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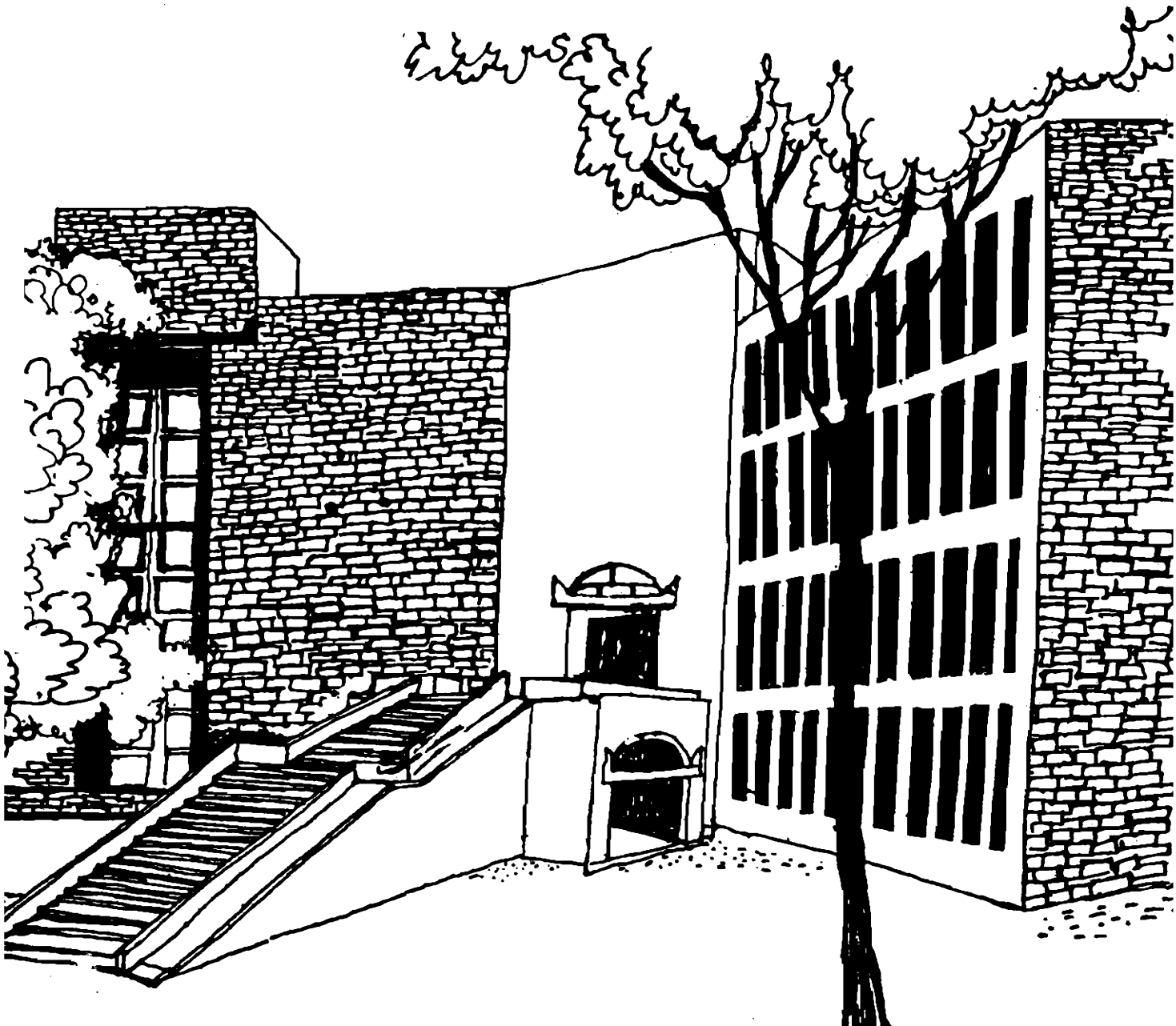

TECHNICAL PROGRESS IN INDIAN AGRICULTURE: TEMPORAL ANALYSIS

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ABSTRACT

An attempt has been made in this paper to estimate the extent of technical progress in Indian agriculture during the period 1950-51 to 1988-89. An analysis of the sources of growth of Indian agriculture is also presented in the paper. The concluding part of the paper examines briefly the role of government in promoting modernisation of Indian agriculture and also presents some estimates of the contribution of technical progress in Indian agriculture to the overall acceleration in economic growth observed in Indian economy during the 80's.

