GREEN REVOLUTION IN INDIA - AN INCOMPLETE TASK

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INTRODUCTION

With the adoption of semi-dwarf high yielding varieties of wheat and rice, there was a spectacular increase in India's wheat production from 12.3 million tons in 1964-65 to 26.5 million tons in 1971-72. The gains in the case of rice were not so signficant during this period (production increased only marginally from 39 million to about 43 million tons over this period) because of the problems connected with water control and water management, bacterial disease control and the cultural practices associated with the high yielding varieties of rice (IR 8). This phenomenal increase in yields due to these new varieties led people to coin the term "Green Revolution".

When foodgrain production in India touched a peak of 108.4 million tons in 1970-71, the word went around that India had become self-sufficient in food and may have to find an export market for wheat. In fact farmers in the Punjab and Haryana regions were advised to cut down the wheat acreage to avoid a collapse in wheat prices.

What happened thereafter is well known. Food production declined to 104.7 million tons in 1971-72 and to 95.2 million tons in 1972-73 (Table I) and did not show any significant improvement in 1973-74 over the level of 1971-72 in spite of having one of the best Kharif seasons (June to November) in which production was about 67 million tons of food in 1973.

The recent crisis in the food situation has led people to wonder what has gone wrong with the Green Revolution. The Green Revolution has been dismissed by a few people as a non-event. A more realistic appraisal of the Green Revolution shows that though it has led to significant increases in food production in certain areas, it has not been sufficiently widespread.

Table I

Foodgrains Production in India from 1964-65 to 1973-74
(000 metric tonnes)

Year	*Rice*	*Jowar*	*Bajar*	*Maize*	*Wheat*	*Barley*	*Other Cereals*	*Gram*	*Other Pulses*	*Total Foodgrains*
1964-65	38738	9812	4473	4603	12172	2438	3899	5723	4722	86625
1965-66	30614	7492	5598	4632	10721	2284	2907	4442	5575	74265
1966-67	30440	8944	4503	4092	11527	2449	3272	3612	5310	75049
1967-68	37858	10107	5132	6275	16567	3469	3943	6042	6194	95587
1968-69	39761	9803	3802	5701	18652	2424	3452	4310	6108	94013
1969-70	40430	9721	5327	5674	20093	2716	3849	5546	6145	99501
1970-71	42448	8188	8000	7413	23247	2860	4074	4247	6329	107811
1971-72	42735	7753	5357	5026	26477	2501	3750	5106	5952	104657
1972-73	38633	6442	3795	6206	24923	2327	3397	4469	5019	95211
1973-74	43742	8992	7086	5643	22072	2327	3996	4006	5748	103611

Source: Statistical Abstract of Punjab, 1974.

Moreover, the Green Revolution has had little impact on the production of grains other than wheat (Table I). The increase that has taken place in production has not been evenly spaced between different cereals. There has been no impact either on pulses or on commercial crops like fibres and oil-seeds. In the case of pulses, production in India has not changed materially from the level of 10 to 12 million tons during the last 13-14 years. Even in the case of wheat, after touching a peak of 26.5 million tons in 1972-73, production has stagnated, even in the wheat bowl of India (Punjab). The new technology has not yet succeeded in making India self-sufficient in foodgrains, nor has it freed agriculture production from fluctuations in yield.

Punjab suffered a set-back in foodgrain production after reaching a maximum of 7.9 million tons in 1971-72. The production of wheat, which is the major crop of this state, declined from 5.62 million tons in 1972-73 to 5.18 million tons in 1973-74. Maize production also registered a decline from 0.86 million tons in 1971-72 to 0.76 million tons in 1973-74 (Table II).

There are various reasons for this decline. One of the important reasons is the recent attack of rusts on wheat. Moreover, the new technology has not been fully applied due to inefficient systems of distribution of seeds, lack of knowledge, unwillingness to make changes, piece-meal adoption, breakdown in system for providing necessary inputs like fertilizers, insecticides, pesticides etc. This shows the Green Revolution is drying up.

A discussion of the causes of the difficulties with the "Green Revolution" and of policy measures which need to be followed so as to maintain and promote this new technology, will be the focus of the report.

Table II

Production, Area and Yield of Foodgrains in the Punjab, 1965-66 to 1974-75

Year	Rice	Jowar	Bajra	Maize	Wheat	Barley	Other Cereals	Gram	Other Pulses	Total Foodgrains
1	2	3	4	5	6	7	8	9	10	11
Production (000 metric tonnes)										
1965-66	292	-	80	643	1916	69	-	370	19	3389
1966-67	338	3	150	614	2451	88	2	508	24	4178
1967-68	415	3	208	774	3335	148	(b)	452	33	5368
1968-69	470	2	204	706	4491	76	(b)	233	30	6212
1969-70	535	3	238	784	4865	80	(b)	393	26	6924
1970-71	688	3	243	861	5145	57	(b)	284	24	7305
1971-72	920	2	171	857	5618	55	(b)	382	20	7925
1972-73	955	3	108	906	5368	59	(b)	267	26	7692
1973-74	1189	2.7	144	764	5181	94	1	315	37	7728
1974-75	1166	2.8	116	918	5325	100	-	300	25	8072
Area (000 heactares)										
1965-66	292	3	156	389	1550	67	1	602	42	3102
1966-67	285	6	184	444	1608	104	3	634	58	3326
1967-68	314	6	209	476	1700	149	1	530	67	3542
1968-69	345	4	193	490	2063	89	2	348	63	3597
1969-70	359	4	213	534	2166	71	1	380	53	3781
1970-71	390	5	207	555	2290	57	1	358	56	3928
1971-72	450	3	145	543	2236	48	1	535	49	3915
1972-73	476	7	129	562	2404	55	1	319	62	4015
1973-74	520	4	147	567	2338	110	2	352	79	4120
1974-75*	570	-	131	536	2280	115	-	332	-	-

Source: Statistical Abstract of Punjab, 1974.

MAINTENANCE AND EXPANSION OF NEW TECHNOLOGY

The new technology for growing the new HYV* is different from the traditional technology. The HYV require large inputs of chemical fertilizers and assured water supplies. Their use is therefore generally restricted either to irrigated areas or areas of assured rainfall. They also need more pesticides and herbicides than the traditional varieties. The new technology is thus more capital-intensive and requires larger cash inputs than the traditional varieties.

This means that the new technology requires more credit. The expanded output also requires expanded storage and marketing facilities. Marketing, particularly, becomes important due to the fact that adoption of new technology leads to a larger proportion of the output going into the market than is the case with the traditional technology. The need for more and better extension services is also recognized because HYV require greater skill in agronomic operations. Price policy also becomes more important because of greater risks associated with larger and more capital-based production.

