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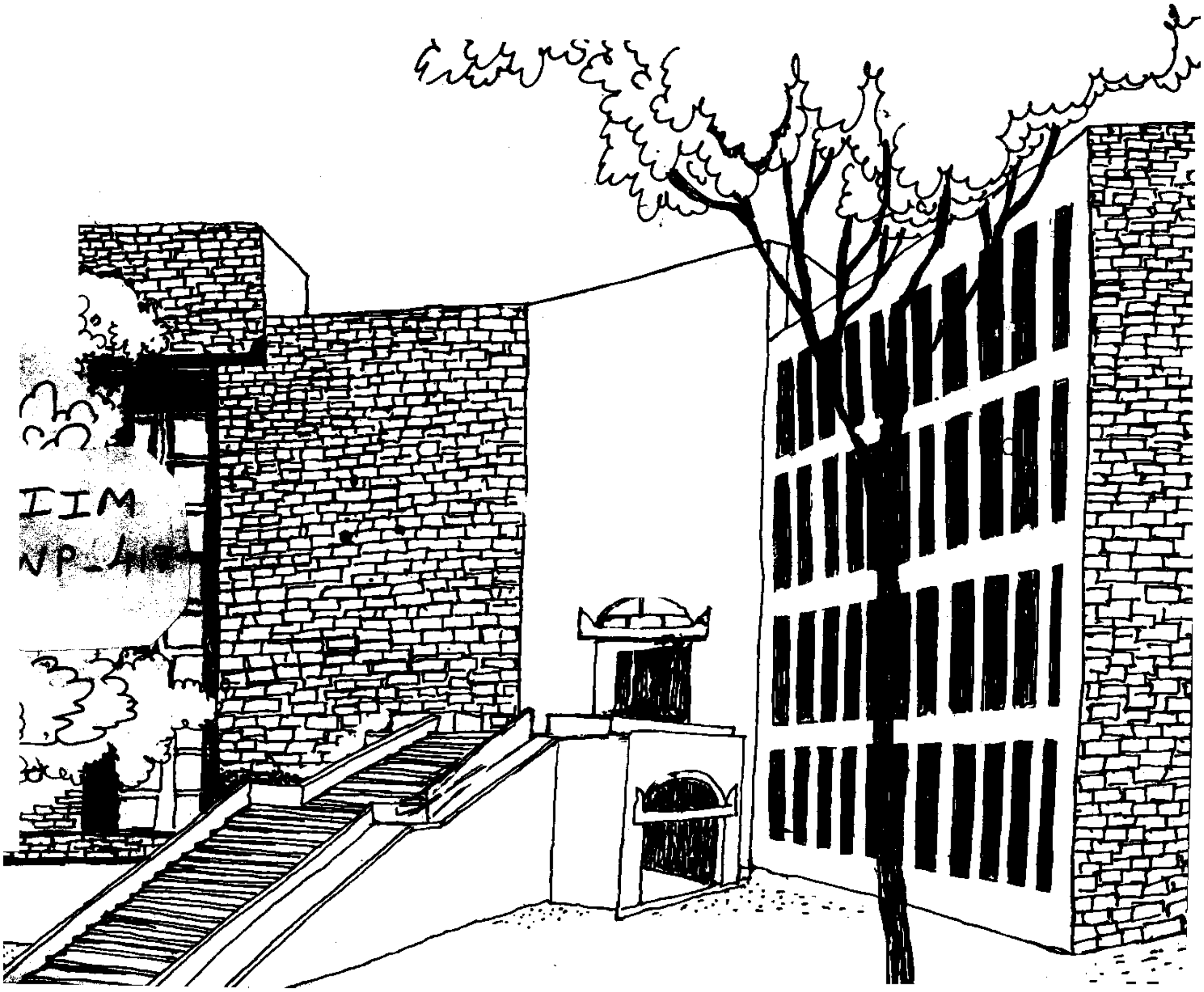

SPURS AND PROPS OF AGRICULTURAL RESEARCH -- ECONOMIC AND SOCIAL UNDER PLUMINGS -- A CASE STUDY OF RICE RESEARCH IN INDIA

By

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SPURS AND PROPS OF AGRICULTURAL RESEARCH--ECONOMIC AND SOCIAL UNDER PLUMINGS -- A CASE STUDY OF RICE RESEARCH IN INDIA

1.1 Introduction

Biological research has moved agriculture from the stage of self-sufficient production for a family or a village community to a commercialized stage where the world community is depending more on the exchange economy to satisfy its basic needs of food and clothing. It has been possible to combine the created resources of fertilizers with the natural resources of water, soil and solar energy to produce much larger quantities of agricultural production, than was possible in pre-biological research era. The spur in the biological research to increase agricultural production has taken place in the last century. The hybridization and evolving non-photosensitive varieties of foodgrains during last two decades have changed the world food problem. At one time it was being thought that it was difficult to sustain the growth of the world population as the growth of food production was not keeping pace with it. But after the event of "green revolution" a breathing time is provided to agricultural production to meet the requirement of the growing world population.

Recently again questions are being raised whether it would be possible to sustain the world population in the year 2000 with a reasonable standard of food consumption if further break-through in biological research does not take place. The major problem of food shortage will be faced by the developing countries.*

To study what kinds of supports are required to spur again agricultural research particularly in food production, a case study of rice production in India is undertaken.

In early sixties, many experts had predicted that a substantial portion of Indian population would die of starvation if immediate steps were not taken to increase food production. Although India had very bad agricultural year in 1965-66 when the foodgrains production reached a bottom level of 72.0 million tonnes in the period from 1961-62 to 1979-80 (Table 1, chart 1), no large scale deaths due to starvation were reported.

1.2 High Yielding Varieties Programme

The high yielding varieties programme which was introduced in 1966-67 seems to have averted the reoccurrence of 1965-66

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* Long-term food prospects in food deficit countries with developing market economics indicate that production of staple food crops in these countries would fall short of demand in 1990 by 120-145 million tonnes -- International Food Policy Research Institute, Current Food Policy Indicators, p.17, Washington, D.C.: IFPRI, Feb. 1977.

