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BACKGROUND PAPERS FOR DISCUSSION
AT
THE INTERNATIONAL SEMINAR
ON
**“COMPARATIVE EXPERIENCE OF AGRICULTURAL
DEVELOPMENT IN DEVELOPING COUNTRIES
SINCE WORLD WAR II”**

NEW DELHI

25th, 26th, 27th and 28th OCTOBER. 1971

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

THE EMPLOYMENT IMPLICATIONS
OF THE GREEN REVOLUTION

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(The new high-yielding wheat and rice seeds clearly need more labor per acre in cultivation, though not necessarily per unit of output. But in areas unsuited to them their employment effect may be negative; and small farmers and tenants who cannot afford them may be displaced. Indirectly, they should also stimulate considerable employment).

Since 1965, new high-yielding varieties of wheat, rice, corn and other coarse grains, have spread to parts of Asia and are beginning to be introduced in Latin America and Africa. The rapidity of the spread justifies the name "Green Revolution". This paper will concentrate on the new high-yielding dwarf wheat and rice varieties; these two foodgrains comprise the great bulk of the acreage under high-yielding varieties. Most of the studies on their impact have been done in India, Pakistan and the Philippines.

Direct Employment Effects

The higher yields and the greater intensity of farming made possible by the new varieties appear to require a considerably larger amount of labor per acre for their cultivation. At the same time, though, the efficiency of complementary inputs, and particularly of fertilizer and water, is improved by use of the new

* Excerpted from "Jobs and Agricultural Development." Washington (D.C.) : Overseas Development Council, Monograph No. 3, 1970, Chapter 3. Source: Development Digest, Vol. IX--No. 1, January, 1971.

varieties; as a result, the required labor for each unit of output is likely to decline. Thus, while yields may double, the labor requirement per acre is not likely to increase by as large a proportion.

Wheat

The relatively sparse data available on wheat in South Asia support this reasoning. A survey of a wheat producing district of Delhi State in 1967/68 showed that use of the Mexican varieties involved a doubling of the family labor employed per acre and a small increase in the amount of hired labor; the gross return on these farms per acre nearly tripled. A report on Ludhiana District in the Punjab (one of India's most advanced wheat-growing districts) showed an increase in the number of jobs faster than the rate of growth of population and a 16 per cent increase in real wages from 1962/63 to 1967/68.

Data from the Program Evaluation Organization of the Indian Planning Commission show that the participants in the high-yielding varieties programs for wheat have much larger expenditures for hired labor than do non-participants on the same size of farm. An average for the samples taken shows that participants on large farms spent about four times as much as non-participants, and that those on small farms spent about ten times as much. It is not clear, however, how much of the increase represented higher wages at peak labor seasons and how much reflected the additional hours of work required by the new varieties.

What stands out on examination of the yields achieved with the new varieties is that they are still low compared to what can be achieved. The average yield for the new varieties in India in the 1967/68 crop year

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was only 2,365 pounds per acre, though the range went all the way from below 2,000 pounds to over 6,000 pounds per acre. In West Pakistan the yields of the new varieties have averaged only about 1,600 pounds per acre. There is some evidence that an improvement in yields will require still more labor in cultivation--more careful preparation of the land, proper spacing of plants, correct fertilization, higher quality of weeding, and so on.

Rice

Rice is by far the most important crop in Asia, so an increase in the labor requirements of this one crop has extremely important implications for the whole region. The available information on rice is rather more conclusive than for wheat, though there has still been no comprehensive survey. With the exception of one study of the rice variety ADT-27 in Thanjavur District, Madras State (where most farmers used tractors for land preparation) the consensus of the material is that introduction of the new rice varieties does require the use of considerably more labor. In the Philippines, the most likely approximation of additional requirements is of the order of 30-50 per cent. In India, the ratio of labor costs per acre for the high-yielding varieties and the local strains varies considerably, from 1 : 1 in the case of Thanjavur all the way to 2.9 : 1 in West Bengal. The average is about 2 : 1, though it is not possible from the data to translate this directly into man-days/hectare. Nor is it possible to estimate the degree to which these ratios reflect differences in the costs of labor and the influence of multiple cropping.

