THE GREEN REVOLUTION IN BANGLADESH : PRODUCTION STABILITY AND FOOD SELF-SUFFICIENCY

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CERTIFICATE

This is to certify that the dissertation entitled "The Green Revolution in Bangladesh: Production Stability and Food Self-sufficiency" submitted by Firdousi Naher in fulfilment of six credits out of total requirement of twenty-four credits for the degree of Master of Philosophy of the University is her original work according to the best of our knowledge and may be placed before the examinees for evaluation.

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CHAPTER I

INTRODUCTION

1.1 Need for New Agricultural Technology

Bangladesh is a highly populated, land scarce country whose economic structure reveals the dominance of agriculture. This sector accounts for about 40 per cent of the GDP and 60 per cent of the overall employment. It is clear that agricultural growth rates are crucial to the Bangladesh economy, as is the nature of agricultural production process and its effect on employment. Agriculture's importance is further corrobated by the evidence that the demand from the rural consumers is a principal source of stimulation for the industrial production of consumer goods. It follows that agricultural income is a critical determinant of the pace of manufacturing expansion. On the supply side, agricultural production determines the extent of food availability, as well as inputs into non-agricultural production, such as raw materials.

Given the obvious importance of the agricultural sector in the Bangladesh economy, it is understandable that unless development options properly identify transformations within it, it could negatively influence growth initiatives. However, the performance of this sector has been quite dismal. At the time of partition of India in 1947, East

Pakistan, the region now constituting Bangladesh, was nearly self sufficient in food. The post 1947 political environment in Pakistan did not help agriculture in East Pakistan to flourish. This, coupled with a rate of growth of food-grain production below that of population during the sixties and afterwards has turned Bangladesh into a region of growing food deficit.[1]

Bangladesh currently supports a population of over 114 million with a growth rate of 2.3% per annum. Continuously high rate of growth of population has resulted in a very low land-man ratio. Between 1960 and 1980, it is estimated to have declined by one quarter.[2] The same is true, albeit to a lesser extent, of the change in the cropped area of land per agricultural labourer. Land, therefore, can no longer

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1. Hossain, Mahabub, "Food Production in Bangladesh : Performance, Potential and Constraints," The Bangladesh Development Studies, Vol. VIII, Winter-Summer 1980.

   The official figures show a high growth rate of 3% for agriculture and 3.2% for major crops during 1958-59 to 1964-65. But this high figure could be due to official exaggeration of the performance of East Pakistan agriculture at the beginning of the Ayub regime. Using 1960-61 as the base period, S.R. Bose estimated that the trend rate of growth upto 1967-68 was only 2.1% for agriculture and 2.2% for major crops against a 3% growth rate in population then.

2. This appears to be an underestimate. It has been argued by many that the method of estimating agricultural labour force in the 1970's amounted to an underestimation relative to that in previous years.

be counted as an important means of expanding agricultural production.

TABLE 1.1

Basic Country data - Bangladesh

Year	Net Sown Area (NSA) (000 ha)	Gross cropped area (GCA) ('000' ha)	Agricultural labourer ('000')	NSA per Labourer (ha)	GCA per Labourer (ha)
1960-61	8.437	11,100	14.523	0.58	0.76
1980-82	8.563	13.161	19.906	0.43	0.66

Source : Khan, Azizur R., "Population Growth and Access to Land - An Asian Perspective" country policy department, World Bank in "Population, Food and Rural Development," Ed. by Srinivasan, Lee et al.

TABLE 1.2

Land-man ratio in Bangladesh

Year	Index of Population	Index of NSA	Land-man ratio index
1890	63	87	138
1901	69	89	129
1931	85	96	113
1941	100	98	98
1951	100	100	100
1981	208	102	49

Source : Same as Table 1

Table 1.2 shows the trend in land - man ratio in Bangladesh over the last ninety years. Land-man ratio must have moved very closely with this index. It was only since the 1960's that its rate of decline was slightly lower than that in the land-man ratio. The decline in the land - man ratio has been a long term phenomenon, but the rate of decline was modest until 1951. Since 1951, the rate of decline accelerated rapidly due to a sharp acceleration in population growth. In a span of thirty years, beginning with 1951, the decline has been 51 per cent.[3]

Against this backdrop, the new seed-fertilizer-water technology, popularly known as the green revolution, was identified as the appropriate one for Bangladesh as it is both land-augmenting and labour using. Though introduced in the 1960s, this diffusion really picked up during the latter half of the seventies. Between the early sixties and mid-eighties, the area irrigated by modern means increased from only 5% of the cultivated area (about 0.9 million acres) to more than 5 million acres (about 16% of the total cropped area). The use of chemical fertilizers increased from nothing to over 100 kg per net cropped hectare between 1960

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3. Land is measured in terms of net sown area. If it were measured in gross cropped area the decline would be less sharp though accelerating at about the same time. For earlier years, estimates of GCA are not available.

and 1980. Over the same period, the area under HYVs (High Yielding Varieties) developed at the International Rice Research Institute (IRRI) and the Bangladesh Rice Research Institute (BRRI) reached over 20% of the total area under foodgrain. Currently about 38% of the total area under rice and almost all the wheat cultivated, is under HYV. Foodgrain production which in the late 1950s averaged 8 million tonnes increased to 13 million tonnes in the late 1970s.[4] Much of the increase was due to the cultivation of IR-8 and BR-3 rice varieties, under irrigation in the dry (Boro or *rabi*) season, though cultivation of the same varieties later on as an early monsoon (*aus* or early *kharif* season) crop, and other varieties such as IR-20 and BR-4 in the late monsoon (*aman* or late *kharif*), were also important.[5] In fact, in 1970, the introduction of IR-20 was a major breakthrough in paddy production technology, as the earlier IR-8 variety could not endure flooding. In parts of the country, especially in the North and West, wheat cultivation also

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4. Jones, Steve, "Agrarian Structure and Agricultural Innovation in Bangladesh" in "Understanding Green Revolutions," edited by Tim Bayliss - Smith and Sudhir Wanmali.

5. Strictly speaking, the words, Aus, Aman, and Boro refer to paddy crops while 'early Kharif', 'late Kharif' and 'Rabi' are seasons in which these crops are grown respectively. However, in common parlance it is usual to refer to them as if they are seasons.

increased rapidly since 1975. Although, the Green Revolution consisted of varieties of many crops, it is only rice and wheat that are relevant in the Bangladesh context, in so far as their potential as well as their success has been the greatest.

1.2 Introduction to the Problem

Despite a significant success achieved in increasing agricultural production, Bangladesh's paddy yield and input use are amongst the lowest in the world. Much more could be done. The factor commonly advanced by researchers to explain the relatively low level of agricultural development in Bangladesh is the nature of agrarian structure.[6] Two aspects of this structure that are commonly held to constrain agricultural development are the preponderance of small farms and the widespread prevalence of sharecropping. The preponderance of small farms has been argued to limit agricultural development in two ways -- by lowering the rate of adoption of HYV and by reducing the overall efficiency with which they are cultivated. Small farm owners are poor, lack resources to invest in improved agricultural techniques and are reluctant to take on the increased risks associated

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6. Jones, Steve, op. cit. pp. 195

with cultivating HYVs. Large farmers, on the other hand, cultivating almost 40% of the agricultural land, enjoy better access to credit and input markets, which together with their ability to bear risks, means that they are both bigger and more productive users of HYVs. The well documented in verse relationship between farm size and productivity may hold for traditional varieties but, it is argued, is reversed in the case of HYVs.[7]

The second way in which agrarian structure is held to impede agricultural development relates to sharecropping. About one fifth of the agricultural land is cultivated by share croppers, most of it on terms, which it is argued offer little incentive to the tenant to increase productivity or to cultivate HYVs.[8] Thus sharecropped land is thought to lower yields than owner cultivated land. It is therefore quite natural to discover that only a small proportion of sharecropped land is under HYVs.

An important infrastructural development associated with agriculture is provision of adequate and timely credit to cultivators. Though a dominant credit market operates in rural Bangladesh as a mechanism of surplus transfer from the

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7. Jones, Steve, op. cit. pp 195

8. Sobhan, Rehman (Ed.), "The Decade of Stagnation -- the State of the Bangladesh Economy in the 1980's" University Press Limited, 1991.

land poor to the rich, it is characterised by borrowings at high rates of interest from money lenders interlocked with land lease and credit markets and interlocked product and credit markets. Institutional interventions in rural credit market began as early as the 1960s but it wasn't till 1977 when a special Agricultural Credit Program was initiated that a major role for formal credit was assured. Between 1978 and 1985, the amount of institutional credit disbursed increased at a rate of 33% per year. However, the access of the rural poor to this greatly increased formal credit remains Limited.

Although agricultural growth has been significant in the post independence period, the achievements fall considerably short of the basic requirements and the goals set. Modernisation of agriculture is far from complete with only a quarter of the cultivated area under irrigation. Many traditional and inefficient practices still persist with considerable scope for research to extend modern technology under field conditions. There is under-investment in agriculture. Deficiency in public investment in agricultural infrastructure especially irrigation is a glaring example of this. Governments' failure to allocate sufficient amounts of development funds to this sector may be taken as one of

the most important causative factors for near stagnation of agriculture in Bangladesh.

One aspect of the new technology which has received increasing attention in recent years is its impact on the stability of foodgrain production. Instability in foodgrain production leads not only to fluctuation in incomes received by producers and the nutritional levels of subsistence farmers, but also to fluctuations in the import requirement of foodgrains, thus creating a further uncertainty in the availability of scarce foreign exchange of the country concerned. A number of studies especially on Indian agriculture (Mehra, 1981 Hazell, 1982; Ray, 1983; Hazell, 1984 etc.) conclude that the introduction of HYV technology has led to increased instability in food grain production. This raises an important question about the sources of productivity growth - more specifically, whether the seed- fertilizer-water technology increases yield variability.

In the light of these findings several pertinent questions can be asked. To what extent has the introduction of the new technology led to alterations in the variability of overall foodgrain production and yield? Is there any significant difference in production and yield variability between traditional and modern foodgrain varieties? Has irrigation had a stabilizing impact on production and yield

fluctuations? All these questions are worth considering in the Bangladeshi context. In most LDCs, including Bangladesh, foodgrains are the most important wage goods. The income elasticity of demand for food is very high, about 0.6 or higher. In the short run, changes in relative food prices critically alter the real income of the low income earners. If technological change leads to greater variability in production and hence supply of food grains, their prices may become more unstable. In LDCs like Bangladesh, this can have important welfare consequences for low income earners and increased fluctuations in incomes received by grain producers.

The food problem in Bangladesh is one of both supply (achieving higher rates of agricultural production) and demand (achieving simultaneous expansion in effective demand by the poor).[9] In some countries, it is possible to treat food policy separately from overall economic development. But in Bangladesh, the food sector is such an important part of the economy that this cannot be done. Achieving food self-sufficiency has been one of the key goals of public policy in Bangladesh in the past twenty five years. Here

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9. Johnson, B.F. and Mellor, J.W., 1961, "The Role of Agriculture in Economic Development," American Economic Review 51.

the challenge to maintain food-population balance is so great because practically all cultivable land is in use. Though the performance in the past has been poor, optimism is expressed in many circles that Bangladesh has great potential for increasing foodgrain production. In fact a World Bank report at the beginning of the seventies concluded that known technologies coupled with gradual development of irrigation and drainage facilities could quadruple Bangladesh's foodgrain output by the end of this century.[10] The recent experience, however, is that investment on irrigation and modern inputs have been speeded up; yet the target of achieving food self-sufficiency is becoming more difficult to realise with the passage of time.

