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SOME TECHNOLOGICAL ASPECTS OF FOODGRAINS PRODUCTION IN NORTH-WEST BANGLADESH

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ABSTRACT

The paper analyzes certain characteristics of foodgrains production technology in North-West Bangladesh. A comparison of regional with national data reveals that the region lags behind the national average in the use of yield raising inputs. The growth of irrigation in the region is also seen to be biased toward high cost technology. Despite these unfavourable conditions, the performance of food-grains production sector is encouraging in the area. The rich potential of the sector in the region is, however, constrained by various socio-cultural and technological factors including non availability of irrigation water during dry season. It is argued that the realisation of the potentials requires appropriate policy measures encompassing several dimensions.

I. INTRODUCTION

In the dominant agricultural sector of the Bangladesh economy, production of food grains plays a crucial role. During recent years, rice and wheat together accurate for about 84 per cent of the total cropped area in the country of which the share of rice is about 80 per cent. Rice contributes more than 70 per cent of the value added in the crop sector, which accounts for nearly 80 percent of total agricultural value added, including forestry, fisheries and livestock (BBS 198.5a). Thus rice alone sets the trend of growth in the agricultural sector and as such the focus of attention of strategies adopted by the government-has been mostly directed toward rice.[1]

With a limited agricultural land base of approximately 22 millionacres and a continuously deteriorating, land-man ratio, efforts in the agricultural sector have been mostly

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directed to the adoption of a package of biological, chemical and mechanical innovations as reflected in high yielding variety (HYV) seeds, chemical fertilizers, pesticides and mechanical irrigation such as low lift pumps, shallow and deep tubewells.[2] Adoption of such a strategy is believed to result in the desired technological transformation in agriculture through wide diffusion of the technology and better and more productive use of the scarce land resource. Central to such government efforts has been the improvements in irrigation and water control to increase the effective area under cultivation. Expansion of irrigated acreage is seen as a precondition to the introduction of HYV seeds, increased fertilizer demand and the application of better management and other yield-improving inputs including labour. Despite some initial success, however, the diffusion of the technology has not been rapid enough to provide the required break through in agriculture.[3] Rapid population growth has absorbed the modest increases in foodgrain production in the past resulting in either stagnation or decline in per capita food intake and nutrition over the years. Shortfall in foodgrain ptoduction was met by imports. Averaging about 1.7 million tons per year since 1972, foodgrain imports typically account for about one-quarter of the total import bill and absorb nearly one-half of the average annual export earning.

Over 1967-68 to 1983-84 period, aggregate crop output in the country increased at an annual rate of 1.46 per cent while crop area increased by 0.36 per cent and yield rate by 1.10 per cent. During the same period, rice output registered a growth rate of 1.84 per cent, area increased by 0.35 per cent and yield by 1.49 per cent. Wheat output, on the other hand, increased at a high rate of about 38 per cent with area increasing at an annual rate of 12 per cent and yield by about 26 per cent.[4] These increases, however, have not been uniform throughout the different regions of the country mostly due to the product and resource specific nature of the innovations adopted. Consequently, there has been differential regional impacts in line with the pace and efficiency of implementation associated with differences among regions.[5] In the paper, an attempt is made to analyze certain characteristics of foodgrains production technology in North-West (NW) Bangladesh. More specifically, the paper compares the performances of foodgrains productin sector in the region with the national economy and suggests certain possibilities in the region.

However, before proceeding further few words should be said regarding the choice of the region. NW Bangladesh, which corresponds to the administrative Division of Rajshahi, comprises about 30 per cent of the total cropped area in the country with wide agricultural potentials.[6] With about 24 per cent of the total population of the country, per capita GDP in the region is the lowest.[7] While such regional differences do exist in many countries, the pertinent questions are whether these are fostered deliberately and the tolerable limits of such disparity. Since answers to these issues are beyond the scope of the paper, the objective here is to assess agricultural potentials especially in foodgrains production in the region.

II. A BRIEF OVERVIEW OF AGRICULTURE IN NW BANGLADESH

North-West Bangladesh, like the rest of the country, is characterized by the co-existence of a largely subsistence peasant economy and some small pockets of industrial activity. By any standard, the region is predominantly underdeveloped. Table 1 shows the per capita gross domestic product and their sectoral contributions during 1983-84. It is evident that the region lacks industrial activity.[8] Compared to the national average, the per capita contribution of industry is only one-third in the region.

