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A N N E X B

ACCELERATING INDIA'S FOODGRAIN PRODUCTION
1967-68 TO 1970-71

Requirements and Prospects for a Growth Rate of 5 Percent per annum

INTRODUCTION

This report deals with the potentials and requirements for increasing India's foodgrain production by 5 percent per year from 1967-68 to 1970-71. It is divided into five parts as follows:

.... brief review of India's agricultural record since 1949-50,

.... description of recent changes in technologies and policies providing a basis for accelerating growth,

.... estimation of 1967-68 foodgrain output,

.... estimation of inputs and other requirements (within specified constraints) for a 5 percent growth rate, and

.... review of current policies and programs bearing on the above requirements.

The year 1970-71 is end of the fourth five-year plan period. As such, it is the year toward which India's official targets on production, inputs and other requirements are specifically pointed.

The year 1967-68, instead of earlier years in the fourth plan period, is chosen as base for a 5 percent per year take-off because

.... 1965-66 and 1966-67 were among the most severe droughts years experienced by India in a century,

.... 1967-68 holds promise as a major turning point in India's foodgrain production potentials and in effectiveness of policies and programs for their realization.

Improvements made in India since its Independence, in 1947, in irrigation and other agricultural bases helped alleviate adverse effects of the 1965-66 and 1966-67 droughts. Nonetheless, output dropped from 1964-65 to 1965-66 by the largest percentage for any year since 1920-21. The drop for 1965-66 and 1966-67 combined was larger than that for any other two consecutive years in this century.

These large production breaks have provided dramatic illustration and created widespread increased appreciation of agriculture's importance to India's general economic progress. This is reflected in greatly increased emphasis upon agriculture in policies and programs and the budgets both of central and state governments and of AID and other national and international development agencies.

Fortunately for the likely success of this new emphasis, it closely parallels large advances in adaptable farm technology - ones which some believe increase India's production potentials more than all the other farm technological advances put together made in the first half of this century. The key elements of these advances consist of varietal breakthroughs for India's major cereal crops - rice, wheat, jowar, bajra, and maize. These hold promise of yield increase potentials roughly comparable to that recently achieved for maize in the United States from use of hybrids. The importance of such grains for India looms particularly large because of the large relative importance of cereals in its total agricultural production.

A foodgrain production growth rate of 5 percent per year has been chosen for the purposes of this analysis because

.... it is near the minimal level needed by India to achieve its own stated objective of self-sufficiency in foodgrain production,

.... it appears to be attainable and economically feasible, assuming appropriate policies and programs for providing inputs, supporting facilities and services, and incentives.

From the side of needs, India must increase its foodgrains production by 2.5 percent per year (some estimates run to 2.7 percent) to feed its growing population at present per capita consumption levels - assuming only its "normal" level of self-sufficiency.

An additional increase of 1 percent or more per year is needed to meet increases in demand expected from rising per capita incomes.

Finally, an additional rate of increase in output is needed

.... for progress toward India's stated goal of self-sufficiency in foodgrain production;

.... for replenishing now exhausted contingency stocks of foodgrain, normally held by farmers, traders, and nonfarm households; and

.... for building buffer stocks to stabilize market supplies and prices.

Fortunately, the rate of growth required to meet the last three needs turns upon India's own sense of urgency - specifically, upon how quickly it wants to become self-sufficient in foodgrain production. For at least the next three to five years, India can effectively absorb as large increases in foodgrain production as it can economically produce.

A 5 percent rate of growth from 1967-68 to 1970-71 will require a sharp upturn in the historical rates of growth. It will meet new needs from population and per capita income growth and enable India to move toward its goal of foodgrain and general economic self-sufficiency.

INDIA'S FOODGRAIN PRODUCTION SINCE 1944-49

Output

India's progress in increasing foodgrains since Independence has fallen short of its goals and needs. It is instructive, however, to look at its record.

.... in context of the political, social and economic problems that India as a new nation has faced; and

.... against progress under colonial rule.

India's main problem since Independence has been that of integrating under a new, democratic nation a population

.... larger than that of the whole western hemisphere; larger also than that of all of Europe outside the USSR;

.... more impoverished and illiterate than that of any but a few relatively small Asian and African countries;

.... more diverse in ethnic features, languages, religions and political ideologies than is that of the whole population of Europe. Such diversities could operate as highly divisive forces weakening the stability and power of both center and states for the decisive action required for rapid economic growth. They did underlie the Partition of India and Pakistan and the difficult problems associated with it.

Even with these problems, India's foodgrain production record since Independence looks good compared with that of the preceding half century. The record in first half of the twentieth century to 1947-48 for undivided India (i.e. the area now comprising both India and Pakistan) is as follows: 1/

Time period	Million tons per year
1900-01 to 1909-10	67.6
1910-11 to 1919-20	72.7
1920-21 to 1929-30	68.1
1930-31 to 1939-40	67.8
1940-41 to 1947-48	67.4

1/ S.R. Sen, Growth and Stability in Indian Agriculture, *Agricultural Situation in India*, January 1967

In contrast, from 1949-50 to 1964-65, India as now constituted increased its foodgrain production by an average of nearly 2 million tons per year (Table 1). Calculated on basis of its annual output series unadjusted for weather and associated yield variations, it had an output growth rate of 2.98 percent (compound) per year. Calculated from 3-year and 5-year moving averages, used to smooth out irregularities caused by weather, it had growth rate of 2.83 percent using the 3-year moving averages and 2.69 using the 5-year moving averages. Projection of trends to 1967-68 at growth rates of 2.83 and 2.69 percent indicates an output of 93 million and 92.7 million tons, respectively.

Neither the 3-year nor the 5-year moving averages show a marked slowing down in the foodgrain growth rate as between the first and second half of the 1949-50 to 1964-65 period, such as is indicated from use of the unadjusted output data. The 5-year moving average indicates consistent year to year increases and a near imperceptable decline in the rate of growth. Even for such decline as is indicated, one cannot be wholly sure whether it reflects a genuine shift in trend or is only the result of using a period of time too short for even a 5-year moving average to smooth out the influence of weather fluctuations such as are quite normal to India.

TABLE 1. Foodgrain Production in India, 1949-50 to 1966-67 and "Trend" Estimates of Production 1967-68 (thousand tons)

Year	Actual Output	Moving Averages of Output Using Years 1949-50 to 1964-65: 3-Year Moving Average	5-Year Moving Average
	(1)	(2)	(3)
1949-50	60,653	-	-
1950-51	54,922	57,028	-
1951-52	55,508	57,368	60,988
1952-53	61,673	63,122	62,979
1953-54	72,186	68,155	65,838
1954-55	70,606	70,669	69,204
1955-56	69,216	70,720	70,170
1956-57	72,337	69,352	71,470
1957-58	66,504	72,509	72,689
1958-59	78,687	73,963	75,249
1959-60	76,699	79,135	77,323
1960-61	82,018	80,474	79,712
1961-62	82,706	81,057	80,023
1962-63	78,448	80,466	82,482
1963-64	80,243	82,562	-
1964-65	88,996	-	-
1965-66	72,264	xx	xx
1966-67	78,000	xx 2/	xx 3/
1967-68 trend estimate 1/	xx	93,076	92,715

1/ Omits use of 1965-66 and 1966-67 data.

2/ Using 1957-58 as "Origin" for computational purposes, $Y = 72416 (1.0283)^t$ where Y = output, and t = time in years.

3/ With 1957-58 as "Origin", $Y = 72038 (1.0269)^t$.

Large shortfalls in production in 1965-66 and 1966-67 resulting from highly abnormal weather conditions have focused world attention on India's food problem and helped to create the impression that India's agriculture is near stagnant while its population is increasing by 2.5 percent or more per year.

India's agriculture has always been highly subject to large year to year variations in output as a result of the highly variable and uncertain monsoon rains upon which it heavily depends. It has experienced severe famine extending over large parts of one or more of its major regions many times in its history. Twenty seven famines, each extending over areas equal in size to one or more such states as Gujarat and Orissa, occurred in the 19th century. Many of India's droughts before 1900, however, resulted in famine largely because of poor transport and communication facilities and lack of administrative machinery for procurement and distribution from surplus to deficit areas.

Since 1900, famines have occurred less frequently than during the nineteenth century. India has, however, experienced a break in its foodgrain production from one year to the next of 10 percent or more five times since 1900. These times and the associated percentage declines in output were as follows:

Year	Percent
1907-08	12.9
1918-19	32.3
1920-21	24.0
1923-24	16.6
1965-66	18.8

Since 1923-24, famine or near famine conditions resulting from drought have occurred much less frequently than between 1900 and 1923-24. However, frequent breaks in output of less than 10 percent per year, have continued to characterize Indian agriculture. Between 1949-50 and 1964-65 such breaks occurred six times as follows:

		(1,000 tons)
From 1949-50 to 1950-51		5,731
From 1953-54 to 1954-55		1,580
From 1954-55 to 1955-56		390
From 1956-57 to 1957-58		5,833
From 1958-59 to 1959-60		1,988
From 1961-62 to 1962-63		4,262
	Total	19,784

Against the above production shortfalls of the frequency and extent that had seemed to become normal from about 1925 to 1964-65, India's foodgrain production from 1964-65 to 1965-66, dropped by 16,732,000 tons as a result of widespread drought. This was a shortfall equal to 85 percent of all six of the shortfalls from the preceding year occurring between 1949-50 and 1964-65. Worse still, this was followed by a second severe drought in Bihar, eastern Uttar Pradesh, large parts of Madhya Pradesh and parts of other states, most of which localities are densely populated and normally productive per unit of land.

