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TECHNOLOGICAL CHANGE IN INDIAN AGRICULTURE: EMERGING TRENDS AND PERSPECTIVES*

C.H. Hanumantha Rao†

Let me, at the very outset, express my deep sense of gratitude to the members of the Indian Society of Agricultural Economics for the honour done to me by electing me the President for this annual Conference in the Golden Jubilee Year of the Society. It is quite in the fitness of things that the Golden Jubilee Conference of the Society should be held in Bombay under the joint auspices of the Department of Economics of the University of Bombay and the Indira Gandhi Institute of Development Research. The Society was born and nurtured in the precincts of the University of Bombay and the stalwarts in agricultural economics from this University have been guiding the affairs of the Society during half a century of its existence.

The very first time I attended the Annual Conference of the Society was in its Silver Jubilee Year in 1964 at Anand. The last 25 years have witnessed major changes in Indian agriculture. Undoubtedly, by far the most important among these changes is the introduction and the widespread use of new technology such as high-yielding varieties (HYVs) of seeds and fertilisers. This has helped us to achieve self-sufficiency in foodgrains and improve the productivity of resources in agriculture. Above all, our farmers are becoming increasingly aware of the benefits that can accrue from the application of science and technology to agriculture, and have been responding favourably to the new practices recommended by the Extension Services.

We as professional economists have, by and large, reacted constructively to these developments in Indian agriculture. Apart from holding annual conferences, our Society, under the leadership of Professor M.L. Dantwala and Professor V.M. Dandekar, has been organising seminars on themes relevant to this phase of rapid technological transformation of Indian agriculture. The scholarly papers on such themes appearing in our Journal bear testimony to the deep interest shown by our profession in the processes of this transformation.

I propose in this address to reflect on some of the broader issues bearing on technological change in Indian agriculture, particularly in the light of the emerging trends in the recent period.

It was becoming clear by the mid-sixties that there was no alternative to technological change in agriculture for achieving self-sufficiency in foodgrains. Even those countries in Asia which could carry out radical land reforms and build up adequate infrastructure for agriculture had taken to the path of modernising agriculture. Japan took the lead in this direction and China followed suit even after successfully experimenting with structural changes and mobilisation of growing labour force for capital construction in agriculture.

After the mid-sixties, apart from the introduction of HYVs of seeds for wheat and rice, public investment in agriculture was stepped up significantly. The new technology raised the profitability of investment for the farmers. Besides, in agriculture, there is a high complementarity between public and private investment. As a result, the annual gross capital formation in agriculture, public and private combined, at constant prices, rose much faster

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†Professor, Institute of Economic Growth, Delhi-7.

than in the pre-green revolution period (see Figure 1). This is reflected in the accelerated increase in gross irrigated area. From less than one million hectares per annum during the pre-green revolution period, it increased to about 2.5 million hectares per annum during the seventies. However, owing to the land constraint, the growth of net sown area slowed down considerably. This explains why despite the accelerated increase in capital formation and the introduction of new technologies, the growth rate of agricultural output was no higher than in the pre-green revolution period.

Nevertheless, there was a rapid increase in the marketed surpluses of foodgrains and in the stocks held by the government through internal procurement. This is due to the basic changes in the structure of agricultural production witnessed in this period. First, the breakthrough in foodgrains output occurred in the developed regions in the North-West and in certain parts of the South. The consumption of foodgrains was already high in these areas and therefore a considerably larger proportion of additions to output was marketed. Second, the use of labour per unit of output showed a significant decline, which also resulted in the generation of larger foodgrain surpluses from the rural areas.

There are two other factors responsible for the rise in marketed surpluses and availability of foodgrains. The increase in output during this period has been taking place mainly through the increase in yield per hectare. Therefore, there has been a decline in the ratio of seed to output, although our official estimates continue to be based on the conventional norms. Secondly, the rate of urbanisation has increased and, for various reasons which I need not discuss here, the average per capita consumption of foodgrains in the urban areas has been significantly lower than in the rural areas.

We are used to comparing the performance in the pre-green revolution period with that in the post-green revolution period as a whole. However, the mid or the late seventies mark a definite departure from the trends observed in the early phase of green revolution in several respects. I would, therefore, like to draw your attention to some of the emerging trends in the recent period.

