pattern Changes in Punjab, Rajasthan, Uttar Pradesh, Bihar and Maharashtra in the Period 1950-70", *op. cit.* and (*ii*) "Study of Cropping Pattern Changes in Andhra Pradesh during 1950-75", *op. cit.*

I

REVIEW OF CHANGES IN CROPPING PATTERN IN SIX STATES UNDER STUDY

1. Punjab (including Haryana)

Over the 25-year period under review, the relative acreage under foodgrains and non-foodgrains remained more or less stationary, *i.e.*, approximately around 70 and 30 per cent respectively (Table I). But within the foodgrains group, the relative shares of some crops changed considerably. For instance, wheat area more than doubled from 16.5 lakh hectares in the quinquennium 1950-55 to 35.2 lakh hectares in the quinquennium 1970-75 Its relative share in the cropping pattern rose from 20 to 32 per cent. Likewise, the relative shares of rice and maize improved from 3 to 7 per cent and from 5 to 6 per cent respectively. The performance of pulses was in the opposite direction, with its relative share having declined from 23 to 13 per cent. The other foodgrains whose relative shares in the cropping pattern declined over the years under review were bajra (from 14 to 10 per cent), jowar (from 4 to 2 per cent) and barley (from 3 to 2 per cent).

Among non-foodgrains, the relative share of cotton alone improved perceptively from 4 to 7 per cent while that of oilseeds and sugarcane increased marginally.

The significant increases in area under wheat, rice, maize, oilseeds and cotton that occurred could be explained in terms of technological impact of significant yield increases of these crops on farmers' relative profitability expectations and/or the benefits these crops derived from the increase in the irrigated area in the State.[3]

2. Rajasthan

Desert soil which results in poor yield characterizes Rajasthan State. Added to this, the irrigation facilities are inadequate; only 13 per cent of the net cropped area was irrigated in the quinquennium 1970-75. The limitational factors in Rajasthan for growth in yield and crop output are therefore the large portion of desert soil with low productivity and inadequate irrigation facilities.

During the 25-year period under review, the share of foodgrains in the gross cropped area increased from 65 per cent in the quinquennium 1950-55 to 76 per cent in the quinquennium 1970-75, and correspondingly the share of non-foodgrains declined from 35 to 24 per cent (Table I). Among foodgrains, the share of bajra in the gross cropped area increased from 26 to 31 per cent, that of pulses from 16 to 21 per cent and that of wheat from 6 to 9 per cent. Among non-foodgrains, the share of oilseeds and cotton in the gross cropped area slightly improved. The share of 'miscellaneous

3. For details, See Venkataramanan and Prahladachar, *op. cit.*

crops'[4] declined sharply from 28 to 15 per cent.

Though the gross irrigated area nearly doubled between the quinquennium 1950-55 and the quinquennium 1970-75, the percentage of gross cropped area that was irrigated increased from about 13 to 16 per cent only.

3. Uttar Pradesh

The gross cropped area in Uttar Pradesh increased by 38.4 lakh hectares or 18 per cent from 208.4 lakh hectares in the quinquennium 1950-55 to 246.8 lakh hectares in the quinquennium 1970-75 (Table I). A major portion of this increase in the gross cropped area was due to the increase in multiple cropped area. Unlike most of the other States, the intensity of cropping in Uttar Pradesh is comparatively high. Also compared to many other States, a relatively high proportion of cropped area is irrigated (about 34 per cent in the quinquennium 1970-75). Despite a high proportion of irrigated cropped area, the fact is that the bulk of multiple cropped area is rainfed. The irrigation facilities apparently are not adequate for raising more than one crop a year.

The cropping pattern in Uttar Pradesh was characterized by dominance of foodgrains throughout the period under reference. But it is worth noting that the relative share of foodgrains declined from 83 to 78 per cent, whereas that of oilseeds increased from 11 to 15 per cent over the 25-year period under review. Among the foodgrains, wheat, rice and maize clearly gained in area, while pulses, barley and jowar lost in area (Table I).

4. Bihar

The review of cropping pattern changes in Bihar during 1950-75 indicates that while the area under total cereals and millets increased from 71.3 lakh hectares in the quinquennium 1950-55 to 82.6 lakh hectares in the quinquennium 1970-75, that under pulses and oilseeds declined in the corresponding period from 21.9 lakh hectares to 15.5 lakh hectares and from 2.5 lakh hectares to 2 lakh hectares respectively (Table I). These developments took place primarily in the post-sixties. Within the cereals group, rice, maize and wheat gained in area, whereas barley lost in area.