1.3 The Green Revolution and Instability of Foodgrain production and yield : A brief literature survey

Several studies, especially on Indian agriculture, have been conducted, both at theoretical and empirical levels, which have emphasized on the destabilizing impact of the new seed-fertilizer-water technology on foodgrain production and

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10. IBRD, IDA Land and Water Resource Sector Study : Bangladesh, Technical Report No.8, Washington D.C. 1972.

yield studies include those of Evenson et al.[11] Finley and Wilkinson[12] and Tisdell.[13] Evenson et al. express the possible role of new technology in accentuating yield variability in developing countries and recommend measures which will promote both growth and stability.

Sen first hypothesized the link between growth of agricultural production and variability of agricultural output, in the Indian context, during the early 1950s when area expansion was the major source of growth. According to him, variability increased as cultivation was gradually extended to the marginal lands when the use of fertilizers increased sharply and where production was contingent to weather fluctuations.

Following Sen's findings, Rao discussed the possible impact of agricultural growth on instability in agricultural production in India in the context of growth based on productivity in the 1960s. Rao's study shows increased fluctu-

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11. Evenson, R.E. et al, 1979, "Risk and Uncertainty as Factors of Crop Improvement Research" in J.A. Roumasset, J.M. Boussard and I. Singh (eds.), "Risk, Uncertainty and Agricultural Development," Laguna, Phillipines.

12. Finley K.W. and G.N. Wilkinson, 1963, "The Analysis of Adaption in a Plant Breeding Programme," Australian Journal of Agricultural Research 14.

13. Tidsell, C.A., 1983, "The Optional Choice of a Variety of Species for Variable Environmental Conditions", Journal of Agricultural economics, Vol. 34, No.2.

ations in the output of all foodgrains and other agricultural commodities, with fluctuations in productivity per acre being greater than that in area. Another study done by Barker, Gabler and Winklemann draws similar conclusions.

More recent studies on Indian agriculture also found evidence of increased instability in agricultural production following the introduction of new technology. As Mehra's[14] findings show, between 1968-69 and 1976-77, the standard deviation in yield of HYVs of four crops viz, rice, wheat, Bajra and Maize in all states except rice in Tamilnadu was much larger than the standard deviation of yield of all varieties taken together. The coefficient of variation in yield was much higher than the coefficient of variation of all varieties in eight out of twelve cases, though the mean yield off HYVs was much higher. Mehra further goes on to suggest that certain components of modern technology helps stabilize yields - one of them being assured water supply. This is underscored by the fact that all states with greater fluctuation in the yield of rabi crop (except Uttar Pradesh, Orissa and Tamilnadu) have a higher percentage of rabi area unirrigated than that of *kharif*. Mehra concludes that

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14. Mehra, Shakuntala, July 1981, "Instability in Indian Agriculture in the Context of New Technology", International Food Policy Research Institute, Research Report 25, Washington D.C.

> whether modern technology introduces stability depends on strengthening and spreading the elements that stabilize yield and on developing the ability of new technology to not only push up peaks in good weather but also to smooth the troughs when weather is bad. To the extent that this is successful, the severity of the conflicts between growth and stability will be reduced.

Hazell[15] goes so far as to conclude that "production instability is an inevitable consequence of rapid agricultural growth, and there is little that can be effectively done about it". Both Mehra and Hazell drop observations relating to 1965-66 and 1966-67 because of a severe drought during those years. As Hazell points out "catastrophes of this kind are sufficiently rare and severe that they can be considered as separate phenomena from year to year fluctuations". Mehra argues that "the mid-1960s witnessed two drought years of 1965-66 and 1966-67 of such unusual severity as to significantly alter the variance of any period in which they are included, thus casting doubts about the validity of their conclusion."[16]

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15. Hazel, Peter B.R., 1982, "Instability in Indian Foodgrain Production," International Food Policy Research Institute, Research Report No. 30, Washington D.C.

16. Mehra, Shakuntala, 1981, op. cit. pp. 10.

Another study done by Parthasarthy[17] indicates a higher degree of variability following the "Green Revolution" in the Indian state of Andhra Pradesh. He further claims that great yield instability is positively associated with districts experiencing higher agricultural growth rates.

It is pity that very few studies have been done in the context of Bangladesh agriculture to analyse the impact of new technology on the variability of foodgrain production and yield. Nevertheless the studies by Mohammed Alauddin and Clem Tidsell[18] (1988) and Mustafa K. Mujeri[19] (1991) are important in their own right. Contrary to the results obtained from the Indian scenario, Mujeri's findings suggest a lower variability during the post adoption period. His study further reveals a reversal of trends during the two periods separated by new technology viz. 1948-49 to 1960-61 and 1977-78 to 1984-85. While the pre-revolution period is charactarised by increasing trends in variability, the post-

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17. Parthasarthy, G., 1984, "Growth Rates and Fluctuations of Agricultural Production : A District-wise Analysis in Andhra Pradesh", Economic and Political Weekly 19.

18. Alauddin, Mohd. and Clem Tidsell (1988), "Impact of new agricultural technology on instability of foodgrain production and yield," Journal of development economies 29, North-Holland.

19. Mujeri, Mustafa K. (1991) "Impact of HYV Technology on variability of Rice Production and Yield in Bangladesh," The Pakistan Development Review.

green revolution phase shows declining trends. However, this analysis differs from others in that Mujeri considers only rice data. According to him rice can be treated as "Comprehensive" for Bangladesh due to its overwhelming importance even though variability of other cereals may be higher than that of rice, the former being seasonal crops. This is because rice is grown throughout the year and in all parts of Bangladesh. Failure of rice in one season can be cushioned. On the other hand, minor crops like wheat barley etc are grown only in one season and there is little scope to cushion the effects of higher variability in these crops. Moreover, India is much more diverse than Bangladesh in terms of agro-climatic differences which needs consideration while making inter-country comparisons.

Alauddin and Tisdell using Bangladesh national and regional data have provided intertemporal and cross sectional evidence on the impact of new technology on foodgrain production and yield variability. For Bangladesh as a whole, inter-temporal analysis indicates falling relative variability of foodgrain production and yield with increasing adoption rates of HYVs, in contrast to Hazell and Mehra's findings for India; this is also true for most districts in Bangladesh. However, it may be mentioned that

Alauddin and Tidsell[20] assert that both Mehra and Hazell's finding are sensitive to changes in time cut-off points and their decision to delete certain observations (pp.202).

Another finding of Alauddin and Tidsell is as follows. During the period 1967-68 and 1977-78 which corresponds to the second period in Hazell and Mehra's study, the years 1972-73 and 1976-77 were extremely unfavourable for Indian foodgrain production (Sawant, 1983)[21] and yield per hectare (Joshi and Kaneda, 1982)[22] In 1972-73, production dropped by 8% over that of the previous year while wheat yield fell by more than 8% over that of 1971-72. During 1976-77, production declined by over 8% compared to that of the previous year while rice yield fell by more than 9% of that in 1975-76. Both Alauddin and Tidsell assert that to be consistent one would have expected these two years to have been dropped by Mehra and Hazell from the analysis of the second period. In that case one would end up with a picture different from that suggested by Mehra and Hazell.

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20. Alauddin, Mohammed and Clem Tidsell (1988) "Has the Green Revolution Destabilized Food Production? Some Evidence from Bangladesh", The Developing Economies, XXVI - 2.

21. Sawant, S.D., (1983) "Investiagation of the Hypothesis of Deceleration in India Agriculture", Indian Journal of Agricultural Economics 38.

22. Joshi, P.K. (1982) "Variability in Yield in Foodgrain Production," Economic & Political Weekly 17.

In another recent study by Hazell[23] (1985) on instability in world cereal production between 1960-61 to 1970-71 and 1971-72 to 1982-83, he compares inter-regional differences in instability in cereal production. While doing so for India, he does not drop observations for 1965-66 and 1966-67 contrary to his previous study. He also takes into account observations for 1972-73, 1976-77 and 1979-80 when foodgrain production fell by 17%. When no observations are dropped from either period one finds that the coefficient of variation of cereal production decreases by 29% during the second period compared to the first while previous studies indicated a rise in the same.

Another study by Jain[24] et el extending Hazell's analysis to 1983-84, without dropping any observations draws similar conclusions.

Tidsell and Alauddin used Mehra's data for fifteen Indian States (Mehra 1981; pp 29) for further analysis and arrived at similar results as that of Mehra, most strikingly

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23. Hazell, P.B.R. (1985) "Sources of Increased Variability in World Cereal Production, since the 1960s," American Journal of Agricultural Economics 36.

24. Jain, H.K., M.Dagg and T.A. Taylor (1986), "Yeild Variability and the Transition of New Technology" in P.B.R. Hazell, ed.," Summary Proceedings of a Workshop on Cereal Yield Variability", International Food Policy Research Institue, Washington D.C.

that irrigation reduces yield instability. Further analysis reveals that the standard deviation of yield increases with HYV area and fertilizer use and declines with higher cropping intensity. The coefficient of variation, of yield, however, shows a tendency to decline with HYV area fertilizer application and cropping intensity, their rank correlation coefficients being -0.1500, -0.1179 and -0.5584 respectively. This finding is in tandem with the hypothesis that new technology has had a moderating influence on yield variability.

1.4 Objective of the Study

a. To examine the extent to which the new agricultural technology has been adopted in Bangladesh.

b. To examine the factors constraining agricultural development in Bangladesh.

c. To evaluate the variability of food grain production and yield in the period of new technology and compare the same between the traditional varieties and the High Yielding Varieties.

d. To analyse the potential for foodgrain production in Bangladesh in relation to past performance and to what extent self-sufficiency in food has been achieved.

1.5 **Date Base**

For the present study, data has been obtained both at the national and disaggregated level from the following sources.

i. Various issues of Monthly Statistical Bulletin of Bangladesh.

ii. Year Book of Agricultural Statistics of Bangladesh, 1993, Bangladesh Bureau of Statistics.

iii. The Bangladesh Census of Agriculture and Live-stock, 1983-84, Vol. I, Bangladesh Bureau of Statistics.

iv. Report on the Agricultural Census of Bangladesh, 1977. National Volume, Bangladesh Bureau of Statistics.

v. Statistical Year Book of Bangladesh, Various issues.

vi. Bangladesh Economic Survey, various issues.

vii. The Fourth Five-year Plan, 1990-95, Planning Commission, Dhaka.

viii. 1960 Census of Agriculture, Pakistan Agricultural Census Organisation.

ix. Various other books and journals.

1.6 Methodology

For the present study a number of statistical tools have been used. The time period has been divided into two phases: Phase I (1969-70 to 1976-77) and Phase II (1977-78 to 1991-92). Semi-Logarithmic linear trend lines have been fitted to Bangladesh, national time series data on foodgrain area, production and yield for two period. The mathematical formulation of the above can be written as

$$\log Y = \alpha + \beta T.$$

From the estimate of ß, the compound growth rate (r) of Y in the sample period was obtained as

$$r = [\text{Antilog } (\beta) - 1] \times 100$$

The coefficient of variation was used as a measure of instability in area, production and productivity. The coefficient of variation (CV_t) was estimated from the de-trended series separately for each period using,

$$CV_t = CV \sqrt{1-\bar{R}^2}$$

Where

$$CV = \frac{\text{standard deviation}}{\text{Mean}} \times 100$$

$\bar{R}^2$ is the adjusted coefficient of determination.