There seems to be some improvement in the growth rate of foodgrains output in the last decade, *i.e.*, 1978-79 to 1988-89, when compared with the first decade of green revolution. Crops such as rice, pulses and oilseeds, whose growth rates in the first decade of green revolution had fallen much below those recorded in the pre-green revolution period, are now showing higher growth rates (Table I). There are thus clear indications that the major inter-crop imbalances in growth witnessed in the early years of green revolution are getting redressed to some extent in the recent period.

Oilseeds and pulses are grown essentially in the rainfed or unirrigated areas. Even for rice, nearly 60 per cent of area is rainfed. The recent experience, therefore, suggests that the disparities in growth between the irrigated and rainfed or dry areas may not be as sharp as in the early years of green revolution. It is also heartening to find that many of the States where poverty is widespread and where the growth of foodgrains output had slowed down in the first decade of green revolution, *e.g.*, Assam, Bihar, Orissa, Madhya Pradesh and West Bengal have shown a much better performance in the last decade. Their performance is nearer, or even higher than, the all-India average. The growth of rice had slowed down considerably in the Eastern States during the seventies. All these States have experienced a step-up in the growth of rice during the last decade and some of them have recorded higher growth than the national average (Table I).

This encouraging performance is basically attributable to the spread of new technology to the lagging crops and regions. The special programmes for rice and oilseeds and increasing attention being given to dry farming and to the less developed States have started yielding results. This is corroborated by the increase in the consumption of fertilisers during the eighties at a faster rate in the Eastern and Western regions than in the Northern and Southern regions. What is more, fertilisers consumed in *kharif* season increased at a much faster rate than in *rabi* season, particularly in the Eastern and Western regions, indicating the spread of new technology to the rainfed and environmentally unfavourable areas. There is also evidence of an increase in the share of the Eastern States in the total gross irrigated area of the country.

TABLE I. STATEWISE COMPOUND GROWTH RATES OF OUTPUT

States	Rice		Foodgrains	
	1967-68 to 1977-78	1978-79 to 1988-89*	1967-68 to 1977-78	1977-78 to 1988-89*
(1)	(2)	(3)	(4)	(5)
Andhra Pradesh	2.66	1.70	2.56	0.41
Assam	0.88	2.12	1.27	1.63
Bihar	0.82	2.83	1.14	3.52
Gujarat	3.39	-0.43	2.23	-4.97
Haryana	11.34	5.12	2.86	3.94
Himachal Pradesh	0.04	-1.14	1.24	0.36
Jammu & Kashmir	1.73	0.09	1.47	0.36
Karnataka	-0.01	-0.44	2.50	-0.58
Kerala	0.54	-2.36	0.48	-2.30
Madhya Pradesh	0.96	5.30	1.23	4.36
Maharashtra	4.79	-0.44	4.84	-0.46
Orissa	-1.00	2.61	0.80	2.59
Punjab	18.21	7.04	5.29	4.57
Rajasthan	10.90	-1.77	3.03	1.37
Tamil Nadu	1.45	0.89	1.69	0.74
Uttar Pradesh	4.06	7.32	4.06	5.16
West Bengal	1.71	5.23	2.60	4.53
All-India	2.16	3.19	2.31	2.68
Pulses	0.27	2.32		
Oilseeds	1.39	3.86		

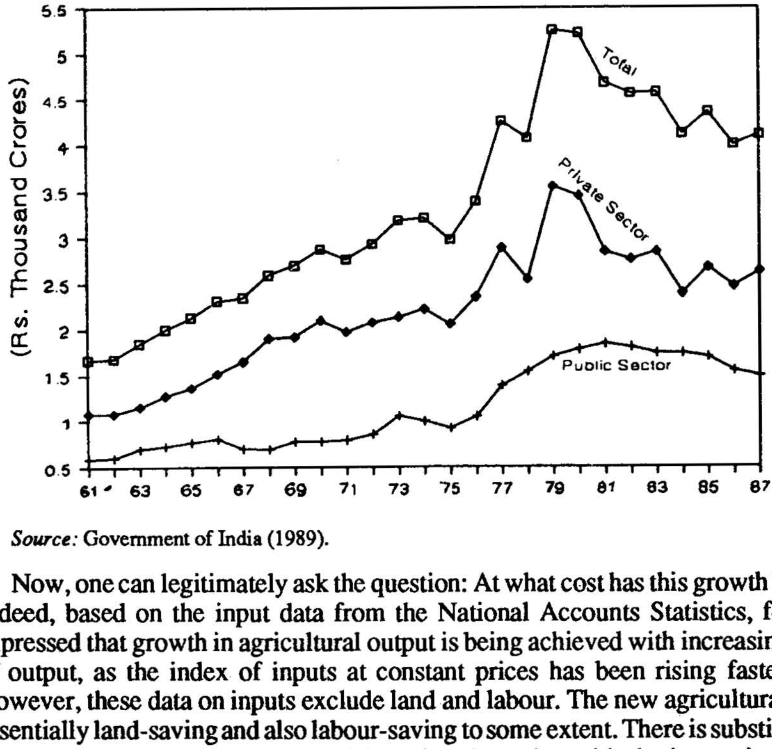
Source: Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India, New Delhi.