In addition to all this it is necessary to make sure that the new inputs also reach the small farmer so that gains from new technology are maximized.

Next will be discussed the problems of improvement in the use of new technology. The major inputs associated with the new technology will be discussed in the following order:

1. Seeds
2. Water

*High Yielding Varieties.

3. Fertilizers
4. Pesticides, insecticides and herbicides
5. Mechanization
6. Electricity
7. Storage and Marketing
8. Credit
9. Extension services.

Seeds

There is no well organized system of distribution of HYV's seed in most of the states in India. Most of the farmers in Punjab state are fortunate enough to get the HYV seed from Punjab Agricultural University. But still PAU does not and cannot supply the needs of all Punjab farmers. There should be some public or organized commercial agencies at the state level, which are able to provide the necessary seed for the whole of the state. Also important is an adequate and efficient system of certification of the quality of the seeds to be made available to the farmers. Government should assume responsibility for this. Failure to do so has often led to the result that HYV's seed sown have not performed to the extent of the potential they have.

Moreover most of the farmers do not adopt the package practices recommended for the new seed by the state Department of Agriculture due to one reason or another. Illiteracy and lack of finance may be among the major reasons.

Since these HYV's require a large amount of cash to work with, having available several varieties of HYV's gives the farmer better security against the risk of total loss from pest, insect, and other hazards than a single variety.

Another aspect of seed input is that there is not much attention paid to the pre-sowing treatment of seeds for promoting their resistance capacity. Seed production is a complex job which requires careful and continuous supervision. It might be desirable for the state to authorize some large progressive skilled farmers to go in the business of seed production by giving them supervision and subsidy.

The distribution part may also be handled by the state itself. How far this action choice would help is not known. But the whole problem of production and distribution of good quality seed needs to be given a high priority. More administrative attention is needed in this area in India. The following suggestions are made to handle this problem.

(1) Seed farms of optimum size should be established all over the country. Official agencies should provide the breeder stock. Seed should be multiplied with technical expertise and close supervision. After examination and pretreatment, if needed, seed should be certified and made available either directly to farmers or to their organizations where they exist or to commercial distributing agencies on a commission basis.

Chinese communes are referred to in this connection. These communes have their own seed multiplication programs. Some of them have done so well that they have become specialists in the process and have been able to experiment successfully on new varieties. Therefore the need for farmer participation both in seed testing and seed multiplication should be recognized. Technical expertise may be provided by the government.

(2) The National Seeds Corporation in India has not made its dent yet. Its whole bureaucratic machinery needs to be overhauled. The government should make sure that the distribution problems are solved by the National Seed Corporation. It should locate seed depots for every large village or group of small villages where seed is readily available to all the

farmers at the right time, at the right place, and at approved prices.

(3) These seed depots could also be used as primary sources for monitoring the performance of the distributed varieties with the data collected and analyzed by the branches of the National Seed Corporation and fed back to the Research Organizations. They could also be used as an instrument for the testing of new varieties on the field by some of their more enterprising and interested customers.

(4) It is a good idea to make the manager of the seed depot a person from the farming community, preferably a small farmer, because he better understands the problems faced by the small and marginal farmers. This man should have received training in the required aspects of seed technology.

Water

Availability of water is a most important condition for the application of the new technology. There must be adequacy and stability in the water supply. It must also be capable of control in the sense that the volume and timing of its application is subject to management. Long before the advent of HYV seeds, the importance of water had been recognized all over India. Irrigation is one of the oldest investments in India in both the public and private sectors.

However, some of the studies show irrigation works in India have not taken enough account of the problem of drainage nor of an equitable distribution of canal water among all the farms.[1] Flood control is also an important element in water management. This makes for optimum use of water for plant growth and increase in output per hectare. Irrigation and water control are thus essential conditions for the successful use of HYV's.

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[1] Rao, V.K.R.V, Growth and Justice in Asian Agriculture, United Nations Publication, Geneva 1974.

Rao believes that all is not well with the current irrigation schemes in India. Many irrigation works, especially tanks and other minor irrigation works, have not been maintained properly or repaired, so that they have either gone out of use or are functioning at a small proportion of their capacity. As regards major and medium irrigation works or canal irrigation, land is irrigated considerably below its potential, and intensity of cropping is much below what the irrigation has made possible. In India, the irrigation area sown more than once was less than a quarter of the total irrigated area. Leaving irrigated land fallow or failing to crop it two or more times a year represents a major waste of investment and natural resources. The underutilization of irrigation may be due to farmer's lack of proper knowledge of rotations of crops.

Kahlon and Grewal believe that even today irrigation remains one of the most scarce resources, and perhaps one of the most limiting factors to increasing agricultural production and cropping intensity in India.[1] In this context fuller utilization of the available irrigation potential assumes critical importance. They maintain that there is underutilization of irrigation facilities from the point of view of putting more area under multiple-cropping.

A major requirement of policy, therefore is a planned and vigorous programme for the repair, maintenance, and ungrading of existing irrigation works. This involves:

1. Reinforcing existing irrigation works with appropriate facilities for drainage and water control.
2. Co-ordinating surface water utilization with ground water utiliza- for bringing about optimum utilization of available water resources.

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[1]Kahlon, Avtar., and Grewal, S. S., "Problem of Increasing Multiple Cropping", The Economic Times, May 1, 1975, p. 6.

3. Modernization and extension of skills for water management to all farmers.

4. Better maintenance of existing irrigation works, both major and minor, so that their efficiency of utilization is not only maintained over time but also improved.

Another important aspect of irrigation policy is the extension of irrigation to new areas. It may not be reasonable to go on increasing irrigation in areas that are already substantially under irrigation but ways should be explored to take care of left-out areas. A conscious attempt should be made to plan the new irrigation works better to get larger returns from the investment. The following suggestions may be relevant in this connection:

(1) A survey of both surface and ground water resources is important before making an investment for the development of the portion that is not being utilized at present.

(2) Integrating into new irrigation schemes drainage, flood control, land leveling, and other farm land improvements in the irrigated region.

(3) Emphasis on quick yielding schemes like tubewells, lift irrigation works, etc. Punjab and Haryana are already developed in these areas. Other states now need immediate attention. Minor irrigation works therefore have an important place in irrigation planning in India, especially for the immediate future.