Below are some of the Philippine data contrasting the high-yielding varieties with local varieties.

	<u>Man-days/ Hectare</u>	<u>Man-days/ Ton</u>
<u>High-Yielding Rice:</u>		
IR-8, farm owner (1967 dry season)	85.7	18.9
IR-8, tenant (1967 dry season)	74.6	17.5
BPI-76, farm owner (1967 dry season)	90.1	24.1
BPI-76, tenant (1967 dry season)	78.3	25.4
IR-8, (1967 wet season)	79	16.5
IR-8, (1968 wet season)	69	18.7
<u>Local Varieties:</u>		
Local (1966 dry season)	53	22.5
Local (1967 wet season)	51	20.4
Malagkit (1968 wet season)	58	20.6

NOTE: All of these figures exclude the time taken in harvesting and threshing, which can be estimated as adding another 20-30 days to the total per hectare.

The new rice varieties do not appear to use at present the same degree of intensity of cultivation as is practised in East Asia, and especially in Japan. The rice varieties used in Japan and Taiwan differ genetically from those being developed in South and Southeast Asia, but they have similar characteristics of fertiliser responsiveness, requirements for water control, and careful cultivation and their history is therefore pertinent. It is believed that the Japanese labor input per crop of rice was as high as 370 man-days per hectare during the period 1910-25 when their improved rice varieties were diffused nationally. Subsequently, with the use of

improved agricultural implements and more irrigation pumps, the labor input went down to 314 man-days in 1933-35. In the post-war years manpower was in short supply in Japan; the power tiller became a major factor and is now in operation on more than half of the farms in the country. Nevertheless, cultivation is still labor intensive; the official estimate for 1965 shows that rice cultivation consumed about 180 man-days per hectare per crop. In Taiwan, the National University has estimated the labor requirement at 150-160 man-days per hectare. These figures compare with a range of 60 to 120 man-days per hectare for crops of traditional varieties in most of South and Southeast Asia. For new varieties in the Philippines, the average is 100-110 man-days per hectare.

A major study by the Asian Productivity Organization shows how, in all the phases of the cultivation cycle except harvesting, more labor is used per acre in East Asia than in South and Southeast Asia. Of special importance is the extra time spent in seedbed preparation, transplanting, and water control. Perhaps the new varieties being introduced into the latter regions may in time cause farmers to spend more time in seedbed preparation, etc., as the productive rewards become better understood. The average yields of the new varieties in 1967/68 were still relatively low compared to the potential demonstrated in experimental stations. These averages were as follows (in milled rice) :

Philippines	2,591 lbs./acre
India	2,400
East Pakistan	2,746
West Pakistan	2,472

These are the yields for the initial farmers adopting the innovations which generally represent the

most favorable environments; as the new varieties have spread, their average yield has so far tended to fall. In comparison, demonstration plots at the International Rice Research Institute have produced two and a half times these yields.

The effect of multiple cropping

As the availability and the quality of controlled water supplies grow, the potential is opened for multiple cropping. This potential is enhanced by the fact that the new rice varieties mature so much more quickly than the local varieties. Double and triple cropping is likely to have a most significant effect on the employment and income opportunities open to Asian farmers. However, the shift from single cropping requires a major investment in irrigation and improved managerial ability. Both are made more worthwhile by the introduction of the new high-yielding varieties.

In those areas where multiple cropping is being made possible, the increase in employment seems to be roughly equivalent to the rise in the intensity of cropping. A study of some large farms in the Pakistani Punjab showed that because of the longer working hours per man per day, and also because of the increased numbers of workers (both family and hired hands), the input of labor per acre on farms irrigated by tube wells averaged 57 per cent higher than that on the farms without irrigation; this corresponded quite closely with the expansion of cropping intensity.