* Estimates for 1988-89 are provisional.

However, the picture is not encouraging regarding capital formation in agriculture in the country during the eighties. After showing a steep rise in the seventies, the gross capital formation in agriculture at constant prices, both by the public and private sectors, showed a significant decline in the eighties (Figure 1). The decline in the net capital formation could be even steeper. While the gross irrigated area increased at the rate of nearly 2.5 million hectares per annum during the seventies, the increase in the eighties came down to less than a million hectares per annum, on an average.

The gains in foodgrains output in the last decade have come essentially from the improved utilisation of the available infrastructure and from the increase in yield per hectare. Already, during the first decade of green revolution increase in yield per hectare accounted for as much as 80 per cent of the increase in foodgrains output. During the last decade, there was some decline in the area under foodgrains. The entire output growth in this period is, therefore, attributable to increase in yield per hectare. This underscores the growing importance of yield-increasing technology.

Figure 1
GROSS CAPITAL FORMATION IN AGRICULTURE
(1980-81 Prices)



Source: Government of India (1989).

Now, one can legitimately ask the question: At what cost has this growth been achieved? Indeed, based on the input data from the National Accounts Statistics, fears have been expressed that growth in agricultural output is being achieved with increasing costs per unit of output, as the index of inputs at constant prices has been rising faster than output.[1] However, these data on inputs exclude land and labour. The new agricultural technology is essentially land-saving and also labour-saving to some extent. There is substitution of capital for land and labour. It is not surprising, therefore, that with the increasing application of new technology, the capital inputs should rise faster than output. What we should really be looking for is the productivity of total inputs – land, labour and capital combined.

The estimates of costs of production brought out by the Ministry of Food and Agriculture, Government of India give the latest position in regard to the shares of land, labour and capital in the total costs. Applying these weights to the growth of different inputs, the index of total inputs is seen to be rising at a little less than 2 per cent per annum in the post-green revolution period against the growth in foodgrains output at 2.6 per cent per annum. On this basis, between one-fifth to one-fourth of the observed increase in the output of foodgrains can be attributed to the increase in the productivity of inputs. Commodity-wise, the contribution to the growth of output from the improved productivity of inputs may be nearly 45 per cent for wheat and about 15 per cent for rice (Tyagi, 1989).

Although the growth rate in foodgrains output seems to have improved because of the impact of new technology, the growth performance has by no means been smooth. The instability or the year-to-year variation in foodgrains output has increased in the post-green revolution period. Even within the post-green revolution period, the instability in the last decade (1978-79 to 1988-89) was higher than in the preceding decade. The rural poor, particularly in the drought-prone areas and in the remote areas of the country, continue to suffer from fluctuations in employment and income and inadequate availability of foodgrains in years of drought.

However, this increase in instability cannot be attributed to new technology. Rather, the instability arises from the adverse agro-climatic conditions in which the technology is used. The new seed-fertiliser technology has raised the response of output to water. Thus, for a given variability in rainfall or moisture conditions, the instability in output would be greater. However, when the new technology is applied under assured irrigated conditions, the increase in output would be on a stable path. This is exactly what has happened in the case of wheat where the new technology has made the maximum impact. The rise in instability is significant for crops like rice, oilseeds and pulses. This is explained by the increasing application of new seed-fertiliser technology for these crops in rainfed areas and under uncertain irrigation in the recent period. This suggests the need for stabilising consumption through larger procurement of foodgrains when harvests are good and their liberal release through public distribution system for the vulnerable groups in years of drought.

