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SCIENCE AND TECHNOLOGY IN AGRICULTURAL DEVELOPMENT – A KEY TO THE FUTURE

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It is an acknowledged fact that application of Science and Technology Transfer were fundamental in the growth of Indian Agriculture. It rose over the past five decades from a state of 'subsistence' to 'surplus' despite being the world's second most populated country. Naturally, such a phenomenal progress has its acknowledged strengths and associated weaknesses. There is a need to analyse the factors and attempt to apply corrective measures.

Agricultural development can broadly be evaluated from two major sectors-Animal and Crop Sciences. An attempt is made in this paper to illustrate, as examples, a few key issues with possible strategic solutions.

Animal Science and Technology in Agricultural Development

The contribution of agriculture sector to the total GDP in 1950-51 was 50.5% of which the share of animal husbandry was 15.5%. During the 1980-87, while the contribution of livestock as percent of agriculture and allied sector rose from 18.6% to 25% in contrast to a reduction of agricultural output from 41% to 33%.

A close look at the achievements (Table 1) shows an annual growth rate of 4.8% in the dairy sector with per capita availability of milk of 185 g per day, per capita availability of eggs increasing from 5 to 30 and of poultry meat from 150 g to 444 g.

Table 1. Production of milk, eggs, meat and wool

Year	Milk (million tonnes)	Eggs (million)	Wool (million kg)	Meat (Thousand tonnes)
1950-51	17.0	5.0	27.5	405
1880-81	31.6	1,006	32.0	802
1889-90	51.4	20,204	41.7	3596
1994-95	63.1	24,553	42.2	4,117

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Table 2. Power availability from energy sources on Indian farms

Source of power	1961 Number (million)	1961 Power MW power	1961 % of total	1971 Number (million)	1971 Power MW power	1971 % of total	1981 Number (million)	1981 Power MW power	1981 % of total	1991 Number (million)	1991 Power MW power	1991 % Of total
Antimate power												
Human	131.10	9780	23.3	126.80	8385	18.7	146.80	10951	12.4	173.00	12906	10.1
Draught animal	80.43	30000	71.6	81.57	30426	60.5	84.60	31556	35.8	80.00	2984	23.3
Sub-total		**39780**	**94.9**		**39811**	**79.2**		**4257**	**48.2**		**44984**	**33.4**
Mechanical power												
Tractor	0.03	671	1.6	0.11	2462	4.9	0.53	11861	13.4	1.14	25513	19.9
Power tillers	0	0	0	0.001	6	0	0.02	119	0.1	0.10	597	0.5
Diesel engines	0.23	856	2.1	1.54	5744	11.4	4.44	16561	18.8	5.10	19023	14.9
Electric motors	0.16	597	1.4	0.61	2275	4.5	4.60	17158	19.5	10.75	40093	31.3
Sub-total		**2124**	**5.1**		**10487**	**20.8**		**45699**	**51.8**		**85226**	**65.5**
Grand total		**41904**	**100**		**50298**	**100**		**88206**	**100**		**129210**	**100**
Net cropped area, (m ha)		133.20			140.30			140.00			141.00	
Available farm power, (kw/ha)		0.31			0.36			0.63			0.92	

Mittal and Srivastava (1993)

The greatest contribution Animal husbandry has made to national economy is its support to the green revolution, particularly the motive power from bullocks valued at 37,000 MW (Table 2). Such stable motive power was achieved through the reduction and control of Rinderpest disease, for which an All India Rinderpest eradication programme was launched in the year 1954. Thus uninterrupted bullock power was provided to Agriculture which was 73% in 1960 though over years it reduced to 23% in 1994.

If the green revoluation has made the country self-reliant in grain production, the technologies developed in the areas of animal Genetics, Breeding nutrition, health care and marketing have made White Revolution possible as an alternative model of rural change with little public investment and incentives. In contrast to Green Revolution, white Revolution narrowed the gap between the rich and the poor; for example, 80% of milk produced in the country comes from small and marginal farmers and landless labourers.

India has large livestock resources among all countries in the world with great diversity of germplasm, the Camel, Mithun, Yak, Pashmina Goat, to cite a few. Historically this country contributed significantly to world animal production. The Red Indian Jungle fowl is the progenitor of the modern commercial layer and broiler breeds, the Indian Runner duck is a source of the best breeds of ducks in the world. Jamnapari was the male parent of Anglo Nubian goats Sindhi, Sahiwal, Ongole, Kankrej and Gir have contributed to the now famous tropical dairy and meat breeds of the world.

