SOME REFLECTIONS ON AGRICULTURAL PRODUCTIVITY IN EASTERN INDIA

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Introduction

Eastern India comprises West Bengal, Orissa, Bihar and Eastern U.P. This region is interesting in many respects, more so agriculturally. The data compiled in Table 1 provide some basis for comparison on parameters related to agricultural activities. There are many similarities among the three States and Eastern U.P. Not only so, they reveal nearly similar types of constraints which stand in the way of arriving at the agricultural potential of the region, which has been assessed quite high. In view of shortage of foodgrains in particular, and of agricultural products in general, the region of Eastern India has been receiving attention both at the Central and the State levels. The cropping pattern of this region is dominated by rice cultivation. Hence, programmes for enhancement of rice production in this region are justifiable. For long a monocropped region, some parts of it have shown fairly high yield of wheat during the rabi season, and of rice again in summer, i.e., boro. These facts, coupled with some isolated achievements in crop production seem to provide a silver lining to an otherwise gloomy picture of agricultural development in Eastern India. The setting up of a Committee recently by the Reserve Bank of India to examine the pros and cons of agricultural productivity in Eastern India is indication of the concern for this region, and perhaps of a hopeful approach to the solution of what afflicts it. Its contribution to the total foodgrains is not inconsiderable, 23% of the total population occupying this region producing 28% of the total foodgrains. When, therefore, even in the wake of high production in other parts of the Country, Eastern India has lagged behind, there is justifiable concern as to what has gone wrong with it.

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Agroclimatic Zones

Agricultural productivity in Eastern India is dependent upon the behaviour of the monsoon. It has been the practice, therefore, to delineate agroclimatic zones or agroecological zones and allocate cropping patterns suitable for each zone. Because the classification into zone is broad-based, there is some degree of flexibility in the choice of crops appropriate for each zone. Moreover, there is likelihood of overlap between zones, because the administrative boundary may not follow the agroclimatic principles. In each of the State of Eastern India, agroclimatic zones have been evolved on the basis of long experience of a more or less stable cropping pattern in each zone and according to the rainfall, soil characteristic temperature, altitude and such land features as slopiness, undulation etc.

The National Commission on Agriculture proposed an alphanumeric system to express the rainfall pattern based on its amount and distribution, and classify zones having the same pattern. This clasification can be made broadly at the State level or, if data are available and detailed classification is necessary, the zoning may be done at the district or even block levels. Each such zone may then be set against the existing cropping pattern. Depending on how a particular cropping pattern performs in a zone having a particular rainfall pattern, modifications of the cropping pattern suggest themselves.

Instead, the Eastern region may be taken as such for broad agroecological classifications, cutting across State boundaries. Such attempts are valuable in the sense that some principles of general agricultural planning may emerge out of them. The exercise made for the categorisation of zones is based on a study of rainfall and agricultural productivity and their variabilities observed over a long period. It is expected that each zone exhibits a stable agricultural production, commensurate with its characteristic. On a long time-scale the cropping pattern and the productivity levels in a zone, no doubt, attain a certain amount of meaning and stability. But variability of monsoon and unpredictability of rainfall pattern offset expectations, especially for seasonal crops. The variability may be of such an order that no seasonal crop can adapt. For such stituations contingency or emergency crop planning is the answer. This measure is admittedly difficult for even an organised sector, what to say of the millions of small and marginal farmers.

