AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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1. SUBJECT CLASSIFICATION

A. PRIMARY: Economics

B. SECONDARY: Agricultural economics

2. TITLE AND SUBTITLE

Estimates of foodgrain production and marketings from input estimates, India, 1949/50 India, 1949/50 to 1973/1974 and projections to 1983/1984

3. AUTHOR(S)

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4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1975	34 p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

Department of Agricultural Economics, Warren Hall, Cornell University, Ithaca, New York 14850

8. SUPPLEMENTARY NOTES (*Sponsoring Organization, Publishers, Availability*)

(In Occasional paper no.83)

9. ABSTRACT

Food grain production for specific years and hence trends over short periods of time are influenced strongly by random variations in weather, thus making it difficult to detect trends in production and the various causal factors in those trends. Indian food grain production analysis has been made from four key inputs -- irrigated land, unirrigated land, labor, and inorganic fertilizer. The input analysis has been chosen for its advantage in utilizing readily available and easily substantiated data. Further, this approach provides a quantitative measure of the structur change in sources of production and the basis for estimating change in marketir. This paper is divided into three sections. The first analyzes the food grain production and marketing record from 1949/50 to 1973/74. The second offers projections, based on past trends, of potential production and marketing from 1970/71 to 1983/84. The third contrasts these trends with official production data and summarizes the implications for future policy.

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAB-930	

12. DESCRIPTORS

Estimating
Grain crops
India
Marketing
Productivity

13. PROJECT NUMBER

14. CONTRACT NUMBER: AID/ta-C-1131 Res.

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

September, 1975

ESTIMATES OF FOODGRAIN PRODUCTION AND MARKETING FROM INPUT ESTIMATES, INDIA, 1949/50 TO 1973/74 AND PROJECTIONS TO 1983/84

By

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Occasional Paper No. 83
Technological Change in Agriculture Project
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Research supported by Contract No. AID/ta-c-1131
"Analysis of Direct and Indirect Effects of Technological Change in Agriculture"
Cornell University and the United States Agency for International Development

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ESTIMATES OF FOODGRAIN PRODUCTION AND MARKETINGS FROM INPUT ESTIMATES, INDIA, 1949/50 TO 1973/74 AND PROJECTIONS TO 1983/84

by

John W. Mellor, Uma J. Lele
Debra Biamonte and Arthur Goldsmith*

Foodgrain production for specific years and hence trends over short periods of time are strongly influenced by random variations in weather, thus making it difficult to detect trends in production and the various causal factors in those trends. This is particularly true in India, where the vagaries of the monsoon lead to substantial annual fluctuations in aggregate production and hence to uncertainty as to the success of past efforts at agricultural development. Moreover, the haziness of the past record obscures appraisal of the potential for increasing the production of foodgrains in the near future.

An accurate appraisal of the medium and long term trend in Indian foodgrain production is of particular importance in the mid-1970s. First, the recent drop in world stocks coupled with ever-mounting consumption sharply limit India's ability to import foodgrains--both because high prices may place an unbearable strain on foreign exchange and because the supplies to meet emergency needs may not be available. Second, the current humanitarian concern with involving the poorest segments of the population in economic growth requires policies to make foodgrains available in greater quantities than in the past. Not only must foodgrain production be increased to meet population growth, it must increase at an accelerated rate to involve the poor in the nation's development. Foodgrains are the primary wage good of India's poor,

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*This paper represents an updating of original work done by Lele and Mellor, with additional calculations on foodgrain marketing. Biamonte and Goldsmith prepared the updated estimates and the bulk of the text.

providing an estimated 59 percent of incremental expenditures of the lowest quintile in income distribution. An improved standard of living for the impoverished classes can only come about through large net increases in foodgrain production, facilitating rural employment, higher rates of food consumption, and the release of expenditures to other sectors of the economy. By contrast, static or slowly growing foodgrain production will constrain rural development by limiting consumption, employment, and income.[1/]

To come to grips with past trends and future potentials in Indian foodgrain production analysis has been made of four key inputs--irrigated land, unirrigated land, labor and inorganic fertilizer. A response coefficient, based primarily on data for 1949/50, has been attached to each input such that the sum of the four inputs and their respective response coefficients provide an estimate of total output in that year. (The derivation of these coefficients is explained below.) All other inputs, such as organic fertilizer, improved seed varieties and mechanization are assumed to move proportionately with these four key inputs. Based on the resulting production estimates, and using some additional assumptions, estimates have also been made of annual foodgrain marketings.

The response coefficients used in this exercise were first developed by Uma Lele in 1963 to evaluate the success of the Second-Five Year Plan in accelerating agricultural output.[2/] The resulting calculations

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[1/] For details, see John W. Mellor, India and the New Economics of Growth (The Twentieth Century Fund, forthcoming).

[2/] For a detailed discussion of the methods of calculation and assumptions used, see Uma J. Lele, "Alternative Estimates of Change in Foodgrains Production, India, 1949-50 to 1960-61," (Unpublished Master's Thesis, Dept. of Agricultural Economics, Cornell University, January, 1963). See also, Uma J. Lele and John W. Mellor, Estimates of Change and Causes of Change in Foodgrains Production, India, 1949-50 to 1960-61, International Agricultural Development Bulletin No. 2, Cornell University (August, 1964); and John W. Mellor and Uma J. Lele, "Alternative Estimates of the Trend in Indian Foodgrains Production During The First Two Plans," Economic Development and Cultural Change, XIII:2, (January, 1965), Pp. 217-232.

proved surprisingly consistent with Lele's other estimates, made by fitting regressions to various years and by independently estimating changes in demand and price relationships. Subsequent evidence supported the accuracy of these results. Of the various estimating procedures used by Lele, the input analysis has been chosen for its advantage in utilizing readily available and easily substantiated data. Further, this approach provides a quantitative measure of the structural change in sources of production and the basis for estimating change in marketing.

This paper is divided into three sections. The first analyzes the foodgrain production and marketing record from 1949/50 to 1973/74. The second offers projections, based on past trends, of potential production and marketings from 1970/71 to 1983/84. The third contrasts these trends with official production data and summarizes the implications for future policy.

Estimates of Foodgrain Production, 1949/50 to 1973/74

Land

Estimates of area under foodgrains (through 1969/70) and irrigated area under foodgrains (through 1967/68) are from various issues of the Statistical Abstract of India.[3/] The total area for 1970/71 to 1973/74 and irrigated area for 1968/69 to 1970/71 were taken from Indian Agriculture in Brief and current issues of Agricultural Situation in India.[4/]

[3/] See Statistical Abstract of India (New Delhi: Government of India, Central Statistical Organisation). Whenever data has been taken from official sources, the most recently published data has been used.

[4/] See Indian Agriculture in Brief: 11th Edition (New Delhi: Government of India, Directorate of Economics and Statistics, 1971); Indian Agriculture in Brief: 13th Edition (New Delhi: Government of India, Directorate of Economics and Statistics, 1974); and Government of India, Directorate of Economics and Statistics, Agricultural Situation in India, 29:8 (November 1974).

At the time of consumption, data for irrigated area were not available for 1971/72 to 1973/74. These years were therefore derived, using the compound growth rate of all irrigated agricultural acreage for the nine years 1960/61 through 1969/70 of 2.4 percent. This is a conservative estimate, as irrigated foodgrain acreage grew at 3.3 percent during that period. Unirrigated area was assumed to be equal to total area minus irrigated area (Table 1).