That this recurrence of severe drought and near famine conditions in 1965-66 and again in 1966-67 is the prelude to a new weather cycle and production breaks of the frequency and magnitude experienced between 1800 and 1923-24 is highly doubtful - if for no other reason than that India now has close to 40 million hectares of land under irrigation.

But whatever the frequency of droughts like that of 1965-66 even mere year to year output fluctuations of the frequency and extent of those between 1949-50 and 1964-65 make it difficult to obtain a statistically reliable estimate of India's rate of growth in foodgrain production from observations covering only 5 to 6 years such as from 1958-59 to 1963-64. Even for periods of 15 to 20 years, one needs in analyses of India's progress to take careful account of yearly fluctuations caused by weather. We have attempted to do this in this report by the use of first three-year and then five-year moving averages.

Not even a 5-year moving average, however, yields a statistic for any year using 1965-66 actual output data in its 5-year average that is free of a large slippage from the trend of earlier years or from any output projection that one could sensibly make for 1965-66 based upon available inputs and normal response ratios.

Data on output by states indicate that a few states had a larger output in 1966-67 than in 1964-65 notwithstanding somewhat less favorable weather in 1966-67. (Appendix Table 1. See also Appendix Table 2.)

Inputs

Inputs of land, irrigation water, labor and fertilizers used in India's agriculture from 1950-51 through 1964-65 are shown in Table 2. Inputs of each of these factors have been increasing rather steadily since 1950-51. Gross sown area, however, increased only from 156.1 million hectares in 1961-62 to 157.9 million hectares in 1964-65. Interestingly, from 1960-61 to 1961-62, it increased by 3.4 million hectares after two earlier years of very little change.

Compensation for this slowing down in area growth rate, however, has been provided in larger part, by increases in area under irrigation, fertilizers, and other yield increasing inputs. Total fertilizer consumption in terms of plant nutrients increased from 65,685 tons in 1952-53 to 652,565 tons in 1964-65, an increase of 586,880 tons. This is an amount sufficient to yield an increase in foodgrain output of 3.8 million tons assuming a response ratio of 6.5.

TABLE 2 - Major Inputs and Production, Agriculture in India, 1949-50 to 1964-65 1/

Year	MAJOR INPUTS			
	Land 2/	Water 3/	Labor 4/	Fertilizer 5/
	(Thousand Hectares)	(Thousand Hectares)	(Thousand Ag. Workers)	(Metric Tons)
1949-50	-	-	-	-
1950-51	131,893	22,563	102,929	-
1951-52	133,234	23,180	103,217	-
1952-53	137,675	23,305	103,506	57,822
1953-54	142,480	24,363	103,796	89,287
1954-55	144,083	24,948	104,087	94,810
1955-56	147,311	24,642	104,429	107,494
1956-57	149,492	25,707	104,789	123,054
1957-58	145,832	26,628	105,149	149,019
1958-59	151,629	26,948	105,509	171,988
1959-60	152,824	27,413	105,869	229,326
1960-61	152,716	27,886	106,186	211,685
1961-62	156,099	28,373	106,505	291,536
1962-63	156,736	29,452	106,824	360,033
1963-64	156,970	30,380	107,144	406,976
1964-65	157,940 =	31,170	107,465	434,473

1/ Includes inputs used on non-foodgrains as well as on foodgrains.
2/ Gross sown area.
3/ Gross irrigated area.
4/ Agricultural workers as reported in National Income Account reports for selected years and estimated for intervening years using rates of change indicated in National Income Accounts Statistics.
5/ Nitrogen fertilizers in tons TN.

This is an output equal to that from about 5 million hectares of land at average yield levels. Fertilizer consumption in 1967-68 is expected to reach 2.1 million tons, enough over 1964-65 to yield an output equal to what could reasonably be expected from the addition of 16 million hectares of additional land.

Multiple cropping is an additional way of extending India's effective land area. At present, India grows only one crop per year on 85 percent of its net sown land. Only about 15 percent of its net irrigated area is being used for 2 or more crops per year. For area with assured supplies of water the year round, two to three crops per year can easily be grown under Indian climatic conditions.

Main Directions of Policies and Programs

In early efforts to modernize India's agriculture following Independence, it was widely assumed the technology for doing so was readily available, consisting merely

... of indigenous techniques already employed by the better farmers, and

... of importable technologies originally developed in and for farmers of economically advanced nations.

Emphasis in these earlier efforts, therefore, centered heavily upon building new institutions to facilitate adoption of already known technologies rather than upon strengthening technological bases. These included

... Extension activities built around widespread use of village level workers and community development programs.

... Cooperatives to provide credit, distribute fertilizers, seeds and other supplies.

... Land reform to provide incentives to India's millions of tenants to adopt better methods which while increasing output would not under existing tenurial arrangements increase their own output and income.

Such price policies as were in effect before the 1960's were directed more to consumer interests than to larger incentives and smaller price risks for producers. Terms of trade between foodgrains and other commodities therefore shifted through most of the 1950's in favor of the latter, to the detriment of farmers and of agriculture as an industry.

As among states and smaller areas of India, the foregoing policies have met with varying degrees of success within limits of available technologies. Punjab (constituted as in 1965), Gujarat and Madras states were able to increase their agricultural output from 1952-53 to 1964-65 by a rate of more than 4 percent per year on a compound basis. Four districts in the Punjab and two in Madras State increased their agricultural production by linear averages of more than 7 percent per year.

These high rates of growth reflected the presence in these states and areas of determined agricultural leadership above average in initiative and in decision-making and administrative experience. This leadership has been successful in helping farmers in these areas to obtain more fertilizers, more irrigation facilities, and more technical assistance of quality than has been provided in most of the other states of India. Such leadership often is found in areas where the spirit of enterprise and entrepreneurial abilities are most widely developed. Some observers have noted that in India's more rapidly developing states, agriculture has been organized in large part around owner-operator free-holds in contrast to large land holding and highly developed hierarched land structure in such slow growth states as Uttar Pradesh.

RECENT IMPROVEMENT IN FOODGRAIN PRODUCTION POTENTIALS

= The achievement of a 5 percent rate of growth in foodgrain production on an all-India basis requires increasing rate of growth throughout the larger part of India to the levels that a few states and in particular a few districts within these states have demonstrated is technically possible. The basis for doing this has been greatly improved as a result of recent improvements in two important parameters of the Nation's agricultural economy. These have been (1) major improvements in applicable farm technology and (2) important shifts in policies and programs of both Central and State governments directed to the exploitation of these technological improvements.

Technological Advances

The key element in India's recent farm technological advance consists of highly productive varietal breakthroughs for rice, wheat, maize, jowar and bajra with new high yielding varieties of these crops now in large enough commercial use to insure relatively large increases in planted area in 1967-68.

A somewhat comparable technical advance in U.S. agriculture was the development and commercial adoption of high yielding maize hybrids. After these were first successfully adopted in the Corn Belt in the 1930's, however, it took more than another decade of further research in each of other regions to develop hybrids well adopted to their soil and climatic conditions. In the United States equally productive varietal advances for wheat, grain sorghums, and other cereals came still several years later.

In contrast, as a result of the transferability of varieties produced elsewhere and of India's own varietal research, new highly productive varieties of rice, wheat, maize, jowar and bajra have all come into commercial use in India within only the last three to four years.

Before turning to available information on the yields and other attributes of these new varieties, brief reference to India's traditional crop varieties will help to set these varietal breakthroughs in their proper perspective.

India's traditional crop varieties - those underlying its production record of the last 20 years if not for hundreds of years - have evolved over centuries of time as the surviving species of harsh physical environment. This has been an environment marked by frequent extremes of droughts and floods, uncertain and widely varying moisture conditions, low soil fertility, and crude tillage practices plus other complex crop production and soil management problems characterizing tropical and semi-tropical regions generally.

The crop varieties that have evolved from out of this harsh environment have been well adapted to it, especially in terms of survival capacities. Except under such extreme drought as that recently in Bihar, they have usually yielded a crop of some size when exotic imported varieties have failed. They have, in other words, demonstrated a capacity for withstanding large variations in soil moisture and associated intake of plant nutrients without correspondingly large variations in yields. These have been exceedingly important qualities contributing for centuries also to the survival capacity of Indian farm people.

On the other hand, the very genetic features that have enabled these varieties to serve the needs of Indian agriculture so well in the past function as important constraints on their responses to fertilizers, water, and other inputs of the kinds that in recent decades have greatly increased agricultural productivity in United States, Japan and elsewhere. Indigenous varieties have shown both relatively low responses to such inputs and capacities to absorb but very small quantities of them within economically profitable limits.

Moreover, until recently, even the improved varieties developed in temperate climatic zones have shown little adaptability to tropical and semi-tropical conditions or to other latitudes than those for which they were developed. One reason for this is their high sensitivity to variations in length of day and sunlight intensity. Hence, in countries like India, available crop varieties have functioned as severe constraints to increasing agricultural output except at costs much higher than those required for comparable output increases in the United States.