Table 1: Composition of Foodgrains in India

(Million Tonnes)

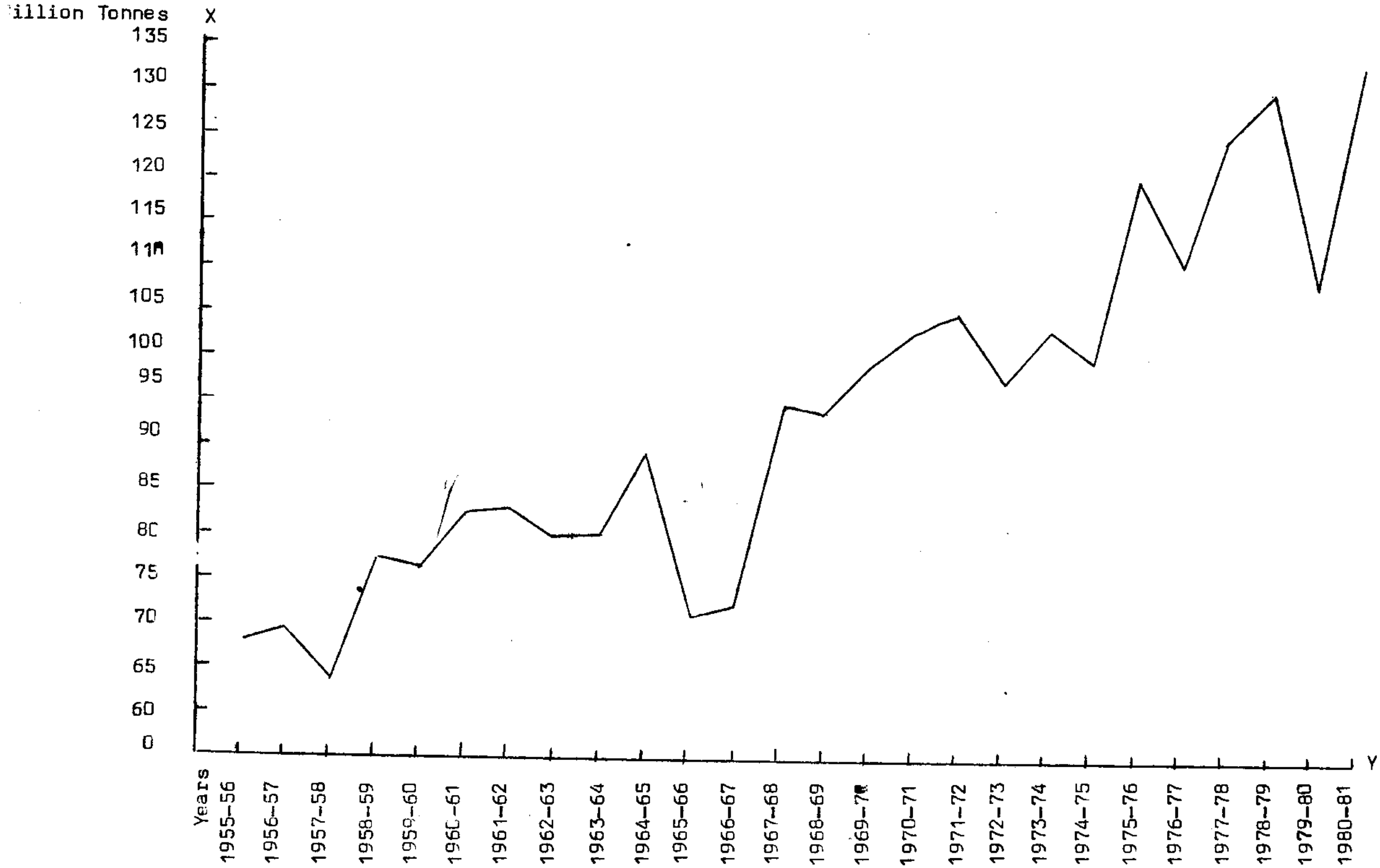
Years	Rice		Wheat		Total Foodg
	Quantity	Per cent	Quantity	Per cent	Quantity
1955-56	27.5	41.17	8.3	13.17	66.8
1956-57	20.0	41.49	9.4	13.45	69.9
1957-58	25.5	39.66	8.0	12.44	64.3
1958-59	30.8	39.95	10.0	12.97	77.1
1959-60	31.7	41.33	10.3	13.43	76.7
1960-61	34.6	42.19	11.0	13.41	82.0
1961-62	35.7	43.17	12.1	14.63	82.7
1962-63	33.2	41.40	10.8	13.47	80.2
1963-64	37.0	45.91	9.9	12.28	80.6
1964-65	39.0	43.82	12.3	13.82	89.0
1965-66	30.7	42.64	10.4	14.44	72.0
1966-67	30.4	40.97	11.3	15.22	74.2
1967-68	37.9	39.68	16.5	17.36	95.0
1968-69	39.8	42.34	18.6	19.78	94.0
1969-70	40.4	40.60	20.0	20.10	99.5
1970-71	42.2	38.93	23.8	22.00	1[illegible].4
1971-72	41.2	39.20	26.4	25.11	105.1
1972-73	39.2	40.32	24.7	25.41	97.2
1973-74	44.0	42.06	21.7	20.74	104.6
1974-75	40.1	40.18	24.1	24.14	99.8
1975-76	49.3	40.74	28.8	23.80	121.0
1976-77	42.6	38.34	29.0	26.10	111.1
1977-78	51.5	41.00	31.3	24.92	125.6
1978-79	53.8	41.00	34.9	26.58	131.3*
1979-80	42.1	38.69	31.5	29.00	108.8*
1980-81	N.A	N.A.	36.0**	27.08**	132.9**

Source: Government of India, "Estimates of Area and Production of Principal Crops in India," 1972-73, 1977-78.

* Government of India, Economic Survey, 1980-81, p.69

** The Economic Scene No.10, 1981, p.23

CHART 1: FOODGRAIN PRODUCTION IN INDIA 1955-56 TO 1980-81



situation. This programme introduced high yielding, fertilizer responsive varieties in major foodgrains such as rice, wheat, maize, jowar* and bajari**. Ever-since 1966-67 the area under high yielding varieties (HYV) is increasing and by 1978-79, the average area under HYV was 32% of the total areas under foodgrains.[1]

Before 1966-67, the source of growth in foodgrain production was expansion in area. But subsequently productivity was the main source of growth for food production.[2] The yield increase was mainly due to large increase in two areas: irrigation and fertilizer use. Table 2 gives the relationships between the growths of foodgrain output and total area under foodgrains, irrigated area and fertilizer use. The increase in irrigation and fertilizer use in foodgrains was mainly because of the introduction of high yielding varieties during the period 1964-65 to 1970-71. However, the growth rate and fertilizer use slowed down between 1970-71 and 1874-75 and resulted in a negative growth rate of foodgrains output of -2.0 per cent. Between 1974-75 and 1976-77 the growth rates of irrigated area and fertilizer use picked up and helped in bringing the growth rate ~~of~~ foodgrain outputs to 5.7 per cent

* Jowar is a local name for sorghum

** Bajari is a local name for pearl millet

[1] D.K. Desai and Madalsa Gandhi, Analysis of Rice Production and Productivity in India -(Based on District Data) and Rice Research Management, (Monograph), CMA, IIM, Ahmedabad, 1982 (unpublished).