In Taiwan, the multiple cropping ratio on the island (that is, the ratio of the total area planted to the area of cultivated land) rose from 1.32 to 1.98 between 1915 and 1965. During that time, the total labor input measured in man-days doubled; as the number of

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agricultural workers grew by 50 per cent the number of days worked by each person increased about one third, and the agricultural output per worker rose by 250 per cent. The man-days spent per year on all farm operations on an average holding had reached 502 per hectare in 1962.

It appears, though, that the potential for multiple cropping in South and Southeast Asia is rather limited. According to a survey by the Asian Development Bank, the land suitable for the double-cropping of rice under existing irrigation is less than 10 per cent of the total rice area of the region, and the present double-cropped area is only about half of that. This is mainly due to the quality of water control; the terminal water distribution and drainage facilities of many irrigated systems are inadequate for growing two or more crops a year, and many of them are too small to store enough water for the dry season. Thus, the opportunities for multiple cropping will have important effects on employment in only a few areas in the near future. Among these are Malaysia, which is relying on the expansion of its area under two or more crops to achieve self-sufficiency in rice, and those large portions of India and Pakistan where relatively cheap private tube wells and lowlift pumps are both feasible and profitable.

In general we can conclude that the introduction of the new cereal varieties by itself does increase the demand for labor. It is impossible at this stage to obtain a firm estimate of this increase, though an overall range of 20-50 per cent seems to be indicated by recent experience. The variations between regions are likely to be considerable. No areas in South and Southeast Asia appear yet to have attained the degree of labor-intensity on Japanese and Taiwanese farms; this raises

the possibility of much higher levels of labor inputs and yields at some time in the future for those areas suitable for the new varieties, especially in conjunction with multiple cropping.

Employment Effects on Various Social Groupings

The direct effects of the new varieties on employment are not spread equally among the cereal farmers of Asia, partly because they are only suited to certain environments, but also because there are some economies of scale attached to their use. A third reason is that the agrarian institutions and social organizations in most of rural Asia tend to make it easier for large farm owners than for others to benefit from the Green Revolution.

Differences by area

The new varieties are suited only to certain environments found in a relatively small proportion of the total cultivated area in Asia. The main limiting factor is the environment's capability for providing adequate water supply and control. The irrigated area in Asia is being expanded remarkably rapidly; but for those areas that must rely for some time to come on rain-fed agriculture, the cost reductions in production of new varieties under irrigation will work to their disadvantage. There will be relative price declines, and many small farmers who are in competition with the rice or wheat growers in irrigated areas may have to consider eliminating production of these crops for the market and concentrating on subsistence production for their families, or diversifying into other crops. For the bigger farmers, there may be some opportunities for extensive farming on a large scale, making use of modern dry land farming techniques and machinery. In both cases the

number of employment possibilities is likely to decrease; the extent of underemployment on small farms is likely to increase.

Research into cereal varieties suitable for the drier areas should partially offset these effects. And diversification into cereals like sorghum and millet that are less dependent on large amounts of controlled water may also offer some hope. But, in general, the prospect is a relative and in some cases an absolute decline in the level of rural development in these areas. It is not possible at this stage even to hazard a guess about the magnitude of these effects. Government policies can do much to alleviate these inequities, but in the long term the alleviation of poverty in these areas depends on the transfer of significant numbers of people into environments where they can play a more productive role.

Differences within regions

There are four main groups within the areas suitable for the new seeds for which the benefits of the new technologies may be very different; large owner-farmers, small owner-farmers, tenant farmers and laborers. In many respects the new varieties appear equally effective on any size of farm; that is, they are neutral to scale. For the seeds themselves, for the fertilizer that is an essential component of their higher yields, and for other agricultural chemicals, all of which are divisible into very small units, this seems to be true. But some other aspects offer returns to scale unless these effects can be neutralized, principally mechanization, irrigation, credit and management. Large farms are in a position to make the best use of tractors, with

