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SEMINAR SERIES - XI

Seminar on

DEMAND AND SUPPLY PROJECTIONS FOR AGRICULTURAL COMMODITIES

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THE INDIAN SOCIETY OF AGRICULTURAL ECONOMICS, BOMBAY

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Seminar on

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THE INDIAN SOCIETY OF AGRICULTURAL ECONOMICS
46-48, Esplanade Mansions, Mahatma Gandhi Road,
Fort, Bombay-1.

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LONG RANGE AGRICULTURAL ADJUSTMENT ANALYSIS

Ralph W. Cummings, Jr.@

The record foodgrain harvest in 1967-68, appearing after the devastating experience of two consecutive, unprecedented drought years, signalled the introduction of the Green Revolution to India.[1] The initial performance was followed in 1968-69 by only a marginally lower output inspite of below normal rainfall.[2] India achieved her first 100 million ton foodgrain harvest in 1969-70. She confidently plans for self-sufficiency in foodgrains by the early 1970s.

@ The author, Advisor in Agricultural Economics with the Harvard Advisory Group in Indonesia, served as Chief, Agricultural Economics Division, USAID/India during 1967 through 1969. The paper summarises research carried out by USAID in India which was presented in the Long Range Agricultural Adjustment Analysis, Annex F to the FY 1971 Country Field Submission. This analysis will be published in a forthcoming book co-authored with Robert W. Herdt. The views expressed in this paper are personal and do not necessarily reflect those of USAID or of the Development Advisory Service of Harvard University.

1. 1. Ralph W. Cummings, Jr. and S.K. Ray, "The New Agricultural Strategy: Its Contribution to 1967-68 Production," Economic and Political Weekly, Vol. IV, No.13, March 29, 1969, pp. A-7—A-16.

2. Ralph W. Cummings, Jr. and S.K. Ray, "1968-69 Foodgrain Production: Relative Contribution of Weather and New Technology," Economic and Political Weekly, Vol.IV, No.39, September 27, 1969, pp. A-163—A-174.

There is convincing evidence that the Green Revolution has shifted the production function for much of Indian agriculture upward. Given adequate government support, this new technology promises to increase significantly the aggregate agricultural growth rate over the foreseeable future. The deeper significance of the Green Revolution is that it creates a new potential for accelerated economic growth well beyond the agricultural sector which at last can provide a higher standard of living for a sixth of the world's population.[3]

There is a new future for Indian agriculture. For this reason, it is necessary to identify prospective problem areas in the long-term growth in order that anticipation of and reaction to expected problems (and positive forces) can accelerate the growth process and ease the attendant adjustment problems. It is the purpose of the "Long Range Agricultural Adjustment Analysis" (LRAAA) to pose questions regarding what policy actions will be required to achieve and sustain this higher trend of production; e.g., to turn agricultural potential into reality.

I

TARGETS

Agriculture is the dominant sector in the Indian economy. It accounts for approximately three-quarters of the labour force, one-half of national income, 40 per cent

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3. John P. Lewis, "Wanted in India—A Relevant Radicalism," Policy Memorandum No. 35, Center for International Studies, Woodrow Wilson School for International and Public Affairs, Princeton University, U.S.A., 1969.

of domestic capital formation, and three-quarters of exports (if we include manufactured agricultural products). It is the primary supplier of necessary consumption goods, e.g., food and fibre.

Experience in the developed countries has shown that economic forces have, in the past, led to a reduction in relative importance of agriculture to employment and national income even though activity in the agricultural sector has been encouraged and the level of agricultural production has increased rapidly. Kuznets has stated this apparent dilemma as follows: "One of the crucial problems of modern economic growth is how to extract from the product of agriculture a surplus for financing of capital formation necessary for economic growth without at the same time blighting the growth of agriculture under conditions when no easy quid pro quo for such surplus is available."

Through the first half of this century when technological change was gradual, Indian agriculture had evolved into an equilibrium which— while being characterized by wide disparities with regard to inter-regional and inter-personal incomes — was relatively accepted. The new technology has upset this equilibrium. It is almost inevitable that certain groups of people and certain regions will gain relative to others even though most groups and regions may benefit positively either directly (through higher incomes) or indirectly (through lower food prices). In a country which is dedicated to developing a "socialistic pattern of society" and in which the demonstration effect is clearly active, the political implications of changing inter-personal and inter-regional income distributions cannot be ignored.

Therefore the objectives of agricultural development must include some combination of growth with equality. The Fourth Five-Year Plan projects an annual target increase in national income of five and one-half per cent. We have tentatively estimated that the levels of (political and) economic objectives in agricultural development necessary to support this target rate of overall growth are as follows:

A. A five per cent annual growth rate in aggregate agricultural production to satisfy demand requirements for food and fibre.

Human consumption requirements were projected for a wide range of commodities from the sum of expected population growth plus the product of the income elasticity of demand multiplied times expected per capita income growth.[4] On the basis of these assumptions, at constant

	Fourth Plan	Fifth Plan	Sixth Plan
Annual population growth (%)	2.7	2.6	2.2
National income growth (%)	5.5	5.5	6.0
Income elasticities of demand:			
Foodgrains ..		0.3—0.45	
Agricultural products		0.5—0.8	
Growth in requirements (%)			
Foodgrains ..	3.5—4.0	3.5—3.9	3.3—3.9
Agricultural products ..	4.1—4.9	4.1—4.9	4.1—5.2

4. For details of these projections including a discussion of the weaknesses see S.K. Ray: Demand for Food in India, 1968-69 to 1983-84, USAID/India, unpublished working paper, January, 1969.

prices aggregate foodgrain demand for human consumption is estimated to grow at approximately three to four per cent per year; demand for non-foodgrains is estimated to increase at a higher rate. To those figures must be added requirements for seed (proportionate growth to acreage), animal feed (growing rapidly) and waste (which should decline as a percentage of production). The sum total of these components is a projected growth in demand for total agricultural products of 4 to 5 per cent annually with stable prices; the quantities demanded will grow faster if prices decline.

B. Achievement of a target rate of resource mobilization to provide that the higher production rate is sustainable into the future; e.g., (1) sufficient increase in the rate of capital formation in agriculture so that the higher rate of agricultural growth is sustainable on the supply side, and (2) sufficient transfer of financial resources from the agricultural to the non-agricultural sectors so that the higher rate of growth is sustainable from the demand side and is consistent with and contributes to accelerated overall economic growth.