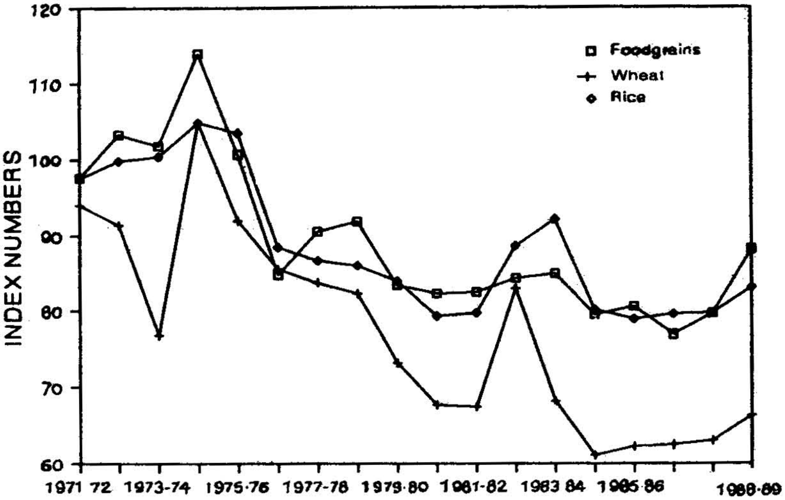
Perhaps the most widely debated issue about green revolution is the growing disparities in income between different regions and classes of farmers. The experience after the mid-seventies covering nearly a decade and half reveals trends which are typical of a diffusion process. These trends are: the spread of green revolution to new areas, the increasing adoption of new technology by the small farmers, the decline in the relative prices of foodgrains (see Figure 2) and the rise in real wages in agriculture in the less developed regions where new technology is spreading.

Even so, the expectation that land-saving technological changes in a labour-abundant economy like India would lead to greater labour absorption in agriculture has been largely belied. The short-duration HYVs of seeds can facilitate an increase in cropping intensity and may thus lead to an increase in labour use. In practice, however, because of the profitability of intensive farming involving the use of large quantity of water and fertilisers per unit of land, there was not much incentive for increasing cropping intensity. Moreover, until recently, the impact of new technology and the expansion of tubewell irrigation was not significant in regions where labour is plentiful. This may explain why the cropping intensity has risen at a much slower rate in the post-green revolution period.

In the early phase of green revolution, large farmers, owing to better access to capital resources, stepped up yields per acre at a faster rate than small farmers. Because of this, in areas experiencing technological change, the inverse relationship between farm size and output per acre began to disappear. In course of time, however, the supply of institutional credit for the less developed regions and small farmers improved significantly (Desai, 1988; Haque and Verma, 1988). As a result of this and also because of improved extension services, the use of new seed-fertiliser technology among small farms caught up with that among large farms. And, because of the continued advantage that small farmers have in respect of cropping intensity, the inverse relationship between farm size and output per net operated acre has started reappearing (Bhalla and Chadha, 1983; Shergill, 1987). However, labour input per acre continued to decline sharply with the increase in the size of holding.

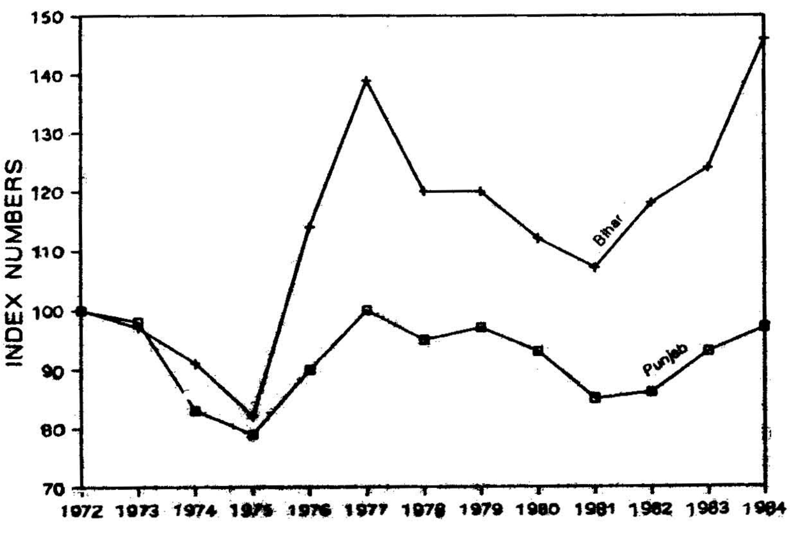
Insofar as large farmers have resumed land for self-cultivation from share-croppers

Figure 2
INDEX NUMBERS OF RELATIVE PRICES
(*1970-71=100; Deflated by Wholesale Price Index*)



Source: Commission for Agricultural Costs and Prices, Government of India.