In relative terms also, the importance of cereals in the cropping pattern improved from 69 to 77 per cent, while that of pulses and oilseeds declined from 21 to 14 per cent and from 2.4 to 1.9 per cent respectively. As regards individual cereals and millets, the relative importance of wheat and maize improved from 6 to 15 per cent and 6 to 8 per cent respectively, while that of barley and small cereals and millets declined from 4 to 2 per cent and from 3 to 2 per cent respectively. In short, the cropping pattern of the State shifted in favour of cereals at the expense of pulses and oilseeds.

4. It needs to be mentioned that the data on area under individual crops have been collected for our study from the source (*i*) Estimates of Area and Production of Principal Crops in India. This source does not furnish data on gross cropped area, which have been drawn from the source (*ii*) Indian Agricultural Statistics. In the case of Rajasthan, the totals of area under individual crops given in source (*i*) however range from 60 to 90 per cent of the gross cropped area figures given in source (*ii*) during the 25-year period under study. Cropwise break-up of the remaining portion of the gross cropped area in each year is unfortunately not known. We categorise this unknown portion of gross cropped area as 'miscellaneous crops' for the purpose of our study.

5. Maharashtra

The conditions of soil and climate in Maharashtra are such that they contribute both to an inferior crop pattern and relatively low yields in most of the important crops. A major part of the State consists of the plateau region where the rainfall is low and highly variable.

During the 25-year period under review, the gross cropped area in Maharashtra increased by 9.30 lakh hectares from 177 lakh hectares in the quinquennium 1950-55 to 186.3 lakh hectares in the quinquennium 1970-75 (Table I). The bulk of this overall increase in the gross cropped area was due to the extension of net cultivated area in the State.

Crops which benefited by the increase in the gross cropped area in the State during the reference period were jowar, cotton, rice, wheat, sugarcane, total pulses and bajra. Even though increases in area under these crops took place, there were no significant changes in their relative shares in the cropping pattern. The cropping pattern in the State remained stable over the entire period.

6. Andhra Pradesh

Andhra Pradesh farmers did not make very large changes in their cropping pattern in the period 1950-75 (Table I). The relative changes in area that took place were mainly under individual crops, not for broad aggregates such as total foodgrains and total oilseeds; the exception to this was the decline in relative acreage under total pulses. The main changes in the cropping pattern that occurred were the relative growth in area under rice (5 per cent), maize area (0.7 per cent), oilseeds area (1.7 per cent), sugarcane area (0.4 per cent) and tobacco area (0.5 per cent) and the offsetting relative decline in area under jowar (0.9 per cent), bajra (1.2 per cent), *ragi* (0.6 per cent), total pulses (1.9 per cent) and cotton (1.6 per cent).

Rice occupied the first place (largest area), jowar the second place, total oilseeds the third place and total pulses the fourth place throughout the period under review.

II

ANALYSIS OF AREA, YIELD AND OUTPUT GROWTH RATES AND THEIR EFFECT ON CROPPING PATTERN

The level of output growth rate, we know, is jointly determined by the growth rate in area and the growth rate in yield. Following the hypothesis that farmers are rational in their production behaviour and that they maximize their net returns, we can state that their input allocating decisions including area allocation are based on expectations relating to relative price and relative yield from the concerned crop, relative to substitutable crops. With this premise in view, we attempt to examine the effect of growth rates in crop output on the cropping pattern in the six States under study in succession.

TABLE I—CROPPING PATTERN IN SIX STATES: 1950-55 TO 1974-75

(lakh hectares)