India with its formidable 28% ruminant population, the largest goat population and fifth largest sheep population should have been a colossus in animal production in the world and one of the most prosperous economies. In fact small countries like Denmark, Holland and New Zealand have pulsating economies based largely on animal production. A small.country, Israel, today is producing the best broiler stock. Unlike India, countries that have imported our zebu stock achieved high level of prosperity, through the establishment of meat industries. Animal production in the country has been the victim of religious sentiments, prejudices, taboos and chronic dearth of funds for development. Indiscriminate breeding, gross deficiency of nutrients, poverty and illiteracy of the farmer have further compounded the problem. Seventy percent of all livestock in India are owned by 67% of small and marginal farmers, 80% of the milk in the country is being produced by this group. It has been estimated that with the growth rate of 5% in dairy and 20% in poultry sector and overall employment growth of 5.3%, this sector is poised for fast track development, can create the required employment and wealth by removing constraints and adppting new strategies, some of which are indicated below, India can generate sufficient employment potential and achieve higher rates of prosperity.

Strategies

The annual growth rate in animal husbandry sector has been at around 5.4% compared to agricultural sector stationary at 2–3%. These figures do not account for large employment generated by the livestock sector for small and marginal farmers and landless labourers particularly women who get part time employment throughout the year in this sector. No proper methodology to collect this information has yet been evolved. Only maintenance of these animals has been estimated to be 31.6 million manday/year. No information is available for household sector of such estimates for Dairy Industry involving consumption and distribution of 85% of the milk produced in India are yet to be made.

With 1950-51 as the base year, India's milk production has tripled, egg production has increased 500 times, wool production has doubled and meat production from goats and other animals has almost tripled mostly during the last 4 decades. But the achievements were by and large through horizontal increase in the population putting a heavy load on feed burden already large under shrinking land resources.

Future strategies have therefore to be based on a mixed approach of reduction in population size and vertical genetic improvement of animals.

Possible Strategy I: The population growth will continue at the present levels of 1-2% in the large ruminants and at around 7% in small ruminants (goats etc.) with the resultant heavy feed burden leading to: the land degradation, loss of grass cover and environmental polution. The achievements so far will not sustain the kind of growth rate achieved during 80s and 90s and the new genotypes of cattle, sheep and other species will become Desi Mangaroles leading to significant drop in animal products particularly requirements of milk for the large vegetarian population of 1 billion indians. A significant change is needed in the policy frame and mode of implementation.

Possible Strategy II: Genetic improvement of livestock and reduction of feed burden are two major strategic components needing imminent attention. In the area of genetic improvement in livestock, the results of research so far have indicated that: with the present literacy rates, it is not possible to put a performance recording system of livestock on the ground at the village level. Therefore development of methodologies or initiating and sustaining projects based on performance recording of livestock should be given low priority. In contrast, more funds should be invested in areas of molecular genetics which holds promise for selecting bulls, bull mothers based on associated markers of QTLs particularly restriction fragment analysis for linked loci and structural genes responsible for economic traits. This is critical to our system. As a corollary, large investment will have to be made in Embryo Transfer Technologies and transgenics to be used as an adjunct to progeny testing programmes based on farm testing of Sires using multiple ovulation and embryo transfer (Bhat 1974, 1995, 1997).

The policy framework needs radical modification. At present, conducive conditions of bull production particularly for cross bred populations are inadequate. Resources available in Military Dairy Farms of about 30 thousands heads of crossbred female cattle have not been mobilized as had been recommended for the purpose of progeny testing and development of a new strain of cattle called "Frieswal". This programme needs intensification.

Genetic resource conservation of indigenous germ plasm has not made any headway, the Government has yet to have a policy framework on conservation of livestock resources and the investment of funds for this activity have to be clearly earmarked. This is a neglected area and will have a lot of impact on future developments in Animal Husbandry in this country and also in the world. India being a major centre of origin for livestock species, their conservation is of highest importance; the methodology is essentially to bė based on DNA fingerprinting for location of structural genes and micro/mini satellites. 'Baroola' gene for fertility in sheep is available in the Indian sheep, but this gene has been patented by the Australians and is available to us at a cost. Such situations can only be avoided if our investments on genetics of native livestock are enhanced.