(4) Taking a whole view of an irrigation scheme to include within its scope not only storage and distributive channels but also the carrying of water to farmers fields. All this should be done in such a way so as to reduce the wastage of water through seepage and also to shorten the gestation period for the investment made in irrigation.

(5) Regional water planning is also required to being irrigation to

the present dry regions.

Perhaps the most important aspect of irrigation policy is the actual utilization of both the existing and new irrigation facilities for the successful operation of the new technology. Irrigation agriculture is very much different from dry land agriculture. Not only does it require large cash inputs but also a well palnned rotation of crops and considerable changes in agricultural practices.

Extension of irrigation to dry or semi-dry areas can bring reasonable gains. Land values and annual incomes go up manyfold when a dry area becomes an irrigated area.

Kahlon believes that revival of irrigation tanks in the southern and western parts of India to conserve the rain water along with the installation of tubewells and pumps will augment the supply of irrigation water.[1] He suggests that surplus labor in villages could be utilized to build up such reservoirs and to properly manage the carrying out of desilting at regular intervals by the village panchayats (village management). No other technology in the Indian situation has greater potential than expanded supply of irrigation water. He further suggests that the first thing every state might do in the first year of the fifth plan is to expand its minor irrigation works. The states should spend more funds on expanding irrigation facilities and flood control until the total potential of around 105 million hectares for major, medium, and minor irrigation works is fully exploited. He also believes in giving top priority to research and development in water harvesting techniques.

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[1]Kahlon, Avtar., "Can HYV Solve Food Problems?", The Economic Times, February 7, 1975.

Fertilizers

Fertilizers play a key role in the new technology. With the adoption of HYV's the demand for fertilizers has risen manyfold. India's fertilizer consumption increased from 765,000 nutrient tons in 1965-66 to 2.2 million tons in 1970-71, an increase of almost 200 percent in five years.[1] About 45 percent of the fertilizer used is from domestic production. Because of the higher international fertilizer price due to the energy crisis India had to cut its chemical fertilizer imports in 1973-74.

With regard to the optimum use of fertilizer India should aim at maximizing the output per unit of fertilizer rather than at maximizing the output per hectare. Better management is more likely with limited inputs of fertilizers than with the ability to get unlimited supplies and this would, in turn, lead to a larger return per unit of fertilizer used.

The optimum use of fertilizers can also be made through the effective use of the 65 soil-testing laboratories.[2] Most of the Punjab soil doesn't need much potash, but some farmers still apply it. It would be better to have their soil tested and apply only those chemical fertilizers which are needed. At the end of 1968-69 there was a capacity of 1.08 million soil samples annually, which could be analyzed to determine the nutrient deficiencies. Only 64 percent of this capacity was used.

Another important factor for consideration is the availability of fertilizers within easy reach of the farmers. This calls for better storage facilities for fertilizers, planning the approximate quantities to be used in the next season, and making them available in time for the farmer to be able to use them.

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[1] India--Planning Commission, Fourth Five Year Plan, New Delhi, 1969, p. 131.

[2] Ibid.

A study in which the co-operative societies in the villages and private depots of fertilizers were compared showed that private depots of fertilizers were more efficient in supplying fertilizer needs of farmers than the cooperative societies.[1] Private depots had better management. They placed the orders of fertilizers in advance of next season and made sure that the supplies reached the farmers at the right time and at the right place. On the other hand, cooperative societies in villages by and large had an illiterate person handling the supplies. He seldom had supplies in time. Even if he obtained the supplies in time there was no good system of storage. Spoiled fertilizer losses were observable for lack of proper storage.

It is important that the cooperative societies in the villages be paid due attention by the states. The manager of the cooperative society in the village should be a progressive farmer who knows how to handle his job so that the supplies of fertilizers reach the farmers at the right time and at the right place.

Kahlon in his article explained that the Japanese experience has shown that the best result could not be obtained without integrating indigenous technology with the western technology.[2] He added that in Japan, which produces chemical fertilizers even for export, the focus on production of organic manures and recycling of human wastes was never lost. In India, after the use of chemical fertilizers became popular in latter half of the sixties, very little effort was made to make use of organic manures. Kahlon suggested that since there is a severe fertilizer shortage now, maximum use of organic manures should be made. He adds that some of the Indian farmers

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[1]Kahlon, Amarjit., "Management of Co-operative and Private Fertilizer Depots", unpublished MBA report, Punjab Agricultural University, June 1974.

[2]Kahlon, Avtar.,"Can HYV Solve Food Problems?", The Economic Times, February 7, 1975.

do not realize the importance of micro-nutrients. Experiments conducted in the All-India Co-ordinated Micro-nutrient scheme indicate a widespread deficiency of zinc in Indian soils. In some cases sulphur also tended to limit crop yields. He suggested that use of balanced fertilizers is, therefore, highly necessary to fully exploit the potential of HYV's.

It is suggested that all of the Indian states should adopt a policy of asking each farmer to use organic manures along with the chemical fertilizers. While organic manures cannot be a substitute for chemical fertilizers in view of their low nutrient content quantity-wise, there is no doubt that they are a complement and a substitute for restricted quantities of chemical fertilizers. This new emphasis on organic manures opens possibilities for a lower rate of increase in the quantum of application of chemical fertilizers and consequent adaptation to the new situation created by the likely trends in the volume and prices of chemical fertilizers over the long period.

It is suggested that it is worthwhile to explore the possibility of international action for securing an adequate supply of fertilizers and other needed inputs at reasonable or concessional prices for India and other developing countries.

Pesticides, insecticides and herbicides

The Indian farmer is very well aware of the hazards to his production caused by disease, insect and other pests, and weeds. But still in some parts of India farmers are hesitant to use pesticides or insecticides. This may be due to lack of education. Another factor may be the fear of toxicity created by some of the chemicals used in the treatment of insects and pests. It is suggested that (1) proper training be provided to the farmers by the extension workers in applying pesticides and insecticides safely and effectively.

(2) A nationally coordinated monitoring and warning agency should be established so that action can be taken in time to prevent serious damage to the crops. (3) Where domestic supplies of pesticides and insecticides are either not available or are inadequate, an even higher priority should be given for importing them. (4) Group action for spraying insecticides or pesticides is important. All farmers of one village or any defined area must act together to eradicate the prevalent insect or pest attack on crops, because laxity on the part of some of them can threaten the success of the whole programme. Aerial spray could also be an effective way of dealing with this problem in appropriate areas. (5) More research needs to be carried out in evolving disease and pest resistant varieties.

Mechanization

Energy is the nucleus of all technological developments and is one of the key variables in economic development.