Based on Lele's estimates, 30 percent was assumed to be the yield increment expected from irrigated acreage as compared to unirrigated acreage.[5/] This is of course the expected increment in production from irrigation without change in fertilizer use or related crop varietal change. The response coefficients per hectare of irrigated and unirrigated land were then calculated as follows:

Total Production, 1949/50 = (Unirrigated land, 1949/50 x response coefficient)
+ (Irrigated land, 1949/50 x 1.3 response coefficient)

$$60.8 \text{ metric tons} = (81{,}732 \times Z) + (17{,}550 \times 1.3\ Z)$$
$$= 104{,}574\ Z$$
$$Z = 0.5815$$
$$1.3\ Z = 0.7559$$

Using a response coefficient of 0.7559 metric tons/hectare on irrigated land and 0.5815 metric tons/hectare on unirrigated land, the total production attributed to land was calculated, and is presented in Table 1. This approach attributes all output in the base year to land and its implicit complement of other inputs. Increase in output over the base period is then due to additions of land and per hectare additions of labor and inorganic fertilizer over the amounts implicitly used in the base period.

[5/] See Lele, op. cit., p. 83.

Table 1. Gross Area and Production Attributed to Land under Foodgrains, India, 1949/50 to 1973/74

Year	Area			Production		
	Unirrigated	Irrigated	Total	Unirrigated	Irrigated	Total
	(million hectares)			(million metric tons)		
1949/50	81.7	17.5	99.3	47.5	13.3	60.8
1950/51	79.0	18.3	97.3	45.9	13.8	59.8
1951/52	78.8	18.2	97.0	45.8	13.8	59.6
1952/53	83.1	19.0	102.1	48.3	14.4	62.7
1953/54	89.0	20.0	109.1	51.8	15.1	66.9
1954/55	87.7	20.1	107.9	51.0	15.2	66.2
1955/56	89.9	20.6	110.6	52.3	15.6	67.9
1956/57	90.7	20.4	111.1	52.7	15.5	68.2
1957/58	88.3	21.2	109.5	51.4	16.0	67.3
1958/59	93.3	21.5	114.8	54.3	16.2	70.5
1959/60	94.0	21.8	115.8	54.6	16.5	71.2
1960/61	93.5	22.1	115.6	54.4	16.7	71.1
1961/62	94.8	22.4	117.2	55.1	17.0	72.1
1962/63	94.4	23.4	117.8	54.9	17.7	72.6
1963/64	94.1	23.3	117.4	54.7	17.6	72.3
1964/65	94.2	23.9	118.1	54.8	18.1	72.9
1965/66	90.8	24.3	115.1	52.8	18.3	71.2
1966/67	89.5	25.8	115.3	52.0	19.5	71.6
1967/68	95.3	26.1	121.4	55.4	19.7	75.2
1968/69	92.4	28.0	120.4	53.7	21.2	74.9
1969/70	94.0	29.5	123.6	54.7	22.3	77.0
1970/71	92.7	31.6	124.3	53.9	23.9	77.8
1971/72	90.2	32.4	122.6	52.5	24.5	77.0
1972/73	86.1	33.2	119.3	50.1	25.1	75.2
1973/74	92.2	34.0	126.1	53.5	25.7	79.2

Errors in summation due to rounding.

SOURCE: Total area: 1949/50 through 1969/70: Statistical Abstract of India (Delhi: Government of India, Central Statistical Organisation) various issues. 1970/71, 1971/72: Estimates of the Area and Production of Principle Crops in India, 1972/73 (New Delhi: Government of India, Directorate of Economics and Statistics. 1972/73 and 1973/74: Agricultural Situation in India 29:8 November 1974). Irrigated area: 1949/50 through 1967/68: Statistical Abstract of India, op. cit., various issues. 1969/70: Indian Agriculture in Brief, op. cit., 1973. 1970/71: Estimates of Area and Production of Principle Crops in India, op. cit.. 1971/72 to 1973/74 projection of 1960/61-1969/70 growth rate, see text. Unirrigated area: Total area - irrigated area.

Labor

The agricultural working population figures for 1951 and 1961 were taken directly from the Indian census. Due to changes in the definitions used in the 1971 census, women and landless laborers were substantially underestimated compared to the 1961 census. The 1971 agricultural working population figure was therefore estimated, as suggested by Krishnamurty, by assuming an overall participation rate decline from 43 percent to 40 percent during the preceding decade; and assuming that 85 percent of the workers added work in agriculture.[6/] Using the respective compound growth rates between these three given years (1951, 1961 and 1971), agricultural working population estimates for the intermediate years were derived. The growth rate for 1951-1961 was also used to determine figures prior to 1951 (Table 2).

In determining the labor use in agriculture, a weighted average of labor use estimates in 1954/55 in five states of India was used, in which gross land under cultivation represented the weights.[7/] The resulting coefficient of 1.53 months/acre or 3.779 months/hectare was multiplied by the gross land under cultivation in 1954/55 to give the total labor use in agriculture. This, then, was divided by the agricultural working population to give an average of 5.117 months or 153.5 days per laborer.

The proportion of total agricultural working population allocated to foodgrains was then determined by assuming that the ratio of labor use in foodgrains to total labor use in agriculture was the same as the ratio of land under foodgrains to total cultivated land. For the years 1971/72 to 1973/74 the respective ratio for land was not available. Therefore, on

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6/ For discussion of underestimation of the agricultural working population in the 1971 census, and the assumptions used here, see J. Krishnamurty, "Working Force in 1971 Census: Some Exercises on Provisional Results," Economic and Political Weekly, VII:3, (January 15, 1972), Pp. 115-118.

7/ The weighted average was calculated by Dan Maxwell Etherington, "Structural Changes in Peasant Agriculture, A Comparative Study of Indian and Japanese Farm Data," (Unpublished Master's Thesis, Dept. of Agricultural Economics, Cornell University, February, 1962).

Table 2. Estimated Labor Use in the Production of Foodgrains, India, 1949/50 to 1973/74

Year	Total Agricultural Working Population	Labor Use on:				Intensification Labor
		Agricultural Acreage	Foodgrains Acreage	Unirrigated Foodgrains Acreage	Irrigated Foodgrains Acreage	
	(millions)	(million man-days)				
1949/50	91.7	14,073.2	10,744.9	8,261.4	2,483.5	0.0
1950/51	94.4	14,498.4	10,698.4	7,985.6	2,592.0	120.7
1951/52	97.3	14,937.5	10,871.5	7,961.7	2,575.3	334.5
1952/53	100.2	15,388.9	11,412.4	8,395.8	2,693.5	323.1
1953/54	103.3	15,855,6	12,137.4	9,000.8	2,833.0	303.6
1954/55	106.4	16,334.6	12,228.0	8,866.6	2,850.0	511.4
1955/56	109.6	16,828.9	12,630.1	9,090.4	2,918.8	620.9
1956/57	112.9	17,338.6	12,889.5	9,166.1	2,894.3	829.0
1957/58	116.4	17,863.6	13,410.2	8,927.0	2,994.8	1,488.4
1958/59	119.9	18,404.0	13,930.0	9,431.1	3,036.8	1,462.1
1959/60	123.5	18,961.3	14,370.8	9,499.3	3,091.1	1,780.3
1960/61	127.2	19,535.4	14,780.5	9,452.5	3,122.4	2,205.6
1961/62	131.1	20,126.5	15,104.9	9,580.7	3,176.6	2,347.6
1962/63	133.5	20,490.3	15,402.6	9,547.3	3,309.9	2,545.3
1963/64	135.9	20,860.3	15,605.6	9,509.7	3,302.7	2,793.2
1964/65	138.3	21,236.5	15,753.2	9,518.5	3,388.2	2,846.5
1965/66	140.8	21,620.3	16,027.1	9,182.6	3,432.6	3,411.9
1966/67	143.4	22,010.2	16,181.9	9,042.5	3,656.9	3,482.5
1967/68	146.0	22,407.8	16,689.3	9,634.5	3,694.0	3,360.8
1968/69	148.6	22,813.1	17,201.1	9,337.5	3,969.6	3,854.0
1969/70	151.3	23,224.5	17,511.3	9,503.6	4,181.3	3,825.4
1970/71	154.0	23,645.2	17,568.4	9,359.8	4,462.0	3,746.6
1971/72	156.8	24,072.0	17,933.6	9,112.1	4,569.0	4,252.5
1972/73	159.6	24,506.4	18,257.3	8,695.7	4,678.7	4882.9
1973/74	162.5	24,948.6	18,586.7	9,307.2	4,791.0	4488.5

Errors in summation or computation due to rounding.