[2] C.H. Shah, "Growth and Inequality in Agriculture" in Agricultural Development of India: Policy and Problems (ed.) by C.H. Shah and C.N. Vakil, Orient Longman, Bombay, 1979, p.111.

Table 2: Growth Rate in Foodgrain Area, Irrigated Area, Fertilizer Use, and Foodgrain Output, 1949/50 to 1976/77

Year	Foodgrain Area	Rice and Wheat Area	Irrigated Foodgrain Area	Fertilizer Use for Foodgrains	Foodgrain Output
1949-50 to 1960-61	1.4	1.4	2.1	16.3	2.8
1960-61 to 1964-65	0.5	1.4	2.1	27.3	2.1
1964-65 to 1970-71	0.9	1.9	3.9	20.9	3.3
1970-71 to 1974-75	-0.7	0.0	2.5	3.3	-2.0
1974-75 to 1976-77	1.2	3.1	4.3	15.1	5.7

Source: J.S. Sarma, et al., Two Analyses of Indian Foodgrain Production and Consumption Data, Research Report 12, IFPRI, November 1979, p.21.

1.3 Importance of Rice in India

India and China are the two biggest producers of rice which accounted for 21.4% and 35% of total rice production of the world in 1978. However, the yield per hectars of rice in India was much lower than many other rice-growing countries. Rice is the most important crop in Indian agriculture. Its contribution to agriculture sector was 28.1% and the contribution of agricultural sector to national economy was 45.7% in 1977-78. Rice is the main staple food of 233 million rice consuming people in India. The per capita net availability of foodgrains in India in 1978 was 468.8 grams per day to which rice contributed 178.9 grams or 38.1 per cent. The net availability of rice varied from 154 to 210 grams per day during the period 1951 to 1978. During the periods of low availability of rice, the rice consuming population had either reduced total consumption of foodgrains or substituted wheat for rice. The substitution has occurred to a greater extent after 1965 than before 1965. The fluctuations in the net availability of rice causes much hardships to rice consuming population because it is difficult to import rice in a substantial quantity as compared to wheat from the world market and it is not easy to switch over from rice to wheat. From 1968-69 to 1970-71 only about 7 million tonnes of milled rice moved annually in international trade.[3] The statistics of imports of rice to India

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[3] C. Peter Timmor and Water P. Palcon, the Political Economy of Rice Production and Trade in Asia, 1973.

show that the maximum quantity that was imported during the period 1961 to 1977 was 0.79 million tonnes in the year 1966. Since then the imports of rice have declined substantially. Now India has become a net exporter of rice. The recent trend of exports of high-value better-quality rice, which is grown in wheat areas of Punjab and Haryana shows the future directions.

1.4 Needed Break-through in Rice Production

Although rice production in India increased from 41.3 million tonnes in 1971 to 53.8 million tonnes in 1978-79, it has not been able to keep pace with the population growth to maintain the same level of per capita availability which has declined from 192.6 gms/day in 1971 to 178 gms/day in 1978. The compound growth rate required to obtain rice production to meet the minimum needs of rice for the projected population of 1985-86 was 3.68 per cent. The growth rate of rice production from 1963 to 1977 was only 1.9 per cent. This was achieved by the growth rates of 0.7% in rice area and 1.2% in rice productivity.

According to the demand projections of foodgrains for 200[illegible] AD by various research scholars, the minimum quantity required for rice consumption would be 80 million tonnes and the maximum quantity would be 197 million tonnes. If we take the maximum quantity of the demand projection, the supply of rice production should be 213 million tonnes.* The growth rate required to achieve this production by the year 2000 A.D. from the present level of production (51.9 million tonnes in 1977-78) would be 6.37 per cent. If we take the minimum requirement of rice according to the demand projection, the rice production required would be 86.6 million tonnes and the growth rate required to achieve this level of 2000 A.D. would be 2.3 per cent.

Assuming the area growth rate as 0.85% the compound growth rates of productivity would vary from 1.44 to 5.52 per cent. To achieve the latter per cent of growth rate a break-through in rice research is required.

1.5 Rice Research in India

Having realized the need for increasing rice production in India, rice research programmes were undertaken both at the Centre and State levels

A large number of varieties were released after the introduction of High Yielding Varieties Programme. During the

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* Availability of rice for consumption is assumed to be 92.4% of total rice production, the rest being used for seed, etc.

Fourth Five Year Plan the emphasis on rice research was on (a) breeding disease-and-past-resistant varieties, (b) improvement of grain type and cooking quality of dwarf variety and (c) developing high yielding varieties with slender grains with or without scent for experts.[4]

The main diseases were the bacterial leaf blight, tungro, helminthosporium leaf blights and blast. The more important pests were stem borers and gall-midge. The problems of water management and allied practices and deficiency of micro-nutrient elements in the soil were also studied.[5] A number of gall-midge-resistant varieties were tried in the special gall-midge minikit trials. Tungro-resistant varieties were also tried in farmers' fields. The sources of resistance to bacterial leaf blight were identified and attempts were made to transfer this quality to dwarf types carrying resistance factors to other diseases and insects. Partial success was achieved in transfer of resistance of stem borer to dwarf types.

During the Fifth Five Year Plan 14 new varieties were under the pre-release test. These varieties had a duration of 70 to 80 days and excellent grain qualities. These varieties were to replace

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[4] Government of India, Planning Commission, <u>Fourth Five Year Plan</u> Vol.II, p.159.

[5] Government of India, ibid, p.160.

HYVs & such as Krishna Sabarmati, Jamuna, Ratna, IET-1039, IET-1136 and IET-1991.[6] Some strains highly resistant to gall-midge were ready for large scale trials. The varieties having resistance to tungro virus and leaf hopper were also evolved.

During the Fifth Five Year Plan much greater emphasis was put on the extension of paddy area during rabi and summer season. Special pilot projects on biological control on paddy pest were taken up. A programme of community rice nursery was introduced in a number of rice-growing states.[7]

1.5.1 Institutional set-up for Rice-Research

The Indian Council of Agricultural Research (ICAR) is an apex body at the national level which promotes, aids and coordinates research in agriculture. In 1946 under ICAR, the Central Rice Research Institute (CRRI) was established at Cuttack. This was followed by the establishment of main centres and regional centres for rice research in different states. In 1965, All-India Coordinated Rice Improvement Project (AICRIP) was established at Hyderabad in Andhra Pradesh to undertake research work on Rice. The CRRI,

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[6] Government of India, Planning Commission, Draft Fifth Five Year Plan 1974-79, Vol.II, P.18.