Kahlon and Grewal believe that the experience of agricultural development in most of the western countries as well as in such Asian countries as Japan and Taiwan where the average size of the holding is just over one hectare shows that there is a positive correlation between energy input per unit area and agricultural productivity.[1] Table III shows that next to the African continent Asia, including India, has the lowest power availability index. It is suggested that India should plan to raise per hectare availability of horse power to 1.00 by the end of the fifth five year plan (1979). It was only 0.30 in the beginning of the fourth five year plan (1968-69).

[1]Grewal, S. S., and Kahlon, Avtar., "Farm Mechanization Pattern", The Times of India, Bombay, India, 1976.

Table III

Power Available for Agriclture
Field Production, 1964-65

Countries continents	H.P. Per Hectare
Africa	0.05
Asia	0.20
India	0.21
Latin America	0.27
Taiwan	0.27
Oceania	0.35
U.A.R.	0.37
Israel	0.85
Europe	0.93
U.S.A.	1.02
U.K.	1.71
Japan	2.30

Source: G. W. Giles: Report on Agricultural Power and Equipment Sub-Panel 3, manufactured Physical and Biological Inputs, World Food Society, U.S. President's Science Advisory Committee, 1966.

Table IV shows that tractor horse power per unit area, productivity of land, employment of farm workers, productivity of labor and wage rates can all move in the same direction. The experience of Japan and Taiwan, which is particularly relevant for India, demonstrates that mechanization is compatible with higher productivity both of land and labor along with higher use of labor and high wage rates. In 1960, there were 1.2 hectares of arable land per agricultural worker in India compared with 0.4 and 0.6 hectare in Japan and Taiwan respectively. Yet, the latter countries were able to raise not only productivity of land and labor but also effective employment of agricultural labor by making hydrological, biological, chemical, and mechanical innovations which suited the small-sized holdings and the agricultural situation of these countries. The labor-intensive agricultural economies of Japan and Taiwan did not face any serious problem of labor displacement from mechanization of the farm sector as their biological, chemical, and mechanical innovations were complementary to labor use. Their mechanical technology mostly focused on the use of stationary power (electric motors and diesel engines) and post-harvest technology. By about 1895 in Japan, when the absolute decline in labor started, power tillers came into use in a big way. And the small power tiller technology helped increase labor productivity without detriment to labor employment. This was supported by the industrial sector of that country which provided small machines to the farm sector. This pattern continued till about the turn of the present century when the fast pace of industrialization and development of tertiary sectors began to siphon off the labor force from the farm sector, thereby causing an absolute decline in the farm labor.

Consequent upon the introduction of HYV's, mechanization has come up quite fast in some parts of India. The states of Punjab, Haryana, parts of Uttar Pradesh, where the green revolution has made its impact, have a

Table IV

Relationship Between Tractor Horse-power
Per Hectare and Other Variables (1967)

Country	Tractor H.P. per hectare	Farm worker/ hectare	Paddy yield qtl/ha.	Cereal production tons/farm worker	Wages of farm workers/day (US $)
India	0.01	0.90	15.5	0.7	0.33
Taiwan	0.11	1.97	34.02	1.8	1.04
Japan	3.5	2.04	57.50	1.8	2.81

Source: Roy E. Harrington, A note on employment of Farm Workers: Problems of Farm Mechanization, Seminar Series IX, Indian Society of Agricultural Economics, Bombay, January 1972.

much higher number of tractors per unit area (Appendix I). These figures support a positive relationship between the availability of tractor power and productivity, although mechanization cannot be considered as the sole variable influencing productivity.

The crux of the problem of mechanization, however, is that in a labor surplus economy like India, where the employment problem is serious, primary concern still remains on what impact mechanization has on employment. For this purpose the major findings of some of the important farm mechanization studies conducted in Punjab, Uttar Pradesh, and Gujarat are briefly stated here.

A project initiated by the World Bank to study the impact of mechanization on Punjab agriculture showed that there was a decline in 82.92 man hours per cropped hectare in the use of family labor on mechanized farms compared to non-mechanized farms (Table V). The use of permanent labor was about the same on the two categories of farms. The employment of casual labor was much higher (23.31 man-hours per cropped hectare) on mechanized holdings. The total employment of labor on mechanized farms was slightly less, it being 471.04 hours per hectare on mechanized farms as against 530.01 hours on non-mechanized farms. But this difference was statistically insignificant.

A study conducted by the national council of applied economic research in the Mujjafarnagar district of Uttar Pradesh showed that the employment of human labor per hectare was the least in the situations when irrigation was not mechanized. The position with respect to the employment of labor on mechanized and non-mechanized farms is shown in Table IV.

There was a substantial increase in labor use on tubewell irrigated farms over non-mechanized farms, it being 363.7 and 204.1 mandays per hectare on tubewell irrigated farms compared with 259.1 and 173.3 mandays

APPENDIX I

State-wide Mechanization and Productivity

States	Cropped Area ('000 hectares)	Estimated tractors in agri.	Tractors per 1000 hectares	Foodgrains kgms/ha.
Punjab	5441	45,000	8.26	1775
Haryana	5150	17,000	3.30	1192
U.P.	22709	35,000	1.54	903
Gujarat	10420	16,000	1.52	960
Tamil Nadu	7309	9,000	1.23	1208
J & K	808	750	0.93	1434
Kerala	2758	2,000	0.73	1339
Mysore	10417	5,000	0.48	748
Rajasthan	16657	11,000	0.66	418
West Bengal	6653	3,000	0.45	1200
Assam	2907	1,250	0.42	890
Andhra Pradesh	12794	5,000	0.39	784
Bihar	10895	4,000	0.37	760
Maharashtra	19197	6,000	0.31	509
M.P.	19653	4,000	0.20	591
Orissa	7446	1,000	0.13	876

Source: M.A. Baig, Mechanization, the neglected resource in farm planning, The Economic Times, Bombay, Monday, July 9, 1973.

Table V

Employment of Human Labour
(Hours) Per Cropped Hectare on
Mechanized and Non-Mechanized Farms, Punjab State,
1972-73

	Bullock operated farms non-mechanized	Tractor operated farms mechanized
Family labour	219.74	136.82
Permanent labour	124.02	124.66
Casual labour	186.25	209.56
Total	530.01	471.09

Source: Kahlon, A.S., W.S. Mann and Harnek Singh, Impact of Mechanization on Punjab agriculture with special reference to Tractorization; unpublished, Punjab Agricultural University, Ludhiana, 1972-73.