Figure 3
INDEX NUMBERS OF REAL WAGES
(*1970-71=100*)



Source: Jose (1988).

because of the profitability of new technology, it has led to lower labour absorption and reduced incomes for erstwhile tenants. However, in quite a few places, cost-sharing on new inputs between landowners and share-croppers has become popular resulting in the sharing of benefits from new technology by the landowners as well as tenants.

Even in the early phase of green revolution, the emerging disparities between different regions were more conspicuous than the disparities between different classes of farmers within regions experiencing technological change. The uneven regional growth was mainly responsible for low absorption of labour within agriculture. In a large number of States, especially in those regions where there was abundant availability of labour, the growth of output was too slow to generate adequate employment opportunities. In high growth regions labour was not plentiful and wage rates were high. The sudden rise in the demand for labour in these areas induced mechanisation and labour-saving practices in general. This happened despite the use of migrant labour from the less developed regions for certain operations. The net result was a significant decline in the elasticity of employment with respect to agricultural output for the country as a whole (Rao, 1975; Bhalla, 1987; Vaidyanathan, 1986). At the same time, the inter-State disparities in the growth of output and in output per worker continued to increase from the early seventies through the early eighties (Bhalla and Tyagi, 1989).

However, the inter-State disparities in agricultural wages started declining since the mid-seventies (Jose, 1988; Nayyar, 1987). The decline in disparities in real wages is even more significant. This is because the decline in the relative prices of foodgrains had a greater impact on the purchasing power of wage earners in low wage areas. For example, the disparities in real wages in agriculture between the Punjab, on the one hand and Bihar, on the other, started coming down since the mid-seventies (Figure 3). The real wages in the Punjab having risen significantly in the early phase of green revolution, virtually stagnated after the mid-seventies whereas the real wages in Bihar started rising. The causes for the decline in inter-State disparities in real wages are: the out-migration of labour from the less developed regions to the high wage areas; mechanisation of agricultural operations in the developed regions; the decline in the relative prices of foodgrains; the increase in employment generated in the less developed regions under the poverty alleviation programmes; and the recent pick-up in agricultural growth in these regions. An encouraging consequence of these developments is that the disparity between male-female wage rate has started declining in several States. The use of new technology may have improved the bargaining power of female labour for operations such as transplanting and interculturing on account of the rise in seasonal demand for such labour.

Low income groups, both in the rural and urban areas, would derive greater benefit from the decline in the relative prices of foodgrains, because they spend a larger proportion of their income on foodgrains than the upper income groups. Agricultural price policy has been able to ensure that the productivity gains from technological change are shared both by the consumers and producers. However, consumers seem to have benefited relatively more than the producers from the productivity gains, particularly in the case of rice and jowar. The demand for wheat has been more favourable than for other cereals. So the decline in the relative price of wheat was only about 25 per cent, while the productivity gains amounted to nearly 45 per cent of output growth.

The indirect contribution of green revolution to equity through food security and the decline in the relative prices of foodgrains has perhaps been more significant than its direct impact by way of labour absorption in agriculture. Because of slow growth of employment in agriculture, the employment and income generated under poverty alleviation programmes had to be stepped up by using surplus stocks of foodgrains. From about 20 million man-days of employment generated annually in the mid-sixties, the employment generated under such programmes in the country as a whole amounted to 850 million man-days in 1988-89. These employment programmes together with the income generated under the Integrated Rural Development Programme (IRDP) seem to make up for about half the deficiency in employment generation in agriculture in the post-green revolution period. The relative contribution of these poverty alleviation programmes to employment generation is more significant in the poorer regions where agricultural growth has been below the national average. These programmes have been made possible because of the increased availability of foodgrains from internal procurement.

Pollution of environment due to the intensive use of chemical fertilisers and pesticides has become a major problem in the developed countries. In India, environmental degradation in the rural areas has arisen not so much from the high level of chemical inputs used as from deforestation and extension of cultivation to ecologically fragile areas. Land-saving technological changes by reducing pressure for extension of cultivation and by augmenting bio-mass, contribute to the conservation of fragile areas and regeneration of forests.