the cost savings related to the size of the tractor. For irrigation, many of the old large-scale systems supply water regardless of the size of the farm. But for the most efficient units, the private tube wells whose use is spreading so rapidly throughout Asia, there is a minimum command area, varying from 25-50 acres, below which the costs of water rise sharply. The costs of credit are usually higher for small farmers than for large, because the risks are greater and because the same cost of administration must support a smaller loan; in some areas cooperatives and banks are reluctant to loan to small farmers at all. Credit is essential to most farmers to purchase the more costly inputs and to make the necessary investments in irrigation and equipment to utilize the potential of the new varieties. In general the complexity of farming increases with multiple cropping, new purchased inputs, and higher risks, so the required level of managerial skill rises. In the Philippines, for example, some very large farmers, with more than 250 acres, are finding it worthwhile to employ professionals to do their planning and management, and a new form of management company is emerging to perform a similar function for groups of rather smaller landlords with adjacent lands.

The advantages possessed by large farmers for the initial adoption of the new varieties have been augmented by the tendency for government programs of agricultural development to concentrate their resources on the larger and more progressive farmers. This is hardly surprising for countries like India and Pakistan, which were struggling to overcome massive national grain deficits; by concentrating on a relatively small number of big farms, it was possible to have a more significant effect on overall output. But this approach can bring

a number of employment problems in its train. The large farmers who were more easily able to adopt the new varieties increased their savings, and in many parts of Asia they have used these savings both to buy machinery that can displace labor, and to purchase more land. This trend increases the income base for those who are already well off. Another tendency noted in India, West Pakistan and the Philippines has been the emergence of a small but growing group of men, not previously engaged in agriculture, who are buying up farms and making a profitable occupation out of cultivating the new varieties.

Small farmers need more help than large farmers if they are to gain from the new technology. Those who have access to irrigation water and credit do appear to have made considerable use of the new high-yielding varieties, once their profitability has been effectively demonstrated. In such cases, employment of family labor and of hired labor for harvesting increases significantly. There is some variation throughout the region in the proportion of small cultivators who have planted the new seeds. For rice in India, the record has been very mixed, with the proportion of small farmers among participants in the high-yielding varieties programs varying from 13 to 70 per cent. For wheat in India, however, a survey of the 1967/68 wheat crop showed a strong correlation between farm size and the proportion of cultivators participating in the high-yielding varieties program. In West Pakistan, too, it was noted that the Mexican wheats were first adopted by a higher percentage of large farmers than of small farmers, though in absolute numbers there are many more of the latter producing such wheats than large farmers. For those small farmers who are unable to make the transition to the new technologies, the prospects are bleak

with the probable decline in cereal prices in the face of growing supply. Many of them will either retreat into subsistence farming, or take advantage of rising land values and sell out to clear their debts and attempt a new start in life.

The prospects for tenant farmers' adoption of the new seeds depend heavily on the prevailing patterns of land tenure in a particular area. As with small farmers, tenants and part-tenants face problems of scale in situations where they lack irrigation and credit. In parts of the Philippines where landlords customarily share the input costs as well as the crops, tenant farmers seem to have been almost as ready as owner-operators to adopt the new rices. In contrast, barely five per cent of the sharecroppers in the Kosi area of Bihar, India have used high-yielding varieties of seeds because arrangements are not nearly so favorable for tenants. In West Pakistan, even large farms operated by tenants tend to have a smaller percentage of adoption than small farm owners.

Tenants' difficulties are compounded by the rise in the value of land associated with the new varieties and their higher yields per acre. Tenants want to lease more land, while land owners are recognizing the gains to be achieved by direct management of their farms. All Asian nations have land reform laws, but the general level of enforcement has been low. Now that land is more valuable, landlords are very reluctant to get into a position where their tenants might be given title to the land. Numerous evasive tactics have been reported in West Pakistan, in India and in the Philippines. Some landlords have directly evicted their tenants who depended on oral agreements; others have prevented their tenants from establishing security of tenure by shifting them frequently. (See Development Digest, April 1970, pp. 23-28). In the absence of more effective land reform,

the prospect is for large numbers of tenant farmers to join the ranks of the landless laborers or migrate to the cities.