Table VI

Labour Input Per Cultivated Hectare (Man-Days) by Farm Size and Levels of Mechanization, Muzzafarnager District, U.P. 1970-71

Level of mechanization	Small farms	Medium farms	Large farms
1. Non-mechanized	259.0	173.3	-
2. Tubewell only	363.7	204.1	132.8
3. Tubewell and Tractor	303.8	202.5	-
4. Tubewell, Tractor and Thresher	289.9	193.6	167.6

Source: Roy E. Harrington. Applied Economic Research, New Delhi, 1973, Impact of Mechanization in Agriculture on Employment.

Table VII

Employment of Human Labour (Mandays)
Per Hectare on Bullock Operated and Tractor Operated
Farms, Gujarat State, 1971-72

Zones	Tractor farms	Bullock farms
Zone I	153	173
Zone II	148	165
Zone III	138	162
Zone IV	266	209
Aggregate	176	167

Source: Statistical Abstract of Gujarat

per hectare on non-mechanized small and medium farms respectively. The employment of labor declined with the introduction of tractors and tractors along with threshers on small and medium tubewell irrigated farms, although in case of medium farms, the decline was nominal (1.6 mandays per hectare). On the other hand in case of large farms there was gain in employment of about 35 mandays per hectare even at the highest level of mechanization (tubewell plus tractor plus thresher) over tubewell irrigated farms.

The impact of mechanization on employment in Gujarat is shown in Table VII. The labor use was higher on bullock farms in two of the four-crop zones while the reverse was true in the remaining two zones. On the whole the employment of labor was slightly higher on tractor farms, it being 176 mandays per hectare against 167 mandays per hectare on bullock farms. But these differences were not significant.

These studies also brought out that tractorization significantly reduced bullock labor utilization. The reduction in bullock labor was as much as 70% in the Punjab, 62% in Uttar Pradesh and it was about 40% in Gujarat. This is a healthy development, inasmuch as reduced demand for draft animals would enable substitution of milch cattle in place of draft animals and put more area under grain crops.

To sum up, it could be said that so far, mechanization appears to have had no adverse effect on human labor employment. It is the use of animal power that was affected the most. This has happened because tractorization has primarily affected the operation of preparatory tillage, sowing, threshing, and transportation. In fact these very operations along with irrigation required the use of draft animals. The introduction of mechanized means of irrigation and tractors has virtually eliminated the use of animal power in these operations. The human labor input has also been influenced but to a lesser degree and that loss has been more or less made up by higher cropping intensity and productivity on mechanized farms.

Kahlon and Grewal believe tha mechanization has not all gone on the right lines in India.[1] Irrigation was rightly mechanized first, followed by the threshing operations of some crops like wheat and maize. This they consider was a step in the right direction. They believe, however, in the matter of introduction of mobile farm power (tractor), the development has not taken place according to the needs of the situation. Tractors on most of the farms in India are of larger capacity than needed for such holdings. They suggest that a small-sized 14 h.p. tractor was sufficient to meet the requirements of even large holdings in case of general crop farms in Punjab. Most of the available tractors, being of larger size, remained underutilized on many farms, resulting in higher unit cost of production. It was estimated by them that about 90 percent of the tractors in Punjab were of 25 h.p. and above. The farmers had to purchase the large-sized tractors because of the non-availability of small-sized machinery in adequate quantities. They suggested that future needs of higher h.p. per unit area may be met through introduction of small sized tractors ranging from 14 to 20 h.p. This is particularly desirable in view of the lower ceilings on land holdings as also to make full utilization of the machines. With the Indian government policy to do away with the import of tractors, it would be necessary to set up the production of small-sized machines in factories within the country.

Kahlon and Grewal state that another weakness in the mechanization pattern lies in the non-fulfillment of the criterion of matching machinery systems. The complement of machines and implements that go with the trac-

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[1]Grewal, S. S., and Kahlon, Avtar., "Farm Mechanization Pattern", The Times of India, Bombay, India, 1976.

tor is often out of alignment with the capacity of the tractor. This leads to wastage of energy and higher costs. India still needs some large tractors for such operations as land reclamation, leveling, etc. It is suggested that this could be done by such agencies as Agro-Industries Corporation and private firms which maintain such machinery to hire out to the needy cultivators instead of the individual farmers purchasing it.

Kahlon and Grewal suggest that mechanization of the post-harvest technology needs more attention. The market operations of handling the produce, cleaning and sieving, weighment, stitching of bags, loading and unloading have been largely performed by the manual labor. Slow performance of these operations aggravates the problem of congestion in the market and adds to marketing inefficiency. These market operations need to be suitably mechanized, for example, by installing mechanical sievers, driers, loading and unloading devices. This might render some labor force idle but gains in the long run will outweigh the loss in employment.

Selective mechanization is meaningful only when it is related to specific farming systems. Where the farmers are handicapped to bring more land under crops owing to the scarcity of labor, harvesting operations may be mechanized in a manner suited to the specific needs of crops. Groundnut and potato diggers are good examples. This type of selective mechanization promotes land productivity and labor efficiency and displaces very little labor. However, large-scale mechanical harvesting of crops through harvester combines is likely to have some adverse effect on labor employment in agriculture.

Kahlon and Grewal consider it essential to pursue a well thought-out policy regarding mechanization.[1] The individual cultivators might be tempted to go in for labor-saving devices. They suggest, however, the pace and pat-

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[1]Grewal, S. S., and Kahlon, Avtar., "Farm Mechanization Pattern", <u>The Times of India</u>, Bombay, India, 1976.

tern of mechanization needed to be given purposeful orientation to avoid social costs of labor displacement but at the same time foster innovations which add to the productivity in the agricultural sector.

Electricity

Electric power plays a vital role in the development of different sectors of the economy. In agriculture, it supplies the mechanical power to the tubewells, pumping sets, threshers, and other equipment. Its importance is paramount in providing perennial irrigation in areas not served by the canals. The rapid mechanization of agriculture is making a staggering demand for mechanical power. Being much cheaper than mineral fuel, the demand for hydro-electric power is fast increasing.

In 1960 power consumed in the agricultural sector was 72.91 million KWH (15 percent of the total electric power generated); it rose to 366.86 million KWH (33.32 percent of total) in 1969-70, and in 1973-74 it had risen to 709.4 million KWH (41.4 percent of total).[1] The phenomenal increase in consumption of electricity in the agricultural sector was due to introduction of HYV's, increased use of fertilizers, and increase in land area under cultivation. In 1974-75 the number of power-operated tubewells in Punjab had gone up up more than four times than the number in 1967.