Private capital formation in agriculture is a function of expected future profits which depend on lower input costs, greater productivity (input-output response), or higher product prices. Resources can be transferred to the non-agricultural sector by (a) depositing the profits from agriculture in financial institutions which could loan the funds to the non-agricultural sectors, or (b) stimulating increased non-agricultural profits either via falling agricultural prices which would relieve input price pressures on wages and raw materials and/or through increased agricultural demand for consumption and investment goods produced by the non-agricultural sector which

could lead to higher prices for non-agricultural products or fuller utilization of non-agricultural capacity. The government enters into this process through taxing, earning profits on its public sector undertakings, borrowing from the public and other forms of deficit financing, or organizing rural works programmes to make effective productive use of available under-employed manpower. Increased exports can provide the final source —valuable foreign exchange.

The achievement of the Fourth Five-Year Plan national income target requires raising the average domestic savings ratio from 9 per cent (1968-69 level) to 12.6 per cent by the end of the Fourth Plan; the marginal savings rate would be 24 per cent. The agricultural sector— both because of sheer size but also, more recently, because of its enhanced growth potential— must play the key role in this process of capital formation. The policy problem is how to provide incentives for accelerated capital formation in agriculture, while at the same time, to mobilize and transfer financial resources to the non-agricultural sector. If the process is successful, the contribution of the agricultural sector to aggregate capital formation may be indirect and the savings may not all appear as agricultural investments in the national income statistics. The agricultural sector must develop in such a way that the aggregate savings target for the economy is achieved.

C. A minimum annual agricultural growth rate for any State of two and one-half per cent to satisfy demands for inter-regional equity.

Only about 80 to 90 million net acres are presently considered to be high potential areas for the new cereal

varieties. This area can possibly be doubled with new irrigation and drainage investments. However, the high potential irrigation areas are unevenly distributed among States.

The prospects for near-term genetic break-throughs for the unirrigable, low rainfall lands which account for a large part of the country are not encouraging. Future production increases in these dry areas must be achieved by methods which have received only limited acceptance in the past — changes in cropping patterns, increased fertilizer application, more effective land preparation with mechanized power, and planned animal grazing. Factor mobility, especially internal labour migration which might be one means to equalize per capita incomes, has not been very active in the past. Therefore, there is the danger that a large "Appalachia" might develop in the dry midland of the country. Any region which feels that it is neglected in the growth process can provide the focus for the easy mobilization of votes to obstruct or skew a development programme.

At the minimum, the growth rate for any State should be no less than the rate of population increases in that State if the average level of standard of living is not to lose ground. More politically attractive would be a narrowing of differences in income levels among States. However, the agricultural sector is only part of the reason for these differences. A realistic target might be to achieve a minimum agricultural growth rate in any State at least equal to the rate of population growth or averaging at least two to two and one-half per cent annually.

D. A minimum annual increase in per capita real income of one to two per cent in the low-end poverty groups to satisfy claims for inter-personal equity.

There are no apparent physical economies of scale required in the adoption of the new technology. All of the necessary inputs, with the possible exception of tractors, are divisible. Small farmers, who have resources, particularly water, and who market some minimum amount of their production for cash incomes in order to have money to pay for purchased inputs, are participating. Some potentially viable smaller farmers may lag behind the larger landholders until they are convinced that the risk of adoption is not too large. However, smaller cultivators without adequate productive resources (some of whom are potentially viable if they had these resources, those cultivating low rainfall lands, and landless labourers in surplus labour areas are vulnerable. They constitute a group which must be brought more successfully into the division of the benefits in order to minimize political discontent.

Ideally— again in terms of political attractiveness— India would like to narrow inter-personal income differences. More realistically, she might attempt to achieve a minimum per capita income growth target for any particular economic group at a level at which all groups in the economy will receive some tangible— although not necessarily large— benefits from development.

These four objectives— within the present context of the Fourth Five-Year Plan terms of reference— provide for sustained increase in per capita availability of food and fibre equitably distributed over space and

among people in such a manner that the agricultural development is consistent with and contributes to overall economic growth. The next step is to design a general set of policies by which to achieve these targets.

II

AN AGRICULTURAL DEVELOPMENT SCENARIO

In order to focus our consideration of and to anticipate some of the implications of the package of policy instruments directly applied to the agricultural sector, we have first worked out a scenario for a sustained five per cent rate of agricultural growth over the next fifteen-year period. The aggregate projection for this medium growth path in foodgrain production, calculated with a synthetic production function assuming additive input responses (empirically derived) of land, irrigation, seeds, and fertilizer, is shown in Table I.[5] This projection plays a unifying role in the analysis by suggesting levels of requirements for the policy categories which are discussed in more detail in the next section. It should be noted that the particular combination of inputs used in Table I is only one of the many possible alternatives which could result in the target output levels. The "best" policy combination must be derived from experience c

5. See William Holst, "Twenty-year Projections of India's Foodgrain and Fertilizer Demand and Supply," Volume II of The World Food Problem, Report of the President's Science Advisory Committee, Washington, D.C., U.S.A. 1967 and W.E. Hendrix, J.J. Naive and W.E. Adams:Accelerating India's Foodgrain Production, 1967-68 to 1970-71, Foreign Agricultural Economic Report No.40, U.S. Department of Agriculture, Economic Research Service, 1968 for studies using similar methodologies.

TABLE I — Medium Projection of Foodgrains Production

	Units	1964-65	1967-68	1968-69	1973-74	1978-79	1983-84
1. Gross sown area	million acres	390.7	392.5	390.0	414.6	429.4	445.3
2. Allocated to cereals	million acres	232.9	244.0	244.9	245.0	245.0	250.0
3. Allocated to pulses	million acres	59.0	56.0	52.5	60.0	60.0	60.0
4. Allocated to non-foodgrains	million acres	98.8	92.5	92.6	109.6	124.4	135.3
High Yielding Varieties - Irrigated Cereals	("tons" are metric tons)						
5. Gross area	million acres	-	14.8	22.9	50.0	90.0	110.0
6. Average NPK dosage	lbs./acre	-	60.0	55.0	85.0	100.0	120.0
7. Package response ratio	-	-	13.5	13.5	13.5	13.5	13.5
8. Package increase	lbs./acre	-	810.0	742.0	1,148.0	1,350.0	1,620.0
9. Basic cereal yield		-	1,300.0	1,300.0	1,300.0	1,300.0	1,300.0
10. Package cereal yield		-	2,110.0	2,042.0	2,448.0	2,650.0	2,920.0
11. HYV cereal production	million tons	-	14.2	21.3	55.6	108.4	146.0

(Contd.)

..(Table I contd.)