Landless laborers

In many areas of the Indus Plain where the Mexican wheats have been firmly adopted, the cost of labor as a percentage of the crop has doubled. Increased expenditures on labor as a direct result of the introduction of the new technologies have reflected both an increase in wages and in work opportunities for landless laborers. There has, as yet, been no distinct pattern to these increases, however, and the gains themselves may be of short duration. As their numbers rise through natural increase and the addition of displaced tenants and small farmers, the position of the landless laborers in rural areas may be expected to become more precarious. The growth of Mechanization is also threatening the job possibilities for this group. Even where output is growing, these pressures have led to signs of a marked deterioration in the relationships between farmers and the laborers they employ.

Two Indian examples illustrate some of the facts involved. In areas where the Green Revolution has made a strong impression, and where the number of agricultural laborers is relatively small, their conditions have improved markedly. In Ludhiana District, Punjab, where landless laborers account for only 18 per cent of all rural families, and where most were idle three or four months a year until recently, they are now able to find employment all year round by combining work in cultivation with some off-season work on the installation of tube wells, and land leveling, and also on the construction of roads and houses. In Palghat District, a major rice-growing area of Kerala State, on the other hand

hand, 55 per cent of the agricultural households consist of farm laborers, each of whom only works for an average of 180-200 days. Nearly all the rice land is already double cropped, but lack of suitable water control has limited the spread of the new varieties to about 10 per cent of the gross cropped area. Agricultural laborers have seen little, if any, improvement in their living standards.

Indirect Employment Effects

The new seeds, with their requirements for more and better inputs as well as increased outputs, should be a considerable indirect stimulus to employment. The production and marketing of seeds and fertilizer, chemicals and equipment will all create jobs, as will the processing and marketing of the additional grain. And here will be a further multiplier effect throughout the rest of the economy. With the present state of available material, it is not possible to make a guess about the overall increase in employment.

One area where there is need for specific policy directions is in the manufacture of agricultural implements. Sophisticated machinery such as tractors and related implements generally have to be made with large-scale capital-intensive machinery. Giles, for example, estimated that the number of jobs created by plants in Asia with the capacity to produce 12,000 tractors per year would be a mere 11,200. But equipment such as tube well materials and simple diesel engines, as well as plows and seed drills to be drawn by animals, can be manufactured more readily at the local level with vastly less complicated factories and skills. This has already been happening in those areas in which the Green Revolution has had its most significant impact. One documented

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example is the town of Dasca in the Pakistani Punjab; Dasca, with about 25,000 people, has grown into a center for the manufacture of simple diesel engines for tube-wells and grain mills. There are now 105 small factories producing diesel engines from principally local materials, employing over 1,000 people who have been entirely trained in the factories as apprentices. There are numerous similar examples.

The whole area of marketing in the broadest sense will also provide new employment. Very large investments in storage, in feeder roads, in food processing and in distribution will be required in order to maintain the momentum of the Green Revolution and to market the increased output, and all of these investments will create jobs. For example, the bread baking industry in India has been growing very fast; in production alone, 92,758 people are employed as compared with 52,171 in 1961. At least part of this expansion can be laid to the extraordinary increase in wheat production between 1966 and 1968.

One effect of the new varieties is to make the supply of staple foodgrains more elastic, more able to respond to changes in demand. It may well be, with the growth of the labor force, and with the impossibility of absorbing all the increase in urban jobs in the near future, that countries determined to face their employment problems will wish to engage in massive labor-intensive public works programs. Since a very large proportion of the wages of laborers so employed are spent on staple foodgrains, an increase in government spending on labor-intensive projects can sharply raise the demand for food-grains. Programs of this type have been made easier by the Green Revolution because grain

supplies are more likely to increase with the demand, and inflationary results become less severe. Such programs are not a long-term solution to the employment problem, but as a medium-term palliative they are an important tool of policy.

Finally, if the increased rural incomes from the additional cereal production are distributed fairly evenly, they should increase the demand for the kinds of consumer goods that can be produced domestically--textiles, furniture, utensils, bicycles, etc. These goods have the additional advantage that they can be made in relatively labor-intensive operations. And the employment generated in these industries will also help to augment the demand for food.