SOURCE: Agricultural working population: 1951, 1961 from Census of India. 1971, see text for derivation. Intermediate years calculated using compound growth rates between 1951, 1961 and 1971, respectively. 1951/52 fiscal year refers to 1951 calendar year and so on.

the basis of the calculated ratios for 1961/62 to 1970/71 74.5 was chosen as the ratio of foodgrain area to total area for those particular years (Table 2).

The amount of additional labor used on irrigated land relative to unirrigated land varies with each crop and the type of irrigation used. A weighted average of the amount of additional labor input required on irrigated land for four crops -- rice, jowar, bajra, and ragi -- of 40 percent was used to estimate the additional labor required per irrigated hectare.[8/] The percent contribution to total production in 1949/50 by each of these four crops represented the weights. Although these crops constituted only 63 percent of the total foodgrains production in 1949/50, lack of additional data forces use of the weighted average calculated as above.

Labor per hectare on unirrigated and irrigated land was then determined as follows:

Total labor flow, 1949/50 = (Unirrigated land, 1949/50 x labor per hecta
+ (Irrigated land, 1949/50 x 1.4 labor per hectare)

$$10{,}741 = (81{,}732 \times Z) + (17{,}550 \times 1.4\ Z)$$

$$= 106{,}302\ Z$$

$$Z = 0.101$$

$$1.4\ Z = 0.141$$

Using the coefficients of 0.101 days/unirrigated hectare and 0.141 days/irrigated hectare, the working population was allocated to unirrigated land and irrigated land respectively. The difference between labor use on irrigated plus unirrigated acreage and total labor use in foodgrains equals increased labor per hectare or intensification labor. Estimates of labor use are presented in Table 2.

[8/] See Lele, op. cit., p. 71.

In determining the response coefficient for labor, the relationship between labor and output was assumed to be linear. The marginal productivity of labor was assumed to be positive and equal to the wage rate, and therefore the response coefficient of labor was assumed to be the same as the marginal productivity of labor. A wage rate of Rs. 1.50 per day, calculated as the weighted average of the wages of field laborers in 1951/52, was used.[9/] Thus it is assumed that labor participation rates remained constant over time, that labor beyond that needed to provide for new irrigated and unirrigated acreage at the base period level of use would represent increased use of labor per hectare and that a response coefficient would be needed for that labor. Response to labor used on added area at the base period of intensity is implicitly included in the response to that increase in area.

The wage rate times total labor flow gave the total value product (TVP):

1.5 Rs./day x 10,744 million man-days = 16,117.3 Rs. million = TVP

A weighted average of harvest prices of all foodgrains for the year 1949/50 provided an average price of Rs. 440.3144 per long ton or Rs. 443.3803 per metric ton.[10/] This figure was then taken to calculate the total physical production (TPP):

$$\frac{TVP_x}{P_x} = \frac{16,117.3}{433.3803} = 37.1898 \text{ million metric tons} = TPP$$

The response coefficient was then determined as follows:

$$\frac{TPP}{\text{Total labor flow}} = \frac{37.1898}{10,744} = 0.00346 \text{ metric tons per man-day of labor input.}$$

[9/] Ibid., pp. 73-79.

[10/] Ibid., p. 78.

The estimated total returns were then calculated and are presented in Table 3.

Inorganic Fertilizer

In estimating fertilizer use, estimates of nitrogen, phosphorus and potassium were used. Figures for consumption, distribution and availability, preferentially in that order, were used. Data for 1949/50 through 1951/52 were taken from the Food and Agriculture Organization, and are estimates of availability.[11/] Data for 1952/53 through 1973/74 are from Fertiliser Statistics, published by the Fertiliser Association in India.[12/] Figures for 1952/53 through 1966/67 are of distribution and those for 1967/68 through 1973/74 are of consumption. When using estimates of availability and distribution, all available or distributed fertilizer respectively, was assumed to be consumed.

The percent of total fertilizer allocated to foodgrains was estimated to be 61 percent by the Government of India in the Third Five-Year Plan.[13/] Gunvant M. Desai has estimated that 73 percent of total fertilizer was allocated to foodgrains in 1969/70.[14/] Therefore, 61 percent was arbitrarily assumed to be the percentage allocation to foodgrains through 1961/62. The compound growth rate between 1961/62 (at 61 percent) and 1969/70 (at 73 percent) was then calculated to determine percentage allocation in the intermediate years. In the years following 1969/70, 73 percent of fertilizer was assumed allocated to foodgrains.

11/ See An Annual Review of the World Production and Consumption of Fertilizers, 1949-50 to 1959-60 (Rome: United Nations, Food and Agriculture Organization).

12/ See Fertiliser Statistics, 1973/74 (New Delhi: Fertiliser Association of India, December, 1974), Table 7.01.

13/ See Lele and Mellor, op. cit., 1964, p. 30.

14/ See Gunvant M. Desai, "Nitrogen Use and Foodgrain Production, India, 1973-74, 1978-79 and 1983-84," Dept. of Agricultural Economics, Occasional Paper No. 55, Cornell University-USAID Employment and Income Distribution Research Project (forthcoming).

Table 3. The Calculated Effect of Labor Input on Foodgrain Production, India, 1949/50 to 1971/72

Year	Labor on Unirrigated Land	Labor on Irrigated Land	Intensification Labor	Total
		(million metric tons)		
1949/50	28.6	8.6	0.0	37.2
1950/51	27.6	9.0	0.4	37.0
1951/52	27.6	8.9	1.2	37.6
1952/53	29.1	9.3	1.1	39.5
1952/54	31.1	9.8	1.0	42.0
1954/55	30.7	9.9	1.8	42.3
1955/56	31.5	10.1	2.1	43.7
1956/57	31.7	10.0	2.9	44.6
1957/58	30.9	10.4	5.1	46.4
1958/59	32.6	10.5	5.1	48.2
1959/60	32.9	10.7	6.2	49.7
1960/61	32.7	10.8	7.6	51.2
1961/62	33.2	11.0	8.1	52.3
1962/63	33.0	11.5	8.8	53.3
1963/64	32.9	11.4	9.7	54.0
1964/65	32.9	11.7	9.8	54.5
1965/66	31.8	11.9	11.8	55.5
1966/67	31.3	12.7	12.0	56.0
1967/68	33.3	12.8	11.6	57.8
1968/69	32.3	13.7	13.3	59.3
1969/70	32.9	14.5	13.2	60.6
1970/71	32.4	15.4	13.0	60.8
1971/72	31.5	15.8	14.7	62.0
1972/73	30.1	16.2	16.9	63.2
1973/74	32.2	16.6	15.5	64.3

Errors in summation and computation due to rounding.

A 10 to 1 response coefficient was used to determine the returns to fertilizer, that is 10 tons of foodgrain production per 1 ton of fertilizer nutrients applied.[15] Allocation of fertilizer to foodgrains and the resultant foodgrains production are given in Table 4.

Table 5 presents estimates of foodgrain production, attributed to the inputs of irrigated land, unirrigated land, labor and fertilizer.