	Units	1964-65	1967-68	1968-69	1973-74	1978-79	1983-84
Local Varieties-Irrigated Cereals							
12. Gross area ..	million acres	53.2	45.2	38.1	21.5	-	-
13. Average NPK dosage ..	lbs./acre	30.0	35.0	35.0	50.0	-	-
14. Percentage of area receiving NPK ..	—	40.0	70.0	70.0	90.0	-	-
15. Average NPK dosage — all area ..	lbs./acre	12.0	24.5	24.5	45.0	-	-
16. Fertilizer response ratio ..	—	9.0	9.0	9.0	9.0	-	-
17. Increase due to fertilizer ..	lbs./acre	108.0	220.0	220.0	405.0	-	-
18. Basic cereal yield ..		1,350.0	1,250.0	1,250.0	1,300.0	-	-
19. Total yield ..		1,458.0	1,470.0	1,470.0	1,705.0	-	-
20. Cereal production—local	million tons	35.3	30.2	25.5	16.7	-	-

(Contd.)

(Table I.contd.)

	Units	1964-65	1967-68	1968-69	1973-74	1978-79	1983-84
Unirrigated Cereal Varieties							
21. Gross area	million acres	179.7	184.0	183.9	173.5	155.0	140.0
22. Average NPK	lbs./acre	10.0	15.0	17.0	30.0	35.0	35.0
23. Percentage of area receiving NPK	-	20.0	20.0	22.0	30.0	30.0	40.0
24. Average NPK dosage— all area	lbs/acre	2.0	3.1	3.7	9.0	10.5	14.0
25. Fertilizer response ratio	-	9.0	9.0	9.0	9.0	9.0	9.0
26. Increase due to fertilizer	lbs./acre	18.0	28.0	33.0	81.0	95.0	126.0
27. Basic cereal yield	lbs./acre	450.0	450.0	450.0	475.0	500.0	525.0
28. Total yield		468.0	478.0	483.0	556.0	595.0	651.0
29. Cereal production	million tons	38.2	40.0	40.3	43.8	41.9	41.4

(contd.)

(Table I contd.)

	Units	1964-65	1967-68	1968-69	1973-74	1978-79	1983-84
30. Total cereal production (normal weather)	million tons	73.5	84.4	87.1	116.1	150.3	187.4
31. Average cereal yield	lbs./acre	694.0	762.0	782.4	1,042.0	1,350.0	1,649.0
Compound growth in yield	per cent.	-	-	-	5.9	6.2	4.1
Pulses							
32. Total Production (normal weather)	million tons	12.1	11.5	10.7	13.0	13.6	14.3
33. Yield ..	lbs./acre	450.0	450.0	450.0	475.0	500.0	525.0

(Contd.)

(Table I concld.)

	Units	1964-65	1967-68	1968-69	1973-74	1978-79	1983-84
Foodgrains							
34. Total production* (normal weather)	million tons	85.6	95.9	97.8	129.1	163.9	201.7
35. Compound growth	per cent	-	-	-	5.7	4.9	4.2
36. Average yield .. (normal weather)	lbs./acre	645.0	703.0	723.5	931.0	1,182.0	1,431.0
37. Compound growth..	per cent	-	-	-	5.2	4.9	3.9
38. Weather index ..	index	104.8	103.0	89.1	-	-	-
39. Actual production	million tons	89.4	98.0	94.0	-	-	-

* Notes: The projections were developed as follows:

1. Data on total foodgrain acreage, high-yielding variety acreage, irrigated acreage and total fertilizer distribution are reported from official sources or extrapolated from earlier years for 1964-65, 1967-68 and 1968-69. Average NPK dosage and per cent of foodgrain area receiving NPK were estimated from survey data. The basic cereal yield and foodgrain-fertilizer response ratios were estimated from experimental data and crop-cutting surveys. The internal consistency of these input quantities and input-output responses was checked against reported production figures for 1964-65, 1967-68, and 1968-69 as corrected by a rainfall index to "normalise" weather.

2. The "normal weather" production estimates for 1967-68 and 1968-69 refer to the normal influence of weather on yield only. Actually favourable rainfall in 1967-68 increased acreage on rain-fed lands and the poor rainfall in 1968-69 decreased this "swing area." Therefore, 95.9 million tons for 1967-68 is an over-estimate and 97.8 million tons for 1968-69 is an under-estimate for totally corrected "normal weather" production

3. Production levels for 1973-74 through 1983-84 are based on input levels discussed in section III on policies.

and further research.[6] It is our judgment that the growth in input use implied in this medium projection is feasible both in physical and economic terms.[7] Even at the end of the Sixth Five-Year Plan, the capacity for agricultural production will be well below full utilization.

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6. The fitting of a more formal disaggregated planning model, embodying regional sub-models, should be a high priority research project for the future. Our approach in all its simplicity has similarities to a linear programming model. We "maximize" a growth rate subject to assigned constraints of area, irrigation, fertilizer, and technology. However, the economics implicit in our approach are not internally a function of the model. We must adjust the relationship to suit our best judgment. This procedure does have benefits in that it forces the policy-maker to consciously evaluate policy trade-offs instead of turning this important decision over to an impersonal model. However, the capacity of our simple approach is limited. Furthermore, the subjectivity of the approach has its negative aspects. A more formal production function model, e.g., non-linear programming, could give a more realistic evaluation of the relative substitutability among inputs (in our scheme, we assume constant returns to inputs individually and in combination regardless of quantity). On the other hand, the fact that technology is changing rapidly, shifting the production function upward and changing the relationships among inputs, reduces the confidence we might place on the coefficients derived from a formal empirical fitted from historical data. A simulation model to explore the implications of different assumptions regarding parameters might be the most flexible, hence most useful, policy tool for this rapidly changing world. In the meantime, until more information is available, our task is to re-check coefficients and input use projections over time, among regions, individually and in combination.

7. It should be noted that while the 5 per cent growth rate is high in historical Indian terms and even as compared to U.S. past performance, several countries including Israel, Sudan, Mexico, Philippines, Tanganyika, and Yugoslavia maintained annual rates of increase of crop output exceeding 5 per cent during the 1948-63 period.

The agricultural development scenario resulting from this medium growth performance might be expected to have the following characteristics:

Cereals Production

The initial production thrust from the High-Yielding Varieties (HYV) has been led by wheat. It is expected that wheat production will continue to increase in the future although at more moderate rates than during 1967-70. Wheat accounts for only 20 per cent of the total foodgrain production. Therefore continued high level foodgrain growth is dependent on progress in rice. The physical potential of the short-strawed rice varieties is great under favourable conditions characterized by low humidity, controlled water, and intense sunlight unrestricted by cloud cover.[8] However, most rice in India is grown during the rainy season. Yields during this period are lower and more variable as compared to the dry season. When high-yielding rice varieties are released which are more compatible with environmental conditions which characterize the most important growing seasons, the rate of adoption will accelerate, the level of input use will increase causing yields to approach physical potentials, and yield variability will decrease. Research to correct identified problems is underway. It is expected that steady increases in yields will also be achieved by maize, sorghum, and bajra with performance being relatively most promising for the latter two cereals on drier lands.