In the case of wheat, new high yielding varieties with genetic features which make them highly insensitive to variations in sunlight and therefore easily adaptable within wide latitudinal ranges have recently been developed. Paralleling this work, under leadership of Rockefeller Foundation scientists working closely with India's own research institutions there has been much research to develop hybrids well adapted to India. This research has also been highly successful, leading in recent years to several high yielding hybrids for maize, jowar and bajra. Both imports and India's own research efforts have contributed to the introduction of high yielding varieties of rice.

These new varietal introductions are not only superior to traditional varieties in their yields under normal monsoon conditions but they greatly excel local varieties in their capacity for productively absorbing fertilizers', water, labor and other inputs. In fact, larger inputs of fertilizers and plant protection materials together with assured supplies of water cannot be over-emphasized as essential to the continuing success of the high yielding varieties. Expressed in another way, the new high yielding varieties involve more than the mere substitution of one kind of seed for another. Their successful introduction will require changes in nearly all components of Indian foodgrain production technology.

Turning to specific varietal introductions, one rice variety introduction now in fairly large scale commercial production is ADT-27 developed in Madras State. In 1965, an average yield of 3820 pounds per acre was obtained on about 3000 acres of ADT-27 grown under farm conditions in Tanjore District in the State of Madras. Yields ranged from 1600 to 5500 pounds with the top decile of growers having an average yield of 5140 pounds and the lowest decile an average of 2480. In 1966, under less favorable weather conditions and with area increased to about 125,000 acres, the average yield of ADT-27 was 2450 pounds compared with 1760 pounds for "other improved varieties". Fertilizers used in pounds of plant food were as follows:

Variety	Percent of Fields Fertilized	Lbs. Plant Food Applied per Acre: Fields Fertilized	All Fields
ADT-27	97	68	64
Other Improved Varieties	80	47	37
Common	75	37	28
Mixtures	55	29	16

Fertilizer yield responses for ADT-27 were somewhat low in 1966, likely because of unfavorable weather conditions. The results were as follows:

Plant Food: Group	Lbs/A	Percent of Fields	Paddy Yield Lbs/A
None	0	3	1320
Under 50	33	38	2250
50-70	60	14	2400
70-90	80	23	2550
90-100	100	11	2810
110 & over	140	11	3080
Average	64	100	2450

These represent at a range up to 50 pounds of fertilizer a response ratio of slightly over 28 to 1.

Results of rice variety trials conducted in the 1966 kharif season under auspices of the Indian Council of Agricultural Research with the Rockefeller Foundation cooperating are shown in Table 3 for two levels of nitrogen application. In these trials conducted in all parts of India, local Indica varieties not only had appreciable lower yields than did new, Dwarf Indica and Ponlai varieties but also demonstrated an appreciably lower response and lower capacity to use fertilizers.

Preliminary releases prepared by the Farm Management Group, Ford Foundation on wheat yields for the 1966-67 crop in Ludhiana District in Punjab State, reveals results as follows:

Variety and Year		Yield (Lbs/A)
Mexican	1966-67	4200
Indian	1966-67	2130
All Varieties	1965-66	1970
All Varieties	1964-65	2015

In applications of nitrogen up to 50 kg per hectare, the improved varieties excelled local varieties, with a response over that yielded by local varieties of more than 10 units of grain per unit of fertilizer used. At least, this suggests a total response ratio of more than 20 to 1.

TABLE 3 - Summary of Yields of Specified Rice Varieties In the Uniform Variety Trials, kharif 1966

Variety	Locations Reporting	Yields of Grain with Nitrogen Applied at 50 kg/ha	100 kg/ha	Difference
	Number	kg/ha	kg/ha	kg/ha
Dwarf Indica				
TN-1 X Taichung 67	14	3885	4351	466
Taichung Native 1	20	3603	4319	716
Dee-Geo-Woo-Gen	15	3644	3899	255
IR 9-60	17	3445	3857	412
Ponlai				
Kachsiung 68	19	3729	4198	469
Tainan 3	20	3577	4155	578
Ghianung 242	20	3344	3947	603
Taichung 65	18	3543	3884	341
Ch.242 X CI 9155	17	3128	3479	351
Local Indica				
NC 1626	14	2893	3200	307
Co 29	14	2884	3167	283

Source: Progress Report of the All India Coordinated Rice Improvement Project, Kharif 1966, Indian Council of Agricultural Research, New Delhi, India and Cooperating Agencies, p 18.

It is estimated that Ludhiana had 37,000 acres of the Mexican dwarf varieties in 1966-67, constituting 11 percent of its total wheat area. It is recognized that this was probably grown by better farmers, which fact partially accounts for a yield nearly twice as large as that obtained for Indian varieties. Interestingly, yield of Indian varieties in 1966-67 varied little from the yields reported in 1965-66 and in 1964-65. All of the farmers growing Mexican wheat used nitrogen fertilizers and 73 percent used phosphate. The average applications were 84.5 pounds of N and 23.3 pounds of P_2O_5 per acre. The average application for all wheat in the District (including Mexican) was 53.6 pounds of N and 11.9 pounds of P_2O_5 per acre, or a total of 65.5 pounds of plant food per acre. The increment of 42.3 pounds of fertilizers used in conjunction with Mexican variety yielded an increment in yield of 2,070 pounds, or 48.9 pounds of grain per additional pound of fertilizers. This high response is response of a whole complex of practices and superior management rather than of fertilizer alone. However, it suggests a response ratio of 15 to 20 pounds per pound of fertilizer is a reasonable expectation for high yielding varieties under average farm conditions.

Data are available on varietal tests for bajra for 1965-66. These indicate higher yields for hybrids than for local varieties in all areas where the tests have been conducted. Ev n with no fertilizers the average yields in one set of tests, as an example, were 1856 kg/ha for local varieties and 2154 kg/ha for hybrids, a difference of 298 kg/ha (Table 4). The large advantage of the hybrids over local varieties, however, lies in their capacity to use larger amounts of fertilizers and to use them more productively. For example, the first increment of 40 kgs. of N resulted in yield increments of 713 kgs. for local varieties and in 1407 kgs. for hybrids, or twice as large as for local varieties. Again these results suggest response ratios of better than 15 to 1 for fertilizers used.

Tests on double cross hybrids of maize run for four years indicate grain yields of 3300 to 7000 kgs/ha (or up to 100 bushels per acre). In all tests yields of hybrids were much above those of local varieties, running generally 40 to 50 percent above local variety yields.

Available data on Jowar (sorghum) indicates yields for hybrids of about 500 kg/ha over those for local varieties and response ratios for varying levels of application of nitrogen as follows:

N Level kg/ha	Response Ratios - kg of grain/kg N	
	Local Varieties	Hybrids
0 to 40	14.2	19.2
0 to 80	4.8	16.1
0 to 120	-	13.0

Source: Indian Economic Policy and the Fourth Five-Year Plan Vol. II Agricultural Policy in India, International Bank for Reconstruction and Development March 7, 1967.

TABLE 4 - Yields of Hybrid and Local Varieties of Bajra at varying rates of Nitrogen Application, Trial at Fatehabad (Agra) Uttar Pradesh, 1965 Kharif

	Yields of Grain (kg/ha)		
Nitrogen	Local Varieties	Hybrids	Differences
0	1856	2154	298
40	2569	3561	992
80	3069	4348	1279
120	3806	5645	1839
160	3393	5967	2574

Source: Progress Report of the Coordinated Millets Improvement Program, 1965-66, Indian Council of Agricultural Research and Cooperating Agencies (Including Rockefeller Foundation)

Shifts in Policy Emphasis

Food crises of the last two years have jarred Indian leaders and had a dramatic impact upon thinking at all governmental levels - center, state and local - in matters pertaining to agriculture. Hence the commercial adoption of new high yielding varieties and provisions of assured water supplies, fertilizers, plant protection materials and other inputs that are part and parcel of the new high yielding variety technology have been greatly facilitated by a new sense of urgency and determination on the part of both center and state governments to avert, if possible, future food crises like those of 1965-66 and 1966-67.

New directions of effort at policy levels are being pointed directly to increasing production through more adequate provision of essential inputs in contrast to emphasis in the 1950's upon major institutional reforms. High current levels of demand by farmers for fertilizers, improved seeds and other inputs clearly indicate that institutional impediments are not currently bottlenecks to uses of these inputs, hence indicates the wisdom of the current policy emphasis.

Currently operative policies and programs are treated in fuller detail in a later section following sections on requirements for the 1967-68 output and a 5 percent growth rate so as to better relate recent and prospective achievements more directly to requirements.

ESTIMATION OF 1967-68 FOODGRAIN OUTPUT

Though evidence in a previous section indicated that a trend extrapolation of outputs would lead to a 1967-68 projection of 92 million tons of foodgrains, in the final analysis, forecasting production for a single year such as the current crop year is dependent upon the supply of production factors. An aggregative framework has been constructed for measuring the production response from these factors. Of course, weather is an uncontrolled variable which underlies the response of the input mix; for this forecast it is assumed normal.[1/] In addition, it is assumed that relative prices are at levels which will provide cultivators the incentive to purchase the necessary inputs.[2/]

The projection method used here measures the marginal response of input changes from a base period to the period under review. The production responses from these input changes are based on likely input-output ratios.[3/] This response added to the base period production results in the forecasted or projected output. This method has the advantage of being capable of taking into account a

1/ Rainfall thusfar during the current kharif season has been favorable.
2/ This also subsumes that credit is available when necessary for input purchases.
3/ See the discussion on "Basis of Yield Estimates".

shift in the production function. The trend extrapolation, on the other hand, implicitly assumes no shift in the production function.