Across different States in India, the extension of area under cultivation and the denudation of forests seem to be high where the progress of yield-increasing technology is slow. In such regions, the levels of agricultural income and wages are low and poverty levels are high. Similarly, the pressure from animals such as goats and sheep on forests and common lands has been increasing in regions where growth in crop production is slow. This is because the rural poor supplement their incomes by rearing these animals (Rao, forthcoming; Mellor, 1988). Apart from yield-increasing technology for crops, the use of new technologies in forestry and animal husbandry to raise the yields from trees and animals and to improve management practices are likely to contribute significantly to the protection of environment. The emerging biotechnologies are opening up opportunities for environmentally sound management of agriculture. I shall come back to this aspect a little later.

So far I have discussed the recent experience relating to technological changes in Indian agriculture in the light of the objectives of self-reliance, productivity, stability, equity and sustainability. I would now like to discuss briefly what I consider to be the major issues in technology strategy and policy and the perspectives before us.

The presumption that green revolution technologies have been basically evolved *within* the developing countries in response to the prevailing factor endowments is not an accurate description of the reality. Many of them have been, in a large measure, transferred from the developed country situations and adapted to the specific circumstances of the developing countries. Therefore, it becomes necessary to understand the features of these technologies which are influenced by the circumstances of the developed countries. It is also necessary to understand the circumstances in the developing economies responsible for their transfer and congenial for their adaptation.

Several developed countries, notably the U.S.A. and Japan, experienced major breakthroughs in crop yields during the first two decades following the Second World War. The infrastructures for agriculture, including water management in particular, were very well developed in these countries. The new seed-fertiliser technologies were evolved there to suit the favourable or relatively homogeneous agro-climatic environments. Moreover, agricultural breakthrough in this period followed the industrial take-off. Apart from the availability of industrial inputs, labour was becoming costly for agriculture. This happened in such diverse situations as the U.S.A. where land was not a scarce factor and in Japan where there was an extreme scarcity of land. The new bio-chemical technologies were, therefore, not only land-saving but also labour-saving and highly capital-using. Further, the entire institutional framework including farmers' consciousness and administrative capabilities were conducive to the speedy absorption of new technologies. This explains why the expenditure on extension services as a ratio to the expenditure on agricultural research was very low in these countries when compared with the developing countries.

The challenge of growing population pressure, in the post-war period, on the limited land available was compelling the governments in many of the developing countries to borrow the yield-increasing technologies from the developed economies. It is not surprising, therefore, that land-saving technology was widely adopted in India in the early phase of green revolution in areas where the availability of land per worker was significantly higher than the national average. On the other hand, regions where land was extremely scarce and labour was abundant lagged behind for quite some time in the adoption of land-saving techniques. This is contrary to what the theory of induced innovation would lead us to expect (Hayami and Ruttan, 1985; Rao, 1976; Janvry and Dethier, 1985; Grabowski, 1979, 1981; Hayami, 1981; Pinstrup-Andersen, 1982).

Environmental or agro-climatic suitability of new technology is, to my mind, the most important factor explaining the regional variation in the impact of new technology. It is understandable that the areas endowed with favourable environment should also be resourceful both in terms of investible capacity and institutional preparedness. The regions with low to medium rainfall but served with assured sources of irrigation have proved so far to be most suitable for the profitable application of new seed-fertiliser technologies. These areas are sufficiently exposed to sunshine and are relatively free from the incidence of pests and diseases. It is also not accidental that the top four States in the country in respect of per capita income have taken a lead in the adoption of new technologies. These are the Punjab and Haryana which have assured irrigation facilities and, Gujarat and Maharashtra which are mainly dependent on rainfall. Apart from the resourcefulness of farmers, these State Governments have adequate resources and have relatively efficient and responsive administration.

The role of well-endowed farmers in influencing the priorities in agricultural research has been well recognised. However, the governments in a democratic polity are also subject to pressures from the consumers and the majority of farmers who are resource-poor. The pressures from these groups can prove to be decisive in the long-run in determining the course of agricultural research.

Economists, true to their analytical tradition of treating technological change as an exogenous variable, tended to regard the available seed-fertiliser technology as unalterable. A large body of economists thought that socio-economic policies have to be designed to realise the full benefits from the *given* technologies under the *given* environments. On the other hand, quite a few felt that there has to be modification of environments through infrastructural development and reform of institutions *before* new technologies are introduced.