Estimate of Marketings from the Foodgrain Sector, 1949/50 to 1971/72

Estimates of marketings from the foodgrain production sector are based on the production estimates, and assumptions with respect to income levels and expenditure or consumption patterns of the recipients of the production.[16] For these estimates, the inputs were separated into three categories--total labor (on irrigated and unirrigated acreage, and intensification labor); total land (irrigated and unirrigated); and fertilizer. It was assumed that output attributable to each input was paid to that input and that a particular expenditure pattern characterized each of these classes. Thus it was assumed that 30 percent of the returns to labor would be marketed and hence 70 percent consumed in the household. This is similar to the average propensity to spend on foodgrains of 63 percent for the lowest

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[15] See Lele and Mellor, op. cit., 1964, pp. 30-33.

[16] For the theory behind these assumptions, see Uma J. Lele and John W. Mellor, "Technological Change and Distributive Bias in a Dual Economy," Dept. of Agricultural Economics, revised Occasional Paper No. 43, Cornell University-USAID Employment and Income Distribution Research Project, (October, 1972); and John W. Mellor, "Models of Economic Growth and Land-Augmenting Technological Change in Foodgrain Production," in Nurul Islam (ed.) Agricultural Policy in Developing Countries, (London: The Macmillan Press, 1974). For empirical data as to the assumptions see John W. Mellor and Uma J. Lele, "Growth Linkages of the New Foodgrain Technologies," Indian Journal of Agricultural Economics, XXVIII:1, (Jan.-Mar., 1973), 33-55. For corroboration of the outcome, see John W. Mellor and Mohinder S. Mudahar, "Simulating a Development Economy with Modernizing Agricultural Sector - Implications for Employment and Economic Growth," Dept. of Agricultural Economics, Occasional Paper No. 76, Cornell University-USAID Employment and Income Distribution Research Project, (June, 1974).

Table 4. Allocation and Increase in Production Due to Inorganic Fertilizer, India, 1949/50 to 1971/72

Year	Total Inorganic Fertilizer Consumption[a]	Inorganic Fertilizer Allocated to Foodgrains	Total Return on Inorganic Fertilizer
	(thousand metric tons)		(million metric tons)
1949/50	0.0	0.0	0.0
1950/51	36.4	22.2	0.2
1951/52	41.7	25.5	0.2
1952/53	65.7	40.1	0.4
1953/54	105.0	64.1	0.6
1954/55	120.9	73.8	0.7
1955/56	130.8	79.8	0.8
1956/57	153.7	93.8	0.9
1957/58	183.7	112.1	1.1
1958/59	223.8	136.5	1.4
1959/60	304.6	185.8	1.9
1960/61	293.9	179.3	1.8
1961/62	383.4	233.9	2.3
1962/63	477.9	298.1	3.0
1963/64	574.2	366.3	3.7
1964/65	652.6	425.8	4.3
1965/66	757.3	505.3	5.0
1966/67	1,203.0	821.1	8.2
1967/68	1,165.8	813.6	8.1
1968/69	1,674.6	1,195.4	11.9
1969/70	1,989.6	1,452.4	14.5
1970/71	2,177.3	1,589.4	15.9
1971/72	2,621.8	1,913.9	19.1
1972/73	2,698.8	1,970.1	19.7
1973/74	2,783.0	2,031.6	20.3

Errors in summation or computation due to rounding.

[a]Including nitrogen, phosphorus and potassium.

SOURCE: 1950/51, 1951/52: An Annual Review of the World Production and Consumption of Fertilizers (Rome: United Nations, Food and Agriculture Organization, 1949-50 to 1959-60). 1952/53 and after: Fertiliser Statistics, 1973-74 (New Delhi: The Fertiliser Association of India, December 1974).

Table 5. Annual and Cumulative Contribution of Various Inputs to Total Foodgrains Production, India, 1949/50 to 1971/72

Year	Unirrigated Land	Labor on Unirrigated Land	Irrigated Land	Labor on Irrigated Land	Intensification of Labor	Inorganic Fertilizer	Calculated Total Production
			(million metric tons)				
			Annual				
1949/50	18.9	28.6	4.7	8.6	0.0	0.0	60.8
1950/51	18.3	27.6	4.9	9.0	0.4	0.2	60.4
1951/52	18.2	27.6	4.8	8.9	1.2	0.2	61.0
1952/53	19.2	29.1	5.1	9.3	1.1	0.4	64.2
1953/54	20.6	31.1	5.3	9.8	1.0	0.6	68.6
1954/55	20.3	30.7	5.4	9.9	1.8	0.7	68.7
1955/56	20.8	31.5	5.5	10.1	2.1	0.8	70.8
1956/57	21.0	31.7	5.4	10.0	2.9	0.9	72.0
1957/58	20.5	30.9	5.6	10.4	5.1	1.1	73.6
1958/59	21.6	32.6	5.7	10.5	5.1	1.4	76.9
1959/60	21.8	32.9	5.8	10.7	6.2	1.9	79.2
1960/61	21.7	32.7	5.9	10.8	7.6	1.8	80.5
1961/62	22.0	33.2	6.0	11.0	8.1	2.3	82.6
1962/63	21.9	33.0	6.2	11.5	8.8	3.0	84.4
1963/64	21.8	32.9	6.2	11.4	9.7	3.7	85.7
1964/65	21.8	32.9	6.4	11.7	9.8	4.3	87.0
1965/66	21.0	31.8	6.5	11.9	11.8	5.0	88.0
1966/67	20.7	31.3	6.9	12.7	12.0	8.2	91.8
1967/68	22.1	33.3	6.9	12.8	11.6	8.1	94.9
1968/69	21.4	32.3	7.5	13.7	13.3	11.9	100.0
1969/70	21.8	32.9	7.8	14.5	13.2	14.5	104.7
1970/71	21.5	32.4	8.5	15.4	13.0	15.9	106.7
1971/72	21.0	31.5	8.7	15.8	14.7	19.1	110.8
1972/73	20.0	30.1	8.9	16.2	16.9	19.7	111.8
1973/74	21.3	32.2	9.1	16.6	15.5	20.3	115.0
			Cumulative				
1949/50	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1950/51	-0.6	-0.9	0.2	0.4	0.4	0.2	-0.4
1951/52	-0.7	-1.0	0.2	0.3	1.2	0.2	0.2
1952/53	0.3	0.5	0.4	0.7	1.1	0.4	3.4
1953/54	1.7	2.6	0.7	1.2	1.0	0.6	7.8
1954/55	1.4	2.1	0.7	1.3	1.8	0.7	7.9
1955/56	1.9	2.9	0.8	1.5	2.1	0.8	10.0
1956/57	2.1	3.1	0.8	1.4	2.9	0.9	11.2
1957/58	1.5	2.3	1.0	1.8	5.1	1.1	12.8
1958/59	2.7	4.0	1.0	1.9	5.1	1.4	16.1
1959/60	2.8	4.3	1.1	2.1	6.2	1.9	18.4
1960/61	2.7	4.1	1.2	2.2	7.6	1.8	19.7
1961/62	3.0	4.6	1.3	2.4	8.1	2.3	21.8
1962/63	2.9	4.4	1.6	2.9	8.8	3.0	23.6
1963/64	2.9	4.3	1.5	2.8	9.7	3.7	24.9
1964/65	2.9	4.3	1.7	3.1	9.8	4.3	26.2
1965/66	2.1	3.2	1.8	3.3	11.8	5.0	27.2
1966/67	1.8	2.7	2.2	4.1	12.0	8.2	31.0
1967/68	3.1	4.8	2.3	4.2	11.6	8.1	34.1
1968/69	2.5	3.7	2.8	5.1	13.3	11.9	39.3
1969/70	2.8	4.3	3.1	5.9	13.2	14.5	43.9
1970/71	2.6	3.8	3.8	6.8	13.2	15.9	45.9
1971/72	2.1	2.9	4.0	7.2	14.7	19.1	50.0
1972/73	1.1	1.5	4.2	7.6	16.9	19.7	51.0
1973/74	2.4	3.3	4.4	8.0	15.5	20.3	54.2

Errors in summation or computation due to rounding.

two deciles in the income distribution.[17] It assumes that growth in payments to labor have increased roughly in proportion to labor force growth and therefore do not represent increases in per capita income. In contrast, it is assumed that increased returns to land went to landowners with higher per capita incomes. Using the marginal propensity to consume of the 6th, 7th, and 8th deciles 16 percent of the returns to land was estimated to be home consumed and 84 percent marketed.[18] For fertilizer it was assumed that 30 percent of total returns to fertilizer was marketed to pay for the fertilizer; 10 percent of fertilizer returns were allocated to labor, 60 percent allocated to land. Thirty percent of that allocated to labor was assumed marketed; 84 percent of that allocated to land was assumed marketed.