TABLE 1. PER CAPITA GROSS DOMESTIC PRODUCT AND THEIR SECTORAL SHARES, 1983-84

(Taka in current prices)

	Bangladesh	NW Bangladesh	Index Ratio of variation (Bangladesh=1)
Gross Domestic Product (at factor cost)	3443	3084	0.90
Agriculture	1753	1806	1.03
Industry	323	105	0.33
Others	1564	1373	0.88
Total GDP (Bilion Taka at factor cost)	329.5	71.6	—

Note : Values for agriculture, industry and others are in current market price. Others include Construction, Trade, Transport, Housing, Banking and Insurance, Public Administration and all other services.

Source : BBS, 1985b.

The land-use structure of the region is indicated in Table 2. Total arable land constitutes more than 78 per cent of total area in the region compared to around 66 per cent for the country as a whole. The economy of the region, as already indicated, is predominantly rural and agricultural. In spite of this overwhelming importance, agriculture remains mostly traditional, as revealed in Table 3. The proportions of both cultivated and cultivable land to total area in the region are higher than the corrsponding figu-

TABLE 2. COMPARATIVE LAND-USE PATTERN OF NW BANGLADESH AND BANGLADESH, 1982-83

Land-use Categories	NW Bangladesh		Bangladesh	
	Area (million acre)	per cent	Area (million acre)	per cent
1. Net area sown	6.24	72.98	21.28	60.25
2. Current Fallow	0.27	3.16	1.28	3.62
3. Culturable Waste	0.19	2.22	0.58	1.64
Total Arable Land	6.70	78·36	23.14	65.52
4. Forests	0.04	0.47	5.30	15.01
5. Area not available for cultivation	1.81	21.17	6.88	19.48
Total non-agricultural land	1.85	21.64	12.18	34.48
Total (1 to 5)	8.53	100.00	35.32	100.00

Source : BBS, 1982

res for Bangladesh. Although the percentage of area under HYVs of rice to total rice area is substantially lower in the region along with the proportion of irrigated area and application of fertilizer per cultivated acre, the average yield of rice is seen to be marginally lower than the national average. The gross value of output per acre of cropped land in the region is also lower. The above figures, therefore, reveal that agriculture in the region is largely traditional and the adopted technological innovations are less diffused compared to the country as a whole.

TABLE 3. SELECTED INDICATORS OF AGRICULTURAL DEVELOPMENT : NW BANGLADESH COMPARED WITH ALL BANGLADESH

Indicators	Bangla-desh	NW Bangla-desh	Index Ratio of variation (Banglagla-desh=1)
Percentage of cultivated land to total area (1982-83)	60.26	73.06	1.21
Percentage of cultivable land to total area (1982-83)	65.52	78.44	1.20
Cropping intensity (1982-83)	154.66	155.09	1.00
Percentage of area sown more than once in total cropped area (1982-83)	30.21	30.21	1.00
Percentage of irrigated area in total cropped area (1982-83)	13.88	11.57	0.83
Percentage of area under rice in total cropped area (1982-83)	79.50	75.09	0.95
Percentage of area under HYV rice to total rice area (1982-83)	24.84	16.46	0.66
Yield of rice in lbs per acre (1982-83)	1198	1156	0.96
Application of fertilizer per cultivated acre in nutrient lbs (1982-83)	27.76	24.97	0.90
Disbursement of Institutional Agricultural Credit in Taka per cropped acre (1982-83)	185.84	136.04	0.73
Per capita cultivated land in acre (1981)	0.38	0.46	1.21
Percentage of agricultural workers in total civilian labour force (1981)	61.32	70.69	1.15
Percentage of economically active population to total population (1981)	29.74	30.04	1.01
Gross value of output per acre of cropped land (Taka during 1982-83)	3363.85	3234.10	0.96

Source : BBS 1984.

III. SOME FEATURES OF FOODGRAINS PRODUCTION IN NW BANGLADESH

The agricultural production system is very complex, especially in a traditional near-subsistence economy like Bangladesh, influenced by various physical, biological, ecological and socio-political factors. Nevertheless, low productivity in agriculture in the region is mainly explained by the traditional farming practices characterized by little use of modern physical inputs such as irrigation, fertilizer and improved seeds.