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I. Introduction

Agriculture continues to play a major role in Indian economy. It still accounts for about one-third of the total income and about two-thirds of the total working force in the economy. Its performance determines how our growing millions would be fed and how a large segment of our industrial sector would fare. Consideration of the productivity of resources employed in agriculture is, therefore, of great significance to the planners and policy makers. While Indian agriculture has been traditional and rain-fed, the seventies and the eighties have witnessed a significant increase in the use of modern agricultural inputs. Moreover, the eighties have also been marked by acceleration of growth and greater resilience of agriculture to weather fluctuations. In fact, the performance of Indian agriculture has been commended by various external agencies. The World Bank has lauded the performance of Indian agriculture and its resilience to severe droughts of recent past.

Given this background, it would be interesting to examine the factors which have contributed to the growth of Indian agriculture. Some of the questions that arise in this context are : What role has the technical progress played in determining the performance of Indian agriculture? What has been the contribution of technical progress to the observed growth of agricultural product in relation to other sources of growth during the four decades of economic planning? Does technical progress in agriculture explain a significant portion of the acceleration of economic growth experienced by Indian economy during the last decade? What role has the government played in promoting the use of modern agricultural inputs in India? The present paper attempts to answer these questions.

The concept of technical progress in agriculture and the methodology used to estimate it in the present paper are discussed in the next section along with the sources of data on the relevant variables. The third section is devoted to the examination of some aspects of the process of modernisation of Indian agriculture during the last four decades. Selected indicators of modernisation of agriculture are considered and compared over different points of time. In the fourth section, trends in the total factor productivity in Indian agriculture are examined. The sources of growth of agricultural product are estimated and discussed in the fifth section of the paper. The sixth section is devoted to a brief discussion of the role played by the government in promoting greater use of modern agricultural

inputs, especially during the eighties. Finally, in the concluding section of the paper, the implications of the technical progress in agriculture on the observed economic growth and its acceleration in recent years are examined.

II. Methodology and Data

Technical progress in agriculture is a very broad term and needs to be clearly specified and defined before any empirical estimation of it is attempted. Like most studies in growth accounting, technical progress is considered synonym with the total factor productivity growth. In the production function framework, technical progress is defined as a phenomenon that shifts the production function over time. Thus, apart from the improvements in techniques of production, advancement in knowledge and greater efficiency of the system, betterment in the management practices, improvement in the quality of inputs, increase in the degree of utilization of resources, etc. are also included in the concept of technical progress as defined in the production function framework. Basically, this is the concept of autonomous disembodied neutral technical progress as defined by Hicks (1963) and Harrod (1948). It is defined simply as the ability of the economy to obtain greater output from the given combination of inputs over a period of time. The same concept of technical progress is adopted in the present study so that more meaningful assessment can be made of the role of technical progress in Indian agriculture in the overall economic growth and acceleration therein during the recent years.

In the context of Indian agriculture, technical progress would measure the impact of shifts in the production technology on account of irrigation, high yielding varieties of seeds, modern agricultural machinery and equipments, fertilizers, pesticides, etc. Moreover, it would also capture the effects of improved quality of labour, better farm management practices, greater utilization of resources like land and equipment which leads to increased crop intensity, changes of cropping pattern in favour of high value added crops, etc.

Although the concept of technical progress used in the present study is derived from the production function framework, the technique of fitting aggregate production function is not used for its empirical estimation here. The exercise of fitting aggregate production function from the time-series data in developing countries like India is generally plagued with two major limitations. Firstly, the time series data based production functions are subject to serious problems of multi-collinearity making the inference about the relative magnitudes of factor elasticity coefficients unreliable and invalid. The remedies in such cases are often worse than the disease. Secondly, in the case of India, data on employment in agriculture are not available on annual basis, but only on quinquennial basis from the NSS rounds. Intra-polation and extra-polation of these estimates are required to generate annual estimates of working force in Indian agriculture. Use of such estimates in estimating the time series aggregate production function involves the problem of errors in independent variables which introduces a

bias in the regression estimates of the elasticity coefficients rendering them unusable for any analytical purpose. Thus, the nature of available date on Indian agriculture precludes the use of 'sophisticated' and 'elegant' technique of aggregate production function based on time-series regression. In the present study, therefore, we have preferred the use of the popular growth accounting method of estimating the total factor productiyity index directly from the component indices applying the weights of factor income shares estimated directly for different time periods. The major limitation of this method is that it is based on the assumption that relative factor shares measure the respective factor elasticities of output. In other words, estimate of technical progress by this direct method subsumes constant returns to scale. However, as argued by Denison (1962 and 1985), this limitation is less disturbing and the estimates of technical progress more acceptable than the available alternative methods.