[7] Government of India, Planning Commission, "Annual Plan 1978-79" and Review of performance 1977-78, p.18.

the major national centre for rice research is involved mostly in basic research whereas AICRIP deals with the problems of adaptive research. AICRIP conducted projects in seven zones, twelve regions and five testing centres. At CRRI, there is a full-fledged scientific staff in different disciplines to conduct an integrated research work on rice. AICRIP has also scientists in major disciplines. ICAR has provided all zonal and regional centres with scientists in each of the disciplines of breeding, agronomy, pathology and entomology. The testing centres in the country are provided with junior staff in disciplines of greater significance at respective locations.

In 1975, the National Academy of Agricultural Research Management (NAARM) was established with an outlay of Rs.50 lakhs for the Fifth Plan period. This academy will be fully developed during the Sixth Plan Period to train the new entrants to Agricultural Research Services in agricultural and rural development and in-service personnel at various levels in ICAR institutions and agricultural universities in agricultural research management.[8]

1.5.2 Allocation of Funds for Agricultural Research Under Five Year Plans

Every Five Year Plan has seperate budget allocation for Agricultural Research and Education. During Fifth FiveYear Plan it was Rs.212.75 crores of which the share of states was Rs.37.30 crores (17.5%). In the proposed Sixth Five Year Plan a total of

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[8]Government of India, Planning Commission, "Sixth Five Year Plan," 1980-85, p.102

Rs.532.67 crores are allocated to Agricultural Research and Education, of which Rs.340 crores (63.8%) would be Central Government's share and Rs.192.67 (36.2%) would be borne by the State Government.[9] This forms 13.8% of Central Government's share of total Central Government's financial outlays and 6.3% of State Government's share to total state government's financial outlays. The expenditure on agricultural research alone would be much lower.

The 17th session of Conferrence of FAO in 1973 recommended that expenditure for research and development should attain in a minimum average level equivalent to ½% of the gross national product.[10] The National Commission on Agriculture in India has stated that combined research and development funding was below even ½% of the gross national product. It has recommended that in view of the important role of agriculture in Indian Economy, the research and development funding should be raised in a phased manner so that in ten years or so it constitutes about 1% of the contribution which the agricultural sector makes to the gross national product.[11]

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[9] Government of India, Planning Commission, "Sixth Five Year Plan" 1880-85, p.142.

[10] S.D. Chamola, "Agricultural Research", The Economic Times, July 15, 1981, p.5

[11] S.D. Chamola, ibid, p.5.

1.5.3 Allocation of Funds for Rice Research

No separate data are available on exclusive rice research in the proposed 6th Five Year Plan. During the 5th Five year Plan out of the total expenditure of Rs.212.75 crores for research and education about Rs.127.5 crores accounted for agriculture research and the rest on agriculture education, extension education and administration. The statistics on exclusive rice research could be traced as follows:

	Rs. in Crores
Central Rice Research Institute	3.06
All India Coordinated Rice Improvement Project	1.75
Operational Rice Research	1.40*
	6.20

*This includes the proposed Ford Foundation Grant

In addition, rice would get some share indirectly from the expenditure on (a) soil, agronomy and engineering (Rs.18.40 crores), (b) plant protection (Rs.9.3 crores), (c) statistics (Rs.1.0 crores) and IARI (Rs.10.0 crores). It can be assumed that this indirect share would not exceed one crore of rupees. Thus, the total expenditure on rice research would be of the magnitude of Rs.7.2 crores which formed (5.6%) of the total proposed expenditure on agricultural research by the ICAR in the Fifth Five Year Plan.

It has been recognized that returns to investment in agricultural research is very high. Griliches in his monumental work has recorded 35% to 40% annual return for hybrid corn in USA during the period 1949 to 1959. In India the estimates of returns to investment in Indian agricultural research varied from 14 to 77 per cent.[12] Various methods are in vogue for evaluating returns to agricultural research.[13] These estimates indicate that agricultural research should get much higher allocation than so far given or to be given in the proposed Sixth Five Year Plan.

Rice contributed 28% in 1977-78 to agricultural income. It is not necessary that rice should get the proportinate share of the national agricultural research. However, the relative share in agricultural income could be used as an important criterion for research allocations because the pay-off from the relative probability of successful research is likely to be much larger than the

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[12] A) Evension R.E. and Jha, D., "The Contribution of Agricultural Research System to Agricultural Production in India", Indian Journal of Agricultural Economics, Vol.XXXVI, No.4, Oct. - Dec., 1973, pp.2

B) Kahlon, et al., "Productivity of Agricultural Research in India, ADC/RIN Conference on Resource Allocation and Productivity in National and International Agricultural Research, Virginia, January 26, 29, 197

C) Bal, H.K. and Kahlon, A.S., "Methodological Issues on Measurement of Returns to Investment in Agricultural Research, "Indian Jour of Agricultural Economics, Vol.xxxii, No.3, July-Sept.1977, pp,181-

[13] Norton George W. and Davis Jeffery S., Evaluating Returns to Agrl. Research A Review, American Journal of Agrl. Economics, Vol.63, No.4, Nov. 1981, pp.685-699

research allocations without taking into consideration such criterion. According to this criterion, rice would deserve much higher allocation in the Sixth Five Year Plan than given in the Fifth Five Year Plan.

1.6 Recommendations from Rice Research and Socio-Economic Constraints

The recommendations of research, if not modified because of the socio-economic constraints, may result into lower benefits and sometimes in losses to farmers. We have prepared only two cases of recommendations based on research results of Tirupati Research Station. To highlight the issues hypothetical situations are discussed for a farmer in Cuddapah district (Appendix 1).

Two case studies were conducted for this farmer:

1. The farmer was advised on rice rotations,
2. The farmer was advised on fertilizer application based on the results of agronomic experiments.

If the farmer had followed ~~the~~ recommendation of rotation of Rice-Rice-Rice in the three seasons of a year he would have earned Rs.21611. However, with the same constraint of capital of Rs.5000, and land of 5.00 hectares, it was possible for him to earn as much as Rs.44,847 by following the rotation of rice-groundnut-rice. The farmer would have lost Rs.23,326 if he had followed the advice of the agronomist on the basis of the maximum net income per acre.

In case of fertilizer application instead of following the recommendations of the agronomist to use fertilizers per hectare as follows:

	Kg/hectare
N : P : K	75:30:30 in kharif
N : P : K	75:28.5:28.5 in rabi

for rice-rice-rice rotation, if the farmer follows:

	kg/Hectare
N : P : K	58:20:20 in kharif
N : P : K	58:19:19 in rabi

for rice:rice:rice rotation, he would have earned Rs.49,795 against Rs.35,485 or additional Rs.14,310 when he is faced with a constraint of availability of fertilizers as 525:262:262 in kgs. of N:P:K and land constraint of 5.8 hectares and capital availability of Rs.5,838.

These case studies show that if the introduction of new technology is done without taking into consideration the economic constraints at the farmers' level, the farmer is likely to lose heavily. Moreover, they also indicate why farmers are reluctant to follow the advice of technologists when their recommendations do not take into account the economic constraints.