Estimates, based on these assumptions, of total marketings from the foodgrain sector for 1949/50 through 1973/74 are presented in Table 6.

Estimates of Production, 1970/71 to 1983/84

In projecting estimates of foodgrain production through 1983/84, a similar method of calculation to that used in estimating production from 1949/50 through 1973/74 was followed.

In many cases, compound growth rates were used to project the estimates of production. The most recent year for which official data was available provided the base year for the growth rates, i.e. 1973/74 total land and fertilizer consumption and 1970/71 for irrigated area. The

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[17] For discussion of consumption patterns in India, see B. M. Desai, Analysis of Consumption Expenditure Patterns in India, Dept. of Agricultural Economics, Occasional Paper No. 54, Cornell University USAID Employment and Income Distribution Research Project, (August, 1972).

[18] Ibid.

Table 6. Contribution of Various Inputs to Total Marketings from the Foodgrain Sector, India, 1949/50 to 1973/74

Year	Labor[a]	Land[b]	Fertilizer[c]	Total
	(million metric tons)			
1949/50	11.2	19.8	0.0	31.0
1950/51	11.1	19.6	0.1	30.8
1951/52	11.3	19.5	0.1	30.9
1952/53	11.9	20.6	0.1	32.6
1953/54	12.6	22.1	0.2	34.9
1954/55	12.7	21.9	0.2	34.9
1955/56	13.1	22.5	0.2	35.9
1956/57	13.4	22.7	0.3	36.4
1957/58	14.0	22.5	0.3	36.8
1958/59	14.5	23.6	0.4	38.6
1959/60	15.0	24.1	0.6	39.6
1960/61	15.4	24.0	0.5	40.0
1961/62	15.7	24.6	0.7	41.1
1962/63	16.1	25.1	0.9	42.1
1963/64	16.3	25.4	1.1	42.8
1964/65	16.5	25.8	1.3	43.6
1965/66	16.8	25.6	1.5	44.0
1966/67	17.0	27.3	2.5	46.8
1967/68	17.6	28.5	2.4	48.5
1968/69	18.2	30.3	3.6	52.1
1969/70	18.6	32.2	4.4	55.2
1970/71	18.7	33.2	4.8	56.7
1971/72	19.2	34.6	5.7	59.5
1972/73	19.6	34.2	5.9	59.7
1973/74	19.9	35.8	6.1	61.8

Errors in summation or computation due to rounding.

[a]Including the 10 percent of fertilizer returns that was assumed to be labor.

[b]Including the 60 percent of fertilizer returns that was assumed to be allocated to land.

[c]Includes only the 30 percent of total returns to fertilizer that was assumed to be marketed to pay for the fertilizer.

agricultural working population was projected on the base of the previously determined 1973/74 figure. Estimates of foodgrain production were again based on the four inputs of irrigated land, unirrigated land, labor and inorganic fertilizer. In each case, the response coefficients derived earlier were used.

Land

Estimates of total area through 1973/74 and irrigated area for 1970/71 were the same as those used in the previous discussion. The 1978/79 and 1983/84 estimates were taken from projections developed by Gunvant Desai.[19/] These projections, made by fitting semi-log growth curves to data on area under different crops during the 1960's, assume that recent trends in irrigation use and cropping patterns will continue through 1983/84. Using the respective compound growth rates between these years (1973/74 as the base year for total area, and 1970/71 as the base year for irrigated area), the figures for intermediate years were derived. Unirrigated acreage was assumed to be equal to total acreage minus irrigated acreage. The response coefficients of 0.7559 metric tons/irrigated hectare and 0.5815 metric tons/irrigated hectare were used to determine foodgrain production attributed to irrigated and unirrigated land respectively (Table 7).

Labor

Using the 1961-1971 growth rate of 1.8 percent calculated earlier, estimates of the agricultural working population were projected. Again multiplying by 153.5 man-days per laborer, the total labor use in agriculture was calculated. Following the procedure used in estimating labor use on foodgrain production for 1971/72 to 1973/74, 74.5 percent of total agricultural labor was assumed to be allocated to foodgrains (Table 8).

19/ See Gunvant M. Desai, op. cit.

Table 7. Gross Area and Production Attributed to Land Under Foodgrains, India, 1970/71 to 1983/84

Year	Area			Production		
	Unirrigated	Irrigated	Total	Unirrigated	Irrigated	Total
	(million hectares)			(million metric tons)		
1970/71	92.7	31.6	124.3	53.9	23.9	77.8
1971/72	90.5	32.1	122.6	52.6	24.3	76.9
1972/73	86.7	32.6	119.3	50.4	24.6	75.0
1973/74	93.1	33.0	126.1	54.1	25.0	79.1
1974/75	94.0	33.5	127.5	54.7	25.3	80.0
1975/76	95.0	34.0	128.9	55.2	25.7	80.9
1976/77	95.9	34.5	130.4	55.8	26.1	81.8
1977/78	96.8	35.0	131.8	56.3	26.4	82.7
1978/79	97.8	35.5	133.2	56.9	26.8	83.7
1979/80	97.9	36.6	134.5	56.9	27.7	84.6
1980/81	97.9	37.9	135.8	56.9	28.6	85.6
1981/82	97.9	39.2	137.1	56.9	29.6	86.5
1982/83	97.9	40.5	138.4	56.9	30.6	87.5
1983/84	97.8	41.8	139.7	56.9	31.6	88.5

Errors in summation or computation are due to rounding.

SOURCE: Total Area: 1970/71 - 1973/74: Estimates of Area and Production of Principal Crops in India 1973/74, (New Delhi: Government of India, Directorate of Economics and Statistics, 1974) and Government of India, Directorate of Economics and Statistics, Agricultural Situation in India 29:8 (November 1974). 1978/79 - 1983/84: See Gunvant M. Desai, Nitrogen Use and Foodgrain Production, India, 1973/74, 1978/79 and 1983/84, Dept. of Agricultural Economics, Occasional Paper 55, Cornell University USAID Employment and Income Distribution Project, forthcoming. Intermediate years: calculated using the respective compound growth rates, see text. Irrigated Area: 1970/71: Indian Agriculture in Brief, 13th ed. (Delhi: Government of India, Directorate of Economics and Statistics, 1974). 1978/79 - 1983/84: See Gunvant M. Desai, op. cit. Intermediate years: calculated using the respective compound growth rates, see text. Unirrigated Area: Total Area - Irrigated Area.