A study by the economics and sociology department of the Punjab Agricultural University showed that by using electic power as a source of irrigation, the gross income in the electrified farm increased nearly by 70 percent. The additional net income was also nearly 70 percent more in the case of the electrified farms. The basic condition assumed was a regular electric supply

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[1] Randhawa, M.S., Green Revolution in Punjab, Punjab Agricultural University Press, October 1975, p. 35.

In 1970-71 the demand for electrical power was 502 MW (Megga Watt) where the available power was 233 MW.[1] In 1973-74 demand rose to 871 MW where the availability increased to 661 MW. This shows a continuous deficit in electric power.

It is suggested that the early implementation of the Thein dam project in the Punjab and construction of a nuclear power plant are urgent necessities.

Marketing and Storage

The new technology adds to the marketing problem, as larger yields make for higher marketable surpluses. Traditionally subsistence farms are also drawn into the market orbit as they have a part of their larger output available to sell. Moreover they need to sell part of their produce to pay for the larger cash inputs that the new technology involves. It would probably be desirable for the central government to support the price by making provision for the purchase of larger quantities at harvest time. If it does not purchase adequate quantities there is a possibility of a fall in prices. This in turn would act as a disincentive to the maintenance and extension of new technology. This becomes particularly important due to the fact that agriculture sells in a perfectly competitive market with no supply control.

It is suggested that farmers may improve their incomes by marketing their produce through their own organizations, cooperatives, etc. Co-operative marketing societies must have managerial talent and a good market intelligence. This particularly mentioned because some of the farmers'

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[1]Randhawa, M.S., Green Revolution in Punjab, Punjab Agricultural University Press, October 1975, p. 35.

organizations such as cooperative farming have not been very successful in India. Some reasons have been: 1) poor management, 2) lack of unity, and 3) lack of incentive because not enough of the gains go to an individual member farmer.

Storage is a continuing problem in the developing countries. There have been many cases of excess grain being stored in school buildings, dilapidated structures and sometimes even on open space (produce lying on platforms). Thus there are substantial losses during the period of storage due to spoilage and insect and rat damage. As the new technology is now generally accepted in most parts of India there is a great need and potential for development of scientific storage and marketing facilities. Apart from storage and marketing, the question of processing also assumes great importance in the context of the new technology. With large increases in output, the transport costs becomes much less if the processing is done near the place of origin than at a great distance.

The following suggestions are made in regard to marketing, storage and processing:

(1) Government should set up purchasing centers in as many places as possible in the producing areas. This will help farmers find a reasonable market for their produce in their vicinity and they will be able to save time and money.

(2) Purchase prices may also be fixed well before the harvest comes to the market. Government may also spell out quality differentials in a clear and unambiguous fashion with farmers' committees and check the determination of quality in case of dispute.

(3) Government may go in for a regular barter arrangement with the farmers. Central government--run input depots may provide inputs to the farmers and purchase their produce at reasonable prices.

(4) Storage facilities both for grain and for the chemical inputs may be provided in the vicinity of production centers. Government of India may adopt a national policy of having as many storage centers as possible, each with a comparatively small capacity (say, for catering to the requirement of 8,000 hectares each). The produce must be scientifically stored.

(5) The government of India may also set up market intelligence services and also ensure their availability to the farming community. Radios may be used effectively to broadcast regularly prices of commodities in different markets and information about farmers programmes.

Credit

Credit plays a pivotal role in increasing agricultural productivity through the new technology. Even without the new technology, credit has always been a problem for the Indian farmer. Many of them have had to borrow from moneylenders who charged exhorbitant rates of interest. This left no incentive for the small farmers to improve their farming techniques, as they felt that any additional yields from their extra labor and other inputs would be taken by moneylenders and landlords.

Rao believes that credit was not only the bottle neck that kept agrocultural improvements at bay but was also largely responsible for distorting the agrarian structure in favor of the landlord, the moneylender, the trader, and the big farmer.

The coming in of new technology has enormously aggravated the problem of credit, as the cash inputs it requires are many times larger than those associated with the traditional technology.

The Indian government is engaged in a concerted effort to deal with the problem of agricultural credit. On July 19, 1969, fourteen major

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[1]Rao, V.K.R.V, Growth and Justice in Asian Agriculture, United Nations Publication, Geneva 1974.

commercial banks of the country were nationalized. Among the objectives spelled out was the provision of adequate credit for agriculture, small scale industries and exports.[1] The nationalized banks are helping the small farmers by providing them cheap credit and agricultural information. It is suggested that these nationalized banks should open branches in as many villages as economically feasible, so that small farmers have easy accessibility.

Rao believes that the government lending agencies have such a medley of procedural requirements that the small farmer feels gravely handicapped in making use of their facilities. The small farmer normally prefers money-lenders because of easy accessibility and no procedural requirements.

Other institutional agencies (cooperatives, etc.) have played a minor role in the provision of credit. Their limited operations catered mainly to the requirements of the bigger farmers. There was also the problem of utilization of production credit for consumption purposes. This led to mounting arrears resulting from 1) misuse of credit and 2) from frequent failures of the harvest.

Adequate handling of the credit problem in the context of the required spread of the new technology, requires:

(1) large increase in the volume of credit availability,

(2) specific measures designed to see that credit is available on reasonable terms,

(3) that credit reaches small and marginal farmers.

In view of these considerations the following suggestions are made:

(1) There should be a national system of credit registration for all cultivators. It may be based on a) their land holdings, b) history of previous production, c) their current production programmes and cash re-

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[1]Eastern Economist, Banking: The Beckoning Seventies, Annual Number, New Delhi, December 26, 1969, p. 1186.

quirements. These cards would have to be prepared at local levels. National organizations may appoint officers for sample checks. The farmers, by presenting this card to credit agencies, should be able to obtain the needed credit. The cards should show all entries of loans given and repayments made. This would help to strike a balance at the end of the year. Then farmer's credit rating may also be revised if necessary, on the basis of his performance.

It is suggested that before such a project is put through on a national scale, it be tried out in a few pilot areas. This will help to identify the difficulties in the practical working.

(2) To make available the large volume of credit needed for the new technology it is suggested that a national agricultural bank may be set up. The national bank could also encourage other banks to adopt the Indian system by acting as lead banks for selected individual districts. The national agricultural bank may be particularly interested in the agricultural financing of small and marginal farmers. This bank may also employ agricultural experts who would advise farmers on technical matters. This will help farmers improve their management efficiency so that they can more easily pay back the loan.

Extension Services

The new technology is not just a matter of HYV seeds, chemical inputs, irrigation, mechanization, and increased cash expenditure. It has also a complex of agronomic practices that are quite different from traditional agriculture. It requires a process of reorientation, if not re-education, of the farmers who are to be introduced to the new technology.