1.7 Experimental Results on Economic Constraints of size of Farm and Adoption of Research Recommendations

The concern for small farmers led research workers to lay out a "Type Experiment" on research farms simulating actual farm conditions as closely as possible. The objective of the experiment was to gather information on economics of small holding under stipulated cropping systems planned to provide requisite production of cereal, pulses, fibre, cash and fodder crops to meet the requirement of a family of two adults and three children.

The data from Bhubaneshwar centre in Orissa showed that the gross income from one hectare of small holding was Rs.9,011. The input cost was Rs.3,785 and the net return was Rs.5,226 per hectare[14]. The gross income is nearly seven times the average gross income (Rs.1,363) obtained from farm management studies per hectare in Cuttack during 1967-68 to 1969-70.[15] Even after accounting for the differences in prices, the difference between gross income of the

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14 ICAR, All India Coordinated Agronomic Experiments Schemes, Annual Report, 1972-73, pp.168-169

15 Government of India, Indian Agriculture in Brief, Twelfth Edition 1973, p.60

simulated small holding of the experimental farm and the actual holding is considerable and indicates potential of doubling the farm income of small farmers. The major problem is how to convert this potential into actual. This calls for the study of socio-economic constraints which must be hampering the realization of the potential.

1.8 Production and Productivity Achieved at District Level

The normative studies taking into consideration the economic constraints and experimental results of adopting the rice research recommendations on simulated small farm sizes show how farmers could be benefited by taking constraints into account. It is important to find out what has been the impact at the aggregate level when farmers have tried to adopt rice research recommendations within various agro-climatic and socio-economic constraints. The data at the district level were analysed to find out the results of impact of recommendations of rice research on production and productivity.

1.8.1. ABC Classification of Rice Growing Districts

Rice is grown in 338 out of 370* districts in India. This shows the adaptability of rice crop in different environmental conditions. The districts were divided into ABC classification

*Certain Union Territories and Jammu and Kashmir were considered as districts.

on the basis of quan n of production as fol.ows:

More than 200000 tonnes	-	A
Between 50000 and 200000 tonnes	-	B
Less than 50000 tonnes	-	C

A-districts formed about 25 per cent of the total number of rice-growing districts and had 64 per cent of the total area under rice and about 67 per cent of total rice production in the country whereas C-districts formed about 35 per cent of the total districts but had only 3.7 per cent of the area under the rice and 2.8 per cent of total rice production in in the country in 1977. A-districts had higher productivity than B and C districts (Table 3).

1.8.2 Distribution of Districts According to Productivity Classification

Except one district , not a single other district had reached level of productivity of more than 3.5 tonnes per hectare. Table 4 gives the distribution of districts by productivity classification prepared from the average yield per hectare for the two-year period, 1976-77 and 1977-78. There were ten districts having yield per hectare of more than 2.5 tonnes. The location of these ten districts gives us some clue to the factors responsible for high productivity. Out of these ten districts only one district (South Arcot in Tamil Nadu) belonged to traditional rice-growing states whereas other nine districts belonged to non-traditional rice-growing

Table 3 : Yield per Hectare in ABC Categories of Rice Production from 1971-77

Category of Rice Production Districts	Yield per Hectare in Tonnes						
	1971	1972	1973	1974	1975	1976	1976
A	1.16	1.19	1.22	1.17	1.29	1.18	1.35
B	1.05	0.97	1.09	1.00	1.19	1.01	1.18
C	0.76	0.57	0.78	0.56	0.88	0.89	1.00
Average	1.10	1.10	1.20	1.10	1.20	1.10	1.30

Table 4: Distribution of ABC Districts According to Productivity

Productivity Yield per hectare (tonnes)	Average of 1976-77 and 1977-78			
	A	B	C	Total
1.00	28	49	61	138
1.00 - 1.5	22	49	54	125
1.5 - 2.00	13	19	8	48
2.00 - 2.5	12	9	4	25
2.5 - 3.00	3	5	-	8
3.00 - 3.5	-	-	1	1
3.5 - 4.00	-	1	-	1
	78	132	128	338

states. Only one district (Ludhiana) in Punjab belonging to category-B had the yield per hectare of 3.8 tonnes. The second district which had yield per hectare between 3.0 to 3.5 tonnes was Sirsa in Haryana which belonged to category-C. There were eight districts having yield per hectare varying between 2.5 to 3.0 tonnes. These were Kurukshetra and Karnal in Haryana, Chitradurga and Mandya in Karnataka, Ganganagar in Rajestan, Faridakot and Kapurthala in Punjab and South Arcot in Tamil Nadu. They were distributed among A and B categories.

This shows that there are special problems which hampered the productivity in the traditional rice-growing states. Hence, except South Arcot in Tamil Nadu no other A-district in the traditional rice growing states had achieved the productivity of more than 2.5 tonnes per hectare. The high productivity districts of Haryana, Punjab and Rajasthan have one thing in common, i.e., irrigation. Moreover, rice-growing in these districts is a recent phenomena and most of the rice areas in these districts were under high yielding varieties. Fertilizer consumption in these districts was more than 20,000 tonnes (1977-78) except Chitradurgh and Sirsa. The natural factors of availability of sunshine during the rice growing season seemed to play an important role in high productivity. All these ten districts were located in areas with relatively high sunshine days during rice-growing season.