Table 4 indicates the average area irrigated over two periods-1972/73-1973/74 and 1980/81-1981/82 and their distribution over crops. As a proportion of total cropped area,

TABLE 4. TOTAL IRRIGATED AREA BY CROPS : NW BANGLADESH AND BANGLADESH, 1972-74 AND 1980-82

(thousand acres)

Crops	1972/73-1973/74 (average)		1980/81-1981/82 (average)	
	NW Bangladesh	Bangladesh	NW Bangladesh	Bangladesh
Rice	473	2706	500	3209
Aus	39	140	55	287
Aman	136	273	152	403
Boro	298	2293	293	2519
Wheat	16	34	257	474
Others	215	363	228	474
Total irrigated area	704	3103	985	4157
Total cropped area	8770	29232	9622	32579
Percent of total irrigated area in total cropped area	8	11	10	13

a. Others include pulses, oilseeds, potato, vegetables, sugarcane, cotton, tobacco and other minor crops.

Source : BBS 1985a,

North-West region is seen to lag behind the national average in the periods. Also one can see some noticeable changes in the area irrigated under different crops. For rice as a whole, although irrigated area in rice as a proportion of total irrigated area has declined for Bangladesh over the period (from 87 per cent to 77 per cent), the decline in case of the region is significant (51 per cent in the second period compared to 67 per cent in the first). There has also been certain significant changes in the proportions over the three varieties of rice. For example, while in NW Bangladesh only about 30 per cent of irrigated area was devoted to boro rice, the corresponding figure for Bangladesh is over 60 per cent during the 1980-82 period. Another important aspect is the relative importance of wheat in irrigated acreage in the region.

If one looks at the irrigated area along with area cultivated under HYVs of rice and wheat, as presented in Table 5, certain points are clear. If it is assumed that all irrigated area in rice are devoted to HYV crops then, for Bangladesh, about 84 per cent of HYV rice area was irrigated during 1972-74 period compared to about 60 per cent during 1980-82 period. The corresponding figures for NW Bangladesh were 64 per cent and 54 per cent respectively. For wheat, similar percentages were 54 and 40 for Bangladesh and 89 and 38 for NW Bangladesh respectively. Thus one can see that compared to Bangladesh as a whole, cultivation of HYVs of rice and wheat in NW Bangladesh has been expanded relatively more in non-irrigated areas. In terms of different varieties of rice, the following conclusions may be derived. While for *boro* the entire HYV area is irrigated, *aus* and *aman* high yielding varieties are cultivated in non-irrigated areas also. For HYV *aus*, the proportion of irrigated area in Bangladesh declined from 57 per cent to about 25 per cent over the period. For NW Bangladesh, while all the HYV area was irrigated during 1972-74, only 57 per cent was irrigated during 1980-82. For HYV *aman*, the situation is different. While for Bangladesh the proportion of irrigated area rose marginally from 16 per cent to 17 per cent, for NW Bangladesh it increased from 24 per cent to about 34 per cent over the same period. The above figures indicate certain observable trends in the economy. While, in absolute terms irrigated area under each variety of rice and wheat increased in the country over the period, in the NW region absolute area under irrigation in *aman* rice marginally increased while in case of *boro* rice it actually declined. Area irrigated under wheat increased rapidly in NW Bangladesh comprising 26 per cent of total area irrigated compared to only 11 per cent for Bangladesh during 1980-82. Further, area irrigated under other crops involved more than 23 per cent of irrigated area in the region during 1980-82 while the same proportion was only 11 per cent for Bangladesh during the same period. This, while reflects a greater degree of diversity in agriculture in the region, has some obvious implications for returns to farmers.

It is usually seen that, especially during the *rabi* season when there exist a wide range of alternative crops to produce, farmers' preferences reflect choices for those crops that rank low in terms of costs and labour requirements. Relative net incomes of

different crops usually reveal no comparable relationship. In fact, in many cases, crops generating high net incomes are seen to be cultivated by fewer cultivators (see for example, MOAF 1980, 1981). This points to one important aspect of the farmers' decision making process. The farmers, especially the small ones, who overwhelmingly dominate agriculture in the country, are more keen to minimise their cash requirements rather than maximise net returns from cultivation of a crop. This is not surprising in view of the meagre resources that most of the subsistence farmers possess for investing in land.