8. W. David Hopper and Wayne H.Freeman, "From Unsteady Infancy to Vigorous Adelescence, Rice Development," Economic and Political Weekly, Vol.IV, No.13, March 29, 1969. pp. A-17-A-21.

Prices

Projections of future price implications of the medium foodgrain growth rate compared with demand projections from the previous section indicate a gradually declining level of foodgrain prices. If there is a gradual rate of infusion of cost-reducing foodgrain technology, economic incentives for foodgrain production should be maintained. If the cost reductions are significant, there will be substantial additional incentives for capital formation in agriculture and for resource transfer to other sectors.

Non-cereals Production

Although there may be some research spin-off from the HYV, rapid yield increases for non-cereals are not expected in the near future. If non-cereals production lags initially, higher prices will stimulate more fertilizer use for these crops. However, increased supply in the future will result primarily from acreage shifts induced by the relatively more favourable prices of non-foodgrains.

Inter-regional Growth

The new cereal varieties are generally insensitive to day length and temperature (within reasonable limits). This introduces much greater flexibility in geographical and seasonal location. There is no guarantee that future regional cropping patterns will resemble present patterns. In theory, the new map of crop location could vary from one extreme of every district being self-sufficient in every crop consumed in that district to the other extreme of a pattern of regional specialisation in production although not necessary in the same locations as presently.

One would guess that regional specialisation will be the prevailing pattern. The new result will be influenced by the technical, physical, and economic factors which define comparative advantage and can be influenced by government policies promoted either to change or reinforce this pattern.

Very approximate projections of future State agricultural growth rates consistent with the five per cent aggregate rate were made by allocating the aggregate growth among States in proportion to the proportion of irrigation acreage in each State at the beginning of the Fourth Five-Year Plan. Table II illustrates the projected State rates as compared to past performance and the relative possible re-ordering of the respective States in the new environment of agricultural performance. On this basis, the two per cent minimum for any State appears to be feasible and a two and one-half per cent minimum growth appears to be attainable if extra effort is made. Even after adjustments are made in the ordering to account for other growth-inducing or inhibiting characteristics of the respective States such as area under assured rainfall, quality of irrigation, and drainage quality it appears that the western section of India (to which might be added Telangana and some of upland Madras) will be the lagging growth area.

Inter-personal Income Growth

Brief analyses were attempted, in part based on recent experience, for each of the primary rural economic groups to determine how they fare under different agricultural growth assumptions. It was concluded that some absolute improvement in real income can be expected even from the lowest income-groups. However, a narrowing of income differences appears to be less likely to be achieved.

TABLE II - Comparison of Post-Independence and Projected Fourth Five-Year Plan (Preliminary) Agricultural Growth Rates by States

(annual compound rates)

Zone/State	Per cent annual growth			Rank	
	Post-Independence	Fourth Plan	Change	Post-Independence	Fourth Plan
North					
Punjab ..	4.6	9.6	+5.0	1	1
Rajasthan ..	2.7	8.4†	+5.7	8	2
Uttar Pradesh ..	1.7	6.7	+5.0	14	4
Himachal Pradesh	3.4	2.0	— 1.4	5	15
East**					
Assam ..	1.2	3.8	+2.6	15	8
Bihar ..	3.0	4.9	+1.9	6	7
Orissa ..	2.5	5.0	+2.5	11	6
West Bengal ..	2.0	2.8	+0.8	13	11
West					
Gujarat ..	4.5	3.1	— 1.4	2	10
Madhya Pradesh ..	2.5	2.1	— 0.4	10	14
Maharashtra ..	2.9	2.5	— 0.4	7	12
Mysore ..	3.5	3.2	— 0.3	4	9
South**					
Andhra Pradesh ..	2.7	7.5	+ 4.8	9	3
Kerala ..	2.3	2.2	—	12	13
Tamil Nadu ..	4.2	5.6	+ 1.4	3	5
All-India ..	3.0	5.0	—	—	—

Source: Government of India; Bandhudas Sen.

Note: The States have been arranged into four roughly similar groupings which have basic similarities regarding (1) cropping pattern, (2) rainfall availability, (3) distribution of land by size of holding, (4) coverage and source of irrigation, (5) NPK usage, and (6) agricultural growth potential.

† This sharp increase is primarily the result of the recent opening of the Rajasthan Canal and is probably substantially over-stated.

** There is a relatively large proportion of tank and canal irrigation in these areas. These sources are dependent on monsoons for replenishment and present difficult on-farm management problems for users.

Summary: This development scenario gives a general overview regarding results which might characterize one level and mix of policies necessary to achieve the desired targets. Alternative combinations of inputs can be evaluated. The implications of higher and lower growth target can also be tested.[9] Once the general order of the policies is decided, the next step is to explicitly consider the details of these policies and to determine the economic decisions which must be made in their implementation.

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9. Alternative growth paths were projected and their implications considered. The low metabolism growth path projects an annual compound growth rate in foodgrain production from 2.9 to 3.7 per cent (cereal yield increase between 3.4 to 4.2 per cent) from the Fourth to the Sixth Plan with only gradual increase in non-foodgrain production. The higher metabolism growth path projects a compound growth rate in foodgrain production declining from 6.9 to 4.2 per cent (the annual increase in cereals yields declines from 7.8 to 4.7 per cent) with fairly rapid increases in non-foodgrain production from acreage shifts. The alternative growth paths are based on different assumptions regarding the spread of HYV, average dosage and coverage of chemical fertilizers, irrigation development, and introduction of new technology.

III

INSTRUMENTS

The basic policy fact of Indian agricultural development is that the operational production and marketing decisions are made by millions of individual cultivators. Co-ordination and order is brought to the individual decisions by (1) the institutional, social, and political environments which have conditioned these cultivators in the East and which will shape their receptivity to new ideas in the future; (2) the market economic environment reflecting changing forces of supply and demand expressed through the price system; and (3) government policies and programmes. It is the government policy role - either expressed directly through government participation or indirectly through influencing the environment for private decisions - to attain the objectives broadly defined in the first section that we now examine in this section.