Crop	Punjab		Rajasthan		Uttar Pradesh		Bihar		Maharashtra		Andhra Pradesh	
	I	II	I	II	I	II	I	II	I	II	I	II
Rice	2·5 (3·1)	7·7 (7·0)	0·6 (0·6)	1·3 (0·8)	36·5 (17·5)	45·2 (18·3)	50·2 (48·5)	51·6 (48·0)	11·0 (6·2)	13·3 (7·1)	23·5 (20·5)	32·8 (25·5)
Jowar	2·9 (3·6)	1·9 (1·8)	8·8 (8·1)	10·0 (6·0)	9·7 (4·7)	7·0 (2·8)	— —	— —	54·3 (30·7)	58·2 (31·2)	24·5 (21·4)	25·5 (20·5)
Bajra	11·4 (14·1)	10·6 (9·7)	28·3 (26·0)	50·8 (30·5)	11·2 (5·4)	10·5 (4·3)	—	—	16·6 (9·4)	16·9 (9·1)	6·3 (5·5)	5·5 (4·3)
Maize	3·8 (4·8)	6·7 (6·1)	4·4 (4·1)	7·8 (4·7)	9·2 (4.4)	14·9 (6·0)	6·6 (6·4)	9·0 (8·4)	—	—	1·7 (1·5)	2·8 (2·2)
Ragi	Neg.	N.A.	—	—	1·9 (0·9)	2·4 (1·0)	1·8 (1·8)	1·6 (1·5)	1·9 (1·1)	2·1 (1·1)	3·1 (2·7)	2·7 (2·1)
Small cereals and millets ..	0·2 (0·2)	N.A.	0·8 (0·7)	0·6 (0·4)	6·8 (3·3)	4·9 (2·0)	2·7 (2·6)	2·0 (1·8)	2·4 (1·4)	2·0 (1·1)	10·7 (9·4)	7·1 (5·3)
Wheat	16·5 (20·4)	35·2 (32·3)	6·8 (6·2)	15·0 (9·0)	35·1 (16·8)	60·2 (24·4)	6·0 (5·8)	16·1 (15·0)	6·8 (3·9)	8·9 (4·8)	—	—
Barley	2·6 (3·3)	2·4 (2·2)	4·1 (3·8)	5·4 (3·3)	19·5 (9·4)	12·9 (5·2)	3·9 (3·8)	2·2 (2·0)	—	—	—	—
Total cereals and millets ..	39·9 (49·5)	64·4 (59·1)	53·8 (49·5)	91·0 (54·7)	129·9 (62·3)	158·0 (64·0)	71·3 (68·9)	82·6 (76·9)	93·4 (52·8)	101·8 (54·7)	70·0 (60·1)	77·7 (60·2)

(Contd.)

TABLE I (*Concld.*)

(*lakh hectares*)

Crop	Punjab		Rajasthan		Uttar Pradesh		Bihar		Maharashtra		Andhra Pradesh	
	I	II	I	II	I	II	I	II	I	II	I	II
Total pulses	18·8 (23·3)	14·4 (13·3)	16·9 (15·6)	35·3 (21·2)	43·6 (20·9)	35·1 (14·2)	21·9 (21·2)	15·5 (14·5)	22·9 (13·0)	23·6 (12·7)	14·5 (12·7)	14·0 (10·8)
Total foodgrains	58·7 (72·8)	78·8 (72·4)	70·7 (65·1)	126·3 (75·9)	173·5 (83·3)	193·1 (78·2)	93·2 (90·0)	98·2 (91·3)	116·3 (65·7)	125·4 (67·4)	84·5 (73·8)	91·6 (71·0)
Total oilseeds	3·2 (3·9)	5·2 (4·8)	6·1 (5·6)	11·8 (7·1)	22·9 (11·0)	37·3 (15·1)	2·5 (2·4)	2·0 (1·9)	12·3 (7·0)	11·4 (6·1)	19·1 (16·7)	20·8 (16·1)
Sugarcane	1·7 (2·1)	2·6 (2·4)	—	—	10·0 (4·8)	13·7 (5·6)	1·4 (1·4)	1·4 (1·3)	0·8 (0·4)	1·8 (1·0)	0·7 (0·6)	1·3 (1·0)
Cotton	3·6 (4·4)	7·3 (6·7)	1·8 (1·7)	2·9 (1·8)	0·6 (0·3)	0·5 (0·2)	—	—	21·8 (12·3)	25·0 (13·4)	5·1 (4·4)	3·6 (2·8)
Tobacco	—	—	—	—	—	—	—	—	—	—	1·3 (1·2)	2·2 (1·7)
Chillies	—	—	—	—	—	—	—	—	—	—	1·6 (1·4)	1·9 (1·5)
Miscellaneous crops ..	—	—	30·0 (27·6)	25·4 (15·3)								
Gross cropped area ..	80·6 (100·0)	108·9 (100·0)	108·7 (100·0)	166·4 (100·0)	208·4 (100·0)	246·8 (100·0)	103·6 (100·0)	107·5 (100·0)	177·0 (100·0)	186·3 (100·0)	114·6 (100·0)	129·0 (100·0)

Note:— I = 1950-55 quinquennium average. II = 1970-75 quinquennium average.