Although extension services exist in practically whole of India, Rao believes that they usually do not have high levels of technical competence.

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[1]Rao, V.K.R.V, Growth and Justice in Asian Agriculture, United Nations Publication, Geneva 1974.

The area assigned to each extension worker is too large for him to cover effectively or establish intimate contact with the individual farmers in his area. On top of it the duties assigned to him are so miscellaneous as to diminish his usefulness.

Rao further adds that above all, there is the extension workers' inclination to pay more attention to what he thinks are 'progressive' farmers which usually means the big landlords or the local elite. This leads to the neglect of the poorer and the smaller farmers.

Rao believes that extension services become more difficult when the agricultural population suffers from a high degree of illiteracy, as is true in many Asian countries, including India. He adds that insufficient effort is made to eliminate rural illiteracy. He particularly stresses the basic importance of adult literacy with a functional bias for the farming population and out-of-school education for the younger among them. It is also necessary to reorganize the system of primary education in rural areas with particular stress on environmental knowledge and work experience in agriculture and allied activities.

It is suggested that vacation periods of the village schools be changed to coincide with the sowing and harvesting seasons. This will help in getting the entire school (both teachers and students) to take part in agricultural activities in their area.

Rao considers it important for an extension worker to give a feeling of belonging to the cultivators amongst whom he works. He has to inspire their confidence not only by his technical experience and practical ability to deal with their technical difficulties, but also by conspicuous identification with the interest of the farmers, especially the small and marginal farmers. It is suggested here that extension workers might be drawn from the class of small and marginal farmers who have a living connection with land and farming.

Rao believes that although it is important for the extension worker to command respect and have influence yet it would not be desirable to make him a power center and dispenser of patronage. He is not in favor of extension workers being entrusted with the supply of inputs for the cultivator. He believes that extension workers should wholly be engaged in education and demonstration of the new technology.

It is suggested that extension workers should be in touch with both successes and failures in the application of the new technology. They should act as communicants to the scientific and administrative agencies at the national and state levels which are responsible for agricultural development. It might also be desirable to arrange their training programmes at or in the vicinity of places where research work is being undertaken in agriculture.

RESEARCH

Research is the foundation of new technology. Kahlon believes in 'specific research' for Indian agriculture.[1] He adds whether it is the HYV's or the associated modern technological inputs including machinery, they all must be adpated to the local situations. Wheat varieties like PV 18 and Kalyan Sona have become more susceptible to new races of rusts. Research has to be oriented towards developing new rust-resistant varieties. Research needs to be speeded up in this direction so that the gains from the green revolution can at least be maintained. Research may be carried out at both national and subnational levels. This is due to the fact that agro-climatic and other ecological conditions vary a great deal even within the same country, which calls for different varieties of seeds.

What is good and economical for Punjab, Haryana and Western Uttar Pradesh, may not be economical for other regions of the country. Research needs to be carried out for all the modern technological inputs like seeds, water, fertilizers, pesticides, insecticides and weedicides, and mechanization for the different local situations.

Another field of research is on the shorter maturity of crops. Increasing the intensity of cropping will enlarge the limited land base. This will help increase production and employment on farms. Finally it is suggested that agricultural research must be interdisciplinary, and involve not only the physical but social sciences. In formulating the new technology, due account must be taken of economic, social, cultural and equity considerations, as these considerations have relevance to the level of implementation.

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[1]Kahlon, Avtar.,"Can HYV Solve Food Problems?", The Economic Times, February 7, 1975.

SUMMARY AND CONCLUSIONS

The development of HYV's of wheat, rice and hybrids of corn is perhaps one of the greatest feats of biological engineering by the geneticists and the plant-breeders. The new semi-dwarf wheats can yield as much as 60 quintals per hectare, as against 30-40 quintals yielded by the indigenous tall varieties. These HYV's of wheat are superior to the indigenous varieties due to the following reasons:

1. HYV's are insensitive to the photoperiod.
2. Relatively hard varieties.

There were not any significant gains in rice yields because of the water control and water management problems. Hybrid corn has not become popular with the Indian farmer, because it gives only a marginal increase in yield over the local varieties of corn and involves high fertilizer doses, which greatly enhance the cultivator's cost and wipe out his margin of profit from the hybrids relative to the local maize.

The sharp increases in yields, particularly in wheat, due to the adoption of HYV's was given the name "Green Revolution". Unfortunately, very recently HYV's of wheats have come under heavy attacks of rust. This has mainly led to stagnation of the "Green Revolution". Two things are needed in this connection: (1) Research needs to be carried out to develop rust-resistant varieties and (2) Improvement in the use of new technology.

In this report the problems associated with effective utilization of the new varieties and their complementary new technology and some recommendations for policies to help solve these problems are discussed under the following headings:

1. Seed
2. Water

3. Fertilizers
4. Pesticides, insecticides, herbicides
5. Mechanization
6. Electricity
7. Storage and Marketing
8. Credit
9. Extension Services

There is a need to reorganize the system of distribution of HYV's seed in India. The National Seed Corporation should make sure (1) that the seeds reach the small and marginal farmers at the right place and at the right time. (2) NSC should certify the quality of seed to be made available to the farmers, so that HYV's seed sown performs to their potential.

Another important condition for the application of new technology is water. Areas with assured supply of water have benefited more by new technology than the dry farming areas. Whereas HYV's have been developed for irrigated areas, suitable varieties are still not available which can give high yields under rain-fed conditions. Since about 78% of the acreage in the country depends on rains, there is a great need to develop varieties which give high yields under conditions of stress.

Fertilizer is an inportant input in the new technology. HYV's require large doses of fertilizers. India should aim at maximizing the output per unit of fertilizer and the focus on organic manures and recycling human wastes should be revived. The importance of micronutrients in the soils should also be recognized. Experiments conducted by the research agencies indicate a deficiency of zinc in Indian soils. Balanced use of fertilizer is therefore important to fully exploit the potential of HYV's.

Another factor for consideration is the availability of fertilizers within easy reach of the farmers. It should be made sure that the fertilizers reach the farmer at the right place and at the right time. International action for securing an adequate supply of fertilizers and other needed inputs at reasonable prices for India and other developing countires may be explored.