Improvement is possible only with people's participation which needs direction. Without direction to the livestock production system in the country, new technologies which have been put in place during the last 40 years will become self defeating.

Vertical genetic improvement will have to be linked with reduction in animal numbers. Any selection programme can go on its own, only till the frequency of genes for high production is increased in the population which is dependent on reduction of genes for low productivity, which calls for a regular culling scheme in the selection process. Unfortunately this is not practised for any species of livestock for various reasons. If the reduction in cattle number is not made mandatory by a policy frame all the feed resources will get exausted by the turn of century as it is already affecting existing feed availability in the country.

Feed Burden

Reduction in population size will obviously lead to a reduction in feed burden. Therefore arguments for increasing area under cultivated forages cannot be sustained especially in view of growing food grain requirement of human population.

To sustain animal production, it has to be based on feeding of crop residues and by-products of industry, particularly crop residues and industrial by-products; oil cake, oil meals from cultivated crops and oil meals from forest produce.

The present research on animal nutrition and physiology has reached a stage that traditional feeding system will not deliver higher productivity levels as the basic raw materials have a low digestibility (2-3 %). It has however a major reserve of energy in the untapped plant cell wall in terms of ligno-cellulose complex and will yield enough energy to feed all the 400 million livestock, if released. This will however require large investments in research on feed biotechnology, of manipulating and constructing microbes which can digest the ligin ring. The current nutrition research has to focus on this area to generate and release carbohydrates from plant cell wall. The source of protein in oil meals and cakes etc. unfortunately is bound by various chemical moieties like tannin and other antigrowth factors and is not readily available to animals. A method has to be found to remove these chemicals from cakes and meals so that the abundant protein available in the meals is available to feed livestock.

The animal health protection system is fairly well organised but needs to be integrated at village level. Keeping pace with global research in animal health should lead to satisfactory levels of protection.

If these two problems are seriously addressed to in the next 25 years, we should be able to become number one nation in livestock production.

Crop Science andTechnology in Agricultural Development

Long and weary milestiones have been crossed with sustained scientific efforts, supporting public policies and sound technology transfer to transform Indian Agriculture from a subsistent past to progressive present. Food grain production, in particular, rose from 179.5 m tonnes in 1992-93 to 191.1 m tonnes in 1994-95 which is projected to stay marginality increased in 1995096. The corresponding growth rate of food production in 1993-94 was 3.7% and of agricultural production 6.3% (estimated). Public food stocks soared to a record level of 36 m tonnes in July 1995 and stood at 24.6 m tonnes at the beginning of 1996 (cf: Economic Survery, 1995-96, Govt. of India). A series of measures was taken to enhance oppottunities to reap remunerative returns from exports; fo instance, 3 m tonnes of rice and 2.5 m tonnes of wheat from buffer stocks were authorised for export, though infrastructure constraints came in the way of execution.

Agriculture still employs two-thirds of India's labour force. There is enormous scope for increasing employment and production in agriculture through higher private and public investment, more and better infrastructure, faster dissemination of location- specific optimal cropping techniques with integrated input management. Higher returns from Agriculture can flow when the bias against agriculture in the overall framework of incentives reducing in the recent past is completely eliminated. Relieving the sectors of agro-industry from licensing control can encourage helthy competition among manufacturers to the benefit of farmers and rural workers. Institutional innovations should be nurtured to make agricultural research and technology transfer more responsive to farmer interests.

The current agricultural scenario needs to be viewed through the trends in total grain production over a period of 4 decades from 1950. It is essential to identify the contribution of majot factors of productivity in achieving the commendable progress. Authentic data (cf: Agricultural Statistics at a Glance, Govt. of India, 1996) on total area, area under high yielding varieties, amount of fertilizers and pesticides used and area under irrigation, for the period 1950-80 at decade intervals and 81-95 at yearly intervals were evaluated through a multipls regression model. The results led to striking inferences.

