III. 1. The new strategy

In discussions on the performance of Indian agriculture since independence, it has now become customery to divide the reference period into two main parts, the dividing line usually being the two years in the middle of the 1960s, i.e. the years 1965 and 1966. The choice of this particular dividing line is not so much because these two years constitute one of the worst periods for agriculture in independent India, as for the fact that the strategy of agricultural development pursued since the mid 1960s is markedly different from the one that was in vogue in the previous period. During the first fifteen years of planning (i.e. from 1951 to 1965) institutional reforms of agriculture, styled as the integrated rural development approach, constituted the mainstay of India's agricultural policy. This included encouragement of co-operative farming, community development programmes and land reform. For several reasons, including the failure of co-operative farming to take shape, growing scarcity of food, etc., there was a major change in India's agricultural policy in the mid-1960s: from the integrated rural development approach to a technology oriented agricultural production approach. The new strategy emphasised the application of modern science and technology to agriculture supported by substantial investment.
in modern inputs, and price incentives for farmers to adopt them. Thus the main strand of the strategy of agricultural development in India since the mid-1960s is a superior agricultural technology based on modern scientific research.

III.2. The new agricultural technology: characteristics and implications.

The new technology, which was introduced in Indian agriculture in the late 1960s as a part of the new strategy of agricultural development, is based on some newly developed crop varieties generally known as the high yielding varieties. As their name suggests, these new varieties are capable of giving yields much higher than those of the traditional varieties, especially when they are used in combination with a number of complementary inputs, such as fertilizers and water.

Discovery of these high yielding varieties, was neither an accident nor a miracle, but the product of long and persistent scientific research in various institutes in India and abroad. Prominent among these research centres are the International Centre for Wheat and Maize Improvement (CIMMYT) in Mexico for wheat, and International Rice Research Institute (IRRI) in Philippines for rice. Research in Mexico had culminated in discovery of new varieties of wheat, which were capable of absorbing high levels of fertilizers to give yields up to above 70 quintals per hectare (i.e. more than twice those of traditional varieties). In Philippines new rice varieties capable of yielding 70 to 80 quintals per
hectare — nearly three times the maximum yield from local varieties were discovered. The good work at these international institutes was adequately supplemented by follow up research in various institutes and agricultural universities in this country. The result of all these is the evolution of the new semi-dwarf high yielding crop varieties which were introduced to Indian farmers in the second half of 1960s.

These high yielding varieties (referred henceforth as H.Y.V.s) possess certain distinctive physiological attributes which are of significant implications. First of all, the new varieties are capable of turning large amount of soil nutrients into grains rather than leaf growth. Secondly, they are quicker maturing in nature i.e. they take shorter duration to mature than the traditional local varieties. Thirdly, they are usually photo-period insensitive i.e. their maturity duration is independent of the length of exposure to daylight.

Because of the first attribute these varieties are able to give higher yields than the traditional varieties, especially if the supply of nutrients to the soil can be increased. So to get better results out of the H.Y.V.s, the soil is to be supplied with additional nutrients through application of chemical fertilizers to it. Since chemical fertilizers contain nutrients in concentrated form, they in turn have to be applied with adequate supply of water to enable plants to absorb the nutrients without causing damage
to themselves. The use of chemical fertilizers with H.Y.V. seeds hence necessitates controlled supply of water. Thus, full utilisation of potentialities of the new technology requires adequate application of the complementary inputs of fertilizers and water with the H.Y.V.s.

The new technology in the form of H.Y.V.-fertilizer-water package also calls for careful and intensive interculture operations. First, the plants require the fertilizer-water input at particular stages of growth. Secondly, as fertilizer can be absorbed by weeds as well as by plants, effective weeding is required to prevent waste of expensive fertilizers. Thirdly, while H.Y.V. seeds give higher yields, they are more prone to damage from excessive watering. For example, shorter stemmed-dwarf varieties are more liable to be flooded. They thus require more effective water control and better drainage. Forthly, being relatively new and non-acclimatised strains, they are more prone to local pests and diseases than established indigenous varieties and therefore require to be protected by pesticides and germicides.