The base period used in this framework is the three-year average centered on 1960-61. This period was selected for the following reasons: (1) Fluctuations in production caused by weather appear to be relatively moderate; (2) Fertilizer consumption was relatively low and the use of improved crop varieties was virtually non-existent; (3) The convenience of a projection base at the outset of the 1960 decade; and (4) To fit the time reference of previous projection studies. 1/

The 1967-68 inputs for foodgrains used in this model are the AID Mission's estimates, based on GOI targets; the self-help measures, as specified in Item V of the PL 480 agreement signed on February 12, 1967; and current reports on input supplies. They include the following:

.... 117.5 million hectares of foodgrains

.... 32.0 million hectares of gross irrigated foodgrain area

.... 1.6 million tons of fertilizers applied to foodgrains (pure nutrients). 2/

.... 6.1 million hectares sown with high yielding varieties.

Table 5 provides a comparison with the base period inputs. In effect the model's task is to calculate the production response from incremental increases of 1.3 million sown hectares of foodgrains, 9.7 million

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1/ See, for instance, The World Food Budget, 1970, 1964, FAER 19 ERS, USDA: and "An Evaluation of India's Fourth Five-Year Agricultural Sector", Abel and Brown, May 1965.

2/ Including N, P_2O_5, and K_2O. Hereafter a unit of fertilizer will be assumed to contain 4 parts N, 2 parts P_2O_5, and 1 part K_2O. It is assumed that foodgrains account for 75 percent of total fertilizer consumption.

TABLE 5 Input Base for Estimating 1967-68 Foodgrain Production in India:[1]
A comparison with the three year average 1959-60 to 1961-62

Input and Units	Base Period [2]	Total Supplies of Inputs 1967/68 [3]	INPUT REQUIREMENTS AND OUTPUT INCREMENTS WITH FACTOR INCREASES							
			Area Expansion Alone [4]	Unused Inputs (2-3)	High Yield Varieties [5]	Unused Inputs (4-5)	Irrigation with local varieties [6]	Unused Inputs (6-7)	Non-irrigation with local varieties	Estimated Inputs and Production 1967-68
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Foodgrain Area (1,000 hectares)	116,212	117,500	117,500	0	0	0	0	0	0	117,500
Gross Irrigated Foodgrain Area [7] (1,000 hectares)	22,318	32,000	22,563	9,437	6,100	3,337	3,337	0	0	32,000
Fertilizer for Foodgrains [8] (1,000 tons)	131 [9]	1,575 [10]	132	1,443	366	1,077	133	944	944	1,575
High Yielding Varieties (1,000 hectares)	0	6,100 [11]	0	6,100	6,100	0	0	0	0	6,100
Production Increments (1,000 tons)	-	-	885	-	4,941 [12]	-	1,197 [13]	-	6,136 [14]	13,159 [15]
Foodgrain Production (1,000 tons)	80,465	-	-	-	-	-	-	-	-	93,624 [16]

1/ Foodgrains include pulses and rice in milled equivalent
2/ The three year average 1959-60 to 1961-62.
3/ Inputs estimated by AID Mission, based largely on GOI targets and self-help measures as specified in PL 480 agreement.
4/ Yield is held constant; production, irrigation, and fertilizers increased at the rate of area increase (1.1%).
5/ The high yielding varieties area was assumed to be irrigated and fertilized at the rate of 60 kg/ha.
6/ It was assumed that fertilizers would be applied at the rate of 40 kg/ha.

7/ Irrigated foodgrain area accounts for about 80% of total gross irrigated area (Fertilizer Statistics, 1965-66).
8/ In terms of pure nutrients, it is assumed that one unit of fertilizer contains 4 parts N, 2 parts P_2O_5, and 1 part K_2O.
9/ It was assumed that 40% of total fertilizers applied on foodgrains.
10/ It was assumed that 75% of total fertilizers applied on foodgrains.
11/ Estimated distribution (mill ha); wheat 2.5; rice 1.9; corn 0.5; jowar 0.7; bajra 0.5.
12/ An input-output coefficient of 13.5 was assumed.
13/ An input-output coefficient of 9.0 was assumed.
14/ An input-output coefficient of 6.5 was assumed.
15/ Implicit input-output coefficient of 8.5 for fertilizers and production increments under columns 5, 7 and 9.
16/ On balance, with relatively favorable weather, 1967-68 foodgrain production will reach 92 million tons and should reach the estimated 93.6 million tons. The difference between the estimated 93.6 million and the 92 million set for the "Big Push" base should be regarded as a safety margin for uncertainties of weather, input supplies and distribution, and assumed response coefficients.

gross hectares of irrigated area, 1.4 million tons of fertilizers, and 6.1 million hectares sown with high yielding varieties.

The model first accounts for the production increment attributed to only the increase in area. This amounted to 885,000 tons or 1.1 percent of the base period production. Yields are held constant by increasing irrigation and fertilizer at the same growth rate as area (1.1 percent).

The next step estimates the increment resulting from the use of 6.1 million hectares of high yielding varieties with the assumption that all of this area will be irrigated and fertilized at the rate of 60 kilograms per hectare. Thus 366,000 tons of fertilizers are applied to 6.1 million irrigated hectares of high yielding grain varieties. A response coefficient of 13.5 was assumed, resulting in a production increment of 4.9 million tons.

The third step measures the output increment from the unused irrigated area of 3.3 million hectares. Only local varieties are grown on this area; fertilizer is applied at the rate of 40 kilograms per hectare, amounting to 133,000 tons. A fertilizer response coefficient of 9.0 is assumed which results in added production of 1.2 million tons.

The residual input is 944,000 tons of fertilizer. This fertilizer is applied to non-irrigated land with local varieties of foodgrains. A response coefficient of 6.5 is assumed which results in a production increment of 6.1 million tons.

The final step totals the production increments and the base period production, resulting in an estimate of 93.6 million tons of foodgrains in 1967-68. Thus, this analysis of input response more than supports the trend projection of 92 million tons. The difference between the estimated 93.6 million and the 92 million set for the "Big Push" base should be regarded as a margin of safety for uncertainities of weather; input supplies and distribution and response coefficients.

The assumption in the third step of applying the residual fertilizer to only non-irrigated land is a conservative element of this model. It could be reasonably assumed that at least a portion of the fertilizer might be applied to the irrigated area in the first step (22.6 million hectares), after accounting for the effect of the area increase. As the model stands only 136,000 tons of fertilizer or an average of 5.9 kilograms per hectare is applied to this area. If all of the remaining fertilizer (944,000 tons) were applied, then the rate would jump to 47.7 kilograms per hectare. Holding other things constant, the output response from fertilizer is higher on irrigated land than on non-irrigated land.[1/] An increase in the response coefficient from 6.5 to 9.0 would result in an additional 2.4 million tons of foodgrains.

If the input and production estimates for 1967-68 prove to be correct and output is merely near the trend level, it would suggest that the input base - fertilizers, high yielding varieties, and irrigation - must be accelerated substantially over recent rates in order to reach a desired annual growth rate of five percent in the near future. The input base of 1967-68 is vastly improved from recent years but apparently in effect it has only substituted for

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1/ See "Yardsticks of Additional Production of Certain Foodgrains, Commercial and Oilseed Crops", Institute of Agricultural Research Statistics, New Delhi, 1964.

the rapid expansion in area and increases in other production factors during the fifties in sustaining the historical growth rate. This fact gives rise to the call for a "Big Push" in order to sustain a 5 percent growth rate.

REQUIREMENTS FOR A 5-PERCENT GROWTH RATE 1967-68 TO 1970-71

Farm Inputs

At an annual growth rate of 5 percent from a 1967-68 estimated output of 92 million tons, India's foodgrain production would reach 106 million tons in 1970-71. With this objective in view, the immediate task is to find what input base is required to reach this desired level of output.

For this computation the following assumptions were made:

.... Normal weather conditions will prevail,

.... relative producer prices are at levels which will provide cultivators the incentive to purchase and use the projected inputs, 1/

.... the gross foodgrain area will total 121 million hectares, three percent above the estimated 1967-68 level. 2/ It is expected that part of this increase will be the result of double cropping,

.... the gross irrigated foodgrain area will total 38.0 million hectares, 3/

.... the area sown with high yielding varieties will total 13.2 million hectares (the Fourth Plan Target),

.... the area of high yielding varieties will be irrigated and fertilized at the rate of 80 kilograms per hectare. The response coefficient is 13.5,

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1/ This also subsumes that credit is available when necessary for input purchases.

2/ The area increase is taken as a trend extrapolation as projected in "The World Food Problem, A Report of the President's Science Advisory Committee", Vol II May 1967.

3/ Irrigated foodgrain area acounts for about 80 percent of total gross irrigated area.

.... fertilizers will be applied to the irrigated area with local varieties at the rate of 60 kilograms per hectare. The response coefficient is 9.0,

.... an input-output coefficient of 6.5 for fertilizer applied to non-irrigated area with local varieties. 4/

The 1970-71 level of three input variables - land, high yielding varieties and irrigation - has been assumed or projected, simplifying the task of computing an input base. The assignment is one of finding the amount of fertilizer which will enable output to reach 106 million tons. The model used to measure the marginal response of input increases is essentially the same as that used for 1967-68 estimate. Again the base period is centered on 1960-61. The model must now find the necessary fertilizer, given other inputs and output whereas in the 1967-68, its assignment was to find output given the inputs.