The policies will be considered in five categories: (1) input availabilities, (2) distribution of inputs and marketing of outputs, (3) economic policies, (4) research and technology, and (5) socially-oriented programmes. Alternatively, it might be appropriate to consider the policies to fall within four analytical categories: (1) to enable the producer to reach the surface of the production function, e.g., to make more effective use of existing resources; (2) to enable the producer to move up the surface of the production function, e.g., to provide more production inputs; (3) to enable a shift upward and outward in the production function, e.g., to increase the input-output response of inputs; and (4) to enable those not fully participating in the economic matrix to enjoy

some of the benefits of economic development. This analytical grouping would be consistent with the four targets identified in the first section.[10] We have chosen instead to use the functional division because it can be more easily associated with present governmental policy organization.

A. Input Availabilities

The primary inputs internal to the production function are water (irrigation), fertilizer, plant protection, energy (labour, draft animals, mechanization), and seeds. Greater input use enables the economy to move up the surface of the production function, and to the extent that new technology is embodied in inputs, induces an upward shift in the production function.

1. Irrigation: The medium projections require that irrigation coverage increase by an average of 4.5 million acres per year over the fifteen-year period. This is a much higher rate than previous experience. During the first three Five-Year Plans gross irrigation increased at an annual rate of approximately 2 million acres per year. However, there is now a much higher economic return to irrigation than previously. Four to five million acres of new irrigation were added in 1965-66.

About half of the new projected irrigated acreage will come from net additions to irrigated area and the other half from multiple cropping of irrigated land.

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10. K.A. Fox, J.K. Sengupta and E. Thorbecke: The Theory of Quantitative Economic Policy, North-Holland Publishing Co., Amsterdam, 1966.

Large, as yet unexploited, potentials exist for both major and minor irrigation development in almost every State. At present only 40 per cent of the major irrigation potential and less than half of a conservative estimate of minor irrigation potential of India have been developed for agricultural uses. Only 15 per cent of irrigated land is multiple cropped.

The availability of manageable water is probably the key factor in future agricultural growth. The new varieties have very specific water requirements if they are to realise full production potential. Furthermore, the HYV are not necessarily sown during set cropping seasons as were the traditional varieties (which were photo-sensitive). When all crops were planted and harvested at the same time, canal deliveries could be scheduled accordingly. However, when each cultivator sets his individual seasonal pattern, water available on the particular farm for the specific crop needs of that farm is necessary. Therefore, there must be a re-examination of investment priorities for the three primary sources of supplementary water.

Private tube-wells: Private tube-wells which provide dependable on-farm water supply will play an increasingly important role in the future in areas where they are applicable. They are effective means of mobilizing private financial resources. They have a very short gestation with pay-off periods often as short as 2-3 years. However, there is a minimum scale factor of about 10 acres (unless water can be sold - which is a frequent practice).[11] While privately financed irrigation permits smaller cultivators greater flexibility to adapt to changing conditions and reduces the size of farm necessary to provide an adequate

11. Dug-wells operated by Persian wheels or small engines can be applied economically to smaller acreages but they are dug only to 30 feet depth, can be constructed only in areas with relatively high water tables, and are vulnerable to falling water tables during droughts.

living, it also exposes these cultivators vulnerable to price declines, particularly if they finance their investment on credit. As more holes are bored into the ground, the need for hydrologic mapping and effective planning of water becomes increasingly important in order to ensure that the water table does not drop rapidly and dry up these wells.

The answer to water requirements of small cultivators may be public tubewells. However, if the command area of each tube-well becomes too extended, distribution problems may offset the anticipated flexibility of delivery and reduce the pay-off. Public tube-wells would be financed by the government; the availability of government water on a reasonably assured basis would reduce the incentive to invest in private tube-wells and could hinder this means of tapping private resources. The deeper drilling depths and greater pumping capacity of these public wells may cause problems (e.g., lowering the water table) for the more shallow private tube-wells if not properly planned.

Finally, there is a large back-log of uncompleted major and medium projects which were suspended during the droughts when inflation was threatening and financial resources were especially tight. Sunk costs are already spent. Economic considerations for further development of these projects would be based on the marginal costs for completion. Returns on previous major irrigation projects generally have been low. Improved scheduling of water deliveries and adjustments in cropping pattern to make most effective utilization of available water can increase pay-offs from these major works significantly.

2. Chemical fertilizers: The NPK requirements derived from our projections to attain the target rate of foodgrain output of 129 million tons set for the Fourth Five-Year Plan total only two-thirds of the official government estimates.

(million metric nutrient tons)

	1969-70	1970-71	1971-72	1972-73	1973-74
(1) Government of India targets	3.35	4.10	4.80	5.61	6.60
(2) Minimum requirements (LRAAA)*	2.29	2.65	3.06	3.54	4.10
(3) Adjusted LRAAA requirements	2.75	3.18	3.67	4.25	4.92
Gaps (1)– (2)	1.06	1.45	1.74	2.07	2.50
(1)– (3)	0.60	0.92	1.13	1.36	1.68

* Minimum requirements for foodgrains are aggregated directly from the supply projections in Table I. The foodgrain requirements were increased by 33 per cent to account for non-foodgrain requirements. Adjusted supply projections include a 20 per cent addition to minimum requirements in order to account for waste, inventory, and lead-time on orders so that the inventory is in place, at the time, nutrient, and quantity needed.

The high-yielding varieties give much higher grain response per nutrient unit than do the traditional varieties. Furthermore, the optional dosage for the HYV is much higher than for the traditional varieties. Presently, actual dosages are well below optional levels. This large, as yet unexploited, potential, for future

fertilizer consumption is one of the primary reasons for confidence in achieving a five per cent annual agricultural growth rate into the future. However, the gap between potential and performance also suggests large scope for work by the extension service, fertilizer distributors, and credit agencies in order to achieve this potential.

Past projections of domestic fertilizer production have consistently over-estimated actual performance. The following projections, based on an appraisal of the progress of starts and letters of intent in July, 1969, should be evaluated with the warning in mind:

(thousand metric tons)

	1969-70	1970-71	1971-72	1972-73	1973-74
Nitrogen	818	1,058	1,463	2,164	3,139
Phosphates	343	365	487	783	1,189
Total	1,161	1,423	1,950	2,947	4,328

If we can rest confidence in these demand and supply projections, the most interesting conclusion is that there may be less pressure than originally thought on scarce foreign exchange to finance NPK requirements. By 1973-74, the import gap may almost be closed. The new phosphate finds in Rajasthan may also reduce the import requirements for raw materials. In the near-term more foreign exchange can be set aside to import industrial parts and

equipment.[12]

However, looking farther ahead, the four to five-year lead-time for plant construction necessitates that decisions made now are becoming crucial in order that the large import gap does not open up again in the future.