In order to get the annual variability in cropped area, output and yield of principal crops, the percentage change on an year to year basis was examined.

For determining the rate of growth of demand for food, the following equation was used,

$$D = P + e_i g$$

Where D is the rate of growth of demand for food

p is the rate of growth of population

e_i is the income elasticity of demand for food

g is the rate of growth of income.

1.7 Organisation of Study

The study is organised into six chapters. The first chapter deals with the introduction, conceptual and analytical framework.

The second chapter gives an overview of the green revolution in Bangladesh. It brings out the major features of the new agricultural technology, most notably, the extent of adoption of modern inputs, change in the land use pattern and cropping intensity.

The third chapter looks into the constraints to agricultural development in Bangladesh. Issues connected with agrarian land distribution structure including the preponderance of small production units, tenancy relations are all dealt with.

Chapter four deals with the variability in foodgrain production and yield with the advent of the new technology. In this context a comparison is made with the local seed varieties and the High Yielding Varieties.

Chapter five analyses the potential for foodgrain production in Bangladesh in relation to past performance of this sector.

Chapter six deals with the Summary of findings and the conclusions.

CHAPTER II

GREEN REVOLUTION IN BANGLADESH: AN OVERVIEW

The main challenge before Bangladesh today is the same as that faced by many other less developed countries (LDCs) of the world: how to rescue two-thirds of the mankind from the age-old dehumanising and how, with that end in view, to harness modern science and technology in the country to produce enough food, to curb the runaway population growth, and to produce other essential goods and services to meet the minimal needs of a civilised life.

In fact, in their book "Famine 1975 - America's decision - who will survive?", the Paddock Brothers, had predicted a famine for the hungry nations on the food front by 1975 and yet a "turn around" took place in the late sixties in the shape of dwarf varieties of seeds.[1] The Green Revolution in rice was triggered off by the massive upsurge in rice resulting from the establishment of the International Rice Research Institute (IRRI) at Manila. The story of the 'miracle seed' dwarf rice did not start till 1962; the path had been charted by wheat in which Borlaug and his team had to spend many years evolving the ideal wheat plant.

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1. Sudhir Sen, "A Richer Harvest - New Horizons for Developing Countries",

In Bangladesh, right since 1971, there have been several attempts to advance agricultural research but compared to international standards, agricultural research still lags behind. When most countries of the world employ modern scientific techniques, Bangladesh still adopts traditional methods.

However, agricultural research in the country got a new fillip only after the establishment of Agricultural Research Council and Bangladesh Rice Research Institute (BRRI) and Bangladesh Agricultural Research Institute (BARI) during the seventies. The two were linked with IRRI and the International Centre on Arid Crops (ICRISAT) respectively. With the Continued efforts of these institutions as also of the Bangladesh Water Development Board (BWDB) and the Bangladesh Agricultural development Corporation (BADC), some headway in the usage of modern agricultural inputs could be made in the late sixties.

Though the High Yielding Varieties (HYVs) of rice were made available to farmers for dry season (*boro*) crops in 1968 and for wet season (*aman*) crops in 1970, their diffusion really picked up in the latter half of the 1970s.[2] The

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2. Mahabub Hossain, "Green Revolution in Bangladesh - Impact on Growth and Distribution of Income" (1989), University Press Limited.

success of the new strategy in agricultural development depends on its package approach viz. HYV seeds, controlled water supply fertilizers insecticides and mechanised equipment which are the main components of the Green Revolution. However, the achievement of optimum results from the investments and the efforts put into cultivation depend on factors like consolidation of fragmented holdings as a part of land reform programs or otherwise, supply of agricultural credit, institutional arrangements for research and education and rural electrification for irrigation purposes (details follow in chapter III). This does not mean that technological change should await appropriate institutional change. The former may help bring about the latter and both should be pursued simultaneously.

Even under a normal but progressive agriculture some of the above components are required but under Green Revolution, each of the above components assumes a marked significance. The 'miracle seeds are the core of the package and they set their own conditions and working environment. The HYV seeds would not achieve full potential without water and fertilisers; their output would be highly variable or could even decline without the use of pesticides; their potential for multiple cropping would not fructify without mechanisation of some operations, and so on.

With the advent of the new seed-water-fertilizer technology in Bangladesh, the structure of production has also undergone a considerable change, particularly in the pattern of land use, cropping pattern and composition of crop output, cropping intensity and crop rotations, etc.

In the present chapter, we take stock of the broad changes noticeable in Bangladesh agriculture. In particular, we would like to see the application of the Green Revolution on technology. Accordingly, our attention is fixed on the following important components:

(a) Expansion of area under HYV seeds.

(b) Irrigation expansion.

(c) Use of Fertilizers.

(d) Change in the land use pattern.

(e) Cropping Intensity.

2.1 **Expansion of Area under HYV seeds**

HYV seed is the major input of agricultural production under the Green Revolution. Rice and Wheat are the principal food crops of Bangladesh. Though experiments in rice and improvement were being conducted at Dhaka Research Station ever since the beginning of 1960s, it was only after the setting up of BRRI in 1970 that varieties suited to local growing conditions were effectively developed. In a

span of fifteen years, the Institute was able to develop fifteen high yielding potential varieties of rice with superior grain quality and higher resistance to diseases. HYV seeds were introduced for all the three varieties ofrice in Bangladesh viz. *aus* (April to August), Aman (August to December) and *boro* (January to May).[3]

Two new varieties of wheat were also introduced in 1975 after rigorous testing of different varieties for their adaptibility to Bangladesh's climate conditions. These were Siete Cerros (*Kalyansona*) imported from International maize and Wheat Improvement Centre (CIMMYT) in Mexico and *Sonalika*which was procured from India. Table 2.1 below shows the expansion of area under HYV seeds of rice and wheat. It can be seen from the table that till the late 1960s, the use of HYV seeds was almost negligible. However, it picked up rapidly in the 1970s and the 1980s except for the intervening years of 1974-78 which witnessed stagnation. By 1991-92, nearly 44 per centof the area was under HYV rice cultivation, the share of *boro, aus* and *aman* being 87 per cent, 21.5 per cent, 43 per centrespectively. By 1985-86, as high as 97 per centof the area under wheat was under HYVs. The percentage share of HYV wheat and rice together to total wheat and rice area was 0.6 percent in 1967-68 and this rose to 46.6 percent by 1991-92.

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3. Mahabub Hossain, op. cit. pp. 24.

TABLE 2.1

Expansion of area under HYV seeds, 1967-68 to 1991-92

Year	HYV Rice			%age of HYV Rice to total area	HYV of Wheat ('000'acres)	% share of HYV wheat to total wheat area	% share HYV wheat and rice to total wheat and rice area
	Boro	Aus	Aman				
1967-68	156	-	-	0.60	-	-	0.6
1968-69	361	17	-	1.50	-	-	1.5
1969-70	580	43	29	2.50	-	-	2.5
1970-71	857	79	200	4.60	-	-	4.6
1971-72	793	121	625	6.70	-	-	6.7
1972-73	1087	163	1378	11.04	52	14.14	11.1
1973-74	1455	329	2043	15.67	72	20.57	15.8
1974-75	1630	699	1240	14.75	82	25.00	14.9
1975-76	1588	872	1376	15.02	217	58.49	15.7
1976-77	1338	902	1046	13.45	288	72.80	14.2
1977-78	1586	981	1233	15.33	388	83.10	16.6
1978-79	1650	1055	1694	17.24	583	89.14	19.4
1979-80	1788	994	2154	19.66	1015	94.80	22.7
1980-81	1845	1200	2376	21.28	1412	96.65	25.4
1981-82	2218	1166	2361	22.23	1277	93.20	25.8
1982-83	2670	1175	2653	24.84	1231	95.92	28.2
1983-84	2635	1235	2628	24.93	1475	113.55	28.3
1984-85	3040	1151	2669	27.15	1622	97.08	31.5
1985-86	2998	1191	2906	27.61	1291	96.70	31.0
1986-87	3311	1342	3085	29.51	1445	100.00	33.2
1987-88	4050	1231	2985	32.41	1476	100.00	36.1
1988-89	5267	1032	3346	38.17	1384	100.00	41.4
1989-90	5323	872	4354	39.90	1463	100.00	42.0
1990-91	5460	901	3959	40.02	1480	100.00	43.3
1991-92	5659	1020	4358	43.60	1420	100.00	46.6

Table 2.2 shows the region-wise expansion of area under rice HYV from 1975-76 to 1991-92. There has been a significant increase in the share of area under HYV rice to total area under rice in all the regions except for Patuakhali where, it went down from 8.26 per centin 1975-76 to 6.73 per centin 1991-92. Comilla has the maximum area (96.83per

cent) under rice HYV cultivation followed by Chittagong (90.69per cent) and Bogra (76.24per cent). For all-Bangladesh, the share of rice HYV to total rice area increased from 15.02 per centin 1975-76 to 21.28 per centin 1980-81 to 27.61 per centin 1985-86 to 43.60 per centin 1991-92.

TABLE 2.2

Region-wise expansion of area under HYV of rice ('000' acres)

Region	1975-76		1980-81		1985-86		1991-92	
	Area under HYV	% share in total area under rice	Area under HYV	%share in total area under rice	Area under HYV	% share in total area under rice	Area under HYV	% share in total area under rice
Dhaka	252	18.66	362	26.87	364	31.81	625	53.79
Kishoreganj	267	20.60	493	37.50	514	40.76	773	62.84
Mymensingh	374	18.43	436	36.82	538	42.60	572	48.8
Tangail	94	11.82	154	16.40	214	27.68	323	52.43
Faridpur	40	2.92	76	6.42	108	7.98	322	25.68
Chittagong	479	49.38	683	69.90	777	76.90	974	90.69
Hill Tracts	67	36.21	101	63.52	107	74.31	96	71.64
Noakhali	324	25.29	519	44.74	461	38.32	598	46.94
Comilla	365	22.90	585	35.96	601	36.69	1007	96.83
Sylhet	346	15.51	323	14.55	458	21.08	623	31.38
Rajshahi	150	9.07	112	7.54	380	22.39	965	56.36
Dinajpur	110	8.53	121	8.73	301	22.85	664	47.26
Rangpur	221	9.14	318	13.91	624	25.42	1202	50.63
Bogra	149	16.16	238	25.29	420	39.81	828	76.24
Pabna	70	7.43	50	5.41	179	19.04	365	55.3
Khulna	99	8.82	165	13.52	164	13.59	317	24.73
Barisal	235	15.94	245	16.05	208	13.72	215	14.17
Patuakhali	63	8.26	53	6.02	47	4.82	65	6.73
Jessore	81	6.06	143	11.23	241	21.10	869	61.2
Kushtia	50	9.86	78	15.92	155	28.54	572	66.59
Jamalpur	-	-	166	17.49	234	26.38	327	41.24
BANGLADESH	3835	15.02	5421	21.28	7095	27.61	11037	43.6

Source: Various issues of Statistical Year Book of Bangladesh
Monthly Statistical Bulletin of Bangladesh - January 1988
Monthly Statistical Bulletin of Bangladesh - May 1993

Table 2.3 shows region-wise expansion of area under new varieties of Wheat from 1975-76 to 1991-92. The compound growth rates for each region for both rice as well as wheat is given by table 2.4. It is clear that for most of the districts, over 90 per cent of the total area under wheat cultivation is subjected to modern varieties. By 1985-86, eight of the greater districts had achieved 100 per cent-share under HYV wheat compared with only 2 districts in 1975-76. Of these, Patuakhali had achieved the maximum expansion of area under new wheat varieties rising from a zero base in 1975-76 to 100 per cent in 1985-86.