1. Taking green revolution phase (1965-70) as a reference plane, the gelling of green revolution benefits more than doubled the total production in 1980-81 compared to 1950-51. The post-green revolution phase consolidated production further giving an increase of about 40% during 1990-91. The pace has slowed down to about 9% now

Table 3. Compartive growth in factors of productivity and total grain production

Period	Y	A	V	F	I	P
Pre-green revolution 1950-51	50.82	97.32	o	0.69	17.6	2.35
Green revolution 1980-81	129.59	126.67	43.08	55.16	54.1	45.00
Post-green revolution 1990-91	176.39	127.84	64.98	125.46	70.8	75.00
Current	191.09	123.35	71.27	135.64	77.9	63.27

Y = Total production (million tonnes); A = Total area (million ha); V = Area under high yielding varieties (million ha)I F = Amount of fertilizers used ('000 tonnes); I = Area under irrigation (million ha); P = Amount of pesticides used ('000 tonnes)

(1994-95) (Table 3).

This trend has not been reflected in total cultivated area which remained unchanged between 1980-90 and marginally decreased in 1995 while increases in the use of high yielding varieties, irrigation and pesticides were evident from 1980-81 to 1990-91. The increase was more than double in fertilizer use during the same period. But other than a 10% increase in irrigation between 1990-91 and 1994-95, other factors were almost stationary of slightly decreasing.

2. The trend in total grain production from 1950-95 fitted a multiple linear regression almost perfectly. Almost all the variation in total grain production (99.5%) was explained by the five variables. The stepwise regression analysis revealed that area under irrigation alone accounted for 95.8% variation in total grain production, while total cultivated area and area under high yielding varieties (HYV) accounted for 1% variation each (Table 4). The contribution of pesticide and fertilizer application ranked still lower with 0.8% each. In fact, irrigated area has increased from 42.7% in 1980-81 to 63.2% in 1994-95. It is revealing that HYV did not sustain

Table 4. Trend analysis of India's total food grain production during 1950-95 Analysis of Regression Trend

Source	d.f	m.s.	
Regression	1	21986	
			R = 0.995
Deviation	10	121	

Regression Trend Equation

$Y = -119.2+1.82\,A + 2.24\,V + 0.08\,F - 0.28\,I - 0.93P$

Rank	Variable	P
1	I : Area under Irrigation	95.8
2	A: Total cultivated Area	1.1
3	V: Area under HYV	1.0
4	P: Amount of pesticides	0.8
5.	F: Amount of fertilizers	0.8

d.f. = degrees of freedom; m.s. = mean squares; ** = F test singnificant at 1% level; Regression variables as in Table 3; P= % of totak variation account for; HYV = High yielding varieties the initial momentum they gave the total production during 1950-80.

3. A close look at the association between pro ductivity of crops with the area covered under irrigation points out that increased coverage under irrigation in rice was accompanied by commensurate increase in productivity but such association was quite subdued in wheat (Table 5). The area covered under irrigation in pulses and oilseeds is quite low yet. Relatively higher response in productivity was observed with increase in irrigated area in pulses compared to oilseeds.
4. Most of the land holdings are marginal (less than 1 ha) or small (1 to 2 ha) (Table 6). In fact, 58% of holdings are marginal and 18% small accounting jointly for more than three-fourths of available holdings. Less than 2% holdings are of the size of 10 ha or more. This would restrict permeation of cultivation technologies using sophisticated farm machinery, particularly mechanical harvest and processing of produce. Technology generation must therefore be geared to the needs of small and marginal farmers.
5. As we know, all efforts to accelerate production and productivity and to plan for earnings from agricultural products have to encounter ever-increasing population. Recent census figures re-emphasized that India is set to become world's most populous country by 2040 A.D. The data of the country-wide census from 1981 to 1991 collected by more that 100 million enumerators have now been analysed. The present population growth rate is 50% more than desired level. The present trends indicate maximum growth in Northern States, particularly in U.P., as a result of increase in birth rate and a simultaneous decline in death rate. While Kerala and Tamilnadu have achieved a total fertility rate of 2.1, M.P. will not reach this

Table 5. Trend in Productivity and area under irrigation in major crops

Crop	1959-60		1979-80		1994-95	
	Y	I	Y	I	Y	I
Wheat	7.7	31.8	14.4	68.3	25.6	80.3
Rice	7.4	35.8	10.7	42.8	19.2	46.1
Total Pulses	4.8	8.5	3.9	8.8	6.1	10.0
Oilseeds	4.7	3.1	5.2	12.6	8.5	22.1

Y = Yield (q/ha); I = % area irrigated; a = as on 1989-90; Data from Agricultural Statistics at a Glance, Govt. of India, 1996