Percentages do not add up to 100, due to non-inclusion of all the crops grown in the States.

Neg. = Negligible. N.A. = Not available.

Figures in parentheses are percentages to gross cropped area in the respective period.

Source: Estimates of Area and Production of Principal Crops in India, Ministry of Agriculture and Irrigation, Government of India.

1. Punjab

The largest output growth rate in the period 1950-75 was in rice (9.6 per cent), followed by wheat (7.8 per cent), oilseeds (5.8 per cent), cotton (5.8 per cent), maize (4.5 per cent) and sugarcane (4.4 per cent). Both the growth in area and yield contributed to their output growth (Table II). Following the rationality hypothesis, it is possible to argue that the favourable expectations relating to high and growing yields per hectare and/or high relative profitability expectations (relative to substitutable crops) induced growth in acreage under the above-mentioned crops, and as a result their relative shares in the cropping pattern improved over the reference period.

Pulses and jowar recorded negative growth rates in their output, mainly due to the corresponding setbacks in their area growth during the 25-year period under study. It is revealing to note that yield growth in these crops during 1950-75 was negligible. It is legitimate to argue that in the absence of higher yield expectations from these crops, the area allocated to them both in actual and relative terms in the cropping pattern declined over the 25-year under study.

2. Rajasthan

The output growth rate was highest for wheat, being 5.3 per cent, followed by 4.2 per cent growth rate for bajra, maize and oilseeds. The highest growth rate in yield was 1.9 per cent in wheat, followed by 1.4 per cent each for jowar and bajra, 1.2 per cent for maize, 1 per cent for total oilseeds (Table II).

The highest area growth rate was recorded in wheat, being 3.2 per cent, followed by maize, pulses and oilseeds of 3 per cent each, bajra 2.8 per cent and cotton 2.2 per cent. But the largest absolute increase in area in the period 1950-75 was under bajra and the next largest increase was under total pulses.

In Rajasthan, as noted earlier, the share of foodgrain crops in the cropping pattern increased from 65 to 76 per cent. This relative shift in favour of foodgrains unmistakably reflects the relative increase of subsistence agriculture with a large increase in area under the low value coarse cereal bajra.

3. Uttar Pradesh

The largest output growth in Uttar Pradesh in the period 1950-75 was in wheat, being 4.4 per cent, followed by oilseeds 3.4 per cent, sugarcane 2.9 per cent, rice 2.7 per cent and maize 2.6 per cent (Table II). Contributions to the output growth in wheat, rice, oilseeds and sugarcane came both from the growth in area and growth in yield, whereas in the case of maize, the contribution to output growth came solely from its area growth. Crops like jowar, barley and pulses recorded negative growth rates in output, following mainly corresponding negative growth rates in their areas.

TABLE II—COMPOUND GROWTH RATES OF AREA, YIELD AND OUTPUT OF MAJOR CROPS IN SIX STATES: 1950-75

(*per cent per annum*)

Crop	Punjab			Rajasthan			Uttar Pradesh		
	A	Y	O	A	Y	O	A	Y	O
Rice	5·5	4·0	9·6	—	—	—	1·0	1·6	2·7
Jowar	—2·0	0·4	—1·5	0·7	1·4	2·1	—1·3	—0·6	—2·0
Bajra	—	3·9	3·8	2·8	1·4	4·2	—0·3	0·3	0·1
Maize	2·7	1·8	4·5	3·0	1·2	4·2	2·5	—	2·6
Ragi	—	—	—	—	—	—	—	—	—
Small cereals and millets ..	—	—	—	—	—	—	—1·5	1·7	0·2
Wheat	3·6	4·1	7·8	3·2	1·9	5·3	2·5	2·0	4·4
Barley	—0·1	1·7	1·6	1·0	0·6	1·6	—2·1	0·9	—1·2
Total cereals and millets ..	—	—	—	2·5	1·4	4·0	0·9	1·5	2·4
Total pulses ..	—2·0	—	—2·0	3·0	0·7	3·8	—1·0	0·2	—0·8
Total foodgrains	1·3	4·0	5·2	2·6	1·3	4·0	0·5	1·3	1·8
Total oilseeds ..	2·6	3·1	5·8	3·0	1·0	4·2	2·8	0·6	3·4
Sugarcane ..	2·4	2·0	4·4	—	—	—	0·8	2·1	2·9
Cotton	3·1	2·6	5·8	2·2	0·9	3·2	—	—	—
Tobacco	—	—	—	—	—	—	—	—	—
Chillies	—	—	—	—	—	—	—	—	—