TABLE 1
Parameters related to agricultural activities—Eastern India

	West Bengal	*Orissa*	*Bihar*	*Eastern U.P.*
Density of population (N/Km^2 1981)	614	169	402	484
Per capita plan outlay (1980-81)	105	94	71	89
Rural population (%)	73.5	88.2	87.5	88.1
Agric. worker (% of total, 1981)	55	75	79	77
Expenditure (Rs./agric. worker, (1974-78)	610	524	379	642
Proportion of holding below 2 ha.	87.1	75.7	86.6	92.0
Proportion of holding below 1 ha.	66.5	46.6	72.6	79.0
Average size of holdings (ha.)	0.99	1.60	1.01	0.74
Gross irrigated area (% net sown 1978/79)	30.2	27.8	22.8	53.0
Major and medium irrigation potential utilised (% 1981-82)	94	99	72	85
All sources irrigation potential utilised (%. 1981-82)	39	29	28	26
Cropping intensity (1977/78)	142	136	133	140
Proportions of cereals area under HYV (1978-79)	40.2	22.3	42.8	47.4
Fertiliser consumption (Kg/ha, 1981-82)	32.8	9.9	18.0	49.6
proportion of villages electrified (March 1981)	45.3	43.4	43.2	33.0
Power used in agric, (KWH/capita) 1978-79)	1.3	1.4	3.1	—
Foodgrains production (Kg/ capita)	143	196	131	165
Foodgrains yield (Kg/ha. 1980-81)	1290	780	928	1070
Growth rate of foodgrains production (during 70's)	1.29	0.42	0.84	2.38
Cultivated area (% of total)	96.3	89.3	77.0	92.9
Area under rice (% gross cropped)	71	68	50	35
Area under wheat (% gross cropped)	3.3	1	16	32
Area under nonfood crops (% gross cropped)	10	20	7	—
Average annual rainfall (mm)	1472 (Gangetic) 3099 (Sub Him)	1229 (Plain) 1349 (Plateau)	1289	—
More than 75% rainfall during	June-Sept.	June-Sept.	June-Sept.	June-Sept.

I have not deliberately mentioned the various agroclimatic zones into which the States have been divided or the agroecological zones into which the region of Eastern India has been divided. These zones are broad and somewhat arbitrary, but may be conveniently divided further into subzones to enable better formulation of action plans for optimising agricultural productivity.

Agricultural Productivity

The term agricultural productivity is commonly used to express the capacity of a soil environment or an agroclimatic or agroecological zone to sustain growth. It is known as yield and is measured, for crops, in kilograms or tonnes per hectare. But one can try to understand productivity of a crop in other ways.

Productivity, being a plant characteristic may be expressed as yield per plant. On this basis the number of plants per unit land area determines yield per hectare, say. It is for this reason the agronomist first of all tries to find out the optimum spacings between plants and between rows. Since competition between plants is the main issue, this can be offset by using high dose of fertilisers and short spacing. This ensures high yield per hectare. But this step of increasing productivity is possible theoretically as it is neither parcticable nor economical.

Since the period covering sowing to maturity of crops varies, another comparative measure appears to be yield per unit of area per unit of time. Responsiveness of plants to fertilisers and water makes it possible to express productivity in terms of unit weight of fertiliser or water. This productivity is more a characteristic of the plant than the soil. But to the extent that the soil is capable of delivering water and nutrients contained in it to the plant, it is also a measure of soil productivity. Optimisation of productivity, therefore, hinges round a proper understanding of the soil-plant-water relationships.

Since the end value of a crop is determined by its use, one may still examine the significance of productivity by measuring it not only in terms of either area or time or fertiliser or water but also in terms of the protein or amino acid or carbohydrate or sugar or nicotine or vitamin or fibre or whatever the useful plant constituents may be. The quality of the crop is reflected in its price and hence the latter may also be regarded as a measure of productivity. The cost benefit ratio is such a norm.

Soil Productivity

It was believed that our soils are too poor to sustain high crop growth. As proof of soil poverty is cited the almost proverbially low yield of crops. It has gradually been realised that crops themselves were genetically low fertiliser responsive and hence a high dose of fertiliser was ineffective and proved uneconomical. The same soils can sustain growth of high yielding varieties giving as high as 2-3 times the previous yields, primarily because the plant types are highly fertiliser responsive. However, the soil factor is not altogether irrelevant. The soil should be capable of improved management, responsive to irrigation without creating any adverse situation. The soil capability as referred to here has not been quantified, nor can it be quantified in terms of increased yield because of the multiplicity of factors involved. Possibly, the water holding capacity, profile characteristics ensuring at the same time drainage and satisfactory irrigation, content and nature of clayminerals are the major soil factors which can sustain the high yielding varieties. But no attempt has so far been made to evaluate the contribution of each of these factors to yield.