We may also define the scope of the agricultural sector for our study. Instead of restricting the exercise only to the narrow definition of agriculture incorporating only the crop sectors, we have adopted a broad definition of agricultural activities. Thus, animal husbandry, plantations, orchards, fishing, forestry and logging are also included in agricultural sector along with the farm sector. There are inseparable interlinks between the farm sector and these other sectors. Sometimes their outputs are joint products in the sense that inputs used for their production are practically inseparable.

Moreover, changes in the production environment in one generally affect the crucial output decisions having implications on management of resources in other allied activities. All these considerations have governed our choice of selecting a broader definition of agricultural sector. Currently, agriculture including animal husbandry accounts for 93% of the income (at constant 1980-81 prices) originating in the broadly defined agricultural sector, with forestry and logging contributing only 4.6% and fishing 2.4% of the total. Thus, the farm sector overwhelmingly dominates the broadly defined agricultural sector in Indian economy.

Another important methodological aspect of our study is the one relating to the estimation of average annual growth rates of different aggregates. Here again, there are several alternatives that may be considered. Basically, we considered four alternatives : (a) simple average annual compound rate of growth based on the end-points which is seriously affected by the choice of the end-points; (b) average annual compound growth rates by taking triennial averages at the end-points to reduce the effect of the selection of the end-points; (c) instantaneous rate of growth based on fitting a semi-logarithmic time trend to the available time series data which satisfies the criterion of sufficiency for the estimates unlike the previous two options; and. (d) a modified time-trend rate of growth by adjusting for weather conditions which is the single most powerful exogenous factor destabilising the production function in the case of agricultural sector. We have preferred the last alternative

since it fulfills the criterion of sufficiency for the estimates besides correcting an important specification error generally committed while following the option (c) above. The exercise of simple time-trend fitting ignores the shifts in the trend for the drought years from the non-drought years. Since Indian agriculture has witnessed drought years persistently with a remarkable degree of regularity, it is necessary for any exercise attempting to measure the growth of factor productivities in Indian agriculture to hold the weather factor constant. While estimating the contribution of technical progress, it is conceptually required to hold constant the exogenous factors influencing production conditions. In order to estimate the growth rates of various aggregates, therefore, we have used the following regression equation :

$$\ln Y_t = a + bt + cD + u \qquad \ldots\ldots\ldots (1)$$

where $\ln Y_t$ is the natural logarithm of any aggregate Y at time t; a, b and c are parameters to be estimated; u is the usual error term and D is the dummy variable distinguishing years with insufficient rainfall. This regression equation gives a unique trend rate of growth for the aggregate (Y) under consideration, but the level of the trend line would differ for the drought and non-drought years provided the estimate of the coefficient of the dummy variable is significant. We have considered more stringent criterion of 1% level of significance for this purpose so as to minimize probability of erroneous inference.

Given the above methodology, we need time-series data on the following variables to measure technical progress in Indian agriculture: (i) NDP in agricultural sector; (ii) Capital stock in agricultural sector; (iii) Working force in agricultural sector; (iv) Net sown area; (v) Relative shares of labour, capital and land in agricultural income; and (vi) Identification of specific years with deficient rain-fall. We have derived the required time-series for each of these variables from various official sources of data and also from the authors' earlier research work publications. The broad methodology followed in deriving estimates of relative factor shares in agricultural income is similar to the one followed in an earlier study on the Sources of Economic Growth in India by Dholakia (1974, 1976). Details regarding the specific sources of data used in the study are given at the end of Table 1.