(*Contd.*)

TABLE II (*Concld.*)

Crop	Bihar			Maharashtra			Andhra Pradesh		
	A	Y	O	A	Y	O	A	Y	O
Rice	0·2	2·0	2·3	0·9	0·4	1·4	1·6	1·7	3·4
Jowar	—	—	—	0·4	—0·4	—	0·3	0·3	0·7
Bajra	—	—	—	0·3	0·9	1·3	—0·4	0·2	—0·2
Maize	1·8	1·9	3·7	—	—	—	2·4	4·8	7·4
Ragi	—	—	—	—	—	—	—0·4	0·4	Nil
Small cereals and millets ..	—1·6	—0·6	—2·2	—	—	—	—2·1	—0·3	—2·3
Wheat	4·7	4·7	9·5	1·0	1·4	2·5	—	—	—
Barley	—2·5	1·6	—1·0	—	—	—	—	—	—
Total cereals and millets ..	0·7	2·5	3·2	2·5	1·4	4·0	0·5	1·8	2·3
Total pulses ..	—1·6	1·3	—0·2	0·3	—0·9	—0·6	—0·1	0·9	0·7
Total foodgrains	0·3	2·5	2·8	2·7	1·2	3·9	0·4	1·8	2·2
Total oilseeds ..	—0·9	2·8	1·8	—0·5	—0·5	—0·9	0·4	0·1	0·5
Sugarcane ..	—0·1	3·5	3·3	4·6	1·3	5·7	4·1	0·8	4·8
Cotton	—	—	—	0·8	1·0	1·7	—1·6	2·6	0·9
Tobacco	—	—	—	—	—	—	2·6	0·1	2·7
Chillies	—	—	—	—	—	—	1·0	Nil	1·0

Note:— A = Area, Y = Yield, O = Output.

Growth rates of relatively minor crops in the respective States are not presented.

4. Bihar

The output growth rate in the period 1950-75 was the highest for wheat 9.5 per cent, followed by maize 3.7 per cent. Contributions to their output growth came equally from growth in area and growth in yield (Table II). It is possible therefore that both favourable expectations relating to high and growing yields per hectare and high profitability expectations (relative to substitutable crops) from growing these crops resulted in farmers allocating relatively more area to these crops.

What is surprising however is the fact that though crops like pulses, oilseeds, barley and sugarcane recorded positive growth rates in their yields, the area under these crops did not increase. On the contrary, these crops (except sugarcane) suffered in their relative importance in the cropping pattern of the State.

5. Maharashtra

As pointed out earlier, the cropping pattern in Maharashtra presented a picture of relative stability, if not stagnancy in the period 1950-75. A plausible explanation for this is evident from Table II. None of the crops in Maharashtra recorded significant growth rate in yields per hectare. In fact, a few of the crops registered negative growth rates in yield. In the absence of changes in relative yields between crops, farmers in Maharashtra did not make significant changes in their cropping pattern.

As we mentioned earlier, even though increases in areas under crops took place following increases in the gross cropped area, there was relative stability in Maharashtra's cropping pattern. The area growth rates for most crops were low; sugarcane with 4.6 per cent area growth rate was the only notable exception. The high growth rate in sugarcane area was evidently contributed by the high profitability from growing sugarcane. Sugar prices rose nearly four times during the period under review. But sugarcane occupied hardly one per cent of the gross cropped area in the State.

6. Andhra Pradesh

The largest output growth rate in the period 1950-75 was in maize 7.4 per cent (Table II). The yield growth rate was also the highest for maize 4.8 per cent; the area growth rate for maize was 2.4 per cent. The very favourable expectations relating to high and growing yields per hectare from maize were possibly responsible for contributing to the growth in maize area allocation of 2.4 per cent in the reference period. Similarly, the growth rate in output of 4.8 per cent under sugarcane, which primarily came through a large growth rate in area, 4.1 per cent, was essentially based on high relative profitability expectations from growing sugarcane because of increasing and rising prices for sugarcane relative to rice during the period.