The soil-water-plant relationship which determines soil productivity may be illustrated as follows. A variety of aman rice gives optimally a tonne or a tonne and a half during the kharif season on a soil, but the same variety on the same soil gives two and a half times to three times yield under irrigation, i.e., regulated water supply, during the rabi season. The latter is characterised by clear sky and good photosynthetic activity and allows application of water according to the crop's need, unlike what happens in the kharif season having many cloudy days and uncontrollable rains. The soil is thus capable of expressing its productive capacity provided its environment is favourable.

Source of Growth

Let me devote some more time to bring home the implications of productivity. The statewise contribution of output and area to growth rate of all crops was calculated from data available from 1949-50 to 1964-65. As an illustration the figures for West Bengal, Orissa, Bihar, and the whole of U.P. (that of Eastern U.P. was not considered) and also of all-India are quoted in Table 2.

The differences in growth rate due to productivity arise out of number of factors enumerated earlier. A rough attempt has been made to split the productivity factor for India as a whole in the last.

column of Table 2 into three elements or sources of productivity as shown in Table 3. The change in yield is contributed by the high yielding varieties. Because of improved farm management and availability of suitable varieties, cropping patterns have changed in favour of multiple cropping, which has also contributed to the yield increase. The interaction is indeed the difference. As already mentioned, in the case of high yielding varieties and choice of cropping patterns, the soil characteristics are inherently significant but not quantified.

TABLE 2

Statewise contribution of output and area to growth rate

State	*Output*	*Area*	*Productivity*
West Bengal	1.94	0.59	1.34
Orissa	2.48	0.81	1.66
Bihar	2.97	0.71	2.25
Uttar Pradesh	1.66	0.72	0.94
All-India	3.01	1.21	1.77

TABLE 3

Three elements of productivity factor

Source of growth	*Growth rate* (%)
Yield	1.41
Crop pattern	0.47
Interaction	0.16

From a knowledge of the area change and fertiliser used in the different States the contributions of each of them to growth rate of output of all crops may be calculated. These calculations are given in Table 4. Other inputs include irrigation. No State seems to have had a large enough increase in the ratio of irrigated to unirrigated area to account for more than 10% increase in production during the period under consideration. The remaining inputs are improved seeds, pesticides, mechanical power, improved tillage, etc. each of which plays its respective role. Even if they are quantified, we shall not get an absolute idea of the contribution made by soil alone. For instance, the amenability of soil to better management is as much due to machines employed as to the soil itself.

TABLE 4

Contribution of area change and fertiliser use to growth rate

State	*Percentage contribution*		
	area increase	*yield increase*	*other inputs*
West Bengal	29.0	22.5	48.5
Orissa	30.9	7.5	61.6
Bihar	22.1	9.1	68.4
Uttar Pradesh	40.7	13.5	45.8

Cost-benefit ratio

From an economic point of view yield data alone per unit area may not give the correct picture, particularly if a high yield has been obtained with the help of high cost inputs. In such cases, the cost of cultivation, inputs and outputs have all to be considered to calculate the economic feasibility or otherwise. Again, a comparison of cost-benefit ratios may be misleading in case where the amount of input and hence its cost are perforce smaller, as in the case of local varieties than the high yielding ones. This sort of situation is observed in the data given in Table 5. C3282 has a higher cost-benefit ratio but the net return is lower than either of the two other varieties. The cost of cultivation of high yielding varieties is high as also that of plant protection chemicals. Even then the high yielding varieties are profitable because of the high yield and from the point of land utilisation.