Table 8. Estimated Labor Use in the Production of Foodgrains, India, 1970/71 to 1983/84

Year	Total Agricultural Working Population	Labor Use on:				Intensification Labor
		Agricultural Acreage	Foodgrains Acreage	Unirrigated Foodgrains Acreage	Irrigated Foodgrains Acreage	
	(millions)	(million man-days)				
1970/71	154.0	23,645.2	17,568.4	9,359.8	4,461.9	3,746.7
1971/72	156.8	24,072.0	17,933.6	9.143.0	4,525.8	4,264.8
1972/73	159.6	24,506.4	18,257.3	8,758.7	4,590.7	4,907.9
1973/74	162.5	24,948.6	18,586.7	9,403.6	4,656.4	4,526.7
1974/75	165.4	25,399.9	18,922.9	9,496.4	4,723.1	4,703.4
1975/76	168.4	25,858.9	19,264.9	9,590.2	4,790.8	4,883.9
1976/77	171.5	26,325.6	19,612.6	9,684.9	4,859.3	5,068.4
1977/78	174.6	26,801.6	19,967.2	9,780.4	4,928.9	5,257.9
1978/79	177.7	27,285.2	20,327.4	9,877.0	4,999.4	5,451.0
1979/80	180.9	27,778.0	20,694.6	9,891.8	5,186.5	5,616.3
1980/81	184.2	28,280.0	21,068.6	9,896.1	5,361.0	5,811.5
1981/82	187.5	28,791.2	21,449.4	9,897.2	5,541.5	6,010.6
1982/83	190.9	29,310.1	21,836.0	9,895.5	5,728.1	6,212.4
1983/84	194.4	29,839.7	22,230.6	9,890.4	5,920.9	6,419.3

Errors in summation or consumption due to rounding.

SOURCE: 1971: see text for derivation. 1970: calculated using the compound growth rate for 1951 - 1961. 1972 and after: calculated using the compound growth rate for 1951 - 1961. 1970/71 fiscal year refers to 1970 calendar year and so on. See text for method of computation of labor use figures.

Labor use on foodgrains was then allocated to irrigated and unirrigated land, using the response coefficients of 0.141 man-days/hectare irrigated land and 0.101 man-days/hectare unirrigated land. The residual from total labor use provides estimates of intensification labor (Table 8). Returns from labor were then calculated using the response coefficient of 0.00346 metric tons/hectare (Table 9).

Inorganic Fertilizer

Estimates of nitrogenous fertilizer consumption in foodgrains production for the years 1970/71 through 1973/74 were computed by first taking 73 percent of the official total nitrogenous fertilizer consumption figures given in Fertiliser Statistics, 1973/74, and then taking the respective percentage which represented nitrogenous fertilizer consumption divided by total fertilizer consumption for each year. Estimates of nitrogenous fertilizer consumption in foodgrains production for 1978/79 and 1983/84 were taken forecasts made by Gunvant Desai.[20/] These estimates of future consumption were based on micro studies of fertilizer use, recommended rates of application, and assumptions concerning the probable spread of various high yielding varieties of foodgrain. Fertilizer consumption for the intermediate years was calculated by using the compound growth rates between the three years 1973/74, 1978/79 and 1983/84. Total fertilizer consumption in foodgrains production for 1969/70 through 1973/74 was estimated as 73 percent of total fertilizer consumption given in Fertiliser Statistics, 1973/74 (see earlier discussion on inorganic fertilizer). Figures for 1974/75 through 1983/84 were computed by dividing the nitrogenous fertilizer consumption figures by 0.676. The divisor, 0.676 was obtained by taking the average ratios of nitrogenous

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20/ Ibid.

Table 9. The Calculated Effect of Labor Input on Foodgrains Production, India, 1970/71 to 1983/84

Year	Labor on Unirrigated Land	Labor on Irrigated Land	Intensification Labor	Total
		(million metric tons)		
1970/71	32.4	15.4	13.0	60.8
1971/72	31.6	15.7	14.8	62.1
1972/73	30.3	15.9	17.0	63.2
1973/74	32.5	16.1	15.7	64.3
1974/75	32.9	16.3	16.3	65.5
1975/76	33.2	16.6	16.9	66.7
1976/77	33.5	16.8	17.5	67.9
1977/78	33.8	17.1	18.2	69.1
1978/79	34.2	17.3	18.9	70.3
1979/80	34.2	17.9	19.4	71.6
1980/81	34.2	18.5	20.1	72.9
1981/82	34.2	19.2	20.8	74.2
1983/84	34.2	19.8	21.5	75.6

Errors in summation or computation due to rounding.

fertilizer consumption to total fertilizer consumption for the six years 1967/68 through 1972/73.[21] A 10 to 1 response coefficient again was used to determine returns from fertilizer (Table 10).

Projected estimates of total foodgrain production are presented in Table 11.

Estimates of Marketings from the Foodgrain Sector, 1969/70 to 1983/84

Projected estimates of marketings from the foodgrains sector were derived using the same assumptions as previously: 30 percent of total returns to labor marketed; 84 percent of total returns to land marketed; 30 percent of total returns to fertilizer marketed; 10 percent of fertilizer returns allocated to labor, of which 30 percent is marketed; and 60 percent of fertilizer returns allocated to land, of which 84 percent is marketed. Total marketing estimates are presented in Table 12.

Conclusions

Analysis of the input estimates of Indian foodgrain production through 1973/74 indicates that production grew at an average of about 2.6 percent per year in the 1950s--a creditable increase over the rate of growth in the decades preceding independence, but still only moderately faster than the rate of population increase. From the early to mid-1960s the rate of production growth stalled, falling to the 1.5 to 2.0 percent range.

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[21] Nitrogenous fertilizer as a percentage of total fertilizer was 68.8 percent in 1967/68; 67.6 percent in 1968/69; 68.4 percent in 1969/70; 68.3 percent in 1970/71; 67.0 percent in 1971/72 and 65.9 percent in 1972/73. See Fertiliser Statistics, 1973/74, op. cit., Table 7.01.

Table 10. Inorganic Fertilizer Use and Increase in Production Due to Inorganic Fertilizer on Foodgrains, India, 1970/71 to 1983/84

Year	Nitrogenous Fertilizer Consumption in Foodgrain Production	Total Inorganic Fertilizer Consumption in Foodgrain Production[a]	Total Returns from Inorganic Fertilizer
	Thousand metric tons		million metric tons
1970/71	1,085.6	1,589.4	15.9
1971/72	1,281.4	1,913.9	19.1
1972/73	1,298.6	1,970.1	19.7
1973/74	1,339.6	2,031.6	20.3
1974/75	1,580.1	2,337.4	23.4
1975/76	1,863.6	2,756.8	27.6
1976/77	2,198.2	3,251.8	32.5
1977/78	2,592.8	3,835.5	38.4
1978/79	3,057.9	4,523.5	45.2
1979/80	3,381.2	5,001.8	50.0
1980/81	3,738.8	5,530.7	55.3
1981/82	4,134.1	6,115.5	61.1
1982/83	4,571.2	6,762.2	67.6
1983/84	5,054.6	7,477.2	74.8

Errors in summation or computation due to rounding.

[a]Including nitrogen, phosphorus and potassium.