However, agricultural scientists who engineer the technologies cannot treat the available technology as *given* and unalterable. While the economists were still debating on the socio-economic consequences of the introduction of new technology, the scientists at the International Agricultural Research Centres with rare consensus decided to change the focus of research. They were striving to evolve technologies suited to unfavourable agro-climatic environments, and packages and practices to suit the resource-poor farmers. In India, the view that there was a need to change the environment to fit the technology as well as to develop technology to fit the environment was gaining strength (ICAR and IRRI, 1977;

IRRI, 1982).

The new priorities in agricultural research in India were (*i*) to reduce yield variability in rainfed areas by evolving high stability varieties (HSV) rather than introducing merely high-yielding varieties (HYVs). This requires varieties with multiple resistance to pests and droughts as also conservation of soil moisture; (*ii*) to minimise costs to the farmers through various input-saving practices including biological fixation of nitrogen; and (*iii*) to evolve cropping and farming systems to raise the incomes of farmers by making the optimum use of their resources throughout the year.

These new priorities require greater interaction with field situations through location-specific research, as unfavourable environments are highly heterogeneous. Besides, greater participation by the farmers in testing out research becomes necessary. Greater collaboration between agricultural scientists and social scientists, particularly agricultural economists, is also needed for understanding the socio-economic rationale of the prevailing systems. Such a knowledge would help to tailor technology to suit the resource endowments and needs of the farmers.

The yield increases in the last decade for lagging crops like rice, oilseeds and pulses, have come more from the vigorous extension of available technology to new areas through special programmes than from breakthroughs in technology. This experience underscores the importance of special programmes and input subsidies in a situation where the green revolution of the early period has brought down the relative prices of output, where yield variability is high and where farmers are resource-poor and risk-averse. Special efforts to ensure remunerative prices to farmers, particularly for oilseeds, also had a significant impact. The impact of technology *as such* on yields seems to be more visible in the case of rice.

The results of National Demonstrations conducted on farmers' fields under the Transfer of Technology Projects of the Indian Council of Agricultural Research, suggest a large gap between the demonstration and national average yields and that the yields can be increased 2 to 3 times in all the major crops. However, under similar agro-climatic conditions, the yield gap between the actual and the potential is, in general, no more than 50-60 per cent (Prasad, Choudhary and Nayar, 1987). The yield gap between the actual and the potential seems to be higher under rainfed conditions and during the *kharif* season, suggesting that the input use by farmers may be restricted owing to uncertain rainfall conditions (Table II). Since these yield demonstrations are individual crop-oriented, it is not known how well these new varieties would fit into the cropping systems of the farmers. The deficiency is most glaring in respect of cropping and farming systems research which is perhaps the most difficult area, as it is both multi-disciplinary and field-oriented.

The net returns per rupee invested seem to be higher under irrigated conditions or for rainfed *kharif* crops when soil moisture is adequate. This potential for raising yields and reducing their variability has prompted the integration of the task for genetic improvements in seeds with the measures for soil and moisture conservation in the dry farming strategy (Jodha, 1989). The National Watershed Development Programme which has been designed for rainfed areas with water-harvesting as one of its major components, seems to have taken a shape after years of experimentation and can be expected to yield significant results in the years to come.

The achievements of the Indian Agricultural Research System so far in respect of raising yields and reducing variability in the unfavourable agro-climatic regions are not comparable with those realised for the favourable environments in the early years of green revolution. The tools of emerging bio-technology like genetic engineering, tissue culture, etc., offer significant possibilities for breaking these barriers. Apart from the possibilities for raising yields and improving the nutritive content of the products, bio-technologies will release, to a significant extent, the agro-climatic constraints to crop production by genetically building up resistance in seeds to moisture-stress, pests and diseases and adverse soil conditions. Through these properties and also through biological fixation of nitrogen, costs on chemical inputs can be reduced significantly. Bio-technologies may contribute significantly to the regeneration of degraded environment, as they help to release marginal lands from cultivation of crops, restrict the use of chemical inputs and facilitate afforestation through tissue culture techniques.