TABLE 5

Kharif : W. Godawari : 1970-71

Variety	*Yield Kg/ha)*	*Fert. cost/ha (Rs)*	*Grain value/ha (Rs)*	*Net returns ha (Rs)*	*Fertiliser cost-benefit ratio*
Pankaj	4532	327	2311	1984	6.1
Jagannath	4467	327	2680	2353	7.2
C3282	3658	108	1865	1757	16.3

Data such as those given in Table 6 often upset the economics of high yielding varieties on the grounds of higher cost of cultivation of and lower price fetched by high yielding varieties because of their relatively inferior quality compared to the better local varieties. Economic yardstick is, therefore, to be cautiously employed for the purpose of measuring productivity.

TABLE 6

Cost of Production

Varity	*Cultural opera-tion*	*Materials*	*Yield q/ha*	*Price Rs./g*	*Value Rs.*	*Cost of prod. Rs./q*	*Net income Rs./ha*
IR-8(Kharif)	285.8	320.0	47	56.7	1064	32.3	1218
HR-35(Kharif)	274.2	274.0	41	65.7	1068	34.3	1435
GEB(Kharif)	245.0	266.0	42	81.0	1353	31.0	2215

As already pointed out, a strict comparison of productivity is in terms of yield per unit of area per unit of time. According to this measure, the high yielding varieties can be sorted out in order of their productivities as shown by figures given in Table 7 for five varieties of paddy.

TABLE 7

Rabi : W. Godavari (1969-70)

Yield	*IR-8*	*Jaya*	*Padma*	*Hamsa*	*SLO 16*
Duration (days)	128	124	117	112	104
Yield (Kg/ha)	6136	5527	4613	4069	3424
Yield (Kg/ha/day)	47.7	44.7	39.1	36.0	34.0

The figures given in Table 8 are not of yield alone on the basis of per hectare per day, but also those of edible matter, calories and protein. These refer to the end value of the crops and not merely the gross yield. These calculations are made on the assumption of the average protein and calorie contents of the food constituents and proportions of edible matter to dry matter production. The latter are 50, 50, 81, 80 and 58 per cent for wheat, rice, potato,

TABLE 8.

Yield per hectare per day including edible matter, calories and protein

Crop	*Duration (days)*	*Yield (Kg/ha)*	*Edible dry matter (Kg/ha)*	*K. calorie $\times 10^{-3}$/ha*	*Protein (Kg/ha)*	*Yield Kg/ha/ day*	*Edible dry matter Kg/ha/ day*	*K. cal /ha/ day*	*Protein Kg/ha/ day*
Wheat	150	890	780	3.08	107	5.9	5.2	20.5	0.7
Rice	130	1,550	950	3.75	76	12.0	7.3	28.8	0.6
Potato	100	7,400	1,850	7.14	118	74.0	18.5	71.0	1.2
Sugarcane	300	47,600	9,520	38.08	—	158.0	31.7	126.9	—
Groundnut (with shell)	120	770	500	2.97	135	6.5	4.2	24.8	1.1

sugarcane and groundnut respectively. On the basis of these figures potato stands out as a superior crop. One may argue in favour of potato to be grown in preference to other crops. The fallacy underlying such a generalisation is obvious, because potato cannot be grown on all soils and climates. The same is true for the other crops. Here comes the soil productivity into consideration. Depending on the soil and agroclimatic situation a rationalisation of cropping pattern on the basis of yield as well as protein, calorie, oil etc. per unit of land area per unit of time can at best be attempted. Whatever the yardstick of productivity, the part played by the soil is clear but its quantification does not seem to be easy and forthright.

Removal of Nutrients by Plants

There is another dimension to soil productivity upon which I would like to dwell at this stage. For this purpose let us examine the part played by soil in supplying plant nutrients. Analysis of crops shows that the latter remove from the soil for their nutrition much larger amounts of nutrients (NPK) than are supplied in the form of fertilisers. From the data analysed for the period 1960-61 to 1973-74 show that in 1960-61, the added nutrients in the form of NPK ($N+P_2O_5+K_2O$) fertilisers constituted no more than 5 per cent, so that the remaining 95 per cent NPK requirement for foodgrains (which amounts to 6.66 million tonnes) has been provided by the soil. As production has increased the amount removed has also increased, of which roughly 10-30 per cent is added as fertilisers the rest coming from the soil itself. The 1973-74 figures reveal that the total nutrients removed by foodgrain and non-foodgrain crops amount to 12.34 million tonnes, of which foodgrain crops accounted for 9.18 milllon tonnes. But the nutrients added as fertilisers are no more than 2.84 million tonnes.