III. Some Aspects of Modernisation of Indian Agriculture

Since the inception of National Economic Planning in India in 1951, sustained efforts have been made by the planners to accelerate the pace of agricultural development in the economy. However, the main emphasis during the early stages of planning was on broadening the industrial base through rapid development of basic and capital goods industries. It was only in mid-sixties when the economy suffered a major setback due to two consecutive years of drought that a shift in development strategy focussing on rapid agricultural development became necessary. In fact, the impact of two consecutive drought years (1965-66 and

1966-67) was so severe that it almost nullified the effect of almost a decade of agricultural development and also in its aftermath brought about a severe industrial recession. Planners were forced to have a "Plan Holiday" for a period of three years from 1966 to 1969. It was during this period that a new strategy of agricultural development focussing on modernisation of agriculture and improvement in farm productivity was launched. This strategy for modernisation of agriculture, widely referred to as the "Green Revolution", has been pursued vigorously in Indian economy since 1967. The term 'Green Revolution' indicates a package for modernisation of agriculture consisting of "large scale application of modern science and technology to agriculture" involving "extensive and intensive use of improved production technology and high yielding varieties of seeds" (CSSC, 1974). Stated briefly the main components of the Green Revolution technology are the introduction of high yielding varieties of seeds for several major crops, utilisation of energised well irrigation and lift irrigation facilities, use of high doses of fertilizers and pesticides and extensive use of farm machinery directed at improving farm productivity.

To examine some aspects of modernisation of Indian agriculture, it would be useful to divide the post-Independence period into two sub-periods : (a) the period of planned economic development preceding Green Revolution (1950-51 to 1966-67); and (b) the period of Green Revolution from 1966-67 to 1988-89, the latest year for which the relevant data are available. Moreover, since there has been a significant acceleration in the overall

rate of economic growth in Indian economy during the eighties, we may further divide the period of Green Revolution into two sub-periods : 1966-67 to 1980-81 and 1980-81 to 1988-89. The basic data on the relevant aspects on Indian agriculture relating to the four benchmark years, viz., 1950-51, 1966-67, 1980-81 and 1988-89, are presented in Table 1, while some indicators of extent of modernisation in Indian agriculture derived from these data are presented in Table 2.

It is evident from the information given in Table 1 that the period of Green Revolution was marked by spectacular increases in the area under high yielding varieties, extent of fertilizer use and extent of irrigation. Thus, during the period 1966-67 and 1988-89, the area under HYV increased from less than two million ha. to more than 62 million ha., the extent of fertilizer use increased from around 1 million ton to 11 million tonnes, the extent of irrigation increased from less than 27 million ha. to around 60 million ha., extent of double cropping increased from 15% to 25% of net area sown, and the number of tractors increased from 54 thousand to 519 thousand. By 1988-89, more than one-third of the gross cropped area was covered by irrigation and use of HYV, while the average doses of fertilizer had increased from less than 7 kg. per ha. in 1966-67 to more than 62 kg. per ha.

Such large scale modernisation of agriculture led to significant improvements in the productivity of land as well as labour. Land productivity, which had increased at an average rate of only 0.56% per annum during the pre-green revolution

Table 1

GROWTH OF INDIAN AGRICULTURE, 1950-51 TO 1988-89

	Variable	Units	1950-51	1966-67	1980-81	1988-89
1.	NDP (All Sectors)	Rs. Crores at 80-81 prices	40,681	66,853	110,139	168,870
2.	NDP In Agriculture	Rs. Crores at 80-81 prices	23,262	29,406	43,921	58,516
3.	Capital Stock in Agriculture	Rs. Crores at 80-81 prices	26,480	40,555	65,664	79,525
4.	Working Force in Agriculture	Million Persons	128.55	162.93	197.93	204.17
5.	NDP in Agriculture	Rs. Crores at current prices	4,906	11,871	43,921	105,171
6.	Capital Stock in Agriculture	Rs. Crores at current prices	4,767	12,978	65,664	171,432
7.	Value of Agricultural Land	Rs. Crores at current prices	15,542	33,148	162,096	289,958
8.	Share of Labour in Agricultural Income	Per Cent	55.2	55.6	57.4	58.7
9.	Share of Capital in Agricultural Income	Per Cent	10.5	12.5	12.3	15.4
10.	Share of Land in Agricultural Income	Per Cent	34.3	31.9	30.3	25.9
11.	Net Area Sown	Million Hectares	118.7	137.2	140.3	142.9
12.	Gross Cropped Area	Million Hectares	131.9	157.4	173.1	177.0

(Contd..)

Table 1 (Concluded)

Variable	Units	1950-51	1966-67	1980-81	1988-89
13. Gross Irrigated Area	Million Hectares	22.6	26.9	49.6	59.8
14. Area Under HYV	Million Hectares	-	1.9	43.1	62.6
15. Fertilizer Consumption	Million Tons	0.15	1.10	5.52	11.04

Sources :

1. Economic Survey (various issues from 1970-71 to 1989-90), Government of India.

2. National Accounts Statistics (Various issues from 1987 to 1990), Central Statistical Organization, Government of India.