The computational steps follow the pattern of the 1967-68 input model as shown in Table 6. The first calculation is the production increment resulting from the area increase (holding yield constant) of 4.8 million hectares; this amounts to 3.3 million tons. To hold yield constant requires 4,000 tons of fertilizer and 915,000 hectares of irrigated area in excess of the base period levels. The additional output resulting from the use of 13.2 million hectares of high yielding varieties is computed in the second step; this totals 14.3 million tons. To reach this level requires 13.2 million hectares of irrigated area and 1.1 million tons of fertilizers in excess of the base period levels.

4/ As was noted in the discussion of the input basis for 1967-68, this assumption provides a conservative element to the model.

TABLE 6 Input Base for Projection of 1970-71 Foodgrain Production in India at 108 Million Tons 1/

A comparison with the Three Year Average 1959-60 to 1961-62

Inputs and Units	Base Period 2/	Given Inputs 1970-71 3/	INPUT REQUIREMENTS AND OUTPUT INCREMENTS WITH FACTOR INCREASES: Area Expansion alone 4/	Hybrid Yield Varieties 5/	Irrigation with local varieties 6/	Non-irrigated with local varieties	Projected inputs and production 1970-71
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Foodgrain Area (1,000 hectares)	116,212	121,000	121,000	0	0	0	121,000
Gross Irrigated Foodgrain Area (1,000 hectares) 7/	22,318	38,000	23,233	13,200	1,567	0	38,000
Fertilizer for Foodgrains (1,000 tons) 8/	131 9/	-	136	1,056	94	1,405	2,691
High Yielding Varieties (1,000 hectares)	0	13,200 10/	0	13,200	0	0	13,200
Production Increments (1,000 tons)	-	-	3,299	14,256 11/	846 12/	9,134 13/	27,535 14/
Foodgrain Production (1,000 tons)	80,465	-	-	-	-	-	108,000 15/

1/ Foodgrains include pulses and rice in milled equivalent.
2/ The three year average 1959-60 to 1961-62.
3/ Area taken as trend extrapolation as projected by Holst, "The World Food Problem, A report of the President's Science Advisory Committee", Vol. II, May 1967. High Yielding varieties area is 4th Five Year Plan target. Gross irrigated area represents a 95 percent fulfillment of the 4th Five Year Plan target.
4/ Yield is held constant. Production, irrigation, and fertilizers increased at the rate of area increase (4.1%).

5/ It was assumed that the high yield varieties area would be irrigated and fertilized at the rate of 80 kg/ha.
6/ It was assumed that fertilizer would be applied at the rate of 60 kg/ha.
7/ Irrigated foodgrain area accounts for about 80% of total gross irrigated area (Fertilizer Statistics, 1965-66).
8/ In terms of pure nutrients, it is assumed that one unit of fertilizer will contain 4 parts N, 2 parts P_2O_5 and 1 part K_2O.
9/ It was assumed that 40% of total fertilizer would be applied to foodgrains.
10/ Expected breakdown (million hectares): rice 12.5; wheat 8.0; jowar 4.0; bajra 4.0; and corn 4.0.
11/ An input-output coefficient of 13.5 was assumed.
12/ An input-output coefficient of 9.0 was assumed.
13/ An input-output coefficient of 6.5 was assumed. The 9.1 million tons was the output needed to reach 108 million tons.
14/ The implicit input-output coefficient is 9.5 for fertilizers and production increments under columns 4, 5 and 6.
15/ On balance, with relatively favorable weather, 1970-71, foodgrain production should reach 106 million tons and is projected at 108 million tons. The difference between the 106 million set for the "Big Push" objective and the projected 108 should be regarded as a safety margin for uncertainties of weather, input supplies and distribution, and assumed response coefficients.

The third step calculates the production increment from the residual irrigated area (1.6 million hectares) using local varieties, which amounts to 846,000 tons and requires 94,000 tons of fertilizer.

The fourth step computes the fertilizer necessary to bring total production to 108.0 million tons. The output increment therefore, 9.1 million tons and assuming a response coefficient of 6.5, the fertilizer requirement is 1.4 million tons.

Therefore, 2.7 million tons of fertilizers together with the gross foodgrain area of 121 million hectares, the high yielding variety area of 13.2 million hectares, and an irrigated area of 38.0 million hectares would result in a total output of 108 million tons. It should be noted that the 2.7 million tons of fertilizer represents only that portion of the total supply that is applied to foodgrains.[1] The total fertilizer supply in this case would equal about 3.6 million tons.

On balance, with relatively favorable weather, 1970-71 foodgrain production should reach 106 million tons and is projected at 108 million tons. The difference between the 108 million and the 106 million set as the "Big Push" objective should be regarded as a safety margin for uncertainties of weather, input supplies and distribution and assumed response coefficients.

The results of this combination of inputs are somewhat surprising in view of GOI Fourth Plan targets. The gross irrigated area and fertilizer consumption are about 5 and 13 percent below the GOI target respectively. It should be noted however, that the GOI targets are aimed at the production of 120 million tons of foodgrains,

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1/ It has been assumed that 75 percent of the total supply of commercial fertilizers is applied to foodgrains.

TABLE - 7 India: Projected annual inputs required to achieve an annual compound growth rate in foodgrain output of 5 percent from 1967-68 1/ to 1970-71

Inputs and Production	Unit	1967-68	1968-69	1969-70	1970-71	Annual Compound Rate of Increase 1967-68 to 1970-71
Foodgrain Area	1000 Hectares	117,500	118,675	119,885	121,000	1.0
Gross Irrigated Foodgrain Area	1000 "	32,000	33,890	35,890	38,000	5.9
High Yield Varieties	1000 "	6,100	7,900	10,200	13,200	29.5
Fertilizers	1000 Tons	1,575	1,880	2,250	2,691	19.5
Foodgrain Production	1000 Tons	93,624	98,212	103,024	108,000	5.0

1/ The inputs and production for 1968-69 and 1969-70 are interpolations between 1967-68 and 1970-71 (See tables 5 and 6). They should be considered as only general trends to achieve the desired 5 percent annual growth.

and not the 108 million tons projected here.

This discussion poses the question, "what would be the level of foodgrain output if the GOI targets were fulfilled". Using the same framework as above with the following inputs:

....	total foodgrain area	120 million hectares
....	gross irrigated foodgrain area	40 million hectares
....	high yielding varieties area	13.2 million hectares
....	fertilizers used for foodgrains	3.1 million tons

the production of foodgrains would total 111 million tons.

On balance, therefore, it appears that the objective of an annual growth of 5 percent is attainable with likely supplies of inputs, and could, in fact, be exceeded. But to do so will require a continuous push to effectively acquire and distribute the necessary inputs for cultivator use. Embedded deeply within the framework of the model is the assumption that the growth of India's agro-industry will be adequate to service the rising demands of agriculture. This assumes away a host of problems which inevitably will arise during the course of the next three years. The scope of this report precludes a comprehensive discussion of these problems but they are important enough to warrant the comments in the following sections.

POLICIES AND PROGRAMS

The preceding section indicates that a 5 percent growth rate in foodgrain production is technically and economically feasible for the period 1967-68 to 1970-71 and beyond. Moreover, important foundations for moving out along, or above, this growth line have already been laid and the GOI is moving forward with unprecedented determination and energy to insure such growth.

Previous pessimism about India's foodgrain growth prospects has been based on two conditions

.... targets for inputs were inadequate to set off and sustain such growth;

.... performance has fallen short in fulfilling even the low input targets set.

In contrast to this past record

.... input targets have been substantially raised; and

.... performance against even these higher targets promises to more closely match requirements for their fulfillment.

With encouragement and support of the AID Mission, the GOI is pressing vigorously to meet inputs needs through rapidly expanding domestic production and allocation of scarce foreign exchange for imports of needed inputs that cannot be supplied domestically. Despite a generally tight budget situation, the GOI has greatly increased its budget allocation for improving its agricultural sector.

Seeds

A single dramatic example of the vigor and impact of the GOI determination to improve agriculture is seen in the importation of Mexican wheat in

1966. Based upon the results of variety tests already made, in the spring of 1966, the Minister of Food and Agriculture proposed to a meeting of State Chief Ministers the importation of $2.5 million worth of Mexican seed wheat for the 1966-67 rabi planting. This amount was immediately raised to $5 million. This higher figure was cleared through the Finance Ministry within 24 hours. Then within a week Indian Seed Specialists were in Mexico making field purchases of wheat. The result was that the world's largest seed shipment on record, 18,000 tons, arrived in India within three months in time for planting an estimated 600,000 acres.

Supplies of seed of high yielding varieties of rice, wheat, maize, jowar, and bajra are now adequate to plant 15 million acres in 1967-68.

The provision of adequate supplies of seed for extending the high yielding varieties to 32 million acres by 1970-71 should pose no serious difficulty (Table 8). Basic plant materials out of which to develop new varieties with larger yield potentials and other qualities increasing their appeal to producers and consumers are now available for all major cereal crops. Supplies of such materials are also being built up for pulse crops by USDA geneticists working in close cooperation with Indian research agencies under a USAID-USDA Participating Agency Services Agreement.

Limited supply of personnel trained in making the crosses and performing the other operations for the production of quality hybrids constitutes a major bottleneck on the speed with which seed supplies of hybrid jowar, bajra and maize can be increased and therefore on the rates at which acreages of high yielding varieties of these crops can be increased.