TABLE 5. TOTAL CULTIVATED AREA UNDER RICE AND WHAET : 1972-74 AND 1980-82

(thousand acres)

Crops	1972/73-1973/74 (average)		1980/81-1981/82 (aver.)	
	NW Bangla-desh	Bangla-desh	NW Bangla-desh	Bangla-desh
A. Total (Local & HYV)				
Rice	661	24103	7106	25661
Aus	2168	7461	2244	7732
Aman	4177	14127	4514	14886
Boro	266	2515	349	3043
Wheat	144	301	687	1320
B. HYV				
Rice	740	3229	922	5363
Aus	13	247	176	1161
Aman[a]	573	1711	448	2369
Boro	154	1271	298	1833
Wheat	18	63	675	1344
Total HYV Area	758	3292	1597	6707

a. includes pajam variety. Source : BBS 1985a.

The rapid expansion of wheat area in NW Bangladesh, in addition to special extension efforts, may also be explained by the same set of factors. Wheat has gained relatively more in terms of area, not because it is more profitable than other crops like HYV *boro* rice, but apparently due to its less labour requirements and costs. According to a survey during 1978/79, the cost of production of HYV *boro* rice was about 68 per cent and net return about 150 per cent higher than HYV wheat in the contry (MOAF 1980). At the same time, HYV wheat cultivation was more profitable than many other alternative crops. These features, especially relatively low cost and medium profitability, make wheat a very attractive crop, especially to small farmers with effective cash constraints. In NW Bangladesh, HYV wheat has some added advantage compared to HYV *boro* rice. It is usually observed that the cost of cultivation of HYV *boro* rice is higher in the region relative to the national average. According to one estimate, the total cost of HYV *boro* rice cultivation is more than 10 per cent higher in the region while, on the basis of cash cost (excluding the cost of family inputs), it is more than 40 per cent higher. This is mainly due to higher cost for irrigation, which is nearly 50 per cent higher in the region (MOAF 1981).

In general, irrigation costs are higher mainly due to the irrigation technologies that have been promoted in the area. Of the various modes of irrigation available in the country, three major technologies are being promoted rapidly—deep tubewells (DTW), shallow tubewells (STW) and low lift pumps (LLP). For example these technologies accounted for nearly 70 per cent of the total irrigated area in the country during 1981/82. Of the total irrigated area by STWs in the country, about 54 per cent was located in the NW region during 1981/82. Similar percentage for DTW is 33 per cent and for LLP, only 23 per cent during the same year. The low incidence of LLP technology in the region is, however, mostly explained by nonavailability of surface water, especially during the dry season. Table 6 provides estimates of irrigation costs for each of these alternative technologies. In terms of costs of irrigation for the crops presented it is clear that LLP is the cheapest technology while the costs of irrigation for same crops by STW and DTW are nearly 40 per cent and 65 per cent higher. Thus LLP appears to be the most cost-effective technology for irrigation followed by STW while DTW is the most expensive technology.[9]

The above figures provide an indication of the trend of growth of irrigation technology in the region ; it is biased toward high-cost technology. While this may be a reflection of the hydrological conditions in the region where surface water, especially during the winter season, are not adequate so that more emphasis is placed on ground water irrigation, this has some obvious cost implications for irrigation. Thus, even though it is estimated that the net returns for HYV *boro* rice is about 5 per cent higher in the region compared to the national average (see, BBS 1985a), the farmers in the region are more inclined to expand HYV wheat area rather than HYV *boro* rice area. While a proper explanation of this trend requires full analysis of all the factors, one may conclude

TABLE 6. ESTIMATE OF IRRIGATION COSTS FOR ALTERNATIVE TECHNOLOGIES

	LLP (2 cusec)	DTW (2 cusec)	STW
Total Costs per hour in Taka (Financial)[a]	36·90	60·70	18·00
Hours of pumping/hectare			
Boro rice (40 inches water)	50	50	145
T. Aus and other rabi crops (20 incl es water)	25	25	71
T. Aman (5 inches water)	6·3	6·3	17·8
Total Cost of irrigation in Taka per hectare			
Boro rice	1845	3035	2574
Other rabi crops	923	1518	1278
T. Aman	233	382	320

a. Includes capital replacement at 12 per cent per annum.

Source : IFAD 1982.

that this, in part, reflects the prime importance of cash constraints in the decision making process of the farmers in the region.