3. Estimates of Capital Stock of Indian Economy, Central Statistical Organization, Ministry of Planning, Government of India, Dec. 1988.

4. Key Results of Employment And Unemployment Survey, (43rd round) National Sample Survey Organization, Ministry of Planning, Government of India, Jan. 1990.

5. National Sample Survey (27th Round, 32nd Round and 38th Round), Ministry of Planning, Government of India.

6. All India Debt and Investment Survey, 1971-72 and 1981-82, Reserve Bank of India.

7. Census of India (1961, 1971, 1981), Government of India.

8. Indian Agriculture in Brief (various editions), Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

9. Dholakia, Bakul H. : The Sources of Economic Growth in India, Good Companions, Baroda, 1974.

TABLE 2

SOME INDICATORS OF THE EXTENT OF MODERNISATION IN INDIAN AGRICULTURE

	Indicator	Units	1950-51	1966-67	1980-81	1988-89
1.	Proportion of Area Irrigated	Per Cent	17.1	17.1	28.7	33.8
2.	Proportion of Area Under HYV	Per Cent	--	1.2	24.9	35.4
3.	Intensity of Fertilizer Consumption	Kg. per Ha.	1.14	6.99	31.89	62.37
4.	Cropping Intensity	Per Cent	111	115	123	125
5.	Land Productivity	Rs. per Ha. at 80-81 prices	1960	2143	3131	4095
6.	Labour Productivity	Rs. per worker at 80-81 prices	1810	1805	2219	2866
7.	Capital-Labour Ratio	Rs. per worker at 80-81 prices	2060	2489	3318	3895
8.	Capital-Land Ratio	Rs. per Ha. at 80-81 prices	2231	2956	4680	5565
9.	Capital-Output Ratio		1.14	1.38	1.50	1.36
10.	Labour-Land Ratio	No. of workers per ha.	1.08	1.19	1.41	1.43

Source : Table 1.

period, increased at an average rate of about 3% per annum during the subsequent period (1966-67 to 1988-89). Similarly, labour productivity, which had been more or less stagnant till 1966-67, increased at an average rate of 2.12% per annum during 1966-67 to 1988-89. The period of Green Revolution was also marked by a significant increase in capital investment in agriculture, with the capital investment per ha. increasing at an average rate of 2.92% per annum during 1966-67 to 1988-89, as compared to the average growth rate of 1.77% observed during the earlier period.

On the basis of an analysis of various indicators presented above, we can identify three distinct phases of development of Indian agriculture. Phase I consists of the period from 1950-51 to 1966-67, which was marked by a significant increase in the net area brought under cultivation through a sustained process of land reclamation and land improvements. This period was marked by only marginal improvement in land productivity, stagnation in labour productivity, and a decline in capital productivity. By the end of sixties, most of the existing potential for expansion of net area available for cultivation was already tapped and it was evident that the future growth of agriculture would have to depend more and more on non-land resources. The period from 1966-67 to 1980-81 represents Phase II of agricultural development, which was marked by widespread modernisation of agriculture coupled with a significant increase in capital investment. In fact, during this period the gross capital formation as a proportion of gross domestic product in agriculture increased sharply to more than 9% from the average

level of around 6% observed during the pre-green revolution period. The period after 1980-81 represents Phase III, which is marked by simultaneous and significant improvements in the productivity of land, labour and capital. During the eighties, the average annual growth rate of land productivity has been 3.4%, of labour productivity 3.2% and capital productivity around 1.2% per annum. During this period, there has been a significant improvement in the utilization of the basic infrastructure and growth potential created during the earlier phase of modernisation. Thus, for instance, it has been observed in the latest issue of Economic Survey (March 1990) that, in the years 1986-87 and 1987-88, the achievement in the utilisation of irrigation potential was more than the targetted level of utilisation.

IV. Growth of Total Factor Productivity

Having examined the trends in partial factor productivity, we may now examine its impact on total factor productivity in Indian agriculture. The growth of partial factor productivity (such as labour productivity or land productivity) indicates the combined effect of changes in factor proportions and technical progress. To estimate the pure effect of technical change, it is necessary to eliminate the effect of changes in factor proportions by constructing the index of total factor input (TFI) as a weighted average of the indices of three factor inputs, viz., land, labour and capital. The index of total factor productivity (TFP), which is generally used as a broad indicator

of the extent of technical progress, is then derived as the ratio of the index of real NDP to index of TFI.