TABLE II. RESULTS OF DEMONSTRATIONS CONDUCTED BY ICAR TRANSFER OF TECHNOLOGY PROJECTS

Regions	*Kharif* 1987		*Rabi* 1988	
	Percent difference between demonstration and control yield	Net return per rupee of operating cost	Percent difference between demonstration and control yield	Net return per rupee of operating cost
(1)	(2)	(3)	(4)	(5)
Rainfed				
Groundnut	53	1.23	-	-
Soyabean:	56	1.68	-	-
(Madhya Pradesh)	42	2.00	-	-
Sesamum	61	1.39	54	0.74
Sunflower	63	1.20	38	1.13
Mustard	-	-	100	2.19
Safflower	-	-	68	1.38
Irrigated				
Groundnut	40	1.33	34	1.77
Sunflower	70	1.86	27	1.62
Paddy (Southern States, 1988)	102	2.14	89	2.14
Mustard	-	-	55	1.77
Sesamum (Tamil Nadu	-	-	28	1.29
Ragi (Southern States)	-	-	119	1.56

Source: Computed from data contained in the Reports of the Indian Council of Agricultural Research (ICAR), New Delhi.

Bio-technologies present a wide range of options. Whereas they can potentially be harnessed to suit the difficult environments and poor farmers, they can also be engineered to suit the entrenched interests to the detriment of the poor. The classic example is that of the choice between pest-resistant versus pesticide-resistant varieties of seeds. The former can be pro-poor as well as environmentally sound because of the savings on pesticides, whereas the latter can promote the interests of multinationals doing business in pesticides (RIS, 1988).

The high flexibility of bio-technology enhances the role of research strategy and policy. The role of governments of developing countries for setting up right priorities in bio-technology research and for achieving self-reliance in R&D becomes even more essential than in the case of green revolution technology. Since favourable environments (controlled irrigation under low to medium rainfall conditions) may not account for more than one-third of cultivated area in India even after the full potential for irrigation is realised, it may be desirable, from the point of view of growth as well as equity, to invest in the generation of new technologies for the unfavourable areas (David, Otsuka and Hayami, 1989). The possibilities opened up by new bio-technologies raise the profitability of such investment in agricultural research.

Bio-technologies will save significantly on conventional resources — land, labour and capital. They will be knowledge-intensive and skill-intensive. Therefore, the distribution of gains from bio-technologies will depend increasingly on the access to new inputs and knowledge, on agriculture-industry relationship and on the dependence of domestic agriculture on Transnational Corporations for critical inputs and services. Public intervention to strengthen the human capabilities of farmers, for widening the base of agro-services and for counteracting the restrictive practices of Multinational Corporations is going to be critical for the speedy adoption of bio-technologies as well as for equitable sharing of benefits. The direct contribution of agriculture towards labour absorption is likely to be even more limited than in the case of green revolution. Food-population imbalance is certain to be overcome but access to food through the generation of employment and purchasing power has to become a major concern of development planning in general.

Because of the wide range of options opened up by bio-technologies, there is a greater scope for economists and social scientists to contribute towards the evolution of appropriate technologies (Swaminathan, 1989; Raman, Balaguru and Samanta, 1989). Economists have been active, particularly in the early years of green revolution, in doing ex post analyses relating to the profitability of new input packages, factors influencing the adoption of new technology and how the gains from technology are distributed. Our professional contribution towards the evolution of appropriate technologies, either in collaboration with agricultural scientists or at the policy-making level, has been limited. May I, therefore, suggest that, in its Golden Jubilee Year, the Indian Society of Agricultural Economics may initiate collaborative ventures with the Indian Council of Agricultural Research to bring together agricultural economists and agricultural scientists for evolution of appropriate technologies and for shaping agricultural technology policy.

I have chosen to discuss in my address mainly the issues concerning technology. Needless to say, the declining trend in real public investment in agriculture has to be reversed, if the potential for agricultural growth is not to come down. Among different sectors, public investment in irrigation and flood control showed the biggest shortfall in real terms when compared with the outlays contemplated both in the Sixth and Seventh Plans. States particularly lagging behind are the less developed ones that are short of resources such as Uttar Pradesh, Bihar, Madhya Pradesh and Orissa.

Special programmes and subsidies for lagging regions and small farmers would serve to neutralise the disincentive effects of falling relative prices of output. At the same time, such a policy would ensure the flow of benefits to the consumers from the increase in productivity. Improvement in overall institutional framework for agriculture, including consolidation of holdings and strengthening credit, marketing, extension and input-delivery systems is essential for speedy absorption of new technology and for equitable distribution of gains.

NOTE

1. V.K.R.V. Rao (1983) was the first to draw our attention to the rising input-output ratio in the case of agriculture and animal husbandry. See also Nadkarni (1988).

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