Agricultural credit is an important input that affects the purchasing power of the farmers to adopt innovations and can play an important role in relaxing the effective cash constraints of the farmers in the region. Although the supply of institutional credit is far below the requirements in the country, the problem is much more acute in NW Bangladesh due to very skewed regional disparity in their distribution. For example, during 1981-82 only about 19 per cent of the institutional credit disbursed by various institutions in the public sector went to the region where nearly 30 per cent of the total cropped area is located (see, BBS 1984). Since the requirement of cash is much higher in the region due to higher costs of irrigation and other purchased inputs, it is only imperative that such proportions should be much greater in order to bring the farmers in the region in comparable position with the rest of the country with respect to adoption of the new technology.

In respect of the application of another critical input, chemical fertilizers, the region is also lagging compared to the national average. During 1982-83 the consumption of fertilizer in the region was about 108 thousand tons compared to 408 tho sand tons (in nutrient terms) in the contry. This reflects lower fertilizer application per acre of cropped land in the region. Moreover, the proportion in which different types of fertilizer are applied are also important for which satisfactory solutions are yet to emerge. Usually fertilizer application in the region, as well as in the country, is dominated by nitrogenous fertilizer which is different from the balanced dose recommended by experts. Further, the gap between practices followed by farmers and those recommended is a major factor accounting for the differences in potential yields and actual realizations. Although it is difficult to provide specific evidences, the low quality and inadequacy of agricultural extension services provide support in this respect.[10]

The above analysis, therefore, points to the relatively disadvantageous position in which the farmers in NW Bangladesh are placed compared to the country as a whole. However, if one looks at the performance of foodgrains production in the region the picture does not appear discouraging at all. Table 7 presents the per acre yields of rice and wheat along with their corresponding high yielding varieties for the two periods under consideration. In case of yields of rice (local and HYVs together), the average is lower in the region compared to the national average during both the periods. However, this conceals some important varietal differences. The average yields of *aman* and *boro* are higher in the region relative to the national average. The yield of *aus* is lower. Thus the lower averge yield for total rice crop is explained by the relatively low yield of *aus* variety and larger weight of this variety in the region. For the high yielding varieties, it is interesting to note that the average yield has increased in the region while, for the country as a whole, it has declined over the two periods considered. Moreover, the yields of *aman* and *boro* varieties are higher in the region, than the national averages while only for *aus*, the regional yield is lower. In case of wheat, the region has a definite comparative advantage over the country as a whole as reflected in yield. This shows the wide potentials of *aman* and *boro* varieties of rice and wheat in the region.

IV. CERTAIN ASPECTS OF FUTURE POTENTIALS

Since agricultural production system, as mentioned earlier, is influenced by various economic as well as socio-cultural, political and other factors, it is important that the constraints that prevent sustained productivity increases be resolved incorporating all the dimensions. One major factor that explains the slow growth of agriculture in the country is the existence of an unfavourable and inadequate socio-economic environment especially in the law and custom governing the ownership and use of land, which has led not only to political and social tensions due to the skewed distribution of benefits for those in favoured position in the existing institutional matrix but also has pre

vented the widespread diffusion of the technology (for details see, Mujeri and Alauddin 1983). Such factors, of course, do operate in the region as well for which a reorganization of the rural power structure, directly related to the ownership of land and other non-labour resources, is essential. However, in this paper, we would confine ourselves to specific regional factors, mostly technical.

Table 8 provides the distribution of cultivable land in the region as well as in the country as a whole in terms of different land types suitable for major rice crops under existing hydrological conditions. It can be seen that a relatively higher proportion of land is suitable for growing rice in the region compared to the country as a whole. While 53

TABLE 7. AVEAGE YIELDS FOR DIFFERENT VARIETIES OF RICE AND WHEAT, 1972/73-1973/74 AND 1980-82

(tons per acre)

Crops	1972/73-1973/74 (average)		1980/81 - 1981/82 (average	
	North-West Bangladesh	Bangladesh	North-West Bangladesh	Bangladesh
A. HYV				
Rice	0.93	0.99	0.95	0.91
Aus	1.11	1.11	0.83	0.88
Aman	0.86	0.86	0.86	0.77
Boro	1.21	1.16	1.16	1.11
Wheat	0.49	0.52	0.77	0.74
B. Total (local and HYV)				
Rice	0.44	0.45	0.51	0.53
Aus	0.32	0.34	0.40	0.42
Aman	0.47	0.43	0.53	0.50
Boro	0.92	0.85	1.09	0.94
Wheat	0.34	0.33	0.76	0.73