Under this spectacular pace of HYV expansion wheat production was bound to increase dramatically since the mid-seventies. The intensive wheat production programmes supported by distribution of domestically produced wheat seeds lent a real dynamism to the whole process, so much so that from being an unimportant crop once, wheat now occupies 22 per centof the *rabi* crop area which includes area under *boro*paddy.

TABLE 2.3

Region-wise Expansion of Area under HYV of Wheat('000'acres)

Region	1975-76		1980-81		1985-86	
	Area under HYV	% share in total area under rice	Area under HYV	% share in total area under rice	Area under HYV	% share in total area under rice
Dhaka	4.45	34.28	36.83	75.46	87.00	88.56
Kishoreganj	4.00	66.66	21.89	100.00	28.00	100.00
Mymensingh	6.00	70.82	7.82	91.03	31.50	99.86
Jamalpur	-	-	9.33	87.52	41.00	98.82
Tangail	8.70	70.73	50.26	95.90	56.00	98.31
Faridpur	8.11	23.92	54.71	85.53	93.00	88.48
Chittagong	0.23	100.00	0.59	100.00	0.23	100.00
Hill Tracts	-	-	0.42	100.00	0.14	100.00
Noakhali	5.43	100.00	2.70	100.00	4.00	100.00
Comilla	50.00	90.00	195.00	100.00	154.00	96.40
Sylhet	0.40	20.00	11.90	98.23	12.00	90.40
Rajshahi	21.10	34.53	135.00	95.96	143.00	98.72
Dinajpur	20.20	88.97	202.00	99.63	117.00	100.00
Rangpur	6.50	45.56	247.00	99.37	129.00	98.81
Bogra	12.43	84.13	77.00	99.92	66.00	100.00
Pabna	17.00	28.81	99.00	95.51	130.57	97.90
Khulna	1.14	82.59	11.00	100.00	11.70	100.00
Barisal	0.30	60.00	5.00	100.00	10.00	100.00
Patuakhali	-	-	0.17	100.00	0.35	100.00
Jessore	17.22	81.62	12.00	65.43	70.00	93.40
Kushtia	34.57	87.97	132.00	97.13	106.00	99.08
BANGLADESH	217.00	58.49	1412.00	96.65	1291.00	96.70

Source: Based on Statistical Year Book of Bangladesh, Various issues; and Monthly Statistical Bulletin - January 1988.

TABLE 2.4

Rate of growth of area under HYV rice and wheat, 1975-76 to 1991-92

Region	Growth rate of area under HYV rice 1975-76 to 91-92	Growth rate of area under HYV wheat 1975-76 to 1985-86
Dhaka	6.84	9.96
Kishoreganj	7.22	4.13
Mymensingh	6.23	3.50
Tangail	9.76	-
Faridpur	14.58	3.35
Chittagong	3.87	13.97
Hill tracts	4.35	0.00
Noakhali	3.93	-
Comilla	9.43	-
Sylhet	4.51	0.68
Rajshahi	12.09	16.28
Dinajpur	11.30	11.08
Rangpur	11.28	1.18
Bogra	10.16	8.06
Pabna	13.36	1.75
Khulna	6.66	13.02
Barisal	-0.72	1.90
Patuakhali	-01.33	5.23
Jessore	15.55	-
Kushtia	12.68	1.35
Jamalpur	--	1.20
BANGLADESH	6.89	5.16

Source: Calculated

2.2 Irrigation Expansion

Optimum performance of the new seed varieties is crucially dependent on assured, adequate and timely supply of water. A large increase in output would therefore depend on the expansion of cultivated area under irrigation. This calls for a degree of sophistication in water control and

management which cannot be attained without major changes in the design and operation of irrigation systems. Besides, increasing area under cultivation during the dry season, this would also stabilize production through supplemental irrigation of rainfed crops. Greater productivity in the crops sector would thus be ensured.

Speaking in aggregating terms there is no water shortage in Bangladesh. Rainfall is abundant ranging from an average of 1478 mm in Rajshahi to a maximum of 4457 mm in sylhet. Moreover the three great rivers - the Ganges, the Brahmaputra and the Meghna - each year carry a volume of water into Bangladesh which is enough to submerge the entire country to a depth of eight metres.[4] The problem, therefore, is to straighten out the seasonal unevenness of this water supply coupled with controlling its year to year variability.

Prior to the partition, irrigation levels in Bangladesh were quite low. The Colonial government displayed little interest in public investment in irrigation, and difficulties of collective action impeded private irrigation at the local level. Irrigation reported in the official statistics

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4. World Bank 1972: WB, Bangladesh land and water resource sector study, Vol VII, Technical Report No. 20, December.

was negligible, although a certain amount of manual irrigation via *dhones* (i.e. swing baskets) was practised. Traditional irrigation by lifting surface water have been in use for ages in Bangladesh. Modern irrigation is a relatively recent phenomenon in Bangladesh. Even as late as 1976-77, 42.4 per centof net irrigation was alone by traditional means. The subsequent development of modern irrigation witnessed a continuous decline in the area under traditional irrigation.

Table 2.5 gives a region-wise profile of irrigation expansion since 1969-70. Though in terms of area covered, the irrigated portion of net sown area has more than tripled since 1969-70, it stood at a mere 37 per centin 1990-91. Barisal and Patuakhali are the areas with very limited irrigation facilities. In these only 12.8 per centand 3.3 per centof the net sown area is irrigated, respectively. Patuakhali, in particular has experienced practically no growth in the irrigated area. In most of the other districts, the figure is even below 50 per centwith the exception of Jamalpur and Bogra. Bogra, in particular has experienced a tremendous expansion in the irrigated net sown area from a mere 13.1 per centin 1969-70 to as high as 80 per centin 1990-91. It may be noted that unirrigated net own area of the hilly regions of the Chittagong Hill Tracts

TABLE 2.5

Irrigation Expansion in Bangladesh, 1969-70 to 1990-91

Former Districts	Net irrigated area as percentage of Net Sown Area				Area under modern irrigation as a percentage of cultivated area			
	1969-70	1976-77	1984-85	1990-91	1969-70	1976-77	1984-85	1990-91
Chittagong	25.5	36.0	43.2	48.63	10.0	18.2	43.2	37.34
Chittagong H.T.	19.5	18.3	15.6	15.90	6.1	4.4	15.6	11.05
Comilla	12.6	23.0	31.0	46.25	6.8	12.8	31.2	36.84
Noakhali	5.1	17.6	11.9	17.19	1.9	5.9	11.9	15.35
Sylhet	29.4	24.5	27.4	31.85	4.2	9.7	27.4	18.41
Dhaka	11.8	21.2	28.5	47.06	9.6	14.7	28.5	44.11
Mymensingh	20.6	24.3	36.0	37.58	6.9	12.7	36.0	34.12
Jamalpur	-	-	33.3	55.13	-	-	33.3	51.92
Kishoreganj	-	-	-	-	-	-	-	42.67
Tangail	8.5	13.6	35.9	45.39	5.8	10.7	35.9	44.06
Faridpur	2.8	5.0	9.0	25.38	1.0	3.2	9.0	24.82
Barisal	3.6	7.4	12.0	12.84	3.3	6.0	12.0	8.10
Jessore	2.7	7.0	19.1	47.52	1.3	6.1	19.1	47.06
Khulna	5.5	5.8	10.5	13.02	1.1	2.2	10.5	11.58
Kushtia	5.9	17.6	43.3	54.24	5.9	17.1	43.3	52.94
Patuakhali	2.7	3.7	2.9	3.28	2.5	3.7	2.9	3.20
Bogra	13.1	13.2	41.4	79.04	5.5	6.8	41.4	76.85
Dinajpur	7.8	9.0	15.3	28.50	4.1	5.3	15.3	26.62
Pabna	4.0	7.3	21.3	46.55	1.8	5.0	21.3	44.65
Rajshahi	18.3	13.3	20.4	42.74	3.3	4.9	20.4	36.52
Rangpur	9.4	9.6	27.7	47.95	1.2	2.1	27.7	40.80
BANGLADESH	12.0	14.7	24.0	37.03	4.0	8.4	19.5	32.18

Source: Various issues of Statistical Year Book of Bangladesh.

Note: Jamalpur & Kishoreganj were previously included in Mymensingh.

and sychet cannot be converted into irrigated area even in the distant future. In these two regions the irrigated area as a percent of cultivated area has remained more or less constant. Another important observation that emerges from this table is that over time the relative share of each

region has changed considerably in most of the districts. This is more pronounced in the case of Comilla. Dhaka, Tangail, Faridpur, Jessore, Kushtia, Bogra, Pabna, Rajshahi and Rangpur.

Table 2.5 also shows the area under modern irrigation as a percentage of cultivated area. In 1969-70, only 4 per cent of the cultivated area was covered by modern irrigation for Bangladesh as a whole. This figure increased 8-fold over a period of 21 years and stood at a little over 32 per centin 1990-91. But for the very poor modern irrigation levels in Barisal, Khulna and Patuakhali, Bangladesh would have had a much higher proportion of its cultivated land under modern irrigation. Amongst the other districts, Bogra, Jamalpur and Kushtia have more than 50 per centof the cultivated area under modern irrigation, with Bogra topping the list at 77 per cent in 1990-91 rising as it did from a low of 5.5 per cent in 1969-70.

Let us see through the sources of irrigation a bit more intimately. Apart from the expanding area under irrigation, the structure of irrigation has also been changing steadily in favour of tubewells for most of the districts (table 2.7). In Bangladesh as a whole, the percentage of net

TABLE 2.6

Growth of Net irrigated area as a percentage of Net Sown Area (NSA), 1969-70 to 1990-91

Region	Net irrigated area as a % of NSA
Chittagong	3.12
Hill Tracts	-0.9
Comilla	6.38
Noakhali	5.95
Sylhet	0.37
Dhaka	6.80
Mymensingh	2.90
Jamalpur	-
Kishoreganj	-
Tangail	8.30
Faridpur	11.07
Barisal	6.24
Jessore	14.63
Khulna	4.18
Kushtia	11.14
Patuakhali	0.96
Bogra	8.94
Dinajpur	6.36
Pabna	12.40
Rajshahi	4.12
Rangpur	8.06
BANGLADESH	5.51

Source: Calculated

irrigated area by tubewells increased from 7.8 in 1976-77 to 58.89 in 1990-91. Traditional irrigation has gone down from 42 per centof net irrigation to 13 per centover the same period. The net irrigated area under tubewells increased considerably in most of the regions barring a few select districts (Chittagong Hill Tracts, Sylhet, Patuakhali and

Barisal) which are either hilly areas or the groundwater there is excessively satty. In the districts of Pabna, Dinajpur, Bogra, Tangail and Jamalpur, more than 80 per centof the irrigation comes through tubewells. Canal irrigation has been steadily declining in almost all the districts with the exception of the hill tracts. In Tangail and Rajshahi, canal irrigation does not exist at all. For Bangladesh as a whole, canal irrigation declined from 8.86 per centof the net irrigated area in 76-77 to 5.71 per centin 1990-91.

Irrigation by traditional methods has declined substantially in most parts of Bangladesh. In most of the districts, area currently irrigated by traditional methods is less than 10 per cent. Traditional irrigation in Bangladesh is concentrated mostly in the *haor* areas and the depressed basins of sylhet, Mymensingh, kishoreganj and Rajshahi districts. These low-lying areas are unsuitable for growing any crops during the monsoon season; these are used for growing local *boro* on water logged land during November-December for which supplementary irrigation is provided during February and March when the field is dry. This is done by lifting water from adjoining low lands.