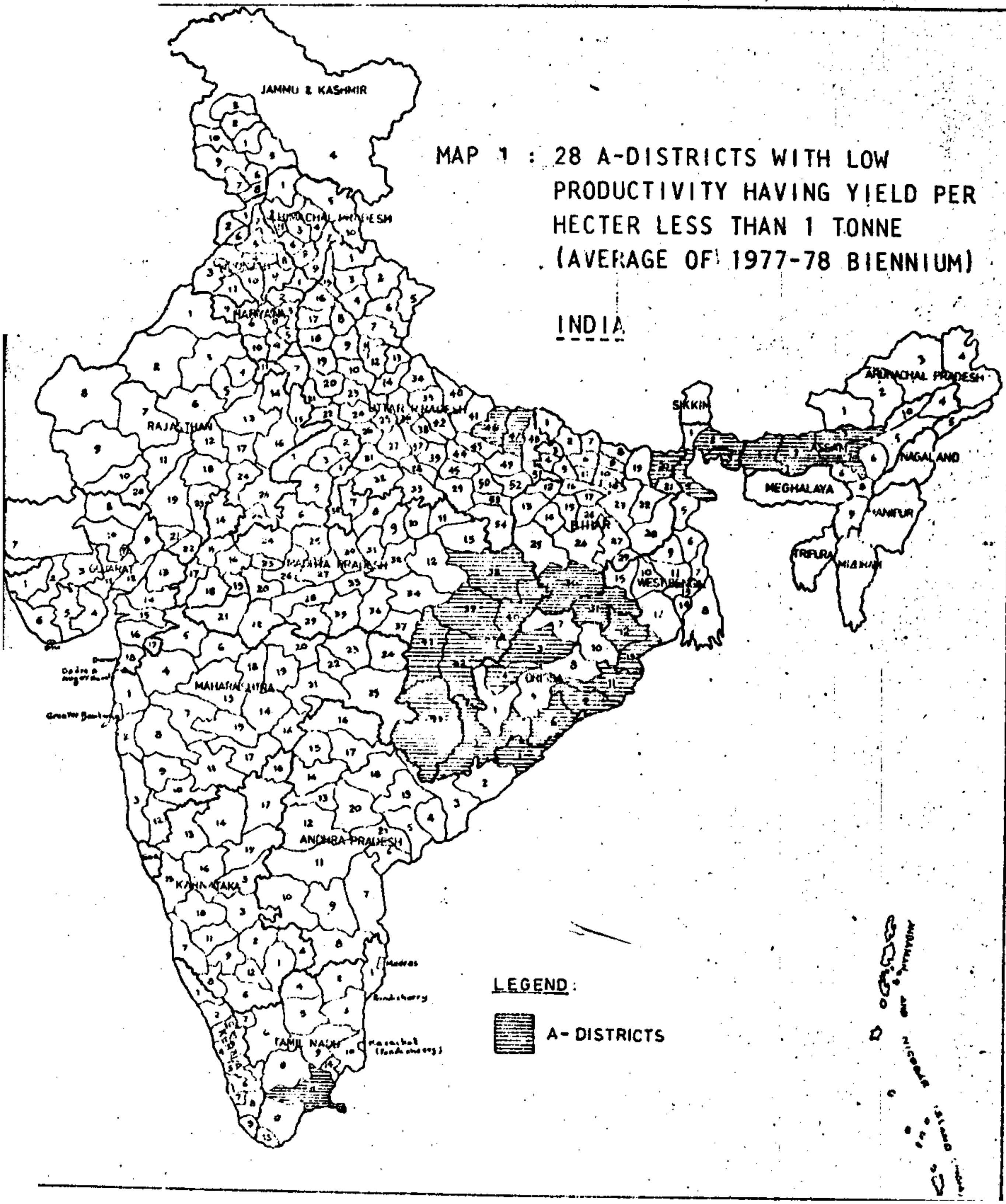
A large number of districts with low productivity having less than (1 tonne/ha.) belonged to categories B and C. The major concern, however, should be for A-districts which had productivity less than one tonne per hectare. There were 28 such districts in category-A forming about 40% of total A-districts. The location of these 28 districts shows that they all belonged to the traditional rice-growing states as follows:

State	District
1. Andhra Pradesh	Srikakulam
2. Assam	Goalparah, Kamrup, Darrang, Nowgong
3. Bihar	Prunea, Ranchi Singbhum
4. Madhya Pradesh	Durg, Bilaspur, Sarguja, Raigarh, Bastar, Raipur
5. Orissa	Balasore, Bolangir Cuttack, Ganjam, Koraput, Mayurbhanj, Puri, Sambalpur
6. Tamil Nadu	Ramanathapuram
7. U.P	Gorakhapur, Basti
8. West Bengal	Jalpaipuri, West Dinajpur, Coach-Behar

The fact that eight low productivity districts belonged to the state of Orissa indicates special socio-economic problems of that state apart from the agro-climatic factors. Similarly, socio-economic factors of six low productivity districts in Madhya Pradesh which formed a contiguous area with Orissa need to be studied. The low productivity districts of Assam, West Bengal and Bihar seemed to form another contiguous geographical area (Map 1). In addition to agro-climatic factors, socio-economic factors which may be responsible for low productivity need to be studied. A comparative study of high productivity vis-a-vis low productivity A-districts will throw much light on the factors affecting productivity.

1.8.3 Districts with High Growth Rates in Productivity

It seems that the majority of districts with high growth rates of production have also high growth rates of productivity. This means that it is the improvement in productivity rather than increase in area which had led to high growth rate in production. Again we find that except in Tamil Nadu not a single coastal A-district had high growth rate of productivity. In the non-coastal districts Nizamabad in Andhra Pradesh, Kolhapur in Maharashtra and Hooghly in West Bengal had more than 3% growth rate in productivity over the 14-year-period (Table 5). The weather-effect is markedly seen on the growth rates of productivity. Except for Chingleput, North Arcot and Hooghly, no other districts have appeared consistently as high-growth-rate-productivity districts in the three periods studied. Another interesting fact is that the 3-year-period (1971-73 to 1974-76) has many more districts with high growth rates in production and productivity. This may be due to favourable weather conditions. The problem of getting consistent high growth rates in productivity



MAP 1 : 28 A-DISTRICTS WITH LOW PRODUCTIVITY HAVING YIELD PER HECTER LESS THAN 1 TONNE (AVERAGE OF 1977-78 BIENNIUM)

INDIA

editional Rice Growing States with High Growth Rate (more than 3%)

to	No. of Distt.	1963-65 to 1971-73 (8-Year-period)	No. of Distt.	1971-73 to 1974-76 (3-year-period)	No.of Distt.	1974-76 to 1977-78 (3-Year-Period)
	1	West Godavari	5	East Godavari Nalgonda Guntur Nizambad West Godavari	-	-
	-	-	1	Nowgong	-	-
	-	-	3	Santhal Parganas Monghyr Prunea	2	Gaya, Singhbum
	-	-	1	Raigarh	4	Durg, Bilaspur Balaghat, Rai[illegible]r
	-	-	3	Ratnagiri, Thana Kolhapur	2	Kolaba Kolhapur
	-	-	2	Cuttack, Mayurbhanj	2	Balasore, Bolangir
	8	Chingleput South Arcot North Arcot Coimbatore Trichirapalli Thanjavour Madurai Tirunelveli	2	Chingleput	6	Chingleput, S.Arcot N.Arcot Tiru-chirapalli Madurai, Tirunelveli
		Hooghly Malda[illegible]	1	Gorakh[illegible]		- Burdwan,[illegible]

appears to be much more difficult. Even with the high growth rates in productivity the levels of yields per hectare achieved in these distr are not very high (Table 6). Bihar which had high-growth-rate-produc vity districts in later two 3-year-periods did not have a single dist which had crossed the productivity level of 1.5 tonnes per hectare. T poses the problems for evolving varieties which would yield consisten ly at high levels both in coastal and non-coastal districts. It also raises questions about policies which would encourage high productivi in the districts which are capable of achieving high growth rates.