3. Plant protection: Plant protection may eventually rival chemical fertilizers as the major cash expenditure for the high-yielding varieties. It is already an important production input for rice and jowar as well as for cotton. The lush growth and thick stands of the HYV of rice are particularly attractive to pests. At present, the dosage is at a very low level. As more information is learned about the requirements, this will become a priority area for economic research.

4. Energy: The HYVs require more frequent care and more precision and timeliness of operations in order to produce at maximum potential.[13] Furthermore, the HYVs create new possibilities for multiple cropping and for extension of production to areas not previously cultivated.

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12. One should treat this policy implication, particularly with regard to the import programme, of these calculations with caution. The cost of having too much fertilizer (excess stocks) on hand for any crop season is probably much less than the cost of having too little fertilizer. Fertilizer is a storable commodity. On the other hand, a shortfall in agricultural production can be translated quickly into rapidly rising prices. Furthermore, many argue that the most effective way to liberalize and modernize the fertilizer distribution system is to ensure that ample supplies are always available which would provoke distributors and producers to aggressively sell the product.

13. Martin Billings and Arjan Singh have made studies of energy requirements based on engineering concepts for several selected States.

Energy requirements should grow significantly in the future.

Once the aggregated requirements are known, the important policy question becomes how to choose among alternative sources of supply to provide for the required needs. The primary sources of energy supply are human labour, draft animals, and electric and diesel motors (mechanization). The agricultural sector is the residual depository of most of the increasing population. There is a tendency to advocate labour-intensive methods of production in order to utilize this "resource." However, evaluation of expected rates of population growth suggest that this source of energy supply alone will not be sufficient to meet the demands particularly with regard to timeliness and precision of operations. The proponents of mechanization argue that it can contribute to higher yield, increased multiple cropping, and less wastage in harvesting.[14] Land no longer required for animal feed production can be devoted to food and fibre production if tractors replace draft power.

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14. The black cotton soils of West Central India are one clear illustration of an area whose cropping potential is inhibited by water management and availability of on-farm power. Land lies idle until the monsoon rains; after the rains the land becomes very difficult to work. As a second example, more timely operations in the interval between wheat and kharif crops in the north could permit triple and quadruple cropping with addition of such crops as mung beans and potatoes by taking advantage of the shorter field duration and later planting requirements of the dwarf wheat.

Based on calculations in terms of private costs and benefits, investments in tractors (as an example) are widely profitable. However, calculations based on social costs and benefits may lead to different conclusions. Energy units might be first evaluated in terms of their contribution to (1) increasing yields, (2) increasing cropping intensity, and (3) decreasing waste. The second category of questions is whether different types of mechanization are labour-replacing (compete directly with labour) or labour-creating (create more jobs through labour demands from multiple cropping, hand cultivating, etc.). This analysis must be conducted at a disaggregated level by geographical areas and by types of mechanization to obtain useful policy results. Presumably a range of answers would be forthcoming depending upon whether one considered tube-wells, tractors, threshers, combines, or rice transplanters and whether the analyses are carried out in Punjab or West Bengal. The scale of operation - power tiller vs. 35 horsepower tractor vs. 50 horsepower tractor - is also relevant in order to determine the employment relationship as well as the geographical placement of investments for production of these inputs.

Mechanization in some form is probably inevitable. The first task is to determine how much mechanization, where it might be used and under what conditions. It would

appear that market compatible methods (e.g., taxes) might be a better means of controlling the rate of adoption to social purpose than by imposing outright quantitative restrictions.

5. Seeds: Failure to multiple and distribute hybrid seeds in sufficient quantities was an early inhibiting factor in the introduction of HYV of sorghum and bajra. Maintenance of pure lines of HYV of wheat and rice will be a conditional factor in the future development of these major cereals. An adequately funded, professionally planned, and closely supervised commercial seed industry is required to maintain seed purity and to carry out multiplication. The 1973-74 target for HYV is 60 million acres. Therefore, the growth of the commercial seed industry and its interaction with the research and extension activities of the government will become an increasingly important component of the New Strategy of Agricultural Development.

B. Input Distribution and Product Marketing

Future development of the input distribution and product marketing system is at the same time undoubtedly one of the most important as well as one of the most difficult policy areas to project. Market development is an enabling investment outside the production function

of the cultivator, which importantly affects production decisions by (1) delivering inputs at the time, place and quantity needed in order to permit utilization of full benefits of production technology by the cultivator, (2) permitting a large proportion of the gains of production activities to be obtained by the cultivator in the form of higher profits, and (3) delivering products at lower prices to consumers. These services enable the cultivator to move to the surface of and up the production function. Market development can be evaluated as an alternative to (complement of) economic policy to provide incentives and would have special advantages over economic policies for encouraging production of certain commodities, especially perishable agricultural products. However, the benefits of investments in market development, like those of most infra-structure investments, are often diffused and difficult to measure directly.

1. The issues: If our projections of rapid output expansion and related input use are accurate, the input distribution and output marketing systems will be under increasing pressures to effectively fulfil their necessary roles to stimulate future growth. However, market development planning is complicated by the fact that (a) the greater volumes will require fundamental organizational changes which involve large investments

of fixed capital but (b) future regional cropping pattern and growth rates - which might guide the placement of these investments - can only be approximately anticipated.

Several general policy questions should receive early attention. For example, how should modernization proceed? The eventual system will be based on bulk handling and all-India grading. Perhaps this will be the common practice in 20 years. But how does one move to that system from the present set of activities based on bag lots and trader grading? The present system is creaky but it works better than most people give it credit for performing.

What will be the future role of the private sector in agricultural marketing? The co-operatives were once seen as a programme to eventually replace private output marketing. The buffer stock poses such a threat at present: selective intervention of the size of the anticipated public operation could periodically pre-empt the private trade and in the process provide serious disincentives for modernization if not even drive private operations from business. The role of the private system in establishing economic prices which signal production and consumption decisions must not be under-rated.

How much storage should be built? Assuming that approximately four to five million nutrient tons of NPK will be required in 1973-74 and that these nutrients are distributed in 40-50 per cent mixtures, then approximately 10 million tons of bulk materials will be moving through the system annually in five years. Approximately two-thirds of this must be available at the beginning of the kharif season which means that five to seven million tons of some sort of cover must be available. Taking into account the seasonal bunching of foodgrain procurement and the expected friction in distribution, a preliminary estimate of total public foodgrain storage requirements would be approximately ten million tons or about double the present owned capacity. It might be advisable to encourage some small lot on farm storage of foodgrains. Private commercial storage requirements might be added to this. A vigorous storage building programme is indicated.