These figures show that the soil is a great storehouse of crop nutrients and without the soil's capacity to supply such huge quantities of nutrients crop growth would badly suffer. If this is so, the question may be asked, why is it that crops fail to yield unless fertilised. The reasons may be several but not perhaps lack of soil's reserve. In a monocropped area, as it is so in Eastern India, which is dominated by rice cultivation, the soil gets depleted through years of cultivating rice and rice alone at the particular soil depth, and hence the yield shows declining trends. It is for this purpose that crop rotation is recommended. This system helps in turning the soil over to some extent, and if crops having deeper roots than rice are chosen in crop rotation, the nutrient reserves at lower depths are depleted at the expense of those at the rice roots layer. Rice in more than one season for the same land is, therefore, to be strongly discouraged even if adequate water is available. Most farmers are, however, typically intoxicated by rice cultivation; this is because rice marketing is no problem. Any substitute for rice should have similarly assured market. The low use efficiency of fertilisers, especially nitrogenous, in flooded soil is another reason. Attempts to improve the efficiency are being made constantly throughout the world.

While on the topic of nutrition of crops and yield let me make two or three more points. It is customary to assume for the purpose of estimating fertiliser requirements, that one kilogram of NPK fertiliser produces ten kilograms of grain. But actual calculations carried out with six year's data, collected from 1966-67 to 1971-72, on yield and amounts of fertilisers added in the form of NPK, show that the response rate for foodgrain crops is about 17, whereas that for foodgrain crops plus oilseeds, sugarcane, potato and cotton is about 23. With 10 as the response rate, the estimate of fertiliser requirement would obviously be very high.

The yield is commonly expressed in terms of grain or the usable part of the crop. But the soil has spent its nutrients reserve and plant its energy, and the two have coupled to produce not only grains but other parts of the crops, which do not normally come into the calculation of productivity. We have made some reference to the removal of nutrients from the soil by plant, meaning thereby the whole plant, i.e., grain and straw. Hence it may be logical to saggest that productivity, whether of the soil or the plant, should take into account other residues or wastes than what are normally taken. How the concept of productivity changes by such consideration may be illustrated by the following figures. An indigenous variety of rice produces straw, say, 3 times the grain, whereas the grain to straw ratio for HYV is 1 : 1. If now the indigenous variety yield 1.5 tonnes of grain, its straw yield is 4.5 tonnes, so that the total yield is 6 tonnes, which would epual an HYV yielding double as much grain. It is, therefore, not quite proper to take into account only the grain portion for the purpose of assessing productivity of a crop and hence of the soil.

If we calculate, as has been done in Table 9, the amount in Kg of total nutrients removed by various crops per tonne, we find that except for potato such amounts vary between 0.056 and 0.098, those for rice, wheat, pulse, oilseed being quite close. The figure for potato is interesting in being very low, namely, 0.014, about one-fifth of that of the major crops, because the unusable residue in the case of potato is much less. It may be recalled that potato has been shown to be a superior crop from the point of its productivity per hectare per unit of time. Does this once again suggest that potato should find a perferred position in our cropping plan? It is no doubt true that several countries, some of them developed, do take potato as a staple crop. But this is not to be in Eastern India. Our conservatism in food habits is so deepseated.