TALBE 2.7

Percentage of net irrigation by different methods

Former Districts	Percentage of Net Irrigation by											
	Power Pumps			Tubewells			Canals			Traditional Methods		
	1976-77	1985-86	1990-91	1976-77	1985-86	1990-91	1976-77	1985-86	1990-91	1976-77	1985-86	1990-91
Chittagong	49.6	54.62	54.34	0.81	5.98	8.45	-	17.73	14	49.19	21.67	23.2
Hill Tracts	24.13	31.5	40.1	-	0.25	-	24.14	28.87	29.22	51.72	39.38	30.69
Comilla	45.03	43.06	34.93	7.8	35.43	40.13	5.32	2.4	4.6	41.84	19.84	20.34
Noakhali	32.3	72.55	76.95	1.24	8.49	11	1.86	1.64	1.35	64.6	17.32	10.73
Sylhet	39.56	42.39	35.96	-	4.52	7.06	12.97	10.23	14.8	47.47	42.87	42.19
Dhaka	49.06	39.96	30	10.19	47.7	58.73	7.55	3.13	5.03	30.94	6.76	6.3
Mymensingh	35.51	15.03	10.86	16.4	72.8	76.59	-	0.6	3.35	48.09	11.58	9.21
Jamalpur	-	17.16	8.31	-	77.27	84.03	-	2.29	1.82	-	3.33	5.83
Kishoreganj	49.86	47.71	40.82	3.01	25.63	36.06	4.93	1.85	1.57	42.47	24.8	21.55
Tang ail	43.37	5.9	2.35	36.14	89.9	94.73	-	0.2	-	20.48	3.96	2.92
Faridpur	59.68	40.9	39.35	4.84	44.97	57.57	16.13	5.22	0.9	19.35	8.92	2.18
Barisal	81.61	39.42	46.9	-	-	-	6.9	19.09	16.23	12.64	41.5	36.87
Jessore	30.49	18.93	12.67	9.76	57.77	75.59	52.44	20.26	10.78	8.54	4.07	0.96
Khulna	36.67	27.92	11.21	-	20.91	70.55	31.67	20.57	7.18	30	30.6	11.06
Kushtia	27.03	15.01	6.62	17.12	39.73	58.31	54.05	42.6	32.68	2.7	2.65	2.4
Patuakhali	95.83	95.91	95.4	-	-	-	-	-	1.27	4.17	4.09	3.34
Bogra	27.96	7.42	5.21	23.66	83.86	90.97	-	3.02	1.06	48.39	5.71	2.75
Dinajpur	24.75	14.57	11.47	33.66	70.3	80.42	3	1.81	1.54	37.62	13.31	6.56
Pabna	56.75	16.38	5.67	11.94	77.48	89.49	1.5	1.25	0.76	31.34	4.9	4.08
Rajshahi	33.63	29.41	18.08	3.54	49.35	67.37	-	-	-	62.83	21.24	14.55
Rangpur	8.7	10.81	3.34	5	62.91	40.7	9.32	3.63	0.61	77.64	23.28	7.83
Bangladesh	41.03	29.02	22.3	7.8	45.9	58.89	8.86	7.78	5.71	42.36	17.31	13.11

Source: Agricultural Statistics, BBS.

Note: Due to rounding off, total may go beyond 100 in some cases.

TABLE 2.8

Irrigation facilities by farm size (1983-84)

Size of farm (acres)	Percent of cultivated area irrigated
Marginal holdings (less than 0.5)	20.3
Small holdings (0.5 - 2.49)	25.9
Medium holdings (2.5 - 7.49)	19.0
Large holdings (7.50 and above)	18.3

Source : The agricultural census 1983-84, Bangladesh Bureau of Statistics.

Coming to how expanding irrigation facilities have been shared by farms of different sizes, table 2.8 gives irrigation facilities by farm size for the two agricultural census years i.e 1977 and 1983-84. It can be seen from the table that the small and marginal farmers irrigate a larger proportion of their land than the medium and large farmers. According to the 1983/84 agricultural census, over 43 per cent of the farm households used irrigation covering an area exceeding 4 m acres. During the 1977 agricultural census, 31 per centreported irrigation which covered 2.17m acres. Thus the number of farm holdings reporting use of irrigation

increased by 129 per centduring the inter-censal period while area irrigated increased by 84per cent. The increase over 1960 irrigation coverage exceeds 202 per cent, giving an annual average growth rate of over 8.4per cent. Small farmers benefitted most from this increase in irrigation coverage. It is found that 74 per cent of the respondents reporting irrigation in 1983-84 were small farmer, 23 per centwere medium holding farmers while large farmers constituted only 3 per cent.

2.3 **Use of Fertilizers**

An important component of the new agricultural technology is the extended use of chemical fertilizers. In Bangladesh, use of modern agricultural inputs was not the outcome of induced technical change; rather they were introduced from outside[5] Therefore, modern inputs, particularly chemical fertilizers was something new to the farmers and they had to be convinced about the gains from their use. As a result, initially, fertilizers were sold to farmers at rock bottom prices. With mounting sales, these highly subsidised rates began to put an increasing burden on the government in the early 1970s. This burden alongwith the increase in the procurement price led the government to reduce subsidies on

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5. Joseph Stepanek, "Bangladesh - Equitable growth?", Pergamon Press, Washington, 1979.

fertilizers, and by 1983-84, it had come down to 25 per centof the cost. At present, there is very little subsidy on fertilizers.

Table 2.9 below indicates that starting with a limited use in the early 60s fertilizer consumption in Bangladesh increased to 5435000 metric tons by 1983-84-an 11-fold increase over that of 1963-64. The annual growth rate of

TABLE 2.9

Trends in Fertilizer Consumption in Bangladesh

Period	Total fertilizer (000 metric tons of nutrient)	Average (lbs/acre)
1663-64	49.7	4
1970-71	144.6	10
1977-78	339.2	24
1978-79	331.9	23
1979-80	400.7	28
1980-81	420.0	28
1981-82	396.8	27
1982-83	458.3	31
1983-84	543.5	36
Annual growth rate		
1963-64 - 1970-71	16.5	14.0
1970-71 - 1977-78	13.0	13.3
1977-78 - 1983-84	8.2	7.0

Source : Mosharaff Hossain, op. cit., pp. 213.

fertilizer intake was 16.5 per centduring the period 1963-64 to 1970-71. However, this figure fell to 13 per cent during 1970-71/1977-78 and further to 8.2 per centduring 1977-

78/1983-84. Most of the fertilizer (about 90per cent) is used for producing rice and wheat.

TABLE 2.10

Use of Fertilizer for rice production by region, 1990

Districts	Aus		Aman		Boro	
	% of fertilized area/1	Average level of use/2	% of fertilized area/1	Average level of use/2	% of fertilized area/1	Average level of use/2
Dhaka	47.43	158.82	57.28	89.12	98.31	165.53
Faridpur	16.79	160.44	2.79	70.66	100.00	138.30
Mymensingh	51.31	95.64	86.25	51.01	74.62	120.55
Tangail	54.37	100.00	100.00	68.85	100.00	100.27
Chittagong	51.96	209.26	96.78	99.00	99.10	129.38
Comilla	47.00	141.83	86.40	70.87	81.60	120.78
Noakhali	41.39	117.33	99.10	80.25	100.00	150.96
Sylhet	54.50	125.67	75.63	78.86	17.56	29.12
Khulna	60.37	125.00	28.24	82.10	97.18	131.91
Barisal	33.98	125.00	33.01	49.54	99.68	96.45
Kushtia	50.15	226.36	99.70	140.23	100.00	215.13
Jessore	41.85	92.99	78.68	61.50	100.00	175.75
Rangpur	100.00	18.17	100.00	47.41	97.91	91.01
Bogra	0.00	0.00	87.84	88.04	100.00	128.91
Dinajpur	32.49	158.61	68.37	46.12	100.00	146.09
Pabna	57.86	85.15	89.48	132.29	95.89	146.39
Rajshahi	57.90	163.25	90.14	79.18	99.78	177.01
Average	47.02	123.77	75.28	78.53	91.86	133.15

Source: Md. Ibrahim Khalil, "The Agricultural Sector in Bangladesh (A Database)" US Agency for International Development, Dhaka, Bangladesh, Sept. 1991.

/1 Percentage of farmers using fertilizers.

/2 Kilogram of fertilizer used per hectare of land.

The inter-regional variation in fertilizer offtake is shown in Table 2.11. Most of the regional differences in fertilizer use is dependent on the amount of control the

farmers have on their water resources. Moreover, among the crops, the difference in application of fertilizer dose is often due to differences in amount of security of water supply for irrigation.

TABLE 2.11

Region-wise chemical fertilizer Consumption (percent)

Region	1974-75	1977-78	1980-81	1983-84	1986-87	1989-90
Chittagong	14	10	7	7	5	5
Hill Tracts	1	0	0	1	2	0
Comilla	13	14	14	11	10	1
Noakhali	5	5	4	2	3	1
Sylhet	5	3	3	3	3	1
Dhaka	8	9	9	10	8	3
Faridpur	1	2	2	2	2	1
Jamalpur	0	0	0	3	4	1
Kishoreganj	6	6	6	5	6	1
Mymensingh	6	7	6	3	4	1
Tangail	2	3	4	4	4	1
Barisal	4	3	3	2	3	1
Jessore	3	5	4	5	5	1
Khulna	2	2	2	2	2	6
Kushtia	3	4	5	5	4	2
Patuakhali	1	1	1	0	1	1
Bogra	6	6	8	8	9	5
Dinajpur	5	5	5	6	5	4
Pabna	3	4	4	5	6	4
Rajshahi	6	6	7	8	7	3
Rangpur	5	5	6	8	7	5
BCIC sales to private distributors	0	0	0	0	0	52
TOTAL	100	100	100	100	100	100

Source: Statistical Year Book of Bangladesh, 1981 and 1990.
BCIC: Bangladesh Chemical Industries Corporation

2.4 Land use pattern

Continuously high growth of population has made Bangladesh an extremely land scarce country and land can no longer be counted as an important source of growth of agricultural production. There has been very little increase in cultivated land since the early 1950s (table 2.12) and by the end of the 1960s a sort of equilibrium had been reached in the land use pattern.

TABLE 2.12

Changes in the land use pattern, 1950-91

(in acres, percentage)

Land use	1950-53		1967-70		1980-85		1988-91	
	Area	Share of total	Area	Share of total	Area	Share of total	Area	Share of total
Cultivated land	20.7	58.7	21.7	61.5	21.3	60.0	20.3	55.4
Current fallow	1.6	4.4	0.8	2.1	1.3	3.6	2.7	7.6
Cultivable waste	2.1	5.8	0.9	2.5	0.7	1.9	1.1	2.9
Forest	5.5	15.7	5.5	15.7	5.3	15.0	4.7	12.8
Not available for cultivation	5.4	15.3	6.4	18.2	6.9	19.2	7.8	21.3
Total area	35.3	100.0	35.3	100.0	35.4	100.0	36.7	100.0

Source: Based on "25 years of Pakistan in Statistics", Karachi, 1972; Statistical Yearbook of Bangladesh, 1991 BBS; and Monthly Statistical Bulletin of Bangladesh, June 1993, BBS, Ministry of Planning, Dhaka.