Table 6. Trend in Productivity and area under irrigation in major crops

Category	No. of holdings ('000)		Size of holdings (ha)	
	1985-86	1990-91	1985-86	1990-91
Marginal (< 1 ha)	56.1	62.1	0.39	0.40
Small (1 to 2 ha)	17.9	20.0	1.43	1.44
Semi-medium (2 to 4 ha)	13.3	13.9	2.77	2.76
Medium (4 to 10 ha)	7.9	7.6	5.96	5.90
Large (> 10 ha)	1.9	1.7	17.21	17.33
Overall	97.1	105.3	1.69	1.57

figure till beyond 2060, Rajasthan will reach the same by 2048, Bihar by 2039 and U.P. after 2100. However, India's crude birth rate has come down from 34.9 in 1981 to 32.7 in 1991, with corresponding firgures of four or more births from 37 to 30%. Yet India is sitting atop a ticking population bomb that needs to be urgetly defused by eliminating hunger and malnutrition through production and productivity jumps further providing food security and stability.

The above scenario reflects our strengths and opportunities in the light of weaknesses and threats. We need to ask crucial questions concerning our agriculatural science and technology to plan realistically for a food-secure future.

1. The profile of Agriculture is dynamic, it is projected as a profitable profiession, industry and modern science. It is the sector that has to bring up an equitable and hunger-free growing population in India. It has to become more and more successful in small and marginal holdings of a farmer milieu.
2. In the light of global conventions including World Trade Agreement and Intellectual Property Rights, we have to address key issues like biodiversity, biosafety, global competition and public-private sector synergy in the process of providing self-sufficient and export-oriented agriculture.
3. Search-light concepts like genotype substitution (Mexican wheats) and genotype reconstruction (dwarfing genes) essentially in wheat followed by rice are a few factors that transcended food production from a state of gloom to glory. But the glory is fast-fading as the concepts have given their best dividends. Yet convential crop breeding cannot be completely substituted both from viability and accessibility points of view. How fast and how soon modern breeding based on molecular approaches would take a lead remain to be seen.
4. While we are conscious of the need to check environmental degradation, we are still way behind checking human resource erosion. To promote frontier science with forward-edge we need to foster quality science and scientists. Innovative science needs to be recognised over imitative nibbling and below-par research. Lopsided research funding needs corrective measures to encourage young and bright scientists in shadow. While we are fairly clear about the Preparing-for-Furture phase, we are still to determine the path to face and shape it.

   It is difficult to deal with every one of the issue and offer remedies. Therefore, one important current issue with possible remedies is thaken up as an illustrative example.

Molecular Approaches to Crop Improvement

One can hardly look into a journal nowadays without exciting possibilities projected by emerging biotechnologies. Super-plants that can produce its own requirement of nitrogen fertilizer, plants that can be grown in poor soils on which cultication is difficult, if not impossible, micro-organisms that can attack their relatives that cause damage to crops, gold-munching Thiobacillus bacteria thriving on oxidising sulphide ores opening up environment-friendly bio-leaching for extracting copper from refractory ore and such an endless list promise unparallelded advantages to agriculture. Soon we will have to get seriously involved in the Bio-revolution and Bio-industry, if we have to usher in a second or ever green revolution. The green revolution served as a vital development with an assured direction in its time and circumstances. The evergreen revolution has to take the current scenario into account in the backdrop of global science and technology promising to lead to a bio- revolution.

Biotechonology over years has become time-efficient and income-oriented. The alternative paths to produce (a) insulin without animal extracts, and (b) interferon and growth hormones are two examples. Agricultural biodtechogy was projected to have a potential of 61.9% of an estimated US $ 50 billion market (Table 7) followed by agrochemicals (20.6%).

At the same time, it is important to be aware of the new problems and negative impacts of bio-revolution. According to US Office of Technology Assessment (OTA), the recent spectaculat advances in molecular biology in the U.S. have areisen from basic research, most of which is federally funded and carried out in university laboratories' but the advances were commercially exploited by transnational companies (TNC). Some US universities receive funds from TNCs like Monsanto, Bayer, Hoechst and Lubrizol and it is not uncommon that research is directed by the interests of the funding agency. Application of biotechnology can also lead to substitution of important imports from developing countries. For instance, HFCS (High Fructose Corn Syrup) extracted from corn by new enzyme techniques can be interchanged with sugar. HFCS has started to replace sugar in USA and Japan, the two important export markets with the result that sugar exports to the U.S. from Carribean, for example, shrank from $ 686 million in 1981 to $ 250 million in 1985 (Hobbelink, 1987; full reference in Table 7 footnote). A similar situation exists for protein production where protein feed base of soybean is threatened by single cell protein production in which modified microorganisms are set to work to make proteins in huge fermentation tanks. Product interchangability is thus a threat; crops as such are no longer raw materials, but the compounds in them-starch, proteins, oils and fats. No doubt biotechnology, production will increasingly tend to tilt the market prices lower to the potential disadvantage of countries with weak agricultural production and/or market infrastructure.