An important area in which the Indian farmer needs to be educated is the application of pesticides, insecticides and herbicides. Proper training should be provided by the extension workers to the farmers in applying the chemicals safely and effectively. Another important aspect of the pesticides, insecticides and herbicides problem is team work. An individual farmer's effort to eradicate weeds or pests from his farm may turn out to be futile because seeds of weeds, for example, can be carried by wind from other farmer's field and infest the field in which chemicals had been applied. So group action for spraying insecticides, pesticides is important. Research needs to be carried out to evolve more disease and pest resistant varieties.

With the introduction of HYV's, mechanization has come up fast in some parts of India. But in a labor surplus economy like India, where the employment problem is serious, the impact of mechanization on employment cannot be ignored. Some studies in Punjab, Gujarat, U.P (states of India) show that mechanization had no adverse effect on human labor employment. It is the use of animal power that was affected the most. The reduction in bullock labor was as much as 70% in the Punjab, 62% in U.P, and it was almost 40% in Gujarat. This is a good development, in as much as reduced demand for draft animals would enable substitution of milch cattle in place of draft animals and put more area under grain crops.

The introduction of mechanized means of irrigation and tractors has virtually dominated the use of animal power in preparatory tillage, sowing, threshing and transportation etc. The human labor input has been influenced but to a lesser degree and that loss has been more or less made up by higher cropping intensity and productivity on mechanized farms.

Some improvements need to be carried out in some of the mechanized farms in India. Tractors on most of the farms in India are of larger capacity than needed for such holdings (average 2-5 hectare). A small sized 14 h.p. tractor is considered sufficient to meet the requirements of even large holdings in India. A study by Kahlon shows that 62% of the farmers in Hoshiarpur and Ferozepur districts of Punjab did not have a matching machinery system. So it is important that if a tractor is purchased by a farmer, other machinery which goes with the tractor should also be purchased to make it economical.

Due to the introduction of HYV's, power consumption on farms has risen manyfold. In 1960 power consumed in the agricultural sector was 72.91 million KWH, (15 percent of the total electric power generated); it rose to 366.86 million KWH (33.32 percent of total) in 1969-70, and in 1973-74 it had risen to 709.4 million KWH (41.4 percent of total). To meet this rising demand it is suggested that the early implementation of the Thein dam project and construction of a nuclear power plant are urgent necessities.

The new technology has also created marketing problem as larger yields make for a larger marketable surplus. Farmers might improve their incomes by marketing their produce through their own organizations, such as co-operatives. There is also a great need and potential for development of scientific storage and marketing facilities. Storage facilities both for grain and for the chemical inputs may be provided in the vicinity of production centers. More storage centers with a comparatively small capacity (say for catering to the requirement of 8,000-10,000 hectares each) may be constructed. Government may also set up marketing intelligence services and also ensure their availability to the farming community.

Another problem which the Indian farmer normally faces is credit. On July 19, 1969, fourteen major commercial banks of the country were nationalized. Among the objectives spelled out was the provision of adequate credit for agriculture. Nationalized banks are doing a good job. These nationalized banks should open branches in as many villages as economically feasible, so that small farmers have an easy assessibility. A national agricultural bank should be set up to make available the large volume of credit needed for new technology.

New technology also involves a complex of agronomic practices that are quite different from traditional agriculture. Extension workers may help the farmers in technical matters. Extension workers should be in touch with both successes and failures in the application of the new technology. They should communicate back and forth to the research agencies and the farmer.

The major conclusion drawn from this report is that modern technological inputs including machinery, must be adapted to the local situations. It is not enough to import certain things or ideas and be contented with it. Mexican wheat seeds were imported by India. The yields doubled at first but later rusts cut down yields. Research is needed to cross-breed and develop rust-resistant varieties. The same is true for mechanization. India imported big tractors from developed countries which did not turn out to be economically feasible for the average holding of 2.5 hectares. It is not a bad idea to import certain technology from abroad but at the same time it needs to be adapted according to the need and situation of the importing country. Only then can imported technology be successful.

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GREEN REVOLUTION IN INDIA - AN INCOMPLETE TASK

by

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ABSTRACT

The achievement of self-sufficiency in foodgrains has long been a policy goal in India. The adoption of new seed-fertilizer-water technology in the mid-sixties resulted in sharp increases in food production. By 1970-71, India appeared to have turned the corner with a record domestic production of 108.4 million tons of foodgrains. The situation looked so optimistic that the government of India started thinking of exporting wheat in the subsequent years. The experience of later years, however, belied the hopes. India also faced droughts in some parts of the country and floods in others. The result was that the production of foodgrains fell sharply in later years. Even in the state of Punjab which spearheaded the "Green Revolution" in the country, foodgrain production suffered a set-back.

What has gone wrong with the "Green Revolution" and some policy measures to increase its effectiveness are discussed in this report. Very recently rusts attacked HYV's of wheat. Due to lack of continuous research on imported high yielding varieties the "Green Revolution is losing its momomentum.

The primary problem of the utilization of high yielding varieties is a complete technological change in the major inputs namely seeds, water, fertilizers, pesticides, insecticides and herbicides, mechanization, credit, storage and marketing, and extension services.

A major problem has been that the full new technology has not been applied due to inefficient system of distribution of seeds, lack of knowledge, unwillingness to make changes, piece-meal adoption, and breakdowns in the system for providing necessary inputs like fertilizers, insecticides, pesticides and herbicides.

It is thought that the green revolution can at least be maintained by implementing some of the following suggestions:

1) The system of distribution of seeds should be made more efficient and quality of seed should be maintained.

2) The improvement in irrigation facilities can help to increase the intensity of cropping. To meet the demand of power early implementation of the Thein dam and construction of a nuclear plant it suggested.

To accelerate the growth in agriculture, the supply of crucial inputs like fertilizers, insecticides, pesticides and herbicides needs to be assured so that these inputs reach the farmers in right quantities, in right form, at the right place, at the right time and a reasonable prices. Modern agriculture requires an increasing use of chemical fertilizers but unfortunately the production of fertilizer has been rather slow and should pick up momentum without further loss of time. The focus on production of organic manures and recycling of human wastes should not be lost.

Marketing and storage facilities need to be expanded as larger yields from HYV's make for higher marketable surpluses. The new technology has a complex of agronomic practices. This requires technical knowledge on the part of the farmer. Extension workers should act as communicants to the research agencies and the farmer. He should take farmer's problems to the research organizations and help the farmer in adopting the new ideas produced by research organizations.

Research is important in the modern technology. Modern technological inputs including machinery must be adapted to the local situations. To maintain the green revolution research needs to be done in developing new rust-resistant varieties. Research should also be carried out for all modern technological inputs like seeds, water, fertilizers, pesticides, herbicides, and mechanization, for the different local situations.