1.8.4 Association of Low Productivity with Low Growth Rates in A-Districts

We have observed in Table 4 that there are as many as 28 A-districts with one or less than one tonne yield per hectare in 1976-78 (Map 1) It is assumed that these low productivity disticts, will have low growth rates also. Seventeen of these twenty-eight districts had less than 1% or negative growth rates in productivity during the 14-year-period (1963-65 to 1977-78) (Table 7). Most of these districts are non-coastal. It is important to study why these non-coastal districts which have concentrated rice production have low productivity and low growth rates.

1.9 Studies Required for Identifying Socio-Economic Constraints to Productivity

Having analysed district data and obtained the growth rates of production, area and productivity, it was possible to select

Table 6: Yield/ha. of High Growth Rates Productivity (More than 3 per cent, A-Districts in Traditional Rice-Growing States for 1977-78

Name of State	Name of District	Yield/ha. (in tonnes)
1. Andhra Pradesh	Nizamabad	1.9
	East Godavari	1.9
	West Godavari	1.9
	Nalgonda	1.6
	Ongole	1.2
	Guntur	1.1
	Nellore	1.4
	Kurnool	1.4
2. Assam	Nowgong	1.0
3. Bihar	Santhal Parganas	1.1
	Monghyr	0.8
	Satharsa	0.9
	Begusari	0.9
	Purnea	0.8
	Kathihar	0.8
	Gaya	1.1
	Singhbhum	0.9
4. Madhya Pradesh	Raigarh	0.8
	Durg	0.8
	Bilaspur	0.9
	Raipur	1.0
	Balaghat	1.1
5. Maharashtra	Kolhapur	2.2
	Kolaba	1.8
	Thana	1.2
	Ratnagiri	1.4
6. Orissa	Mayurbhanj	0.8
	Cuttack	1.0
	Puri	0.9
	Balasore	0.9
	Bolangir	0.9

Table 6 (Contd.)

Name of State	Name of District	Yield/ha. (in tonnes)
7. Tamil Nadu	Chingleput	2.3
	South Arcot	2.7
	North Arcot	2.3
	Tiruchirapalli	2.2
	Coimbatore	2.4
	Thanjavour	2.1
	Madurai	2.4
	Tirunelveli	2.3
	Salem	2.3
	Dharmapuri	1.9
8. UP	Gorakhpur	0.9
9. West Bengal	Hooghly	2.0
	Malda	1.1
	24 Parganas	1.2
	Burshidabad	1.3
	Burdwan	1.8
	Birbhum	1.6

Table 7: Low Productivity A-districts Associated with Low Growth Rates

Name of the States/ Districts		Cost/ Non-Cost	14-year-period	Growth Rates in productivity 8-year-period	3-year period	3-year-period
Andhra Pradesh						
	1. Srikakulam	C	-	-	-	-6.0
Assam	2. Golpara	NC	0.4	0.6	-1.3	1.7
	3. Kamrup	NC	-0.2	1.1	-1.0	-2.7
	4. Darrang	NC	-1.0	-	-0.7	-3.4
Bihar	5. Singhbhum	NC	0.1	-0.4	-3.7	5.6
MP	6. Sarguja	NC	0.6	1.4	-1.7	0.8
	7. Bastar	NC	0.3	-	-	1.4
Orissa	8. Balasore	C	0.5	0.8	0.1	4.5
	9. Bolangir	NC	-0.4	-1.1	-6.1	7.6
	10. Ganjam	C	-2.8	-1.5	1.6	-10.7
	11. Koraput	NC	-	-	-	0.7
	12. Sambalpur	NC	-	-0.1	2.2	-1.9
Tamil Nadu	13. Ramanathpuram	C	-0.3	2.0	2.0	-5.6
UP	14. Basti	NC	-0.3	-1.3	2.2	-
West Bengal	15. Jalpaiguri	NC	-1.0	0.9	-6.1	-0.8
	16. West Dinjpur	NC	-0.2	0.4	-4.3	2.5
	17. Cooch-Behar	NC	-1.0	1.3	-7.6	-0.1

C = Coastal; NC = Non-Coastal

(a) A-districts with high growth rate and high productivity, and

(b) A-districts with low productivity and low growth rate.

The A-districts with more than 3% growth rate of productivity over the 14-year-period and having more than one ton yield per hectare in 1977-78 (biennium) were designated as high growth rate high productivity A-districts. Similarly, the growth rates for the 14-year-period of A-districts which had yield per hectare less than 1 ton were found out. These districts were designated as low-productivity low growth districts.

A comparative study relating yield per hectare and factors affecting yield in these districts would show the importance of these factors. Policy measures required to promote growth of productivity could be evolved on the basis of such studies. These studies would also identify socio-economic factors and their constraints which hamper productivity particularly in low productivity low growth rate districts.

Lessons from the Case Study of Rice Research

The case of study of rice research indicates that research results should take care of the primary motivation of farmers in producing the crop and take into account the agro-climatic and socio-economic constraints under which farmers are operating. But the whole burden of obtaining the results at farmers' and cannot be put on agricultural research. If the objective of the farmers is profit-maximization, the research results should be such which would meet this objective. But at the same time efforts will have to be made to loosen the socio-economic constraints. The difficulties of taking into account the agro-climatic constraints are so heavy that the research scientists tend to put the socio-economic constraints under the "ceteris paribus" conditions when they conduct research experiments.

In order to get better results from agricultural research, it should be more location specific as agro-climatic conditions vary from location to location. The social scientists should help agricultural scientists by indicating the socio-economic factors which could be taken into consideration while formulating research projects. They should try to remove those constraints without whose removal agricultural research cannot yield results. It is this area in which agricultural research needs a large support from social scientists, policy makers and administrators.

Supports Needed for Agricultural Research

It is obvious that basic facilities for conducting agricultural research would be the first requirement. These facilities cannot be provided by either the producers or consumers of agricultural products. Research requires long period to get the relevant results and the impact of the research results is also felt after a fairly long period. Therefore, the creation of infrastructure facilities required for agricultural research will have to be the function of government.

The most important role in agricultural research will have to be played by scientists who have to generate research "ideas"; formulate projects and implement them. The creation and training of agricultural scientists are the basic needs of agricultural research. It is important therefore that well-coordinated agricultural research and education systems are evolved in the country which wants to solve the problem of agricultural production. In India a large number of Agricultural Universities are established after 1960s. This has contribued a great deal in creation of the needed scientific personnel for research.

In the countries where agricultural production is primarily in the hands of farmers, the scientists will have to take into consideration the constraints which cannot be removed within a foreseeable time by the government and other organizations. The major support which agricultural research needs after relevant research results are obtained is to communicate these results to the farmers through a well-coordinated efficient agricultural extension system. The modern techniques of communication can take care of large number of farmers who can be reached quickly and simultaneously and they can be explained vividly the modern agricultural practices. In India, large agricultural extension services are established at the state levels. Several changes were made in the structure and methods of agricultural extension. The latest change which is made in many states is the T and V method (Training and visit) evolved by Dr.Bennor of the World Bank.