TABLE 9

Total nutrient removed (kg) by various crops per tonne

Crop	*Production million tonnes (1970-71)*	*Total nutrient removed million tonnes NPK*	*Nutrient removal Kg/tonne*
Rice	42.2	3.13	0.074
Wheat	23.8	1.87	0.078
Maize	7.5	0.74	0.098
Pulses	11.8	0.87	0.073
Oilseeds	9.3	0.66	0.070
Sugarcane	13.0	0.73	0.056
Potato	4.8	0.069	0.014
Jute	4.9	0.31	0.060
Tea	0.42	0.024	0.056

Boro Cultivation

Two situations dominate the region of Eastern India. The one is the monsoon with its peculiarities which is Nature's gift, and the other is the densely crowded millions of small and marginal farmers, which is our doing. Eastern India has to face these two situations. Monsoon cannot be curbed. The existence of the small and marginal farmers has also to be taken for granted. The possibility of consolidating them, is, in my view, remote. Land fragmentation stands, according to many, in the way of introducting high yielding varieties and the associated technologies. Here also I am of the opinion that the aman season cannot accommodate HYV technology. But the boro season does and there is justifiable demand from farmers for boro cultivation. The problems of boro cultivation can best be illustrated by the analysis carried out for West Bengal, (Table 10).

TABLE 10

Expenditure (Rs/ha) by farmers for the increased production of rice (1980-81)

Item of expenditure	*Aman*			*Aus*			*Boro*
	Local	*HYV*	*Total*	*Local*	*HYV*	*Total*	*HYV*
Seed	773	190	963	125	39	164	1146
Manure	467	139	606	66	21	87	656
Fertilisers	953	437	1390	151	47	198	3986
Plant protection	27	45	72	12	4	16	467
Implement	548	136	684	51	16	67	419
Irrigation	159	76	235	8	3	11	2085
	2927	1023	3950	413	130	533	8759
Unit cost per tonne including labour (Rs)	845	1055		1239	873		851

(Derived data from *Farm Management Studies*, West Bengal)

Boro is cultivated in only a fraction of the total area under rainfed kharif rice, where irrigation facilities exist. Boro depletes greatly the soil of nutrients, if grown year after year, and makes the soil poorer for the subsequent aman rice. This adverse effect has been mentioned in the general case of rice after rice cultivation, but is more accentuated in the case of boro. Against such a high input (including water) crop, other crops like wheat, pulses and oilseeds which are relatively low input crops should have preference over boro. In fact, by restricting water for boro cultivation during the recent droughts in West Bengal and allowing vegetables, potato, oilseeds and pulses, the farmers are known to have reaped better benefits.

In spite of high yield of boro rice the cost of production, taking that of water used for irrigation, is too high to favour boro. However, if short duration varieties of boro, say, of 4 months, are available, the cost of water will be reduced making boro a fasible proposition. Or else, boro may be restricted to those areas that are waterlogged or accumulate water in depressions. Boro cultivation is to be discouraged on account of the possibility of local depletion caused by excessive withdrawal of groundwater, of water levels beyond the capacity of centrifugal pump or manually operated tubewell. Experience for the past several years has shown that tubewells meant for drinking water supply have run dry in intensive boro areas. Instead of boro, therefore, if irrigation facilities are developed by taking recourse to minor irrigation through shallow tubewells, dugwells and tanks, they should more usefully be empolyed to give protective irrigation to kharif rice or to irrigate during rabi season such crops as oilseeds, pulses and vegetables requiring much less water. In either case the total quantum of benefit will be much greater than what will accrue from boro cultivation. At this stage I should mention the urgent need for evolving, through concerted research, small-farm technology, not necessarily based on high input technology, that will be applicable to lands of millions of small and marginal farmers. Consolidation in my view, is not in sight for decades to come. We cannot, therefore, wait for that occasion, and let the small farmers negotiate, perhaps unsuccessfully with the constraints they are facing at the moment.

Boro cultivation and its consequences have been deliberately dwelt upon in some detail, in view of the pitfalls in an otherwise attractive proposition. In doing so the West Bengal situation has been highlighted because of the availability of an indepth analysis of the past experiences in connection with boro cultivation in this State. Other States of Eastern India should examine this venture in the same way as has been done in West Bengal.