The output growth rate for rice was 3.4 per cent, equally contributed by growth rate in area and yield of about 1.7 per cent. The growth in area under rice appears to have been induced by higher yield and higher price expectations for the crop. The output growth rate in tobacco was

2.7 per cent, all of which was practically contributed by area growth rate. The growth in area allocation of tobacco came from higher price expectation for tobacco relative to substitutable crops such as chillies.

The overall shift in the cropping pattern in Andhra Pradesh was in favour of relatively large area under rice, maize, sugarcane and tobacco. For some crops such as cotton, pulses, *ragi* and bajra, there was a decline in area allocation over the period reflected in negative growth rate (Table II).

III

DECOMPOSITION ANALYSIS

In this section, following the 'decomposition' scheme suggested by Minhas and Vaidyanathan,[5] we attempt to analyse the relative contributions of component elements, *viz.*, area growth, yield growth, cropping pattern changes and the interaction between yield growth and cropping pattern changes to the growth in crop output in the six States under study during the period 1950-55 and 1970-75. The relevant results for these States are presented in Table III.

TABLE III—RELATIVE CONTRIBUTIONS OF DIFFERENT COMPONENTS TO THE GROWTH OF CROP OUTPUT IN SIX STATES DURING 1950-55 TO 1970-75

State	Per cent increase attributed to					Overall rate of growth
	Area	Yield	Crop pattern	Inter-action	Total	
Punjab	19·5 (1·1)	47·7 (2·6)	13·2 (0·7)	19·6 (1·1)	100·0	5·5
Rajasthan	52·7 (2·5)	43·4 (2·0)	1·1 (0·1)	2·8 (0·1)	100·0	4·7
Uttar Pradesh	26·3 (0·7)	50·1 (1·4)	14·2 (0·4)	9·5 (0·3)	100·0	2·7
Bihar	6·4 (0·2)	66·7 (2·0)	9·1 (0·3)	17·8 (0·5)	100·0	3·0
Maharashtra	40·0 (0·4)	2·7 (0·02)	46·8 (0·4)	10·5 (0·1)	100·0	0·9
Andhra Pradesh	13·4 (0·3)	42·7 (1·0)	34·9 (0·8)	8·9 (0·2)	100·0	2·4

Note:— Figures in brackets are the respective contributions in terms of percentage points in the overall growth rate.

Among the six States, the highest growth rate in crop output was in Punjab 5.5 per cent, followed by Rajasthan 4.7 per cent, Bihar 3 per cent, Uttar Pradesh 2.7 per cent and Andhra Pradesh 2.4 per cent. The growth rate in crop output was the lowest in Maharashtra 0.9 per cent. It is evident from Table III that the relative contributions of component elements to output growth varied from one State to another. For instance, in Punjab, a little less than 50 per cent of the growth in crop output was

5. B. S. Minhas and A. Vaidyanathan, "Growth of Crop Output in India: 1951-54 to 1958-61—An Analysis by Component Elements", *Journal of the Indian Society of Agricultural Statistics*, Vol. XVII, No. 2, December 1965, pp. 230-252.

contributed by yield growth and the remaining 50 per cent by area growth (20 per cent) and crop pattern changes (13 per cent) and interaction between yield changes and cropping pattern changes (20 per cent). The crop output growth in Rajasthan was nearly entirely explained by area growth (53 per cent) and yield growth (43 per cent). Nearly two-thirds of the growth in crop output in Bihar was due to the contributions made by yield growth, and the contributions of area and crop pattern were small. In Uttar Pradesh, yield growth explained about 50 per cent of the growth in crop output, area growth explained about 26 per cent and crop pattern changes about 14 per cent. Major contributions to crop output growth in Andhra Pradesh came from yield growth (43 per cent) and crop pattern changes (35 per cent). In Maharashtra, the contribution from yield growth was negligible, crop pattern changes and area growth were the major contributing factors to the output growth.

Despite the variations in the relative contributions of component elements, the common feature that emerges from the decomposition analysis is that with the notable exception of Maharashtra, a significant portion of output growth in these States is explained by yield increases.

IV

MEASUREMENT OF CHANGES IN CROPPING PATTERN INTO SUBSTITUTION AND EXPANSION EFFECTS

By comparing the area growth rates in individual crops with the growth rate that occurred in the gross cropped area, we suggest in this section a method for measuring the 'aggregate' change in the cropping pattern in terms of 'substitution' and 'expansion' effects.