Source : BPS 1985a,

TABLE 8. DISTRIBUTION OF CULTIVABLE LAND BY LAND TYPES

Land Type	Percent of Total Cultivable Land	
	NW Bangladesh	Bangladesh
1. High land with intermittent flooding (flood depth 0-30cm)	53	36
2. Medium-high land with seasonal flooding (flood depth 30-90cm)	33	35
3. Medium-low land with seasonal flooding (flood depth 90-180cm)	8	16
4. Low land with seasonal flooding (flood depth greater than 180cm)	6	12
5. Low to very low land with seasonal/perennial flooding (flood depth greater than 180cm)	—	1
Total	100	100
Total cultivable land (million hectares)	2.45	9.03

Note. These land types are rspectively suitabe for HYV rice ; local varieties of aus and transplanted aman rice; broadcast aman rice; broadcast aman (low potential) ; and no tice production.

Source : MPO 1985.

per cent of the total regional cultivable land is suitable for growing HYVs of rice, the country as a whole has only 36 per cent of its cultivable land suitale for such use. Thus the potential for expansion in HYV acreage seems to be quite high in the region in terms of and suitability. Despite this, only 1.82 million acres were cultivated with HYV of rice and wheat during 1982/83. Although HYV wheat covers more than 95 per cent of the total cultivated land under wheat in the country,, there have been wide variations in case of rice. Table 9 provides the land use by crops during 1984/85. It shows that while HYV *boro* covers 88 per cent of total *boro* rice area cultivated in NW Bangladesh, it is planted on about 70 per cent of such area in Bangladesh. However, in case of *aman* and *aus* such percentage are only about 12 for both varieties in NW Bangladesh and below 20 for Bangladesh as a whole. This reveals the existence of certain technical cons-

TABLE 9. LAND-USE BY CROPS OVER DIFFERENT CROPPING SEASONS, 1984-85

(in million acres)

Crops	Cropping Seasons			
	Rabi		Kharif	
	NW Bangla-desh	Bangla-desh	NW Bangla-desh	Bangla-desh
Aus local	—	—	1.71	5.61
Aus HYV	—	—	0.22	1.29
Aman local	—	—	3.56	11.36
Aman HYV	—	—	0.49	2.52
Boro local	0.05	1.04	—	—
Boro HYV	0.37	2.20	—	—
Wheat	0.64	1.46	—	—
Potato	0.12	0.20	—	—
Jute	—	—	0.37	1.24
Sugarcane	0.17	0.34	0.17	0.34
Pulses	0.20	0.59	—	—
Oilseeds	0.13	0.49	—	—
Spices	0.08	0.32	—	—
Other crops (including vegetables, tobacco)	0.10	0.40	—	—
Orchard	0.07	0.40	0.07	0.40
Total	1.93	7.44	6.59	22.76
Percent of Net Cultivable Area	29.60	33.00	101.30	101.90

a. The figures presented here are based on thirty-two crops which cover 96 per cent of the total cropped area.

Source : MPO 1985.

traints in wider adoption of these two varieties. Most of the high yielding varieties of rice have high yield potentials under controlled and assured water supply which, relatively speaking, is generally the case during the *boro* season compared to the *aus* and *aman* seasons. Moreover, crop environment during these seasons is not favourable for achieving full potential yields because of uneven distribution of rainfall, flooding at variable depths, low solar radiation and high temperature and humidity. Thus expansion of HYV acreage during the *aus* and *aman* seasons without adequate considerations to their adaptability to ecological conditions and relatively less responsiveness of these varieties to chemical fertilizers and other modern inputs compared to HYV *boro* varieties are reflected in their slow acreage expansion and larger decline in yields over the years. Unless this technical problem of creating appropriate HYV seeds with high yield potentials are resolved along with provisions for adequate water management and control, the prospect for rapid expansion of HYV area during the *aus* and *aman* seasons do not appear to be bright in the region as well as in the country as a whole.