In road building, should the government concentrate on farm-to-market, market-to-market or both types of road; how many miles; where? My instinct is to favour market-to-market roads. It can be argued that if better farm-to-market roads are required (e.g., are economically justifiable), the villagers themselves will build them. Obvious exceptions to this generalization would be found in low-lying areas in West Bengal where jute must be promptly processed if export quality is to be attained or areas such as the Tungabhadra in Mysore where large amounts of earth must be banked. However, the farm-to-market roads do provide a prime means of organizing rural works programmes; curiously, the roads presently

built in India have a high capital component relative to labour.

Agricultural processing industries have received very little attention in overall agricultural planning to date. Whole industries are growing up for concentrated animal feed, modern bakeries, and oilseed (soybean) processing. Again the questions are how much, where and when to invest.

2. Rural centering: Perhaps the key organizing concept of this whole problem of market development could be an attempt to integrate agricultural development with industrial and commercial activity through new (or remodelled old) strategically located and comprehensively planned market towns. Convenient location can both increase the marketed surplus from and facilitate delivery of supplies to cultivators. Credit facilities, and extension information might be added. Dispersion of small scale agro-industries to these market towns would be a means to effectively employ off-season idle labour. The integrated concept of market planning embracing input supplies, production sales, credit, extension, and industrial and commercial activity in one site can be a growth nexus with spread effects which, if strategically planned to promote spatial growth objectives, could trigger a growth multiplier. The close relationship of agricultural progress with urbanization and industrialization is documented in the West. Ludhiana and Coimbatore, although obviously not planned for such a purpose, are private enterprise examples of this process in India already.

This micro approach to market planning might be integrated into the macro policy to attack the broader spatial dimension of agricultural development. Inter-regional equity was explicitly stated as a development target. Government programmes which can influence the future regional growth patterns include transportation construction and rate structure; urbanization policy; price support programmes; and investment location for irrigation, storage, and output processing. The large number of sugar-crushing and refining mills in north India almost insures that a substantial proportion of sugar will continue to be grown in the north in the future. Future location of starch industries can influence maize location. Oilseed-solvent plant placement can influence future soybean acreage concentration. These policies can be explicitly designed to influence future location of agricultural development. Alternatively, they can be planned to respond to and facilitate the growth patterns that might be expected from the normal operation of economic forces.

C. Economic Policy

The role of prices, taxes, credit, and administrative measures in influencing the levels of profits and thereby the level and allocation of resources becomes more and more important now that the new technology is available to shift agricultural growth to a higher trend line. However, it must be noted that these policies provide only the environment by which existing resources are allocated and new resources are created. Technological change can be more rapidly induced or it can be discouraged by the economic environment.

However, aggressive policies in the other policy areas assume equal importance. Favourable economic policy is a necessary, but by no means a sufficient condition for agricultural growth.

1. Price policy:[15] In the present transitional situation in which modern agriculture is becoming increasingly based on inputs which are purchased commercially in contrast to the previous reliance on on-farm generated inputs, it is desirable that the price level (the terms of trade of agriculture) be high enough to provide an economic incentive to use the inputs. As the new technology becomes more fully integrated into the system, then it is anticipated that declining agricultural prices (accompanied by cost-reducing technology so that economic incentives are maintained) will be a primary means of resource mobilization for the non-agricultural sector.

Over the longer run, it is inevitable that market forces of supply and demand are the basic determinants of price levels. However, government policy can attempt to supplement the operation of market forces and improve

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15. We are assuming that price policy should focus primarily on commodity rather than input prices. We would guess that the cultivators are more responsive to output prices as economic signals. Also, the new technology has now been adopted by so many cultivators that an input subsidy programme might be too costly. We would assume that input policy would concentrate on keeping prices low and supplies readily available through encouraging market competition.

the economic environment in three primary ways. First, it can implement a system of support prices, announced in advance of sowing and backed up with guaranteed purchases, to provide a minimum expected price to reduce the risk in planning production decisions. Secondly, it can ensure some degree of price stability from year to year and season to season so that economic waste from inefficient production, marketing, and consumption decisions is minimized. Support prices provide the lower limit for harvest prices. The upper limit to harvest prices should be flexible enough so that producer's incomes are protected in years of low incomes. Seasonal prices should be allowed to rise above the harvest price level at least enough to cover storage costs including interest and some profit (including a risk factor in order that good years are sufficient to balance off bad storage years). Thirdly, government policy can see that attempts to influence particular commodity prices, e.g., attempts to correct supply/demand imbalances in specific commodities, do not have undesirable effects on competing crops in production, e.g., via the effect of relative prices on relative acreages sown.

The buffer stock - an integration of several price and food policy instruments - is a market compatible programme which can cope with short-term problems as well as allow economic signals to direct inter-crop and inter-spatial acreage and input allocations necessary for high growth.[16] It is estimated that a target level of approximately seven million tons of foodgrains might be

16. Seminar on Foodgrains Buffer Stocks in India, Seminar Series - VIII, Indian Society of Agricultural Economics, Bombay, 1969.

a current compromise target which is large enough so that downward pressure could be added to the market in times of short production while at the same time not tying up too many financial resources which might otherwise be spent for production investments. The actual level of the buffer stock would fluctuate being built up in times of favourable harvests and depleted in shortfall years. Development of decision making rules for inventory management consistent with the dual objectives of price stability and cost minimization considering the expected fluctuations in future foodgrain production is a high order research priority.[17]

2. Taxation: The incidence of taxation on Indian agriculture is low. While there is ample scope for research in this area, the probability for implementing higher taxes is also low primarily because of political, not economic reasons. Selective input pricing does

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17. Building and implementing an adequate buffer stock operation is a fundamental pre-requisite for the removal of foodgrain zones and the accompanying ad hoc administrative measures which have been introduced during food shortages in the past. The new technology may upset the optimal regional location of agricultural crops significantly during the next few years. The economic adjustment mechanism (e.g., cultivators reallocating acreages and variable inputs to greatest returns) must be allowed to operate freely on an all-India basis if a new pattern of comparative advantage corresponding to the new technology can be attained whereby resources are used most efficiently (as directed by pricing signals) at all parts of the country.

present some limited possibility for resource mobilization. However, taxes are costs. They may have an undesirable disincentive effect on use of some important inputs, e.g., fertilizer. On the other hand, selective input taxing may be an elastic source of revenue where returns are to certain inputs high, e.g., electricity for tube-wells. Furthermore, selective input taxation may be a flexible method to shape private decisions to more socially desirable directions e.g., on tractors or combines. Taxes have many effects. Therefore, the total influence of the taxation policy must be evaluated with the influence of other policies regarding the net economic effect.