If we define an unchanged cropping pattern as a situation where the respective areas under all crops bear the same proportion to the gross cropped area over the years, then it implies that the rate of growth in area under individual crops must equal the rate of growth in the gross cropped area over the same time period. We can express such a change in the form of a linear homogeneous gross cropped area function, where given proportionate changes in area under individual crops are related to equal proportionate change in the gross cropped area. The rates of growth in the area of individual crops which differ from the rate of growth of gross cropped area therefore provide evidence of change in the cropping pattern. The 'area'-gross cropped area elasticity which can be defined either as the ratio of the rate of growth of area under a crop to the rate of growth in the gross cropped area, or as the ratio of the area under the crop to the gross cropped area after and before the change can be used to measure the shift in the cropping pattern.

On the basis of "area-gross cropped area elasticities" we can distinguish the individual crops into three categories.

Category 1: Crops whose area growth rates are equal to or exceed the rate of growth of gross cropped area, *i.e.*, their elasticities being equal to one or more than one.

Category 2: Crops whose area growth rates are less than that of gross cropped area but positive, *i.e.*, their elasticities being positive, but less than one.

Category 3: Crops whose area growth rates are negative, *i.e.*, their elasticities being less than zero.

We consider the differential elasticities above-mentioned to reflect the fact that crops falling in category 1 and 2 gain in area partly at the expense of area from category 3 crops.

The total change in the cropping pattern over time is the sum total of the substitution effect—the relative decline in area under some crops and corresponding equivalent increase in area under other substitutable crops for a given gross cropped area and the expansion effect (effect of increase in the gross cropped area).

We consider the total decline in acreage under category 3 crops to measure the substitution effect of the aggregate cropping pattern change. The increase in area under category 1 and 2 crops, we consider, is the sum total of the substitution and expansion effects. The substitution part of the gain in acreage under the aggregate of category 1 and 2 crops may be taken to have been derived at the expense of the aggregate of category 3 crops. This permits us to 'separate' the total gain in acreage that took place in category 1 and 2 crops in terms of substitution and expansion effects, and thereby in arriving at the 'expansion effect' of the aggregate change in the cropping pattern.

The exercise we have suggested above for measuring the 'aggregate' change in the cropping pattern in terms of 'substitution' and 'expansion' effects may be done for irrigated and rainfed portions of gross cropped area separately. The results of this exercise are shown in Table IV.[6]

The empirical evidence presented in Table IV shows that there was decrease in area under several rainfed crops in all the States except Rajasthan, and an increase in area under several irrigated crops in all the States. The increase in area under irrigated crops was the joint result of increase made possible partially by loss of acreage under rainfed crops and partially through an increase in the gross cropped area.

V

SUMMARY AND CONCLUSION

An inter-State comparison of changes that occurred in the cropping pattern in the six States: Punjab, Rajasthan, Uttar Pradesh, Bihar, Maharashtra and Andhra Pradesh enables us to identify the factors which were conducive to more rapid rates of crop output growth in some States and how they were a constraint on output growth in other States.

6. It needs to be pointed out that our arithmetic of total change in the cropping pattern due to substitution and expansion effects in these six States does not tally exactly with the aggregate absolute change in their gross cropped area over the years. The differences arise because of aggregation and accounting errors and due to the non-consideration of all the individual crops grown in the States.

TABLE IV—CROPPING PATTERN CHANGES IN SIX STATES—SUBSTITUTION AND EXPANSION EFFECTS ON CROP AREAS

(thousand hectares)

Crop	Punjab				Rajasthan				Uttar Pradesh			
	I		R		I		R		I		R	
	S	T	S	T	S	T	S	T	S	T	S	T
Rice ..	—	516	—13	—	—	51	—	33	—	614	—	609
Jowar ..	—8	—	—96	—	—12	—	—	175	—10	—	—272	—
Bajra ..	—	89	—122	—	—	73	—	2268	—	5	—96	—
Maize ..	—	307	—18	—	—20	—	—	337	—	179	—	530
Barley ..	—	104	—77	—	—	84	—	31	—259	—	—462	—
Wheat ..	—	2252	—317	—	—	624	—	84	—	2876	—50	—
Total pulses ..	—49	—	—528	—	—	212	—	1220	—115	—	—826	—
Total oilseeds	—	—	—	51	—	—	—	438	—	—	—	1994
Cotton ..	—	353	—39	—	—	116	—2	—	—	3	—14	—
Sugarcane ..	—	147	—10	—	—	—	—	—	—	349	—	69
Aggregate area (irrigated × rainfed)	S = —1277 T = 3819				S = —34 T = 5746				S = —2104 T = 7228			

(Contd.)