Photoperiod insensitivity of the new varieties allows farmers greater flexibility in laying out their cropping schedules, while shorter duration of maturity of the crops leaves farmers with enough time to slip in one or two additional rounds of cultivation during the course of a year. Thus H.Y.V.s, besides giving higher yields on crops, give farmers an opportunity to abstract more out of their land.
resource through the practice of multiple cropping.

In raising crop-yields per unit of land, and in making it possible to raise cropping intensity of land, H.Y.V. seed-fertilizer-water package has the same effect on agricultural production as that of an increase in the total land resource. This land augmenting character of the new technology makes it very appropriate for Indian conditions, where cultivable land is becoming increasingly scarce with the continued rapid population growth.

III.3 Measures taken to promote adoption of new technology

Technical appropriateness of the H.Y.V seed, chemical fertilizer and water package is one thing while effective implementation of the new technology in the farmers' fields is quite another. Adoption of the new technology package by farmers would require along with other things—
(a) irrigation facilities to ensure controlled supply of water for crops,
(b) efficient extension service to help farmers in adoption of new practices,
(c) adequate supply of such inputs as H.Y.V. seeds, fertilizers, pesticides...etc. in appropriate time and at prices affordable to the farmers,
(d) provision of credit to match requirements of increased farm investments on purchase of inputs of new technology, installation of pumpsets and such other things, and
(e) facilities for marketing the increased volume of farm products at remunerative prices.
Various measures have been adopted by government to meet these requirements. Public investment on irrigation has been on the rise. Inputs and implements are being supplied to farmers at subsidised rates. Extension service networks of the states are being intensified. Steps taken to boost the flow of institutional credit to agriculture sector include extension of branches of nationalised commercial banks to rural areas, establishment of new financial institutions (specialised in rural credit) called the Regional Rural Banks, and formulation of National Bank for Agriculture and Rural Development (NABARD) as the apex body for regulation of the rural credit system. A credit linked crop insurance scheme is being implemented in a phased manner in the country. The scheme aims to protect the credit-worthiness of farmers in the event of crop failure. Government has also adopted a practice of annually announcing minimum support prices for fifteen crops and procurement prices (i.e., the prices at which foodgrains are to be procured for the public distribution system) for foodgrains, in order to guarantee minimum selling prices for the products of the farmers.

Desirability, adequacy and methods of implementation of some of these measures are the subjects of a good deal of controversy. A survey of these debates has not been attempted here. However discussions on these measures in the context of agriculture in Assam would come up at a latter stage.
III.4 Impact of the new technology on agricultural growth in India

In trying to assess the performance of the new agricultural strategy, the first thing one tends to consider is its contribution to agricultural growth. It is therefore questioned whether introduction of the new technology has led to any enhancement in the pace of agricultural growth in the country. To answer this question it is necessary to compare the growth experiences of Indian agriculture since the late 1960s with those of the 1950s and early 1960s.