In the past, it has often been difficult to maintain high standards with respect to purity and quality of seed supplies - this even in some

TABLE 8: High-Yielding Varieties Program - Revised Targets for 1967-68
(Kharif & Rabi/Summer)

Figures in 000 acres

State	Paddy		Maize		Jowar		Bajra		Wheat		Total	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
1. Andhra Pradesh	700	720	65	30	70	116	70	20	-	-	905	886
2. Assam	71	7	13	2	-	-	-	-	-	2	84	11
3. Bihar	500	300*	200	220*	-	-	-	-	-	500*	700	1020*
4. Gujarat	160	-	50	8	6	-	300	100	-	314	516	422
5. Haryana	23	-	10	-	-	-	30	-	-	200	63	200
6. Jammu & Kashmir	100	-	30	-	-	-	10	-	-	20	140	20
7. Kerala	250	500	3	-	-	-	-	-	-	-	253	500
8. Madhya Pradesh	50	-	100	1*	95	10*	16	-	-	120	261	131*
9. Madras	800	100	1	9	7	143	21	28	-	-	829	280
10. Maharashtra	400	100	150	150	1000	800	300	-	-	200	1850	1250
11. Mysore	200	70*	50	45*	250	90*	50	1.50	-	10*	550	216.5*
12. Orissa	220	140	12	8	3	0.1	-	-	-	5	235	153.1
13. Punjab	50	-	100	-	-	-	100	-	-	1000	250	1000
14. Rajasthan	2	-	45	-	10	-	80	-	-	125	137	125
15. Uttar Pradesh	250	-	325	-	20	-	80	-	-	2000	675	2000
16. West Bengal	300	75	10	5	-	-	-	-	-	40	310	120
17. Himachal Pradesh	20	-	17	-	-	-	-	-	-	20	37	20
18. Delhi	0.5*	-	1*	-	-	-	20*	-	-	5.75*	21.5*	5.75*
19. Goa	25*	5*	0.6*	5.0*	-	0.20*	-	-	-	-	25.6*	10.20*
20. Pondicherry	15*	5*	-	-	-	0.20*	-	-0.25*	-	-	15.0*	5.45*
TOTAL	4136.5	2022	1182.6	483	1461	1159.5	1077	149.75	-	4561.75	7857.1	8376.00

* - Provisional as the program has not been finalized by the Central Team.

cases for seeds grown on state seed farms. Programs to insure purity and quality of commercial seed stock need to be strengthened throughout most of India. A step in this direction was passage this year of a National Seed Law to provide quality controls through seed certification and registration procedures. State implementing legislation will be necessary to making the National Seed Law effective. Such state legislation is now under discussion.

In the multiplication of improved seeds, heavy emphasis has heretofore been placed on state seed farms. Currently, however, the private sector is being used extensively to supplement state seed farms in the production and distribution of seeds. Increasing emphasis on use of the private sector will help to insure adequacy of seed supplies needed to sustain a rapid rate of growth. It is not clear, however, that the private sector firms producing seed are being utilized fully in the distribution of the improved they produce and in extending to new growers benefits of the knowledge they have gained of their production requirements. Rather, it is known that in some cases governmental agencies have brought powers of government to bear on procurement from private individuals at prices little above foodgrain prices of seed stocks they have produced from out of carefully preserved seed supplies of an acre or two grown in the preceding year.

Fertilizers

There has been a dramatic change in the fertilizer situation during the past two years; attention had been focused on avoiding a possible glut in distributing minimal amounts of fertilizer, but present concern is with meeting much higher and rapidly increasing demand for fertilizers. This shift can be demonstrated in various ways:

.... Fertilizer availability targets for the 4th Plan are up 4-5 times over 3rd Plan availabilities; domestic production targets show the greater increase but foreign exchange has been committed to imports necessary to meet the balance of targets.

.... India's targets for fertilizer production, imports, and availability are steeply rising as well as high. Her performance against the targets relating to the first two crop years of the Fourth Plan has been creditable. Nitrogen available for the first agricultural year of the Plan was over 900,000 metric tons - an increase of 55% over the previous year and about 90% of the GOI goal. Similarly, availability of nitrogen for the second agricultural year will increase to over 1.3 million metric tons - an increase of 45%, and 95% of the target in the February, 1967, Food for Peace Agreement, Availability of P_2O_5 doubled the first year and increased an additional 50% in the second, while K_2O availability showed lesser, but significant, gains.

.... For N and P, shortfalls in availability have been largely in the production sector, stemming from raw materials shortages and drought-aggravated power shortages. Nonetheless, production has risen substantially, both absolutely and as a percentage of the higher targets. Even more encouraging has been the GOI's evident willingness to commit scarce foreign exchange and to carry-through on importations of N and P in excess of import targets as well as improving the records on imports of K.

.... In several instances the GOI has demonstrated growing administrative flexibility to meet changing needs:

.... Earlier commitment of funds against pending budgets has permitted more timely placing of fertilizer orders in the last two years.

.... Difficulties experienced by the State Trading Corporation in obtaining adequate sulphur led, in January 1967, to formation of a joint Government-Industry Fertilizer Allocation Committee to review import requirements and prospective contracts. Current estimates indicate that the 600,000 ton annual requirement will certainly be met and possibly exceeded. Proliferation of buyers, including private traders, and the freedom to develop a variety of contract patterns have widened the supply prospects and resulted in price benefits on longer contracts.

.... Contract negotiations have been expedited and the most recent new plant was constructed in brief two years.

Irrigation

Compared to Third Plan allocations, the Fourth Plan has given dramatic emphasis to minor irrigation expansion; allocations for minor irrigation increased by 93% while those for major and medium increased only 47% - a good part of which represents completion of previous starts.

These target increases should also be viewed in the context of Third Plan performance levels which exceeded targets for minor irrigation projects of major/medium targets. For the first year of this Plan period 20% of the Plan target area was covered. Continuation of this relationship would bring area coverage to 140% of the target by the end of the Plan or 16.3 million additional acres instead of only 12 million.

There has also been a significant shift in the pattern of minor irrigation programs. In the First Plan, the additional areas irrigated by surface (tanks and canals) and ground (wells) water development were about equal, whereas the area increment expected in the Fourth Plan from ground water development is more than double that from surface water.

Of the various types of wells to be developed under ground water programs, tubewell expansion efforts are clearly emphasizing private over public: compared with the previous Plan, the number of additional private and filter-point tubewells is to increase nearly 160% while public tubewells will increase only 100%, and the former will cover an area nearly twice as great as the latter.

The planned increase in energized pumpsets (243% of Third Plan Achievement for electric and 112% for diesel) will further reinforce the production potential from the increased well construction in the Fourth Plan. As an example of the strength of intent in this sphere, U.P. State originally planned to energize 10,000 pumps in IFY 1966/67, later under drought conditions raised the target to 17,000 and then reached the new target before the end of the fiscal year. Rural electrification has a high priority in the current Plan and energizing of pumpsets has been given top claim over village electrification and alternative uses. The GOI estimates, as a result, that they will be able to remove the present two year delay in pumpset emergizing within the next few years. This development would obviate the alleged preference given to public wells in obtaining power connections in some areas. It is estimated that the rate of energizing wells increased 50% between 1965/66 and 1966/67 and further increases are expected this year.

A variety of measures have been, and are being, taken to resolve former problems and questions about the effectiveness of irrigation programs. The "command area" for irrigation projects is being made operationally more realistic: tubewells are being constructed within existing major project areas to supplement water availability within the command area and new projects are being defined with reduced "command areas". The Ayacut (command area) Development Program was recently organized at the Center to promote integrated local development of irrigation projects in such related spheres as shaping of channels, changing cultivation practices, assuring needed inputs and water management measures calculated to support more effective utilization of irrigation water. More generally, a Water Utilization Unit has been organized within the Ministry of Food and Agriculture to direct the Ayacut Program and to promote better utilization of water resources through coordination of irrigation agencies. Through the Ayacut Program and the Water Utilization Unit, there should be gains in integrated local focus as well as better top-level coordination of irrigation activities. There has been an appreciable increase in credit resources through established institutions (Land Development Banks and Agricultural Refinance Corporation) for financing tubewells and land shaping and new credit institutions for similar purposes are being actively considered.

Plant Protection Materials

The advent of the high yielding varieties highlights the need for more plant protection measures. Often the higher yields of the seeds results from the fact that the new seeds are amenable to much denser planting; the larger plant populations lead directly to greater insect populations, and provide an ideal environment for the spread of disease. With traditional materials, systematic plant protection measures were only marginally profitable, if not unprofitable. Relative to cost there seemed little to be gained by adding 10% to a small yield, but a similar 10% on a large crop can pay for a comprehensive plant protection program and leave a substantial net earning.

Plant protection benefited from the GOI's import liberalization in 1966 which freed the importation of needed technical ingredients; production of plant protection materials for 1967-68 is estimated to be nearly 20% greater than for the preceding year.

.... the GOI has recently agreed to continue subsidizing the cost of plant protection materials.

Acres covered by plant protection measures over the past few years have shown a dramatic increase from 41 million acres in 1965-66 to 63 million acres in 1966-67 with 126 million acres planned for coverage in 1967-68. This increase is indicative of the determination of the GOI to improve protection although it does not provide conclusive evidence of the effectiveness of such action: acres covered may or may not be thoroughly done, the actual need for protection - say from a locust infestation - may vary greatly from year to year, climatic variations also influence the need for protection, and there are many alternative means for protection as well as alternative protection needs. However, a "survey and warning" system is being established to provide the capability to arrest any potentially serious infestation before epidemic proportions are reached.