On the other hand, the major constraint for further expansion of HYV area during the *boro* season is the limited availablity of water for irrigation. The land-use patterns during the *rabi*, and *kharif* seasons as presented in Table 9, show that during the *rabi* season only about 30 percent of the net cultivable area in the region is cultivated compared to 33 percent for the country. The reason for such low percentages is, of course, the non-availability of water for irrigation, Thus, despite the existence of certain favourable conditions to achieve high potential yields, e.g., high solar radiation, low humidity and wide variation in day and night temperatures, lack of adequate soil moisture seriously limits the expansion of cropped area during the *rabi* season. This calls for rapid expansion of irrigation during winter season in the country. Such increases can be achieved through expansion of ground water irrigation, especially shallow tubewells, in the medium term. Although superior in terms of returns, low lift pumps are not likely to play a critical role in the process especially in NW Bangladesh due to inadequate surface water potentials under present hydrological conditions. A programme of rapid expansion of such technologies, however, needs to be supplemented by careful analysis of certain important issues, e.g., command area per installation, capital and, operation and maintenance costs, ecological impacts of rapid ground water extraction and other related factors.[11]

V. CONCLUSIONS

The above analysis makes it clear, therefore, that despite the existence of unfavourable conditions and traditional farming practices agriculture in NW Bangladesh, as reflected in the performance of foodgrains sector, has been able to show signs of dynamism. However, in the presence of inadequate agricultural infrastructure seriously affecting the agricultural growth process in the region, appropriate policy measures are

lacking. Over a large part of the region crop diversification, if properly encouragad and developed, could be the basis for a balanced cropping pattern and greater economic stability. In addition to extension of irrigation and better cropping practices, functionally integrated communication system and an adequate and efficient marketing network serving the rural people in the area are necessary for extensive diffusion of the adopted technological innovations in foodgrains production.

In short, the basic elements of a successful strategy to accelerate technological change in foodgrains production and agricultural growth in the region must necessarily encompass certain dimensions: organized efforts to diffuse innovations and scientific knowladge, timely availability of inputs to the farmers, establishment of an efficient marketing system linking rural supplies and urban demand and other infrastructural services. At the same time, it is also important to realize that technology is not simply transferable, it must be adapted to the peculiar conditions of individual locations which not only has a time dimension but also requires an adequate agrarian structure. Any strategy for desired transformation of agriculture in the region must take note of all these important considerations while formulating plans and programmes.

NOTES

1. Although in recent years the production of wheat has been increasing rapidly during the winter season due to cultivation of high yielding varieties, yet its overall impact in the economy is quite limited.

2. There is little or no scope for bringing any new land under cultivation. Culturable waste accounts for only around 2 per cent of total net cultivable area. Further, net cultivable area in the country is likely to decline further with growing population and higher demand for housing and urbanization. Hence increasing the intensity of cropping through more intensive use of land remains the only alternative to ease the land constraint.

3. For analysis on this aspect see, Hossain 1980 ; Alauddin and Mujeri 1986a.

4. These growth rates are calculated by fitting semi-log trend lines to the relevant variables over the period.

5. For an analysis of such regional aspects, see Alauddin and Mujeri 1985, 1986b.

6. One aspect of the rich agricultural potential of the region is reflected in the fact that under present hydrological conditions, 53 per cent of the cultivable land in the region is suitable for HYV rice cultivation compared to 36 per cent for the country as a whole (see MPO 1985).

7. During 1983/84, per capita GDP (at current factor cost) of different regions (Divisions) were as follows : Chittagong Tk. 4114, Dhaka Tk. 3295, Khulna Tk. 3229, Rajshahi Tk. 3084, See, BSS 1986b.

8. For an analysis of the causes of lack of growth of industrial activity and future prospects in the region see, Mujeri and Alauddin 1984.

9. For an analysis of profitability of these irrigation technologies based on financial and economic returns, see, Hanratty 1983.

10. Detailed information are not available on the number and the performance of extension workers in this respect. However, on average, only 1.37 extension personnel (crops) per thousand agricultural holdings were available during 1984/85. See, BBS 1986.

11. Increasing command area per installation is a critical factor since this is associated with high economic returns (see. Harnatty 1983). This is especially important in NW Bangladesh where average command area per installation is already lower than the national average. During 1984/85, average area irrigated for deep tubewell was 63.07 acres in NW Bangladesh compared to 64.50 acres for Bangladesh as a whole. The corresponding figures for shallow tubewell were 9.22 and 10.16 acres respectively, See, BBS 1986a.

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