Estimation of growth rate of agriculture sector for any period is a complicated problem involving various methodological issues. According to the estimates of the Directorate of Economics and Statistics, Department of Agriculture and Co-operation, Government of India, production of all crops in India grew at an annual compounded rate of 2.64% during the entire period from 1949-50 to 1985-86. The annual compounded growth rate for the period from 1949-50 to 1964-65 has been given as 3.13% and the same for the period from 1967-68 to 1985-86 as 2.68%. These figures indicate that the pace of agricultural growth has in fact slowed down to some extent instead of having an acceleration since the introduction of the new technology in Indian agriculture. Prof. Nilkanta Rath's study for the period 1955-1978, based on fitting of exponential trend functions to Index Numbers of production of the major crops in India, gives similar results. He finds that the total agricultural
production in India grew at an average rate of 2.48% per year during the 23 years 1955-56 to 1977-78 ....... The rate of growth was somewhat higher, 2.95% during the 10 years ending in 1964-65, than during the subsequent 13 years, when it was only about 2.42%. T.N. Srinivasan however, finds that output and yield of food-grains and all crops grew more or less uniformly over the entire period 1949-50 to 1977-78, with no evidence of either acceleration or deceleration since 1967-68. Studies such as those of S.D. Sawant and Desai and Namboodiri, examining traces of any possible deceleration in the growth of agricultural production since the late-1960s, do not come up with any significant positive evidence in support of the deceleration hypothesis. Similarly, Mahendra Chattopadhyay and Gautam Bhattacharya's exercise with fitting of alternative trend functions, also does not find 'any tendency of shifting of trend curves with introduction of new technology in India'. The safe conclusion therefore seems to be that any step-up in the growth rate of overall agricultural production did not materialise following the introduction of the new technology in Indian agriculture.

A closer look at the growth experiences of the agriculture sector however indicates that sustaining the growth of agricultural production in India probably would not have been possible after the middle of 1960s, but for the introduction of the new technology. During the 1950s and early 1960s, it was on account of increase in total area under cultivation that much of the agricultural growth took
place. But the scope for area expansion to support output growth had become fairly limited by the middle of 1960s. It is the continued increase in yield per hectare which has been primarily sustaining the growth of agricultural product since that time. This becomes evident from the comparison of figures of growth rates of yield and area in the two periods. The annual compounded growth rate of total area under cultivation declined from 1.61% for the period 1949-50 to 1964-65 to 0.41% for the period 1967-68 to 1985-86, while that of yield per hectare registered an increase from 1.30% during 1949-50 and 1964-65 to 2.03% during 1967-68 and 1985-86. The relatively high rate of growth of yield, which is primarily responsible for sustaining growth of agricultural output since the late 1960s, probably would not have been there without the improvement in the technique of cultivation in the country during this period.

Thus while the new agricultural strategy had little success in accelerating agricultural growth in India, it had prevented the possibility of any significant downward slip in the growth rate of agricultural output after the middle of 1960s.

III.5 The new technology and production of individual crops

Among all crops, wheat seems to be the biggest beneficiary from the new strategy of agriculture in India. During the period 1967-68 to 1985-86, wheat production increased at a very impressive annual compounded rate of 5.64%. This was made possible by an yield growth rate of
3.15% and area growth rate of 2.41% per annum during the same period. Wheat also gained steadily in its share in total cropped area, which indicates that wheat cultivation has become relatively more profitable compared to other competing crops after the technological breakthrough in Indian agriculture. The phenomenal success of wheat under the new strategy is the reflection of large scale adoption of new technology in wheat cultivation. By 1984-85, area under H.Y.V. of wheat had gone up to 19.09 million hectares, comprising 81% of total wheat acreage for that year. The success of new strategy on wheat has been aided by factors such as absence of serious problems of pests and diseases with the new wheat varieties and the existence of superior water management systems in a large part of the wheat growing areas of the country (namely Punjab, Haryana and western Uttar Pradesh).

The impact of the strategy is however somewhat less spectacular on the production of rice - India's number one foodcrop. Whereas wheat production had gone up fourfold from 10.4 million tonnes in 1965-66 to 44.9 million tonnes in 1985-86, rice production barely doubled from 30.6 to 64.2 million tonnes during the same period. The smaller extent of the success of new strategy in case of rice is also evident from the fact that by 1984-85 only 22.78 million hectares were brought under H.Y.V. of rice. This works out to a lowly 53% of total rice acreage, compared to 81% of wheat area under H.Y.V. coverage for the same year.
The limited nature of the success of the new strategy in case of rice, can be ascribed partly to technological factors. Compared to the H.Y.V.s of wheat, the new varieties of rice are, as Kahlon puts it, 'more susceptible to bacterial diseases, more sensitive to photoperiod and more subject to risks and uncertainties in agriculture'. Moreover, 'being a kharif crop in most parts of the country, it presents a serious water management problem and for these reasons adoption rate of these varieties is much lower than that of new wheat'. In recent years however, there has been some improvement in the situation following the development of some new varieties which produce rice output of superior quality and which have shown better adaptability to Indian conditions. Another significant development in case of cultivation of H.Y.V. rice is that it is being adopted in a big way in traditionally non-rice-growing areas, where adequate irrigation facilities are available.