Recently the Mission and GOI reached agreement on a $3 million Mission loan to supply airplanes parts, and technical assistance to the GOI's and private sector aerial spray programs.

Transport Facilities

To achieve the annual growth rate of 5 percent in foodgrain production will require even higher rates of growth for all major inputs except land (Table 7). The projected annual rates of growth are 1.0 percent for foodgrain area; 5.9 percent for irrigated foodgrain area; 29.5 percent for the area under high yield varieties; and 19.5 percent for fertilizer consumption.

These high rates would suggest that they must be accompanied by a substantial expansion in the facilities that supply and distribute farm inputs to the cultivator. In fact the 5 percent annual growth rate in foodgrain production in itself will require additional marketing facilities that can effectively transfer the foodgrains from the producer to the consumer.

Transportation is the underpinning of an agricultural marketing and distribution system. In almost every developing country, the network of access roads between farms and local market towns is still inadequate.

In India there is only about 0.7 of a mile of road per square mile of cultivated land, as compared to about 4 in the United Kingdom, France, Japan and the United States.

It has been estimated that in India a million miles of roads will have to be constructed to satisfy the access needs of 580,000 villages throughout the country. Only 11 percent of these villages now have reasonably adequate roads and one out of three is more than five miles from a satisfactory road.1/

The most important transport program for Indian economic development in the Fourth Plan would be to concentrate on the agricultural sector to permit the distribution of necessary farm supplies and to make possible the marketing of farm commodities. With sharply rising supplies of farm inputs and the increased output that is anticipated from these inputs, there is an immediate urgency in developing an adequate transport network.2/

Agricultural Credit

In the past year the GOI has shown a willingness to act in the direction both of setting up new institutions (or making significant innovations in existing institutions) and in allocating greater funds for credit purposes

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1/ The World Food Problem, A Report of the President's Science Advisory Committee, Vol; II. May 1967.

2/ For a discussion of a suggested transportation program for India see The World Food Problem Vol. II, pp. 589-592.

.... Compared to the 1967-68 expansion of credit funds for agricultural purposes of Rs. 100 crores agreed to by the GOI in the February 1967 PL 480 Agreement, the GOI has published commitments to expand credit by over Rs. 95 crores with at least an additional Rs. 5 crores promised if performance by credit institutions in lending is adequate: Nearly Rs. 17 crores are allocated to medium/long term facilities (1.4 to the Land Development Banks and 15.5 to the Agricultural Refinance Corporation), an additional 9 crores to medium term lending (the newly formed Agro-Industries Corporations) and Rs. 70 crores to short-term lending (25 through the cooperatives and 45 in support of input program lending). The additional 5 crores promised will go to the Land Development Banks upon demonstration of effectiveness of the new levels.

.... The recent creation of the Agro-Industry Corporations and pending government legislation setting up Agricultural Development Corporations in States having weak cooperative lending institutions are indications of the desire of the GOI to expand the types of rural credit institutions.

.... In addition, the GOI has been highly responsive to Mission suggestions for still other agricultural credit institutions or patterns of rural lending. The Mission has been actively engaged in discussions with the GOI, lending institutions, and borrowers about several alternative schemes oriented to further widening and loosening up credit facilities, especially those related to fertilizer distribution and construction of tubewells.

.... Recently, the Association of Indian Commercial Banks has announced the intention of setting aside a fund of Rs.350 crores for agricultural production lending. This step was taken as a partial answer to the growing public discussions of the need to nationalize banks to make them more socially responsible. There has been increasing criticism of the unwillingness of commercial banks to share the responsibility for rural credit needs. While the details have not yet been worked out on the operation of this fund, there are indications that it will be directed in the first instance toward greater credit facilities for individual cultivators and in the second instance for utilization by a wide variety of input suppliers and the distribution channels.

Agricultural Research and Education

In the field of research the Rockefeller Foundation, through its coordinated research programs for hybrids and new wheat and rice varieties, has contributed substantially to the present promise of the high yielding varieties program. These efforts are being augmented by the research programs conducted by the Indian Agricultural Research Institute at the Center and various research facilities in the states. A recently signed agreement between the GOI and the International Rice Research Institute is a further indication of research emphasis, looking to the future of this important crop.

Agricultural research has been of late coming closer to field operations: In 1967-68 scientists of the Indian Council of Agricultural Research (ICAR) will continue to organize National Demonstration Projects in the field which will be supplemented in several states by Demonstration Farms with the assistance of agricultural extension staff. A coordinated research program for about 20 commodities in various states has been undertaken by the ICAR in collaboration with the State Governments.

The GOI/Mission programming of the Field Problems Research teams is a healthy development relating research, extension, and operations. Currently operating in four states, these five-man teams are expected to actively engage in promoting better use of fertilizer, seed and plant protection inputs and better water management by expediting and promoting the linkage between field experiences, research facilities and extension activities within the states. Working with state agencies on the one hand and agricultural universities on the other, these field units will also underscore the work of the Mission's agricultural universities program which is oriented to a more pragmatic and unified relation between teaching, research and extension.

The degree of success experienced by the GOI in developing the foregoing and related programs will determine the long run ability of the agricultural sector to maintain the projected growth trend. More specific concerns on specific farm inputs are considered in the following sections.

Incentives

The situation with respect to price policies is currently more uncertain and confused than is that relating to any other major requirement for sustaining a rapid rate of growth in foodgrain production. Creation of the Agricultural Prices Commission in 1965 indicates a public awareness of the need for more rational price policies than formerly prevailed. That actual improvements of note have been made in India's agricultural price policies remains to be seen.

Currently, India has a system of support prices, but the announced level of these supports falls so far below both current price levels and those in the years 1962-63 to 1964-65 that they can hardly be called incentive supports.

Prices of foodgrains are currently favourable throughout India, a fact best attested to by the large current demand for fertilizers and other inputs. Price relationships among states and between commodities are, however, now greatly distorted and is wholly inconsistent with objective of efficiency in allocation of scarce inputs and with that of efficiency in food distribution. The reason for this is the existence of the state zonal system prohibiting free inter-state trade in foodgrains.

India's zonal system is currently depressing prices of foodgrains in localities having the largest comparative advantage in their production and inflating their price in deficit producing areas. Under present demand-supply relations applicable to fertilizers and other superior inputs, these distorted price relations have little effects upon the overall amount of these inputs now being used. It stands to reason, however, that unless counteracted by appropriate allocative controls of an administrative nature, such distortion of price relations must be an added source of inefficiency in the allocation of inputs that are scarce and strategic to the meeting of India food needs. There is inevitably large inefficiency in allocation of the Nation's scarce supplies of seeds, fertilizers and other inputs simply because of the speed with which these supplies have been increased. This "administrative" source of inefficiency is an added waste at a time when efficiency is of the utmost importance not only to achieving the nation's food production targets but to the conservation of foreign exchange.

As India approaches a 5 percent per year growth rate in foodgrain production, its very successes will press down foodgrain prices from their presently high scarcity levels. Determination of the level of price supports needed to insure adequate incentives to producers without, however, distorting price relationships generally and the role of free market prices as an agent of economic organization poses a very delicate and a very difficult analytical problem.

APPENDIX

COMMENTS ON PSAC REPORT ON THE WORLD FOOD PROBLEM

General Report

There are no basic inconsistencies between the PSAC report and PM. The former is properly global in its view. It is addressed to a very wide range of problems treated in broad general terms without assignment of priorities and without reference to specified constraints in respect to budgetary considerations, input availabilities, and many other items that are specific to our own situation. In developing our PM, we have attempted to assess development potentials and requirement under conditions that are specific to India. We have attempted to project a program that we believe is attainable, yet challenging, within limits of budgetary, resource, organisational and other constraints applicable to India.

In our PM we have also placed heavy emphasis upon programs with good promise of early large increases in food production. India's current food crisis, very recent but large improvements in foodgrain technology, and recent shifts of emphasis in GOI food production policies all make this emphasis upon achieving large early increases in output desirable. Measures to achieve these short-run gains will, however, help to strengthen long-term development programs, including those of agricultural education, extension and research.

Our PM - as well as recent policy emphasis of both the Mission and GOI - is fully consistent with the high priority assigned in the PSAC report "to providing production inputs essential to accelerating agricultural productivity" (Vol. I, C.3, p 27).

The Mission's program in support of agricultural education, extension and research is being strengthened by the addition of U.S. agricultural experts to work jointly with Universities and State Departments of Agriculture in production promotion activities.

<u>The Holst Paper</u>

Compared with the "self-sufficiency" figure of 113.5 million tons of foodgrains needed for 1971 in the Holst model, our figure (106 million tons) of that which is attainable is conservative. However, there are several differences between the information and assumption we used and those used by Holst,

.... his model includes in the concept of self-sufficiency an increase in the nutritional level of the population which would increase the total needed by some unspecified amount;

.... drawing on seed and fertilizer responses derived from 1963-64 data, he projects from a technological base which has been dramatically altered by the unexpected and rapidly spreading introduction of new varieties of wheat, paddy and hybrids. These high-yielding varieties, when coupled with the equally rapid and dramatic rise in fertilizer availability, will produce in the immediate future, and on a sustained basis thereafter, levels of production not anticipated until years later in his model.