3. Credit: Credit permits the cultivator to enjoy the production benefits of the new technology now and to defer payments until after the output is realized. Since Independence progress has been made in increasing the institutionalized share of agricultural credit. However, the moneylender still accounts for a large (and probably socially, but not necessarily economically, productive) share of the market. When one looks to the future: (1) credit requirements can be expected to increase more rapidly as agriculture becomes increasingly commercialized and particularly as a large share of inputs are purchased, and (2) if agriculture does grow rapidly, prices do fall, new technological changes are forthcoming, and innovation and flexibility become the key determinants of economic viability, then credit policy will assume an increasingly important role in insuring equity among cultivators as well as in support for sustaining and reinforcing the aggregate growth rate.

D. Research and Technology

If the availability of high-yielding varieties of seeds was the critical new element which set off the New Agricultural Strategy, by the same token, the development by Indian institutions of a continuing stream of new technology adaptable to Indian conditions will be the key element to establishing a sustainable higher growth rate of cereal production as well as non-cereal production over the next fifteen years. If the higher production potential is accompanied by a significant reduction in unit costs of production, the resource transfer to the non-agricultural sector will be strengthened. Furthermore, agricultural research can provide the basis to solve the problems of inter-regional and, to some degree, inter-personal equity. In summary, the results of research can enable the cultivator to move to the surface and up the surface of the production function and, more importantly, the results of research can shift the production function outward.[18]

India is now building a viable, indigenous research capability focusing on all-India co-ordinated programmes, strengthened by the establishment of ten new State agricultural universities, and staffed by a growing flow of young researchers returning from graduate training abroad. Pay-offs to investments in research have been high in

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18. Our assumption in the projections regarding technological change is measured by the degree to which we can maintain the same foodgrain-fertilizer response ratio as we increase the levels of fertilizer dosage (which amounts to an upward shift in the function).

developed countries, generally well above returns to other investment opportunities. The future level of expenditure for agricultural research must be raised. Furthermore, priorities for the direction of future research - dry lands vs. wet, large farms vs. small, what crops, what seasons[19] - must be a high order of business.

Once improved technology is available, an equally important task is to promote its effective use. Extension will have to play a key role in the future if the growth and equity targets are to be achieved. The most progressive cultivators were the first to adopt the new varieties: they were sown first on the highest potential land. Future spread of the new varieties will be to increasingly more difficult areas. Getting information to the cultivator is only part of the task; the cultivator must have the knowledge to be able to use it. A more adequate information base to suggest what influences cultivator adoption is needed; this analysis must go beyond the simple economics to investigate environmental and cultural factors. The economics of extension recommendations - the pay-off to components separately and in combination of recommended packages of practices - must be calculated. The basic question is what determines the leads and lags in adoption?

E. Socially-Oriented Programmes

The main thrust of any effort to extend the gains of the new technology must be accomplished through "trickle-down" effects of the economic core of the total investment

19. For example, research on crops which could be harvested just before and sown just after flood seasons might be an alternative to investment in flood control.

programme. However, it is unrealistic to expect that the pace of non-agricultural activity contemplated in the Fourth Five-Year Plan is sufficient to provide enough non-agricultural employment to improve the unemployment situation compounded by the high rates of population increase.[20]

To the extent that general, production-oriented programmes do not directly extend income gains to all regions or economic groups, explicitly socially-oriented programmes must be developed. The welfare aspects of these programmes should be openly acknowledged; political and social costs and benefits should be weighed explicitly along with economic analysis. These programmes should be

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20. The agricultural labour force is a "residual" employer and is almost certain to increase for some time. Using the formula

$$z = \frac{x - ay}{1 - a}$$

where

z = rate of growth of agricultural labour force,
x = rate of growth of total labour force,
y = rate of growth of non-agricultural labour force, and
a = per cent of population in non-agricultural employment,

and inserting approximate numbers for the Indian economy ($x = 2\frac{1}{2}\%$, $y = 4\%$, and $a = 25\%$), then the agricultural labour force can be expected to have to absorb an increase in population of approximately 2 per cent per year. The non-agricultural sector is not large enough nor growing fast enough to absorb much of the increase in population. However if the employment in the non-agricultural sector grew at 8 per cent, the rate of growth in the agricultural labour force would decline to approximately 1 per cent. The "burden" on the agricultural labour force would be reduced further as the non-agricultural sector increases in relative size.

directed at the dry land areas, the potentially viable small farmers, tenants and rentiers, non-viable small farmers, and landless labourers. For example, the new Small Farmers Development Agency with the specific aim of getting production resources to potentially viable farmers could have very high pay-offs. Rural works programmes, making use of the labour force in surplus labour areas during the whole year and in all areas during seasonal slack labour periods, could be used for a series of projects which are not easily carried out by individual action or not easily organized for village co-operative action. The public foodgrain distribution programmes could be reshaped. Internal migration could be facilitated. Land tenure relationships could be strengthened.

At the minimum, these programmes may lead to some improvement in income distribution. Also India can possibly "buy time" until the pace of overall economic development becomes sufficient to provide adequate employment (income creation) as part of its own growth momentum. However, the more optimistic achievement could be more infra-structure building, additional resources generated, and possibly some significant impact on the inter-personal and inter-regional distribution problems.

This policy area, perhaps even more than others, must receive increasingly imaginative conceptual and empirical attention in the near future. The challenge is to design these programmes in such a way that they do add to the production base of the country rather than compete scarce resources away from high pay-off economic investments. Success in these efforts may, perhaps even more so than other programmes, very well determine the ultimate course of India's political and economic future.

IV

CONCLUDING COMMENTS

The outcome of the Green Revolution is not assured. Continued adequate government support is a requisite which cannot be over-emphasized if potential is to be translated into reality over the longer run. The requirements for adequate government support to achieve the agricultural sector targets which we estimate to be required within the Fourth Five-Year Plan terms of reference are large in financial terms - but achievable. The Green Revolution, by permitting the re-activation of the Fourth Five-Year Plan after postponement of three years finally unlocks the means to obtaining the necessary financial resources.

This paper has gone beyond simple projections of supply and demand in an effort to establish the purpose of these projections. Supply and demand are alterable by government policies. The purpose of these projections then is to make more explicit the policy requirements upon which the projections are based.

In our larger volume we have reviewed the information content of previous research which is applicable to future policies. In that exercise, we have attempted to pull together this existing information base in order to permit more careful evaluation of policies. This paper is the summary of that larger effort. It is hoped that we have posed relevant questions in such a way that answers - future research to supplement and improve present knowledge - can be attacked more systematically. Certainly the pay-offs to research relevant to agricultural development planning are high.