During 1988-91, cultivated land was 58.4 per centof the total area and the wasteland that could be reclaimed for cultivation was only 2.9 per cent. The cultivated land as a proportion of total area actually declined from 60 per centin 1980-85 to 55.4 per centin 1988-91 largely under mounting pressure from rural housing, infrastructural and other development activities.

Table 2.13 shows district wise land use pattern in Bangladesh. In all Bangladesh, an equilibrium seems to have been reached with the net cropped area remaining more or less steady over the past many years. This is adequately born by the fact that it witnessed an extremely sluggish growth of about 0.04 per cent p.a. between 1976-77 and 1986-87. During the decade 71-72 to 79-80, the net sown area did not grow by more than 2 per cent. Whatever small increase came about in the net sown area was because of bringing in otherwise fallow land under cultivation with increments in irrigated acreage and providing more land with flood control and drainage facilities. In fact, for most of the districts this area has gone down in 1990-91 compared to the figures in 1986-87, clearly reflecting the rising population pressure, penetration of industrial activities into the countryside, and so on. The situation might worsen if cultivable

TABLE 2.13

Land use classification in Bangladesh

Region	Total Area				Not Available for cultivation				Forest Area			
	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91
Chittagong	1731 (100.00)	1731 (100.00)	1848 (100.00)	2035 (100.00)	319 (18.43)	320 (18.49)	429 (23.21)	601 (29.53)	519 (29.98)	531 (30.68)	531 (28.73)	569 (27.96)
Hill Tracts	3260 (100.0)	3260 (100.0)	3235 (100.0)	3285 (100.0)	92 (2.82)	111 (3.40)	502 (15.52)	755 (22.98)	2964 (90.92)	2911 (89.29)	2236 (69.12)	2047 (62.31)
Comilla	1660 (100.00)	1660 (100.00)	1654 (100.00)	1660 (100.00)	266 (16.02)	281 (16.93)	296 (17.9)	281 (16.93)	2 (0.12)	2 (0.12)	2 (0.12)	2 (0.12)
Noakhali	1187 (100.00)	1187 (100.00)	1342 (100.00)	1525 (100.00)	157 (13.22)	167 (14.07)	616 (12.0)	402 (26.36)	5 (0.42)	33 (2.78)	144 (10.73)	65 (4.26)
Sylhet	3062 (100.00)	3062 (100.00)	3725 (100.00)	3113 (100.00)	826 (26.97)	831 (27.14)	1266 (33.99)	863 (27.72)	197 (6.43)	190 (6.21)	224 (6.01)	187 (6.01
Dhaka	1845 (100.00)	1844 (100.00)	1797 (100.00)	1838 (100.00)	398 (21.57)	407 (22.07)	407 (22.65)	455 (24.76)	65 (3.52)	60 (3.25)	68 (3.78)	65 (3.54)
Mymensingh	1724 (100.00)	1724 (100.00)	1709 (100.00)	1726 (100.00)	443 (25.70)	451 (26.16)	443 (25.92)	338 (19.58)	-	-	-	-
Jamalpur	N.A.	840 (100.00)	833 (100.00)	839 (100.00)	N.A.	124 (14.76)	148 (16.76)	166 (19.79)	N.A.	30 (3.57)	17 (1.93)	30 (3.58)
Kishoreganj	1372 (100.00)	1372 (100.00)	1446 (100.00)	1380 (100.00)	310 (22.60)	313 (22.81)	377 (26.07)	326 (23.62)	3 (0.22)	(0.22)	3 (0.21)	2 (0.14)
Tangail	1866 (100.00)	1027 (100.00)	1012 (100.00)	1078 (100.00)	282 (15.11)	157 (15.29)	160 (15.81)	259 (24.03)	64 (3.43)	34 (3.31)	36 (3.56)	39 (3.62)
Faridpur	832 (100.00)	833 (100.00)	844 (100.00)	844 (100.00)	78 (9.38)	78 (9.36)	100 (11.85)	36 (4.27)	113 (13.58)	114 (13.69)	107 (12.68)	123 (14.57)
Barisal	1669 (100.00)	1669 (100.00)	1961 (100.00)	2041 (100.00)	449 (26.90)	451 (27.02)	690 (35.19)	493 (24.15)	13 (0.78)	10 (0.7)	43 (2.19)	43 (2.11)
Jessore	1630 (100.00)	1630 (100.00)	1621 (100.00)	1623 (100.00)	340 (20.86)	342 (20.98)	353 (21.78)	218 (13.43)	-	-	-	-
Khulna	2977 (100.00)	2977 (100.00)	2963 (100.00)	3062 (100.00)	447 (15.02)	450 (15.12)	447 (15.09)	481 (15.71)	1426 (47.90)	1421 (47.73)	1421 (47.96)	1427 (46.60)
Kushtia	878 (100.00)	877 (100.00)	863 (100.00)	861 (100.00)	142 (16.17)	144 (16.42)	141 (16.34)	(17.31)	-	-	-	-
Patuakhali	1045 (100.00)	1072 (100.00)	1174 (100.00)	1245 (100.00)	305 (29.19)	292 (27.24)	323 (27.51)	207 (16.63)	20 (1.91)	39 (3.64)	42 (3.58)	56 (4.5)

Continued...

Region	Total Area				Not Available for cultivation				Forest Area			
	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91
Bogra	961	961	960	960	216	217	226	238	-	-	-	-
	(100.00)	(100.00)	(100.00)	(100.00)	(22.48)	(22.58)	(23.54)	(24.79)				
Dinajpur	1670	1670	1644	1644	296	300	283	312	24	24	26	25
	(100.00)	(100.00)	(100.00)	(100.00)	(17.72)	(17.96)	(17.21)	(18.98)	(1.44)	(1.44)	(1.58)	(1.52)
Pabna	1201	1201	1214	1201	233	235	297	299	-	-	-	-
	(100.00)	(100.00)	(100.00)	(100.00)	(19.40)	(19.57)	(24.46)	(24.90)				
Rajshahi	2339	2339	2341	233	502	513	534	535	7	7	5	7
	(100.00)	(100.00)	(100.00)	(100.00)	(21.46)	(21.93)	(22.81)	(22.93)	(0.3)	(0.3)	(0.21)	(0.3)
Rangpur	2371	2371	2376	2377	521	529	558	544	5	5	5	6
	(100.00)	(100.00)	(100.00)	(100.00)	(21.97)	(13.09)	(23.53)	(22.89)	(0.12)	(0.12)	(0.21)	(0.25)
BANGLADESH	35281	35308	36562	36669	6622	6712	8141	7958	5438	5416	4910	4693
	(100.00)	(100.00)	(100.00)	(100.00)	(18.77)	(19.0)	(22.27)	(21.7)	(15.41)	(15.34)	(13.43)	(12.80)

Continued...

Region	Culturable Waste				Current Fallow				Area Cropped more than once			
	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91
Chittagong	39	38	42	64	166	149	119	139	289	330	353	452
	(2.25)	(2.20)	(2.27)	(3.14)	(9.59)	(8.61)	(6.44)	(6.83)	(16.70)	(19.06)	(19.10)	(22.21)
Hill Tracts	14	29	25	172	25	31	15	97	82	55	30	71
	(0.43)	(0.89)	92.10)	(5.23)	(0.77)	(0.95)	(2.1)	(2.95)	(2.52)	(1.69)	(2.44)	(2.17)
Comilla	11	7	6	77	152	91	51	171	637	787	777	883
	(0.66)	(0.42)	(0.36)	(4.63)	(9.16)	(5.48)	(3.08)	(10.30)	(38.37)	(47.41)	(46.97)	(53.20)
Noakhali	71	58	74	117	30	76	81	60	413	381	442	507
	(5.98)	(4.89)	(5.51)	(7.67)	(2.53)	(6.40)	(6.03)	(3.93)	(34.79)	(32.10)	(32.94)	(33.24)
Sylhet	138	135	169	143	616	220	219	227	332	700	771	692
	(4.51)	(4.41)	(4.54)	(4.60)	(20.12)	(7.18)	(5.88)	(7.30)	(10.84)	(22.86)	(20.70)	(22.22)
Dhaka	9	8	9	261	127	110	61	110	470	476	808	654
	(0.49)	(0.4)	(0.5)	(14.2)	(6.89)	(5.96)	(3.39)	(5.98)	(25.47)	(25.81)	(45.52)	(35.58)
Mymensingh	5	4	1	39	46	75	20	76	539	456	651	806
	(0.29)	90.23)	(0.05)	(2.26)	(2.67)	(4.35)	(1.17)	(4.40)	(31.26)	(26.45)	(38.09)	(46.70)
Jamalpur	-	8	14	28	-	16	9	77	-	418	521	437
		(0.95)	(1.59)	(3.33)		(1.90)	(1.02)	(9.17)		(49.76)	(59.0)	(52.08)
Kishoreganj	47	44	28	77	162	106	79	83	444	568	562	487
	(3.43)	(3.21)	(1.94)	(5.57)	(11.81)	(7.73)	(5.46)	(6.01)	(32.36)	(41.40)	(38.87)	(35.28)
Tangail	17	8	2	31	48	35	2	46	540	547	697	588
	(0.91)	(0.78)	(0.20)	(2.87)	(4.68)	93.41)	(0.20)	(4.26)	(28.94)	(53,26)	(68.87)	(54.54)
Faridpur	20	16	5	9	11	5	4	12	358	469	385	371
	(2.40)	(1.92)	(0.6)	(1.06)	(1.32)	(0.60)	(0.47)	(1.42)	(43.03)	(56.30)	(45.62)	(43.95)
Barisal	25	24	31	26	14	16	8	135	399	429	482	544
	(1.50)	(1.44)	(1.58)	(1.27)	(0.84)	(0.96)	(0.41)	(6.61)	(23.91)	(25.70)	(24.58)	(26.65)
Jessore	23	21	10	40	25	19	12	235	408	476	443	844
	(1.41)	(1.29)	(0.62)	(2.46)	(1.53)	(1.17)	(0.74)	(14.47)	925.03)	(29.20)	(27.33)	(52.00)
Khulna	6	5	2	37	72	37	10	79	214	292	288	295
	(0.20)	(0.17)	(0.07)	(1.20)	(2.42)	(1.24)	(0.34)	(2.60)	(7.19)	(9.81)	(9.72)	(9.63)
Kushtia	2	1	1	41	101	105	65	99	180	209	386	443
	(0.23)	(0.01)	(0.12)	(4.76)	(11.52)	(11.97)	(7.53)	(11.50)	(20.50)	(23.83)	(44.73)	(51.45)
Patuakhali	15	14	15	46	63	25	13	97	149	215	314	316
	(1.42)	(1.34)	(1.28)	(3.70)	(6.03)	(2.40)	(1.12)	(7.80)	(14.26)	(20.57)	(26.75)	(25.38)
Bogra	1	1	1	6	41	16	9	53	316	376	511	541
	(0.1)	(0.1)	(0.1)	(0.62)	(4.27)	(1.66)	(0.94)	(5.52)	(32.88)	(39.13)	(53.23)	(56.35)

Continued...