.... Another point of difference is the historical growth rate of agriculture and, therefore, the normative base from which he projects. We have demonstrated that a good part of the flattening of the growth curve which Holst notes in the late 1950's and early 1960's can be attributed to markedly poor weather. Foodgrain prices were relatively low which would have also contributed to the flattening of the curve, but prices have shifted greatly in favour of foodgrains since 1963-64. Therefore, given the higher base level for projections which we feel is justified and in view of the input/output changes consequent on the new technology now well in process in India, our estimates can be viewed as more conservative than Holst's.

.... Finally, Holst uses a loss figure which is much larger than that customarily used by either the Mission or the GOI. While it may reasonably be argued that some higher loss figure is justified, currently there is no firm basis for making it as high as in the Holst model nor does his project of this high loss rate appear to consider the determined efforts now being made by the GOI to increase the amount of improved storage facilities, the rapidly expanding plant protection program, the increased development of resistant grain varieties and rodent control programs. All of these efforts are having, and will continue to have, an influence in reducing losses. (Loss estimates are not relevant to the output projections made in our analysis, but they do bear on the extent to which these output levels fulfill the objective of self-sufficiency in foodgrains.)

BEST AVAILABLE

APPENDIX TABLE 1. FOODGRAIN PRODUCTION BY STATES, 1964-65 TO 1966-67 1/

(000's M.T.)

	1964-65 (1)	1965-66 (2)	1966-67 (3)	(3-2) (4)	(3/2)% (5)	(3-1) (6)	(3/1)% (7)
NORTH EAST							
Assam	1,966	1,902	1,900	- 2	100	- 66	97
Bihar	7,531	6,951	4,100	- 2,851	59	- 3,431	54
West Bengal	6,228	5,449	5,700	+ 251	105	- 528	92
Orissa	5,045	3,799	4,100	+ 301	108	- 945	81
Nagaland	71	43	100	+ 57	232	+ 29	140
NORTH AND NORTH WEST							
Uttar Pradesh	15,052	13,924	13,500	- 424	97	- 1,552	90
Punjab	7,103	5,553	7,400	+ 1,847	133	+ 297	104
Rajasthan	5,261	3,792	4,800	+ 1,008	127	- 461	91
Jammu&Kashmir	576	449	600	+ 151	134	+ 24	104
CENTRAL AND WEST CENTRAL							
Madhya Pradesh	10,140	6,675	7,500	+ 825	112	- 2,640	74
Gujarat	2,818	2,305	2,000	- 305	87	- 818	71
Maharashtra	6,862	4,700	6,500	+ 1,800	138	- 362	95
SOUTH							
Andhra Pradesh	7,311	6,356	7,400	+ 1,044	116	+ 89	101
Madras	5,792	5,251	6,000	+ 749	114	+ 208	104
Mysore	4,557	3,261	4,000	+ 739	123	- 557	88
Kerala	1,136	1,033	1,330	+ 297	129	+ 194	117
UNION TERRITORIES	949	847	1,000	+ 153	118	+ 51	105
TOTAL ALL INDIA	88,398	72,290	77,930	+ 5,640	108	-10,468	88
(a) TOTAL MINUS BIHAR	80,867	65,339	73,830	+ 8,491	113	- 7,037	91
(b) TOTAL MINUS BIHAR, U.P. & M.P.	55,675	44,740	52,830	+ 8,091	118	- 2,845	95

1/ Includes pulses.
Data from AGR 296, June 5, 1967.

APPENDIX TABLE 2. FOODGRAIN PRODUCTION BY CROPS, INDIA
1964-65, 1965-66 and 1966-67

(Million Tonnes)

Crop & Season	1964-65	1965-66	1966-67
Cereals			
Kharif			
Rice: Autumn	7.41	6.47	6.72
Winter	30.76	23.40	22.71
Total	38.17	29.87	29.43
Jowar	6.45	4.88	5.09
Bajra	4.46	3.80	4.40
Maize	4.86	4.63	4.88
Ragi	1.90	1.31	1.52
Small Millets	1.95	1.60	1.57
Total Kharif	57.57	45.82	46.89
Rabi			
Rice	0.86	0.75	1.47
Wheat	12.29	10.72	12.03
Barley	2.52	2.28	2.29
Jowar	3.32	2.61	3.76
Total	18.99	16.26	19.55
Total Cereals	76.56	62.25	66.44
Pulses			
Kharif	3.61	3.00	3.01
Rabi	8.83	7.02	6.52
Total Pulses	12.44	10.02	9.53
Total Foodgrains	89.00	72.27	75.97

It is significant that the Rabi cereals output in 1966-67 exceeds that in 1964-65.

APPENDIX TABLE 3. YIELD OF MAJOR FOODGRAIN CROPS SHOWN WITH AND WITHOUT IRRIGATION INDIA, 1964-65

Crops	Irrigated		Not Irrigated		Yield Difference* (2)-(4)
	Hectares (000)	Yield Kg/Ha	Hectares (000)	Yield Kg/Ha	Kg/Ha
	(1)	(2)	(3)	(4)	(5)
Rice	13,424	1,371	22,940	899	472
Wheat	4,858	1,173	9,602	766	407
Jowar	681	734	17,257	536	198
Bajra	268	560	11,458	378	182
Maize	551	1,452	4,067	949	503
Ragi	347	1,009	2,090	741	268
Barley	1,294	1,159	1,390	736	423
Gram	1,374	873	7,522	610	263
Other	966	621	18,444	434	187
Total Foodgrains	23,763	1,229	93,779	836	393

*Note: These yield differences reflect not only the influence of irrigation on yields but that also of associated differences in inputs of fertilizers, seeds, pesticides, and "management". It is believed that most of the fertilizers used in India in 1964-65 was used on irrigated crops; also that improved seeds are more commonly used on irrigated than on non-irrigated land.

APPENDIX TABLE 4. STATE-WISE GROWTH-RATES(COMPOUND) OF AGRICULTURAL PRODUCTION, AREA AND PRODUCTIVITY, 1952-53 to 1964-65

State	Production (Percent)	Area (Percent)	Productivity (Percent)
Above Average			
Punjab	4.56	1.90	2.61
Gujarat	4.55	0.45	4.09
Madras	4.17	1.10	3.04
Mysore	3.54	0.81	2.71
Himachal Pradesh	3.39	0.71	2.67
Fair			
Bihar	2.97	0.71	2.25
Maharashtra	2.93	0.44	2.45
Rajasthan	2.74	2.85	- 0.11
Andhra Pradesh	2.71	0.26	2.45
Madhya Pradesh	2.49	1.28	1.21
Orissa	2.48	0.81	1.66
Low			
Kerala	2.27	1.30	0.96
West Bengal	1.94	0.59	1.34
Uttar Pradesh	1.66	0.72	0.94
Assam	1.17	1.25	- 0.08
All India	3.01	1.21	1.77

Source: Growth Rates in Agriculture, 1949-50 to 1964-65, the Directorate of Economics and Statistics, Ministry of Food and Agriculture, GOI, March 1966.

APPENDIX TABLE 5. ANNUAL AVERAGE WHOLESALE PRICES OF RICE

(Rupees per quintal)

State	Variety	No. of Markets	1961	1962	1963	1964	1965	1966
Andhra Pradesh	Akkulu	(3)	55.62	54.99	54.39	61.24	63.07*	65.02*
Assam	Sali	(3)	51.12	55.65	59.92	66.06	65.58*	65.14*
Bihar	Coarse	(5)	55.73	57.74	63.54	70.51	85.08	126.43
Kerala	Coarse	(2)	60.91	58.57	60.90	71.20	63.50*	68.67*
Madhya Pradesh	Coarse	(3)	41.52	43.92	52.26	58.13	58.23*	64.80*
Madras	Medium	(3)	60.24	59.05	57.21	65.33	66.03*	65.10*
Maharashtra	Coarse	(3)	55.78	52.20	59.74	68.92	70.05*	69.72*
Mysore	Coarse	(3)	59.44	59.59	53.53	66.80	89.36	116.60
Orissa	Coarse	(4)	39.71	48.86	61.59	61.20	59.90*	76.56
Punjab	Coarse	(1)	44.21	44.21	44.21	50.17	60.00*	60.00*
Uttar Pradesh	Coarse	(3)	51.51	52.20	54.34	69.16	65.67*	129.09
West Bengal	Common	(5)	52.77	61.26	77.73	64.05	66.11	72.00*

*Statutory controlled prices fixed by State Governments (average).

APPENDIX TABLE 6. ANNUAL AVERAGE WHOLESALE PRICES OF WHEAT

(Rupees per quintal)

State	Variety	No. of Markets	1961	1962	1963	1964	1965	1966
Bihar	White	(1)	49.59	48.92	49.96	69.30	97.00	107.50
Gujarat	Red	(1)	51.20	51.02	51.17	62.98	68.99	72.98
Madhya Pradesh	White	(3)	36.62	40.28	40.48	56.55	60.57	60.16*
Punjab	Coarse	(1)	39.41	42.49	40.34	51.47	58.40	70.88
Rajasthan	Coarse	(1)	43.72	41.69	39.38	52.32	51.23	74.14
Uttar Pradesh	Red	(1)	38.78	36.09	39.15	65.15	75.21	69.81
	White	(2)	40.09	39.13	41.68	71.00	79.68	78.91
	Dara	(1)	41.86	40.70	42.85	72.08	61.67	79.17

*Statutory prices fixed by the State Governments (average).