TABLE IV *(Concld.)*

Crop	Bihar				Maharashtra				Andhra Pradesh			
	I		R		I		R		I		R	
	S	T	S	T	S	T	S	T	S	T	S	T
Rice ..	—	379	—127	—	—	102	—	207	—	1269	—92	—
Jowar ..	—	—	—	—	—	125	—	400	—	5	—	186
Bajra ..	—	—	—	—	—	35	—	75	—	5	—70	—
Maize ..	—	11	—	304	—	—	—	—	—	46	—	70
Barley ..	—14	—	—147	—	—	—	—	—	—	—	—	—
Wheat ..	—	734	—	178	—	211	—175	—	—	—	—	—
Total pulses ..	—36	—	—201	—	—	17	—	158	—	—	—	—
Total oilseeds	—	—	—68	—	—	—	—160	—	—	174	—	394
Cotton ..	—	—	—	—	—	70	—	367	—	4	—200	—
Sugarcane ..	—	19	—15	—	—	163	—	—	—	111	—9	—
Aggregate area (irrigated × rainfed)	S = —608 T = 1625				S = —336 T = 1930				S = —371 T = 2264			

Note:— I = Irrigated, R = Rainfed, S = Substitution effect, T = Total effect,

∴ Expansion effect = T — S.

Figures estimated by multiplying the crop area in the initial triennium with the growth in crop area over the 25-year period.

The relative acreage under foodgrains and non-foodgrains in the Punjab remained stationary over the period 1950-75, but the relative shares of wheat and rice among foodgrains and that of cotton among non-foodgrains improved. The favourable factors for their growth either singly or jointly were the use of high-yielding varieties (HYV), fertilizers and irrigation. Punjab had the highest percentage of irrigated crop area, nearly 65 per cent of the net cropped area was irrigated in 1974-75, and the intensity of cropping was quite high, *i.e.*, 141.2 in 1974-75. In short, crop output growth in Punjab was largely the result of technological transformation aided by the spread of HYV crops and irrigation.[7]

In contrast to the Punjab, in Rajasthan the percentage of net cropped area irrigated was only 19 per cent in 1974-75. The intensity of cropping was also very low, 112.5 in 1974-75. The major limitational factor in Rajasthan for growth in yield and crop output is the large portion of desert soil with low productivity. Unlike in Punjab, in Rajasthan the share of foodgrain crops in the gross cropped area, bajra in particular, increased considerably. This development in Rajasthan unmistakably reflects the increase of subsistence agriculture and the growing disparity in farming conditions and farm incomes between States like Punjab and Rajasthan.

Turning to Uttar Pradesh, it is to be pointed out that in comparison to many other States, a relatively high proportion of net cropped area is irrigated, 45 per cent in 1974-75. The cropping intensity is also quite high, 132.7 in 1974-75. But the bulk of multiple cropped area is rainfed; apparently the irrigation facilities are not adequate to raise more than one crop a year. Despite the increases in irrigated area in the State, the growth in yields were low, in marked contrast to the performance in Punjab.

Compared to Uttar Pradesh, the yield increases in Bihar were distinctly impressive, though the overall performance was very much behind the Punjab. It is worth noting that nearly two-thirds of the growth in crop output in Bihar was contributed by yield increases.

The soil and climatic conditions in Maharashtra are such that they contribute to an inferior crop pattern and relatively low yields for most crops. Besides, the percentage of net cropped area irrigated is low, about 9 per cent in 1974-75. It is quite clear that agriculture in this State cannot register progress unless irrigation is provided over much wider areas and the new seeds are suitable and economical for adoptation under unirrigated conditions.[8]

The main changes in the cropping pattern that occurred in Andhra Pradesh during the period 1950-75 were the improvements in the relative shares of rice, maize and sugarcane (the latter two crops however occupied small shares in the gross cropped area). Yield increases and/or the spread of irrigation were the main contributing factors for their area growth, and consequently in the growth of their output.

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7. Venkataramanan and Prahladachar, *op. cit.*
8. Nilakantha Rath, "Performance of Agriculture in Maharashtra, 1960-1972", Gokhale Institute of Politics and Economics, Pune, 1977 (mimeo.).