SOURCE: Nitrogenous Fertilizer Consumption: 1970/71 through 1973/74: computed by taking 73 percent of official total fertilizer consumption figures from Fertilizer Statistics, 1973/74 (New Delhi: The Fertiliser Association of India, December 1974), and then taking the respective percentage which represented total nitrogenous fertilizer consumption as a percentage of total fertilizer consumption for each year. 1978/79, 1983/84: see Gunvant M. Desai, Nitrogen Use and Foodgrain Production, India, 1973/74, 1978/79 and 1983/84, Department of Agricultural Economics, Occasional Paper No. 55, Cornell University USAID Employment and Income Distribution Project, forthcoming. Intermediate years: calculated using the respective compound growth rates between 1973/74, 1978/79 and 1983/84. Total Fertilizer Consumption: 1970/71 through 1973/74: 73 percent of the official total fertilizer consumption given in Fertiliser Statistics, 1973/74, op. cit. 1974/75 through 1983/84: computed by dividing nitrogenous fertilizer consumption by 0.676. The divisor, 0.676, was obtained by taking the average ratios of total nitrogenous fertilizer consumption divided by total fertilizer consumption for the six years 1967/68 through 1972/73.

le 11. Annual and Cumulative Contribution of Various Inputs to Total Foodgrains Production, India, 1970/71 to 1983/84

r	Unirrigated Land	Labor on Unirrigated Land	Irrigated Land	Labor on Irrigated Land	Intensification of Labor	Inorganic Fertilizer	Total Production
			(million metric tons)				
			Annual				
0/71	21.5	32.4	8.5	15.4	13.0	15.9	106.7
1/72	21.0	31.6	8.6	15.7	14.8	19.1	110.8
2/73	20.1	30.3	8.7	15.9	17.0	19.7	111.7
3/74	21.6	32.5	8.9	16.1	15.7	20.3	115.1
4/75	21.8	32.9	9.0	16.3	16.3	23.4	119.7
5/76	22.0	33.2	9.1	16.6	16.9	27.6	125.4
6/77	22.3	33.5	9.3	16.8	17.5	32.5	131.9
7/78	22.5	33.8	9.3	17.1	18.2	38.4	139.3
8/79	22.7	34.2	9.5	17.3	18.9	45.2	147.8
9/80	22.7	34.2	9.8	17.9	19.4	50.0	154.1
0/81	22.7	34.2	10.1	18.5	20.1	55.3	161.0
1/82	22.7	34.2	10.4	19.2	20.8	61.1	168.5
2/83	22.7	34.2	10.8	19.8	21.5	67.6	176.7
3/84	22.7	34.2	11.1	20.5	22.2	74.8	185.5
			Cumulative				
0/71	2.6	3.8	3.8	6.8	13.0	15.9	45.9
1/72	2.1	3.0	3.9	7.1	14.8	19.1	49.8
2/73	1.2	1.7	4.0	7.3	17.0	19.7	51.9
3/74	2.7	3.9	4.2	7.5	15.7	20.3	55.8
4/75	2.9	4.3	4.3	7.7	16.3	23.4	60.8
5/76	3.1	4.7	4.4	8.0	16.9	27.6	66.3
6/77	3.4	4.9	4.6	8.2	17.5	32.5	72.4
7/78	3.6	5.2	4.6	8.5	18.2	38.4	79.2
8/79	3.7	5.6	4.8	8.7	18.9	45.2	86.9
9/80	3.7	5.6	5.1	9.3	19.4	50.0	93.3
0/81	3.7	5.7	5.4	9.9	20.1	55.3	100.2
1/82	3.7	5.7	5.8	10.6	20.8	61.1	107.7
2/83	3.7	5.7	6.1	11.2	21.5	67.6	115.9
3/84	3.7	5.6	6.5	11.9	22.2	74.8	124.7

ors in summation or computation due to rounding.

Table 12. Contribution of Various Inputs to Total Marketings from the Foodgrain Sector India, 1970/71 to 1983/84

Year	Labor[a]	Land[b]	Fertilizer[c]	Total
	(million metric tons)			
1970/71	18.7	33.2	4.8	56.7
1971/72	19.2	34.5	5.7	59.4
1972/73	19.6	34.1	5.9	59.6
1973/74	19.9	35.9	6.1	61.8
1974/75	20.4	37.7	7.0	65.0
1975/76	20.8	40.0	8.3	69.2
1976/77	21.3	42.9	9.8	74.0
1977/78	21.9	46.1	11.5	79.5
1978/79	22.5	49.8	13.6	85.9
1979/80	23.0	52.4	15.0	90.4
1980/81	23.5	55.4	16.6	95.5
1981/82	24.1	58.6	18.3	101.1
1982/83	24.7	62.2	20.3	107.2
1983/84	25.3	66.1	22.4	113.8

Errors in summation or computation due to rounding.

[a]Including the 10 percent of fertilizer returns that was assumed to be allocated to labor.

[b]Including the 60 percent of fertilizer returns that was assumed to be allocated to land.

[c]Includes only the 30 percent of total returns to fertilizer that was assumed to be marketed to pay for the fertilizer.

Between 1966/67 and 1970/71, however, the rate appears to have accelerated to over 4.0 percent. For the decade as a whole a growth rate of 2.9 percent is indicated (Table 13). These trends are consistent with those shown by official estimates of production -- with a growth of 2.8 percent per year in both the 1950/51 - 1960/61 and the 1960/61 - 1970/71 periods.

The record in the early 1970s is more ambiguous. The official estimates indicate that after the peak in 1970/71, production fell in the two subsequent years before making a partial recovery in 1973/74. Over the four year period as a whole production dropped by 4.8 million tons or 4.4 percent. The annual rate of growth from 1960/61 to 1973/74 appears to have been only 1.8 percent. Using 1964/65 as the base shows a similar growth rate of 1.7 percent.

The input analysis, by contrast, shows a more optimistic view of production growth in the 1970s. While indeed the rate of increase does appear to have slackened subsequent to 1970/71, production appears to be growing at 2.5 percent per year, in contrast with the negative growth shown by official data. Similarly, the input analysis indicates that production increased at an annual rate of 2.8 percent between 1960/61 and 1973/74, or nearly 50 percent higher than the rate shown by official figures. Taking 1964/65 as the base year, the rate of growth through 1973/74 is shown as 3.1 percent, or 80 percent higher than the official growth rate. The input analysis thus suggests that the fall in the rate of foodgrain production growth which has occurred in the early 1970s is due primarily to poor weather and is likely to pick up during reasonably good growing seasons.[22/] This view is reinforced by the fact that 1970/71

22/ Alternatively, it may be that the efficiency of the inputs has decreased over time meaning that the response coefficients used in the calculations are too large and hence over-estimate production in the 1970's. However, the parallel between the growth rates shown by the official estimates of production and the input estimates from 1949/50 to 1970/71 suggests that such a decline did not have a significant impact until after 1970/71. One must therefore assume a precipitous drop in efficiency to account for the drop in production indicated by the official statistics. Because of the actual weather conditions from 1971/72 to 1973/74, it is most reasonable to assume that lack of rain rather than a decline in input efficiency accounts for the poor harvests.

Weather introduces an additional problem when calculating long term growth rates. Conditions in the base and terminal years can bias the results up or down. The growth rate shown by official data between 1960/61 and 1973/74 and between 1964/65 and 1973/74 are on the low side because both base years experienced good weather while the terminal year had only average weather.