According to Dharam Narain, the impact of new technology on productivity of rice has been obscured to some extent by "clouding effects" of "locational shift in rice acreage". As mentioned above, after the introduction of H.Y.V.s farmers in traditionally non-rice-growing areas are taking up rice cultivation on a substantial scale. This has resulted in a shift in the locational distribution of area under rice in favour of non traditional areas. Dharm Narain finds that when the effect of locational shift in rice acreage is eliminated 'the growth rate for pure increase in its per
hectare yield is seen accelerated by about 50%.

Thus the progress of the new strategy in case of rice has been somewhat slower and less dramatic than in case of wheat. But nevertheless the results so far achieved are fairly impressive. Elsewhere in the agriculture sector, the new strategy is yet to make much of impression. Its progress in case of maize, jawar and bajra has been very limited. The strategy has so far been a complete failure in boosting the production of pulses. Nor has it been able to make notable contributions to the production of oil-seeds, cotton, jute and sugarcane. The prime cause of the dismal showing of the new strategy in these areas is the inability to develop successfully suitable H.Y.V.s for these crops.

III.6 The new technology and regional disparity.

One of the criticisms of India's new agricultural strategy is that it has significantly benefited only some selected geographical areas (namely Punjab, Haryana, western Uttar Pradesh), and consequently widened the regional disparities in agricultural production in the country. Studies on inter-regional agricultural performance confirm an increase in the regional imbalance in agricultural production since the introduction of the new technology. For example, C.H. Hanumanta Rao found that inter-state variation in the output of foodgrains as a whole had increased somewhat during the period 1964-65 to 1970-71, the co-efficient of variation (in the output of foodgrains in different states) being 50.5 for the year 1964-65 and 53.6 for 1970-71. The
variation in the output of foodgrains in per capita terms was found to have increased by a much greater extent during the same period, the co-efficient of variation (inter-state) in the output of foodgrains per head of total population recording a significant rise from 34.2 in 1964-65 to 50.3 in 1970-71. V.S. Vyas also found evidence of increase in the regional variation in the per hectare production of foodgrains between the triennia 1959-62 and 1969-70. He further observed that the bulk of the increase in the regional variation in foodgrain production during that period could be accounted for by the performance of the state of Punjab (including Haryana), for, the exclusion of that state from the analysis left the difference in his measure of regional variation for the two periods more or less insignificant. This indicates that the observed increase in the regional variation in foodgrains production in India in the early 1970s was on account of the technological breakthrough in foodgrain production in the two states of Punjab and Haryana.

The increase in the regional imbalance in agricultural production following the introduction of the new technology is a direct consequence of government's policy to initially confine the new technology to selected geographical areas with favourable initial conditions. The rationale for this policy was that given the limited amount of resources at the disposal of the state the strategy would yield better result if efforts were concentrated in selected areas having necessary infrastructure (of irrigation and extension
service), instead of scanting the resources in a thin way through out the country. It was hoped that once the new strategy worked out successfully in these areas, it would gradually spread to other areas subsequently and with that the regional disparities would be reduced. In fact S. M. Dev's study reveals that inter-regional variations of output per area, which had earlier increased in 1970-73 as compared to 1962-65, decline in 1975-78 to the level of 1962-65. The co-efficient of variation in output per capita among the regions was however found to increase continuously from 1962-65 to 1970-73 and from 1970-73 to 1975-78. Mr. Dev ascribes this increase in regional variation in per capita agricultural production mainly to demographic factors, rather than technological factors.