Our estimates of the growth rates of total factor productivity in Indian agriculture are presented in Table 3.

TABLE 3

GROWTH RATES OF FACTOR INPUTS AND TOTAL FACTOR PRODUCTIVITY IN INDIAN AGRICULTURE

(Average Annual Growth Rates in Per Cent)

Factor	1950-51 to 1966-67	1966-67 to 1980-81	1980-81 to 1988-89	1950-51 to 1988-89
NDP in Agriculture	1.99	2.24	2.90	0.86
Labour Input	1.51	1.30	0.34	1.37
Capital Input	2.56	3.32	2.35	2.98
Land Input	0.88	0.15	0.11	0.37
Total Factor Input	1.42	1.19	0.55	1.27
Total Factor Productivity	0.57	1.05	2.35	0.86

Source : Same as Table 1

It is evident from Table 3 that there has been a significant decline in the growth rates of labour input and land input during the period after 1966-67. However, the growth of capital input shows a marked acceleration during the sub-period 1966-80 followed by a significant deceleration during the eighties. Recent studies by Patnaik (1987), Rath (1989) and Shetty (1990)

have analysed this phenomenon of significant deceleration in the growth of agricultural investment. The main conclusion emerging from these studies is that private investment in agriculture is significantly affected by public sector investment in agriculture and the growth of the latter has declined steadily during the eighties.

The observed trends in the growth of individual factor inputs have resulted in a decline in the aggregate supply of factor inputs to agriculture especially during the eighties. The average growth rate of total factor input has declined from 1.42% during the period upto 1966-67 to 1.19% during the subsequent period (1966-67 to 1980-81) and further to 0.55% in the period after 1980-81. As against this, the growth of NDP in agriculture has accelerated significantly during the post-green revolution period as compared to the earlier period. The average growth rate of net agricultural output (NDP) increased from 1.99% during pre-1967 period to 2.24% during the subsequent period and further to 2.90% during the eighties. This phenomenon of a significant acceleration in the growth of agricultural production during the eighties has been analysed in a recent study by Mahendradev (1987), based on detailed state level data on the growth of foodgrains production. The general conclusion emerging from Mahendradev's study is that the eighties have witnessed a significant increase in the growth of foodgrains production in many states including the hitherto low growth states such as Rajasthan, Madhya Pradesh and West Bengal, and that this

acceleration in the growth of production could be attributed to the spread of bio-chemical technology to these states during the first half of eighties. It may be mentioned here that Mahendradev's study covers the period upto 1984-85 and there has been a significant increase in the level of foodgrains production in almost all the states during the period 1984-85 to 1988-89.

Mahendradev's study has also examined the relationship between growth and instability of agriculture and its conclusion is that during the last two decades the degree of instability has declined significantly in both high growth states as well as low growth states, which indicates a negative rather than positive relationship between growth rates and the degree of instability. Thus, the Indian experience of agricultural growth does not support the hypothesis of high rates of growth causing high instability. In fact, the ability of agriculture to withstand the adverse effects of successive run of poor monsoons for three years culminating in the severe drought of 1987-88 without experiencing major reduction in foodgrains production clearly indicates that the Indian agriculture has acquired a remarkable degree of resilience during the eighties. This has been achieved partly by the spread of modern technology and partly on account of the protective benefits of irrigation. A recent study by Dhawan (1987) shows that the output elasticity with respect to rainfall declines from 1.6 in low rainfall states and 1.0 in medium rainfall states without irrigation to the levels of 0.2 and 0.5, respectively, with irrigation. Thus, the acceleration

in the growth of agricultural production brought about by the green revolution has actually reduced the degree of instability experienced by Indian agriculture and thereby made it less dependent on the weather conditions.

Given the significant acceleration in the growth of net agricultural output and the simultaneous deceleration in the growth of total factor input, it is hardly surprising to observe that the post-green revolution period witnessed a phenomenal increase in the growth of total factor productivity in the agricultural sector. It is interesting to note that during the pre-green revolution period total factor productivity in Indian agriculture grew at an average rate of only 0.57% per annum. As against this, the average annual growth rate of TFP increased to about 1.05% during the period 1966-67 to 1980-81, and it went upto 2.35% per annum during the period 1980-81 to 1988-89. Thus, the modernisation of Indian agriculture during the period of green revolution has succeeded in bringing about major technological transformation as indicated by the high and rising growth rate of TFP in the agricultural sector.