Region	Culturable Waste				Current Fallow				Area Cropped more than once			
	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91
Dinajpur	62	49	32	60	167	67	49	98	386	347	398	686
	(3.60)	(2.9)	(1.95)	(3.64)	(10.0)	(4.0)	(2.98)	(5.96)	(23.13)	(20.78)	(24.21)	(41.72)
Pabna	1	1	3	71	47	44	32	182	412	416	554	460
	(0.08)	(0.08)	(0.25)	(5.91)	(3.91)	(3.66)	(2.64)	(15.15)	(34.30)	(34.64)	(45.63)	(38.30)
Rajshahi	72	69	22	53	59	82	32	116	440	347	427	485
	(3.08)	(2.95)	(0.94)	(2.27)	(2.52)	(3.51)	(1.37)	(4.97)	(18.81)	(14.84)	(18.24)	(20.78)
Rangpur	85	78	25	44	84	79	30	187	1160	1227	1248	1296
	(3.58)	(3.29)	(1.81)	(3.93)	(3.54)	(3.33)	(1.26)	(7.86)	(48.92)	(51.75)	(52.52)	(54.52)
BANGLADESH	662	619	660	1442	2100	1404	973	2379	8534	9701	11097	12058
	(1.88)	(1.75)	(1.81)	(3.93)	(1.95)	(3.98)	(2.66)	(6.48)	(24.19)	(27.48)	(30.35)	(32.88)

Continued...

Region	Net Cropped Area				Area sown more than once as a percentage of NSA				Gross Cropped Area			
	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91
Chittagong	736 (42.51)	693 (40.03)	728 (39.39)	662 (32.53)	39.27	47.62	48.49	68.28	1081	1090	1174	1200
Hill Tracts	175 (5.37)	177 (5.43)	260 (2.91)	214 (6.51)	46.85	31.07	31054.00	33.18	276	238	356	300
Comilla	1230 (74.1)	1278 (76.99)	1298 (78.48)	1129 (68.01)	51.79	61.58	59.86	78.21	1949	2171	2189	2233
Noakhali	916 (77.17)	852 971.78)	883 (65.80)	881 (57.77)	45.09	44.72	50.06	31.34	1412	1320	1430	1513
Sylhet	1816 (59.31)	1687 (55.09)	1846 (49.56)	1693 (54.38)	81.28	41.50	41.77	40.87	2477	2458	2698	2484
Dhaka	1210 (65.58)	1259 (68.28)	1253 (69.73)	947 (51.52)	38.84	37.81	64.48	69.06	1763	1823	2214	1736
Faridpur	1197 (69.43)	1195 (69.31)	1245 (72.85)	1273 (73.75)	45.03	38.16	52.29	63.32	1832	1753	2056	2271
Jamalpur	-	661 (78.69)	645 (73.05)	538 (64.12)	-		80.00		-	1141	1266	1056
Kishoreganj	983 (71.65)	907 (66.11)	958 (66.25)	892 (64.63)	45.17	62.62	58.66	54.59	1554	1558	1590	1443
Mymensingh	1416 (75.88)	792 (77.12)	812 (80.24)	703 (65.21)	38.14	69.07	85.84	83.64	2416	1379	1608	1385
Tangail	599 (71.91)	620 (74.43)	628 (74.41)	664 (78.67)	59.77	75.65	61.31	55.87	1003	1241	1111	1133
Barisal	1163 (69.68)	1168 (69.98)	1190 (60.68)	1344 (65.85)	34.31	40.15	40.50	40.45	1702	1738	1736	2150
Jessore	1205 (73.92)	1248 (76.56)	1245 (76.80)	1130 (69.64)	33.86	38.14	35.58	74.69	1613	1803	1736	2150
Khulna	1024 (34.39)	1064 (35.74)	1082 (36.52)	1038 (33.90)	20.90	27.44	26.61	28.42	1262	1397	1419	1379
Patuakhali	650 (62.20)	703 (67.27)	781 (66.52)	839 (66.38)	27.69	30.58	40.20	37.66	811	936	1130	1189
Bogra	716 (74.51)	727 (75.65)	725 (75.52)	663 (69.06)	44.13	51.72	70.48	81.60	1097	1180	1350	1339
Dinajpur	1105 (66.17)	1230 (73.65)	1254 (76.28)	1149 (69.90)	28.60	28.21	31.74	59.70	1577	1859	1703	1980

Continued...

Region	Net Cropped Area				Area sown more than once as a percentage of NSA				Gross Cropped Area			
	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91	1975-76	1980-81	1986-87	1990-91
Pabna	883 (73.52)	921 (76.79)	882 (72.65)	659 (53.37)	43.71	45.17	62.08	70.88	1359	1426	1564	1214
Rajshahi	1678 (71.74)	1668 (71.31)	1748 (74.67)	1622 (69.52)	24.55	20.80	24.43	29.90	2188	2043	2234	2418
Rangpur	1698 (71.62)	1679 (70.81)	1758 (73.99)	1596 (67.14)	25.91	73.08	71.00	81.20	3035	3099	3195	3164
Kushtia	568 (64.69)	627 (71.49)	656 (76.01)	572 (66.43)	30.43	33.33	58.84	77.45	728	867	1085	1094
BANGLADESH	20968 (59.43)	21158 (59.92)	21878 (59.84)	20198 (55.08)	40.7	45.85	50.72	59.7	31135	32521	34883	34680

land gets diverted to non-agricultural use which is almost inevitable with urban pressures. Moreover, bringing the forest area under cultivation is out of the question. The only alternative for Bangladesh to increase the effective supply of land is, therefore, to increase the cropping intensity.

As a matter of fact, this has indeed been an important means by which production has been increased in the face of limited land base. In the early 1950s, only 25 per cent of the total land was cropped more than once. The cropping intensity increased very rapidly in the 1960s - from about 130 per centin 60-61 to 148 per centin 1969-70. It continued to increase after independence in 1971 but the rate of increase slowed down. Further, increase would depend on expansion of irrigation facilities which allow the growing of additional crops on seasonally fallow land during the dry winter season.

Table 2.14 gives the compound growth rate of the net sown area in Bangladesh between 1975-76 and 1986-87. It can be clearly seen that the rate of growth in the net sown area has been extremely sluggish with a number of years showing even a negative growth. This further highlights the severe poverty of land in the country.

TABLE 2.14

Compound growth rate of Net Cropped area to total area 1975-76 to 1986-87

Region	Growth rate of Net Sown Area
Chittagong	-0.50
Hill tracts	-3.94
Comilla	0.38
Noakhali	-1.05
Sylhet	-1.20
Dhaka	0.40
Faridpur	0.32
Jamalpur	-
Kishoreganj	-0.52
Mymensingh	0.38
Tangail	0.23
Barisal	-0.92
Jessore	0.26
Khulna	0.42
Patuakhali	0.45
Bogra	0.09
Dinajpur	0.96
Pabna	-0.08
Rajshahi	0.26
Rangpur	0.21
Kushtia	0.11
BANGLADESH	0.04

Source: Calculated

Table 2.15 shows the district-wise change in cropping intensity in Bangladesh from 1975-76 to 1990-91. For the whole of Bangladesh, the cropping intensity increased from 148.48 percent in 1975-76 to 171.70 percent in 1990-91. During 1990-91, 59.7 percent of the net sown area was sown more than once compared to 45.85 percent in 1980-81. During

TABLE 2.15

Cropping Intensity in Bangladesh

Region	1975-76	1980-81	1986-87	1990-91
Chittagong	146.88	157.28	161.26	181.27
Hill Tracts	157.11	134.46	136.92	140.18
Comilla	158.44	169.87	168.64	197.79
Noakhali	154.13	154.92	162.06	171.74
Sylhet	133.35	145.70	146.10	146.72
Dhaka	145.73	144.79	176.70	183.32
Faridpur	153.03	146.69	165.14	178.40
Jessore	-	172.61	196.43	196.28
Kishoreganj	158.10	171.77	165.87	161.77
Mymensingh	170.63	174.11	198.15	197.01
Tangail	167.49	200.16	177.07	170.63
Barisal	146.40	148.80	149.12	149.11
Jessore	133.90	144.47	139.52	190.27
Khulna	123.30	131.29	131.15	132.37
Patuakhali	124.81	133.14	144.56	141.72
Bogra	153.24	162.31	186.21	201.96
Dinajpur	142.64	151.13	135.81	172.32
Pabna	153.92	154.83	177.12	187.06
Rajshahi	130.41	122.48	127.13	148.08
Rangpur	178.69	184.57	181.80	198.85
Kushtia	128.23	138.27	165.40	191.26
Bangladesh	148.48	153.70	159.44	171.70

Source: Statistical Year Book of Bangladesh, Bangladesh Bureau of Statistics, Dhaka, various issues; and Monthly Statistical Bulletin of Bangladesh, May 1993, BBS, Dhaka.

Note: Jamalpur was previously included in Mymensingh district.

1990-91, Comilla, Mymensingh, Bogra and Rangpur had cropping intensities of more than 190 percent with Bogra having the highest of 202 percent. Thus the effective supply of land has been raised by growing more and more additional crops on the same land every year.

To sum up, this chapter has briefly reviewed the status of the green revolution in Bangladesh. In particular, the pace at which the usage of modern inputs spread and intensified has been dealt with. The area under HYV seeds has expanded at a fast-rate, starting from less than 1 percent of the total rice and wheat area to nearly 47 percent in 1991-92. Currently all the wheat cultivated in Bangladesh is that of the High Yielding Vvariety. From being a relatively unimportant foodgrain in Bangladesh, it was emerged as a very important crop.

The spurt of irrigation expansion began around the late 1970s. However, inspite of a large increase, irrigated acreage stood at less than 40 per centin 1991-92. Moreover, in several areas of Bangladesh, traditional methods of irrigation are still used.

The use of another important component of the HYV package namely fertilizers has also increased substantially. However, its use is dependent on the amount of control farmers have on their water resources.

Coming to the land use pattern, an equilibrium seems to have been reached with the net sown area remaining more or less steady over the past three decades. As a result, cropping intensity has gone up substantially to facilitate an increase in the effective supply of land and thereby bring about an increase in production.

CHAPTER III

AGRARIAN STRUCTURE AND AGRICULTURAL GROWTH

In this chapter, an attempt is made to study the nature of agrarian structure in Bangladesh. One factor commonly advanced by researchers and development agencies to explain the relatively low level of development of agriculture in the country is the archaic nature of its agrarian structure. This chapter examines, in particular, the emerging pattern of land distribution, size of agricultural holdings, tenancy and fragmentation of holdings.

A cursory look at the agrarian structure of Bangladesh bring out the following points:

(i) A marked inequality in land ownership with a high incidence of landlessness;

(ii) Preponderance of small farms coupled with increasing pressure on land leading to a decline in average farm size which, in turn, leads to further proliferation of small farms;

(iii) Prevalence of share tenancy on approximately 20 to 25 per cent of the operated area;

(iv) Landholdings are highly fragmented: the 1976-77 agricultural census found that the average operational holding (reported as 3.5 acres, owing to exclusion of very small holdings) consisted of 9.6 non-contiguous plots.

A more detailed examination of the above points bring to light some important features of the agrarian structure of Bangladesh.

3.1 The Pattern of Land Distribution

The ownership of land is of crucial importance in rural Bangladesh. However, a big proportion of the rural population is landless. According to the 1983-84 Census of Agriculture and livestock, landlessness increased from 17 per cent of the rural households in 1951 to 56.5 per cent in 1983-84. Of them 8.7% claimed ownership of no land whatsoever. On the other hand a large chunk of land is concentrated in the lands of a handful of people. The land occupancy Survey(LOS) of Bangladesh, 1978, found that 10 per cent of the rural households own more than half of the country's cultivable land.