The spur in the biological research has created demand for manufactured inputs fertilizer, insectici es, mechanical contrivances for supplying higher power and better sources of energy. This calles for an organized agricultural supply system which would provide needed inputs to the producers on itme. The organization of the supply system in the developing countries has been the most difficult task. Unless modern inputs of better uality seeds, fertilizers, insecticides and mechanical power a e properly supplied, the bilogical research by itself cannot do much.

Agricultural production converts the modern inputs of fertilizers, seed and water, etc. with the help of farmers' labour and natural resources into consumable products over a period of time. During this period agricultural credit is required to sustain the production process and the producers' living standards. The support of credit from a well organized agricultural credit system is a must for the success of agricultural research.

The production at the farm level is not necessrily in the form and type which can be used by the consumers. This has to go through a stage of processing and marketing before it reaches the consumers in the final form.

The development of agricultural processing system to process the products produced by the agricultural production system supports indirectly the agricultural research. In most developing countries this is the weakest link in the whole agricultural system.

To deliver the processed and unprocessed products to the consumers an organized agricultural marketing or distribution system is needed. The functions of procurement, storage, transportation, wholesaling and retailing are to be performed efficiently. The infrastructures for transport, storage and transactions are needed. The development of efficient agricultural marketing system is another indirect support which is needed for effective agricultural research.

The role of government in developing an efficient agricultural research system and building up necessary infrastructure so that the producers can take advantage of the results of agricultural research, increase their income and produce goods which are required by the economy as a whole needs hardly to be stressed. The Government have to evolve development policies, structures, and procedures which give proper props to spur agricultural research.

In conclusion, Agricultural scientists by themselves alone cannot conduct research without the society at large gives them the objectives and directions in which the research should be conducted. The people who have to use the results of agricultural research need to be properly motivated to participate in the production process. All the infrastructure facilities required to promote production and consumption to be created either by government or other agencies will provide the real props to agricultural research. It cannot be conducted in isolation wihtout taking into account the socio-economic constraints.

Appendix 1 Example of a rice farmer

A farmer in Cuddapah district had 5.80 hectares of land and had 2.1 adult family workers. He had also capital of Rs.5,000.

On the basis of the research results obtained, the agricultural scientist advised this farmer to adopt a rotation as follows:

	Crop	Variety	Expected Yield hectare	Gross income	Expenditure on fertilizers and insecticides	Surplus
Autum	Rice	Cauvery	5666	6289		
Winter	Rice	Tellahamsa	5179	5749		
Summer	Rice	TR-20	6344	7042		
		Total		19080	3515	15495

On the basis of this advice, the farmer could earn only Rs.21611 by growing rice-rice-rice on 1.39 hectares as the capital of Rs.5,000 would act as a severe constraint.

With the restrictions of capital and land and labour, he could have followed other alternatives giving less surplus per hectars and obtained higher revenue.

Crop Rotation	Capital Used (Rs.)	Land Used (Ha.)	Net Revenue obtained (Rs.)
1. Rice-rice rice	5000	1.39	21611
2. Rice-wheat-ragi	5000	3.24	22334
3. Rice-maize-gram	5000	4.08	27689
4. Rice-g.nut-bajra	5000	4.11	38985
5. Rice-g.nut-gram(gr.)	5000	4.30	39446
6. Rice-g.nut-rice	5000	3.02	44047

The farmer would have lost Rs.23236 if he had followed the advice on the basis of the maximum net income per hectare.

If the farmer could get credit at 10 per cent, he could have followed a different rotation than the one of rice-groundnut-rice. A linear programming model with the activities and restrictions (Table A) was needed to find out the optimum solution.

The optimum solution obtained was as follows:

Activity	Acre
Rice-rice-rice	5.80
Net income	85113

Shadow price:

Land	Rs.142216
Labour:	3.3
Kharif	3.3
Rabi	3.3
Summer	3.3
Capital	.1

Table A

Restrictions		Activities									
		Rice-g.nut-rice	Rice-rice-rice	Rice-maize-rice	Rice-g.nut green gram	Rice-Wheat-ragi	Rice-g.nut-bajra	Labour hiring (Kharif)	Labour hiring (rabi)	Labour hiring (Summer)	Capit borr ing
1.	Land 5.80 (acres)	1	1	1	1	1	1	1	0	1	0
2	Labour 168 days (Kharif)	82	82	82	82	82	82	1	0	0	0
3.	Rabi 252 days	88	96	105	88	78	88	0	-1	0	0
4.	Summer 210 days	101	101	78	64	80	90	0	0	-1	0
5.	Capital Rs.5830	Rs.1464	3585	895	895	1395	895	3	3	3	-1
	Net Income	Rs.14745	15495	7127	9565	7046	9798	0	0	0	10

The same farmer was advised by an agronomist for the application of fertilizers, insecticides and weedicides on rice-rice-rice rotation as follows:

(Per hectare)

Use of fertilizers	Kharif	Rabi	Total
N (Kgs)	75	75	150
P (Kgs)	30	28.5	58.5
K (Kgs)	30	28.5	58.5
Full plant protection measure	Rs.100	100	200
Weedicides	Handweeding		

On the basis of the expected yield of 10349 kgs/ha of rice and the gross income of Rs.10884/ha and the cash expenditure on fertilizer and pesticides of Rs.734/ha the farmer could obtain the net revenue of Rs.10150 per hectare.

The farmer faced the following constraints on the availability of fertilizers and pesticides, the labour, land and capital constraint remaining the same as in the case.

N (Kgs.)	525
P (Kgs.)	262
K (Kgs.)	262
Land (hectares)	5.8
Labour	
Kharif (days)	168
Rabi (days)	252
Capital	Rs. 5830

with the advice of the agronomist, the farmer could row the rice-rice-rice rotation in 3.5 hectares and expected to obtain Rs.35485.

As aginst this, if he could have followed an alternative (which is obtained by the use of linear programming model) of fertilizers and pesticides application as follows:

	Kharif	Rabi	Total
N (Kgs)	50	50	100
P (Kgs)	20	19	39
K (Kgs)	20	19	39

The expected returns per hectare for this alternative was only Rs.9481. The solution showed that he could put almost the whole area under the crop (5.25 hectares) and use fertilizers as follows:

N (Kgs.)	525
P (Kgs.)	260
K (Kgs.)	260

and obtain thereturn of Rs.39795. Thus, by following the fertilizer application nearly at half the recommended doses, the farmer could have earned additional Rs.14310

These two cases clearly bring out the need for taking into consideration the economic constraints which the farmers face in real world situation and adapt the technology to suit these constraints.