V. Sources of Growth of Indian Agriculture

The relative contribution made by growth of TFP to the overall growth of Indian agriculture can be seen from the analysis of sources of growth presented in Table 4. During the pre-1967 period, more than 70% of the growth of agricultural NDP was contributed by the growth of total factor input, while the growth of TFP accounted for less than 30%. This position has

TABLE 4

SOURCES OF GROWTH OF INDIAN AGRICULTURE

Source of Growth	1950-51 to 1966-67	1966-67 to 1980-81	1980-81 to 1988-89	1950-51 to 1988-89
	Absolute Contribution (Percentage Points Per Annum)			
Labour	0.84	0.73	9,29	0.78
Capital	0.29	0.41	0.32	0.38
Land	0.29	0.05	0.03	0.11
Total Factor Input	1.42	1.19	0.55	1.27
Total Factor Productivity	0.57	1.05	2.35	0.86
Growth Rate of NDP	1.99	2.24	2.90	2.13
	Relative Contribution (Per Cent)			
Labour	42.2	32.6	6.9	36.6
Capital	14.6	18.3	11.0	17.8
Land	14.6	2.2	1.1	5.2
Total Factor Input	71.4	53.1	19.0	59.6
Total Factor Productivity	28.6	46.9	81.0	40.4
Growth Rate of NDP	100.0	100.0	100.0	100.0

Source : Tables 1 and 3

changed dramatically during the period 1980-81 to 1988-89 with the growth of TFI accounting for only 19% and growth of TFP accounting for 81% of the growth of net agricultural output. During the first phase of post-green revolution period (1966-67 to 1980-81), growth of TFP has accounted for 47% of the growth of net output.

Thus, there has been a steady and significant acceleration in the contribution made by growth of TFP to the overall growth of agricultural output during the post-1966 period. It is particularly noteworthy that this acceleration in the growth of TFP has occurred over a long period during which the growth of total factor input has actually declined, the decline being quite sharp during the eighties. This clearly indicates that had there not been any noticeable acceleration in the growth of TFP, the overall growth rate of agricultural output would have actually declined during the post-1966 period.

The relative contributions made by labour, capital and land inputs have also undergone significant changes during the last four decades. During the pre-green revolution period, labour was the main source of growth of Indian agriculture, its relative contribution being more than 42%. Moreover, land and capital also made significant contributions to the growth of agricultural output during that period. This pattern has totally changed during the post-green revolution period. Thus, during the eighties, capital is found to be the only major factor input that has made a significant contribution to the growth of agricultural output. The relative contributions made by the other two factor inputs (viz., labour and land) have declined considerably during the eighties. As a result, the overall pattern of sources of growth of Indian agriculture shows dramatic changes during eighties as compared to the earlier period, especially the pre-green revolution period.

The main features of the change in the pattern of sources of growth of Indian agriculture observed during the eighties are : (a) insignificant absolute as well as relative contribution made by land input; (b) significant decline in the relative contribution made by labour input; (c) marginal decline in the relative contribution made by capital input; and (d) a sharp increase in the relative contribution made by growth of total factor productivity. In fact, growth of TFP and growth of capital input have emerged as the two pre-dominant sources of growth of Indian agriculture during the eighties.

VI. Role of Government in Modernisation of Agriculture

Government intervention for the development of agricultural sector is a common feature in most LDCs. In India, the government has played a major role in promoting agricultural development in general and modernisation of agriculture in particular. Of the various aspects of government intervention in Indian agriculture, the following two aspects deserve special mention : (a) direct intervention in the market mechanism through price support/procurement policy; and (b) subsidisation of major agricultural inputs.

The government has followed administered price policy in respect of several agricultural commodities by fixing their procurement/support prices. The minimum support prices for various crops are announced well in advance and arrangements are also made for the corresponding procurement or price support

operations through public, cooperative and other state-designated agencies. While fixing the agricultural prices, various factors such as cost of agricultural inputs, trends in market prices, inter-crop price parity, etc. are taken into account. It is now well recognised that the government's price policy has played a crucial role in protecting the farmers from market uncertainties and it has also been instrumental in encouraging the adoption of high yielding varieties which has contributed to the speeding up of the process of modernisation.