Table 13. Estimates of Foodgrain Production, India, 1949/50 to 1973/74

Year	Official Estimates of Production	Percent Change from Previous Year	Growth Rate	Trend Line of Production	Input Estimates of Production	Percent Change from Previous Year	Growth Rate
	in million metric tons						
1949/50	60.8	0.0		60.8	60.8	0.0	
1950/51	55.0	-9.5	2.2	62.5	60.4	-0.7	2.6
1951/52	55.6	1.1		64.2	61.0	1.0	
1952/53	61.8	11.1	4.8	66.0	64.2	5.2	3.2
1953/54	72.4	17.1		67.8	68.6	6.8	
1954/55	70.8	-2.2		69.7	68.7	0.1	
			2.8				2.6
1955/56	69.4	-2.0		71.7	70.8	3.1	
1956/57	72.5	4.5	4.1	73.7	72.0	1.7	2.9
1957/58	66.7	-8.0		75.7	73.6	2.2	
1958/59	78.9	18.3	3.4	77.8	76.9	4.5	2.6
1959/60	76.9	-2.5		80.0	79.2	3.0	
1960/61	82.2	6.9		82.2	80.5	1.6	
1961/62	82.9	0.8	2.1	83.9	82.6	2.6	2.0
1962/63	80.3	-3.1		85.7	84.4	2.2	
1963/64	80.7	0.5	2.1	87.5	85.7	1.5	2.4
1964/65	89.3	10.7		89.3	87.0	1.5	
			2.1				2.9
1965/66	72.3	-19.0		90.8	88.0	1.1	
1966/67	74.2	2.6		92.3	91.8	4.3	
1967/68	95.0	28.0	2.8	93.8	94.9	3.4	2.9
1968/69	94.0	-1.0		95.4	100.1	5.5	
1969/70	99.5	5.8	1.8	97.0	104.7	4.6	2.8
1970/71	108.4	8.9	3.3	98.6	106.7	1.9	3.5
1971/72	104.7	-3.4		100.2	110.8	3.3	
1972/73	97.0	-7.4		101.9	111.8	0.9	
1973/74	103.6	6.8	1.7	103.6	115.0	2.9	3.1

Source: Official Estimates: 1949/50 through 1964/65 from Estimates of Area and Production of Principal Crops in India, 1970/71 (New Delhi: Government of India, Directorate of Economics and Statistics, 1971); 1965/66 through 1971/72 from Economic Survey: 1972/73 (New Delhi: Government of India, Ministry of Finance, 1973); 1972/73 and 1973/74 from Government of India, Directorate of Economics and Statistics, Agricultural Situation in India, Vol. XXIX, No. 8 (November 1974).

Trend Line: 1949/50, 1960/61, 1964/65, and 1973/74 are official estimates. The compound growth rate between the four years were used to compute the intermediate years.

Input Estimates: See Table 5.

was a year of exceptionally favorable weather, while the three succeeding years ranged from slightly better than average to poor.

Perhaps of greater significance, the rate of foodgrain marketings, which lagged behind production growth in the 1950s and early 1960s, appears to have accelerated significantly (Table 14). This counterbalances to some extent the disappointing harvests of the early 1970s.

The relatively optimistic view of foodgrain production indicated by the input analysis should not obscure the critical problems which have arisen. Nor should the fact that the poor record of the 1970s is largely accounted for by weather hide the necessity for policies to facilitate further production increases. The input analysis points to three areas of principal concern: increased supplies of inorganic fertilizer, expanded irrigation facilities, and strengthened supportive institutions for research, credit, and extenstion.

Fertilizer

Increased use of fertilizer appears to have accounted for the bulk of foodgrain production increase in the 1960s (Table 14). This share dropped between 1970/71 and 1973/74, reflecting a serious decline in incremental consumption. Of course the increase in international petroleum prices and the shortage of world fertilizer production capacity are primarily to blame--yet it is clear that India needs to take vigorous steps to alleviate this constraint, either through increased imports or expansion of domestic capacity. The projections of potential foodgrain production, developed above, show fertilizer to account for three-quarters of the increase by 1983/84. This can only be achieved through annual increments in fertilizer use of 500,000 metric tons--far exceeding the increments of the past.

Irrigation

During the 1960s, when irrigated foodgrain acreage grew by 3.3 percent per year, this input accounted for approximately one quarter of the increase

Table 14. Input Estimates of Change and Sources of Change in Foodgrain Production and Marketings India, 1949/50 - 1983/84

Year	Estimated Production Attributable to Specific Inputs: Unirrigated Land	Irrigated Land	Intensification Labor	Fertilizer	Input Estimate of Total Production	Domestic Marketings from the Foodgrain Sector	Domestic Marketings Plus Imports a/
	(Percent of Increased Production from Previous Period Attributable to Each Input in Parentheses)				(Rate of Growth Between Periods in Parentheses)		
			(million metric tons)				
1949/50	47.5	13.3	0.0	0.0	60.8	31.0	35.8 b/
					(2.4)	(2.3)	(1.9)
1956/57	52.7 (46)	15.5 (20)	2.9 (26)	0.9 (8)	72.0	36.4	40.0
					(2.9)	(2.4)	(2.1)
1960/61	54.4 (20)	16.7 (14)	7.6 (55)	1.8 (11)	80.5	40.0	43.5
					(2.0)	(2.2)	(4.1)
1964/65	54.3 (6)	18.1 (21)	9.8 (34)	4.3 (38)	87.0	43.6	51.1
					(3.5)	(4.5)	(2.3)
1970/71	53.9 (-5)	23.9 (29)	13.0 (16)	15.9 (59)	106.7	56.7	58.7
					(2.5)	(2.9)	(4.3)
1973/74	53.5 (-5)	25.7 (22)	15.5 (30)	20.3 (53)	115.0	61.8	66.6
					(5.1)	(6.8)	(5.2)
			Future Potentials				
1978/79	56.9 (10)	27.7 (6)	18.9 (10)	45.2 (76)	147.8	[illegible]	85.8
					(4.7)	(5.8)	(5.8)
1983/84	56.9 (0)	31.6 (10)	22.2 (9)	74.8 (79)	185.5	113.8	113.8

a/ Assumes no imports for 1978/79 and 1983/84.

b/ Import figures for 1949/50 were unavailable. Therefore 1950/51 figures for production and imports were used. The growth rate given is for 1950/51 - 1956/57.

Source: Foodgrain imports: Government of India; Ministry of Finance, Economic Survey, various issues.
All other figures: See Tables 5, 6, 11 and 12.

in production. While its relative importance in increasing foodgrain production seems likely to have declined, this crucial input still provides large absolute increments. The projections of the potential trend from 1973/74 to 1983/84--to which increased irrigation will provide an additional 500,000 metric tons of grain per year--assume that irrigated acreage will grow by over 2 percent per year. Though seemingly modest this rate of growth will require expansion by 630,000 hectares per year. Particularly as more accessible water resources are tapped, continued growth at this pace will require massive investment. The need for such investment is underlined by the fact that the bulk of past fluctuations in harvest are accounted for by the irregularity of the monsoon.

Supportive Institutions

Implicit in the need to expand the use of fertilizers and irrigation is the necessity for institutional support. First, because HYV's tend to be more responsive to these inputs than are traditional varieties, research must be continued to develop new strains which are adaptable to specific growing regions. Additionally, work is needed on drought-resistent varieties for areas where irrigation must be postponed. Second, expanded rural credit must be provided if farmers are to continue investing in tube wells, water pumps, inorganic nutrients, and new seed types. Third, the agricultural extension services must actively instruct farmers in the techniques for growing the new seed types, the most efficient use of fertilizer, the optimal use of irrigation, and related innovations.

Future Potentials

Provided that the assumptions about potential fertilizer use and irrigation are correct, and that the critical institutional support is forthcoming, the possibility exists for foodgrain production to accelerate by 1983/84, even to as much as 4.5 percent per year. Such a dramatic

increase seems improbable. However, assuming that this figure overstates the true potential growth rate by 20 percent would still result in relatively rapid annual growth of 3.6 percent. As Mellor and Mudahar document, such a rate of growth in foodgrain production can have a significant impact on the level of employment--in both the agricultural and nonagricultural sectors.[23/] Further, it is likely that foodgrain marketings will accelerate even more rapidly and continue to outstrip the rate of production growth. These two factors, i.e., rapid increase in both foodgrain production and marketing, could set the stage for accelerated overall economic growth by alleviating the wage goods constraint of the past and permitting greater transfer of resources to other sectors of the economy. Perhaps even more significant, in the short run greater availability of foodgrain will help ameliorate the pressing nutritional problems of India's poor.

[23/] Mellor and Mudahar, op. cit.