Production Potential

The next legitimate question is how high the productivity could be. This is a question which can be answered on the basis of experimentation because there is no acceptable theoretical basis for calculating productivity. The factors determining productivity are, however, fairly wellknown. By suitably varying these factors we are in a position to arrive at increasing yields. As in any biological system, the law of diminishing return becomes operative, so that a peak or a plateau is observed as the factors determining productivity are varied towards maximization. The usual practice is to do controlled experiments, with, say, a variety of a crop under near-ideal environmental conditions. In this way the achievable productivity potential is known. Then the agronomist puts the crop under less ideal conditions, available at various locations. The experiments are then subjected to economic analysis, on the basis of which the crop variety is made available to users, the farmers. Depending on the efficiency of the farmers, the yield of the same crop shows variations. If the latter are within the range of economic returns it is acceptable. Let me illustrate this situation with the data obtained in National Demonstration trials, and reproduced in Table 11.

TABLE 11

Mean yields obtained in National Demonstration Trials (1968-69 to 1970-71)

Crop	*Mean yield (tonnes/ha)*		
	1968-69	*1969-70*	*1970-71*
Rice	5.95	5.69	5,61
Wheat	4.00	4.07	—
Bajra	3.30	3.24	3.07
Maize	4.33	4.24	3.81
Jowar	4.66	3.59	3.58

The yields in tonnes/ha/year of crops in multiple cropping under National Demonstration Trials are given in table 12, showing the height of production that can be reached by taking recourse to high cost technology.

TABLE 12

Yields tonnes/ha/year of crops in multiple cropping under National Demonstration Trials

Crop rotation	*Average yield (tonnes/ha/year)*		
	1967-68	*1968-69*	*1969-70*
Rice-rice	10.5	9.4	10.5
Pearl millet-wheat	7.9	17.7	7.2
Sorghum-wheat	6.5	8.1	8.0
Rice-wheat	10.7	12.6	—
Rice-rice-rice	13.3	15.4	13.7
Jute-rice-wheat (grain)	9.9	10.3	10.1
Jute-rice-wheat (fibre)	2.1	2.1	1.3

The average yield of rice obtained in Eastern India, however, varies from 1.0-1.5 tonnes/ha. Under regulated irrigation during rabi season the average yield of rice goes up to 2.5-3.0 tonnes/ha, which is more or less the same as Punjab gets, also under irrigated condition. Yields of wheat which is always irrigated are around 3 tonnes or less in Punjab and about 2.5 tonnes in Eastern India. In fact, under irrigated condition the environment becomes identical, more or less, whether it is the Western, Northern or the Eastern region of the country. The gap between what is achievable and what is generally being achieved can be filled up partially, if not wholly. The degree of success depends on how close one can go to the conditions stipulated in the National Demonstration Trials.

Future Outlook

What has been said about agricultural productivity applies not only to situations prevailing in Eastern India, but is also applicable generally for India. In this connection, it may be recounted that much of the efforts of agricultural scientists to increase productivity, whether of plants or animals, lie in the areas of environmental manipulation or induced natural selection. But it is believed, even by the pioneers of green revolution, that conventional plant breeding research will continue to make major contributions to enhance food production. Artificial selections so far obtained perform very well in fertile environment. But our researches on increasing productivity under environmental stresses are scanty. The latter, however, are of more general occurrence. Eastern India exemplifies one big chunk where environmental stress is the rule rather than the exception. In such circumstances, it is not expedient to try to create, at high cost, fertile environment. On the other hand, it may be worthwhile to consider, even though prematurely, the application of techniques used by microbiologists to induce the synthesis of new enzymes in microorganisms to the problems of producing stress-resistant crops. If, for example, the relationships between rhizobia and mycorrhizae are known in greater detail it may be possible to better utilise soil nutrients for enhancing the yield of crops. These relationships will of course differ in accordance with the nature and degree of environmental stress.