Hence, with the spread of the new technology to agriculturally backward areas in due course, the regional imbalance created in the initial years under the strategy is likely to be automatically corrected.

III.7 The other consequences of the new agricultural technology: the question of equity and employment.

Besides the volume, composition and regional distribution of agricultural production, the new strategy of agriculture has significant consequences for various other aspects of socio-economic conditions in rural India. Of particular importance are the consequences of the new farm technology for equity and employment in the villages. The issues involved are of great importance in the context of
social justice. A sizable volume of literature on this subject has already appeared in prints. But being not quite directly relevant in the context of the present research, the subject will be discussed very briefly here.

Regarding equity, it is often argued that the new strategy has benefited mostly the large farmers, thereby increasing the economic inequality in the villages. Technically the H.Y.V. seed-fertilizer-water package is scale neutral in character, i.e. it can be adopted with equal efficiency for both small and large scale farming. However, the fact that adoption of the new technology package involves sizable investment in buying inputs like fertilizers and pesticides, installation of pumpsets, etc., puts large farmers in an advantageous position. Because of their stronger resource base they usually enjoy easier access to scarce inputs as well as to such things as bank credit and extension service. Thus 'the reason why large farmers have done better under the new technology lies not in their being large so much as in their being rich'. Recent case studies show that small farmers are progressively catching up with the large farmers in adopting new varieties. But the effective rate of utilisation of new varieties has been found to be relatively high for large farmers, the principal reason for the relatively low rate of utilisation for the small farmers being their low resource base. The inequality between the small and the large farmers in adoption and effective utilisation of the new technology therefore can be corrected
by extending infrastructure and credit facilities to small farmers.

Regarding employment effects of new technology, it can be seen that in requiring more careful planting, better weeding and water management, more vigorous plant protection measures, etc, the adoption of H.Y.V.-fertilizer-water package creates additional demand for labour in farming. Larger harvests resulting from the use of the new technology should also increase demand for labour in harvesting and post-harvesting operations. Moreover, in-so-far-as the new technology leads to increase in the cropping intensity, it increases labour demand over the year as a whole. Thus the spread of H.Y.V.-fertilizer-water technology can be expected to increase employment opportunities for agricultural labourers substantially, provided of course, the spread is not accompanied by labour displacing mechanisation of farm operations.

Although adoption of new technology in the form of H.Y.V seed, fertilizer and water package does not necessitate much mechanisation, some farmers — particularly the large ones — may find it convenient to replace labour by capital in different farm operations. There is some evidence to show that mechanisation of Indian agriculture, through the introduction of power-driven tubewells, tractors, thrashers and combine harvesters in farming operations, has been on the rise since 1966. The states of Punjab, Haryana and Uttar Pradesh, in which the new agricultural strategy has already
worked out fairly successfully, have been found to be in the lead in the mechanisation process.

The question therefore arises as to what extent mechanisation negates the positive employment effects of H.Y.V. seed-fertilizer and water package. The question however cannot be answered a priori. For instance, tractorisation has both employment generation effects and labour displacing effects. It displaces labour employment in ploughing and transportation. On the other hand, it facilitates multiple cropping by reducing land preparation time and raises yield per unit of land because of better ploughing of land. These effects are likely to generate more employment opportunity. Thus the net effect of tractorisation on employment may go either way depending on the magnitudes of the labour displacing effects and employment generating effects. Empirical evidence on the nature of the net employment effect of tractors is inconclusive.

While employment effect of tractorisation is ambiguous, mechanisation through the use of combine harvesters and thrashers almost certainly displaces labour employment.

In the face of severity of the problems of rural poverty and unemployment in India, appropriate measures are called for to restrict indiscriminate mechanisation of farming operations in the country.

III.8 The new technology and environment.