Information on the trends in the minimum support/procurement prices of selected agricultural commodities in India is provided in Table 5. It is evident that the minimum support prices

TABLE 5

MINIMUM SUPPORT/PROCUREMENT PRICES OF AGRICULTURAL COMMODITIES

(Rupees per Quintal)

	Commodity	1980-81	1988-89	Percentage Increase
1.	Wheat	117	173	48%
2.	Paddy	105	160	52%
3.	Pulses	200	360	80%
4.	Groundnut	206	430	109%
5.	Cotton	304	500	64%

Source: Economic Survey 1985-86 and 1989-90, Government of India.

announced by the government for various agricultural commodities have increased significantly during the period 1980-81 to 1988-89. It is interesting to observe that the government intervention in the form of administered prices has not been at

the cost of economic efficiency. In a recent study, Gulati (1989) has shown that investment programmes aimed at increasing the production of wheat, rice and cotton had high economic rates of return during the eighties.

The strategy of modernising agriculture is likely to succeed only to the extent to which the individual farmers actually use modern agricultural inputs. In India, the government, therefore, adopted the policy of providing a wide range of incentives to the farmers in the form of specific subsidies on modern agricultural inputs. Thus, the subsidies have been provided to the farmers to encourage the use of chemical fertilizers, irrigation facilities, electricity and also to avail credit facilities. Ashok Gulati (1989 a) has estimated the magnitude of different types of subsidies enjoyed by the farmers during the period of eighties. Table 6 brings out the trends in input subsidies in Indian

TABLE 6

TRENDS OF INPUT SUBSIDIES IN INDIAN AGRICULTURE

(Rs. Crores at Current Prices)

	1980-81	1986-87	Percentage Increase
Fertilizer Subsidy	505.0	1187.3	135.1
Irrigation Subsidy	4953.7	8438.6	70.3
Electricity Subsidy	353.0	1457.0	312.7
Credit Subsidy	595.5	1641.4	175.6
Total Input Subsidies	6407.2	12724.3	98.6

Source : Ashok Gulati (1989 a).

agriculture. It can be seen from this table that each of the four major types of input subsidies has increased significantly during the period 1980-81 to 1986-87. Total input subsidies increased from the level of 64.1 billion rupees in 1980-81 to 127.2 billion rupees in 1986-87. In relative terms, total input subsidies represent 15% of NDP in agriculture in 1980-81 and this proportion has risen to 17% by 1986-87. Moreover, the estimated magnitude of total input subsidies measured in real terms (at constant 1980-81 prices) shows an increase of 35% during the six year period, indicating an average compound growth rate of 5.1% per annum. Thus, the rapid pace of modernisation of Indian agriculture has been sustained to a considerable extent by a significant subsidisation of agricultural inputs.

VII. Conclusion

The main conclusion emerging from the analysis presented above is that there has been a significant technical progress in Indian agriculture during the last two decades. Moreover, the contribution of technical progress to the overall growth of Indian agriculture has been steadily rising. In fact, during the eighties, the extent of technical progress has increased considerably as indicated by the significant acceleration of total factor productivity growth in agriculture.

It is interesting to examine the impact of accelerated growth of TFP in the agricultural sector on the growth of the economy in general and agricultural sector in particular.

According to our estimates, if the growth of TFP in agriculture had been at the same rate during the post-1967 period as in the pre-1967 period, the level of real NDP in agriculture in the year 1988-89 would have been lower by about 172.7 billion rupees, which indicates a decline of 29.5% over the level actually achieved. The direct impact of the lower level of agricultural NDP on the overall NDP would have been to reduce its level in 1988-89 by 10.2%. This would have resulted in a decline in the growth rate of the economy as a whole from the observed level of 4.3% per annum to 3.8% per annum during the period 1966-67 to 1988-89. More specifically, the significant acceleration in the overall economic growth experienced by Indian economy during the eighties would have been considerably reduced if the total factor productivity in agriculture had not shown a remarkable acceleration during this period. If the growth of TFP in agriculture during the period 80-81 to 88-89 would have been at the same rate as during the pre-1967 period, the overall growth rate of the economy during this period would have declined from the observed level of 5.5% per annum to 4.7% per annum. Thus, the acceleration in the TFP growth in agriculture has made a significant contribution to the acceleration in the overall growth of the economy during the eighties.

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