Table 7. Potential of an estimated US $ 50 billion biotech market by sectors

Sectors	% of total market
Agriculture	61.9
Animals	2.1
Chemicals	20.6
Aquaculture	1.0
Pharmaceutical	10.3
Food Ingredients	4.1

Source: UNCSTD, ATAS Bulletin 1:14 (1984) quoted in Biotechnology and Third World Agriculture: New Hope or False promise? by Hobbelink, H. ICDA (1987) 72 pp.

Biotechnological tools are more apparent and applied in the area of biotic stresses. They provide tools to increase pest resistance in agricultural crops but they do not automatically cause a break-through in resistance-breeding. Most of the advances are on one gene-one pest situations. Polygenic resistance is still far from the grip of biotechnological tools. Further, it is also common that research is devoted to make crops resistant to pesticides than to pests. Thus the frail and fine balance between biotechnological benefits (new opportunities) and conventional crop improvemetn strategies (existing strengths) has to be maintained with clinical precision if our Agriculture has to bypass the inherent threats and dangers of the emerging opportunities.

To cite a few points deserving attention-

a. It is true that we could quickly employ the concepts of genetic reconstruction to produce high yielding (HYV) varieties of wheat and rice that brought to bear on a green revolution and sustain it. But the response to such concepts is receding over time. Genotype substitution alone does not help any more. We need intensive basic/strategic research which takes ground information as the base and develops strategies to optimise agroecological system output. Obviously, HYVs alone cannot be the sole strategy. In the light of our earlier trend analysis of foodgrain production, there is a need for emphasis on crop varieties with substabtially high yield potential, optimal crop-soil-water synergy, genetic resistance compatible to IPM and internationally acceptable quality which can profitably fit in a cropping system adaptable to small and marginal land holdings.

b. It is time that we develop concepts to generate such crop varieties in preference to identification of suitable varieties from a milieu. We must work on innovative lines and keep in secondary hold the development of marginally superior varieties identified usually on repetitive, routine and large scale trial and evaluation. We know that even somachlonal selection and its genetic incorporation have given competive varieties in mustard and lathyrus, for example. But they should not stand as isolated instances. It is time to blend conventinal and modern concepts and develop conceptual leads that are only heritable by the second line of researchers who enter the field with energy and expectations. We must admit that we have a vast gap between genetic targeting and the trial-and toil process of securing a new variety. To fill the gap is not an easy task; for, concept generation, application and realisation of targeted pruduct with an extent of reliability require research innovation needing a strong interface between several scientific disciplines.

c. At present, research infrastructure for innovative research in frontier areas like molecular biology is far inadequate. Despite some extent of funding, and even initial build-up of some facilities, the up-time of equipments and useful work turnout remain below standard. Modern research with a cutting edge would need capable human resources; a lot remains to be done in this area.

d. Innovative agricultural outputs, be it a variery, a planting pattern, a technology to save crops from pest damage, need an intensive program of extension from lab to land. The system has now to associate in it the vital component of technology transfer to the grass-root level. Instead of using a transmission channel from resarch worker to extension scientist to farmer, it will be beneficial to build a direct link among those involved so that problems cropping up in the recipient land can be understood and solved without time lapse. The weak links in this activity need strengthening.

e. Irrigation or water, in general terms, has been shown to be a potential variable influencing total production. Yet a large percentage of area in the country is still rainfed. Therefore, there is a need for developing varieties with high water utilsation efficiency and also for water conservation and utilization techniques. Though this area has been identified, result-oriented program approach is still to make significant inroads.

As mentioned earlier, a large number of issues needs thoughtful implementation. The emphasis is particularly right provisions coming into operation. But there is optimism that India which came up from adversity to limelight, can again reorient itself to realise the fruits of bio-revolution.