Of late, the new technology of Indian agriculture has come under serious criticism from the environmentalists. In
the early years, the implications of the new agricultural strategy for ecology and environment escaped largely unnoticed by the public eye. But with the growing environment consciousness in the country in the last few years, the conservationists' criticisms of the new technology have gained wider public attention and support. It has been alleged that the new agricultural strategy involving the use of H.Y.V.s, water, chemical fertilizers and pesticides has resulted in 'steady depletion of micro-nutrients from the soil and utter degradation of its natural chemistry, lowering of the water table to new depths, sometimes as low as hundred or even two hundred feet, inadequate resurfacing of underground aquifers due to high evaporation losses, destruction of contours of the land leading to excessive water run off and top soil erosion, spread of salinity and waterlogging and poisoning of the air, water, land and vegetation by toxic agro-chemicals at an extensive scale'.

Although all this may appear as a bit too strongly worded, the environmentalists' allegations against the new agricultural technology are not without any substance. The danger posed to the environment by the new agricultural technology cannot therefore be lightly dismissed. It is necessary to take stock of the damage already done and whatever redressing measure is possible should be taken up with a sense of urgency. Further spread of the new technology should proceed along with caution so as to keep its environmental degradation effects to the unavoidable
Research on development of crop varieties more resistant to pests and diseases and less intensive in agrochemicals and, intensification of soil and water conservation measures, assume added importance in this context.

III.9 To sum up, it can be said that the new agricultural strategy in India, popularly referred as the Green Revolution, did not exactly succeed in bringing about a full blown agricultural revolution, but it has contributed significantly in sustaining the growth of agricultural production in the country since the late 1960s. To realise its full potentials, the new agricultural technology needs to be extended to areas in which the strategy is yet to make its mark. But the spread of the new technology should now be pursued with more caution so as to avoid further degradation of the environment in the country. The problems concerning equity and social justice associated with the new strategy are more of institutional rather than technological origin and therefore, these can be solved through appropriate policy measures. As Ladejinsky puts it, "It is not the fault of the new technology that the credit service doesn't serve those for whom it was originally intended, that the extension service is not living up to expectation . . . ., tenurial legislation in general is deliberately miscarried, or that wage scales are hardly sufficient to keep body and soul together. All these are to a considerable degree man-made institutional inequalities. If only some of them are dealt with . . . . a measure of economic
or social justice would be fused with economic necessity, thereby adding another essential dimension to the Green Revolution." Adoption of such corrective measures and their implementation in letter and spirit, is however, a political and administrative matter, involving political will of the government and honesty and efficiency of the bureaucracy.

Notes and references:—


2. Description of the new technology is now available in a large number of writings. Some useful sources are—

   (a) W. Ladeginsky "How Green is the Indian Green Revolution?", EPW, December 1973 (Review of Agriculture).

   (b) Pramit Chaudhuri "Indian Economy, Poverty & Development", Vikash 1978, Chapter 5.

   (c) D.S. Sidhu and A.J. Singh "Technological Change in Indian Agriculture" in "Indian Agricultural Development since Independence" (ed) Indian Society of Agricultural Economics, Oxford and I.B.H., 1986.


4. A discussion on these issues is available in V.M. Dandekar's 'Introduction', IJAE, April-June 1980. More details can be found in No. XIV Seminar on Data Base and Methodology for Study of Growth Rates in Agriculture, Indian Society of Agricultural Economics 1980.


9. B.M. Desai and N.V. Namboodiri "Deceleration Hypothesis and Yield Increasing Inputs in Indian Agriculture" IJAE October December 1983.
14. Government of India, op cit, table 1.54 (1)
16. Government of India, "Indian Agriculture in brief", 21st Edition op cit, table 1.54(1)
21. S.M. Dev "Direction of Change in Performance of All Crops in Indian Agriculture in Late 1970s - a look at the levels of districts and agro-climatic regions.