It is generally observed in empirical studies that the distribution of ownership holdings is much more unequal than that of operational holdings. In other words, the land concentration in term of operational holdings is likely to be lower compared to that of ownership holdings. The relative shares of net cultivated area in the three size group categories of households can be seen in table 3.1. Small

TABLE 3.1

Inequalities in Land Distribution in Bangladesh

Farm Size Category (in acres)	1960 (%)		1984 (%)	
	Households	Net cultivated	Household	Net cultivated
Small (0.05 - 2.49)	51.64	15.73	70.34	28.28
Medium (2.50 - 7.49)	37.68	46.66	24.72	46.05
Large (7.50 and above)	10.68	37.61	4.94	25.67
Total	100.00	100.00	100.00	100.00

Source: Bangladesh census of Agriculture and Livestock, 1960 and 1983, Bangladesh Burean of Statistics.

farm households increased from 51.64 per cent in 1960 to 70.34 per cent in 1984 while their share of net cultivated area increased from 15.73 per cent to 28.28 per cent. Medium farm size households declined from 37.68 per cent to 24.72 per cent over the same period, while net area cultivated by them remained almost constant. The large farm households have, on the other hand, declined drastically from 10.68 per cent of all households in 1960 to less than 5 per cent in 1984 while the proportion of net cultivated area has declined to 25.67 per cent from 37.61 per cent. The inequality in land distribution is thus clearly brought out by the Table 3.1. In sum, in 1984, on one extreme, 70.28

per cent of the households were cultivating only 28.28 per cent of the land while on the other extreme, only 4.9 per cent of the households were cultivating over one fourth of net cultivated area.

Table 3.2 shows structural mobility of rural households, their net cultivated area and the average net cultivated area per household during 1960-1984. Small farm households (cultivating 0.05 & 2.49 acres) increased at a rate of 3.34 per cent over the 24 year period while their net cultivated area and average net cultivated area per household increased at a rate of 2.66 per cent and 0.68 per cent over the same period. The middle farm size households (2.5 - 7.49 acres) increased at a rate of 0.30 per cent and their share of net cultivated area increased at a rate of 0.30 per cent while the average net cultivated area per households in this category declined by 0.14 per cent. Large farm size households with 7.5 acres and above of cultivated area declined by 1.16 per cent while their net cultivated area and average net cultivated area per household have gone down by 1.38 per cent and 0.22 per cent respectively. Finally, a look at farm households in general shows an increase of 2.05 per cent while their net cultivated area and net cultivated area per household increased by 2.21 per cent and 1.84 per cent respectively.

TABLE 3.2

Annual Growth Rates of Rural Households, Net Cultivated Area and Average Net Cultivated Area per Household by Size Categorizes: 1960 - 1984

Farm size/group categorizes	Annual growth rate in percentage 1960 - 1984
Non farm households	0.96
Small farm households	3.34
(i) Net cultivated area(NCA)	2.66
(ii) Average NCA per household	0.68
Middle farm households	0.30
(i) Net cultivated area	0.16
(ii) Average NCA per household	-0.14
Large farm households	-1.16
(i) Net cultivated area	-1.38
(ii) Average NCA per household	-0.22
All Farm households (Bangladesh)	2.05
(i) Net cultivated area	2.21
(ii) Average NCA per household	1.84

Source: Banik, Arindam, "Changes in the Agrarian Structure of Bangladesh: 1960-84", The Bangladesh Development Studies, Vol.XVIII, No.4, December 1990.

3.2 Size of Agricultural Holdings

The pattern of the distribution of the size of land holding is also indicative of an increasing rate of pauperisation of peasant families in rural Bangladesh. The average land holding is very small, even by the usual South Asian standards. Table 3.3 shows the size distribution of farm holdings in Bangladesh. The average size of holding

TABLE - 3.3

Size Distribution of Farm Holdings, 1960 - 83/84

Farm size	Average size of holdings	
	1960	1983-84
Small Farm	1.11	0.90
Medium Farm	4.29	4.10
Large Farm	12.00	11.90
Total	3.54	2.30

Source: Pakistan Census of Agriculture, 1960; and Bangladesh Census of Agriculture & Livestock, 1983-84.

around 1938-40 was estimated at 4.02 acres. As Table 3.3 shows it declined to 3.54 acres in 1960 and was further reduced to 2.3 acres according to the Agricultural census of 1983-84. Over a period of about 45 years i.e between 1938-40 to 1983-84, the average size of land held by a peasant family has been almost halved. The average size itself has today become almost a marginal size. While the average size of small holdings has gone down from 1.11 to 0.90 between 1960 and 1983-84, that of large farms has reduced marginally from 12.00 acres to 11.9 acres over the same time period. Thus for the medium and large farms, the shift is negligible but for small farms, the shift has been quite substantial.

A more detailed breakdown of farm size distribution in 1983-84 is presented in Table 3.4. It shows very clearly that the crisis has been deepening in land peasant relationship in Bangladesh agriculture. Of the small farms, the majority are practically non-viable. In all 24.06 per cent of the farms are below 0.05 acres in size; another 16.37

TABLE - 3.4

Percentage Distribution of Number and Area of Farm Household, 1983-84

Farm size (acres)	Percentage of number of farms	Percentage of area of farms
0.05 - 0.4	24.06	2.74
0.05 - 0.99	16.37	5.08
1.00 - 1.49	13.28	6.96
1.50 - 2.49	16.63	14.78
Total Small farms	70.34	28.98
2.50 - 04.9	17.98	27.45
5.00 - 7.49	6.74	17.64
Total Medium farms	24.72	45.09
7.50 - 9.99	2.30	8.62
10.00 - 14.99	1.78	9.14
15.00 - 24.99	0.69	5.47
25.00 & table	0.17	2.70
Large farms	4.94	25.93

Source: BBS, The Bangladesh Census of agriculture and Livestock 1983-84, Vol.I.

per cent lie between 0.50 to 0.99 acres. All farms below 1.5 acres constitute 53.71 per cent of the total. But together they account for only 14.78 per cent of the total

farm area. Disparity in an acute form is observable in the lowest category of farms below one-half of an acre in size; nearly one fourth of the farms operate only 2.74 per cent of the cultivated area. On the other extreme, 0.17 per cent of the farms covering 2.70 per cent of the farm land are in the size group of 25 acres and above. Another 0.69 per cent in the 15.00 to 24.99 acres group operate 5.47 per cent of the area under cultivation. Inequalities are obviously very sharp. It may, however, be noted that, even the bigger farms are not very big if we look at the conditions obtaining in many neighbouring countries so much so that a farm of 7.50 acres is now being defined as large in Bangladesh.

The pattern of distribution of farm households is not uniform all over Bangladesh. It is true that an overwhelming majority of farm households is very small, practically in each region, yet they cover a wide range of sizes. For example as table 3.5 shows, Comilla has the highest percentage of small farms followed by Noakhali, with their small farm concentration being 84.4 per cent and 83.4 per cent respectively. In six of the remaining regions viz Chittagong, Dhaka, Barisal, Tangail, Bogra, and Faridpur, the percentage varies between 70 to 80 per cent. In nine other old districts of Mymensingh, Jamalpur, Rangpur, Sylhet, Patuakhali, Khulna, Pabna, Kushtia and Rajshahi, the per-

centage of small farms varies between 60 per cent to 70 per cent; in Jessore and Dinajpur, it is 59.14 and 51.46 respectively. Only in two of the old districts i.e. Hill Tracts and Bandarban, which are hilly regions, the number of small farms constitute less than 50 per cent of all farms.

TABLE 3.5

Percentage distribution of the numbers of farm household in different farm size categories in Banglash, 1983-84.

Region	Percentage of the number of		
	Small farms	Medium farms	Large farms
Bandarban	38.46	50	11.54
Chittagong	79.77	18.14	2.09
Hill Tracts	45.65	46.74	7.61
Comilla	84.4	14.49	1.11
Noakhali	83.43	14.23	2.34
Sylhet	67.11	25.74	7.14
Dhaka	78.89	18.79	2.32
Faridpur	70.49	25.04	4.17
Jamalpur	69.67	26	4.33
Mymensingh	69.83	25.36	4.86
Tangail	72.31	24.42	3.26
Barisal	75.61	20.71	3.6
Jessore	59.14	33.61	4.23
Khulna	66.17	26.43	7.4
Kushtia	62.3	29.92	7.79
Patuakhali	66.67	26.07	7.26
Bogra	71.15	24.73	4.12
Dinajpur	51.46	38.83	9.71
Pabna	64.83	28.49	6.69
Rajshahi	60.26	31.37	8.47
Rangpur	67.21	27.66	5.13
BANGLADESH	70.34	24.72	4.94

Source: Agricultural Census, 1983-84.

The distribution of large farms is also uneven. It ranges from 1.11 per cent in Comilla to 9.71 per cent in Dinajpur. Apart from Bandarban it is nowhere above 10 per cent. The distribution of the number of medium size farms also show similar uneveness ranging from 14.93 per cent in Noakhali and 14.49 per cent in Comilla to 46.74 per cent in Hill Tracts and 30 per cent in Bandarban.

It appears that from the point of view of viability of the size of landholdings, the distribution pattern is least unfavourable in Dinajpur and Rajshahi while it highly acute in Comilla, Dhaka, Chittagong and Noakhali.

Table 3.6 gives the share of total area under different farm size categorises across different regions of Bangladesh during 1983-84. With ever-increasing population pressure on land, it is obvious that the total area under small farms has been on the rise in Bangladesh while the area under large farms has been on the decline. However, the distribution under different categories of farms is not uniform in Bangladesh. In other words, the aggregate area under small farms is relatively higher in regions which have a more pronounced preponderance of small farms. For example, as Table 3.6 shows, Comilla tops the list with 53.17 per cent share in net cultivable area against 84.40 per cent share in the number of holdings, as far as small farms are con-

cerned. Other regions in this category are Noakhali with 44.11 per cent, Chittagong with 43.53 percent and Dhaka with 42.21 per cent.

TABLE 3.6

Percentage distribution of cultivable area among farm household in different farm size categories in Bangladesh, 1983-84.

Region	Percentage share of the area of		
	Small farms	Medium farms	Large farms
Bandarban	12.5	57.69	29.81
Chittagong	43.53	42.15	14.33
Hill Tracts	14.63	57.62	27.74
Comilla	53.17	38.31	8.51
Noakhali	44.11	36.09	19.8
Sylhet	23.6	41.75	34.65
Dhaka	41.21	43.38	15.41
Faridpur	29.66	47.01	23.32
Jamalpur	29.31	47.43	23.26
Mymensingh	29.58	45.19	25.24
Tangail	33.91	47.72	18.37
Barisal	33.19	44.43	22.39
Jessore	20.84	50.22	28.94
Khulna	22.27	43.30	34.43
Kushtia	20.41	46.26	33.33
Patuakhali	20.89	42.93	36.18
Bogra	32.26	45.41	22.33
Dinajpur	17.13	49.13	33.75
Pabna	24.23	45.35	30.42
Rajshahi	20.66	45.53	33.83
Rangpur	27.96	47.53	25.5
BANGLADESH	28.99	40.09	25.92

Source: Hossain, Mosharaff, "Agriculture in Bangladesh: Performance, Problems and Prospects", UPL, 1991.

In the mountainous terrain of Bandarban and Chittagong Hill Tracts, small farm cover only 12.5 per cent and 14.63 per cent of the total cultivable area respectively. In Dinajpur also, the figure for area under small farms is a low of 17.18 per cent. In the regions of Rajshahi, Kushtia, Jessore and Patuakhali, the corresponding figure is around 20 per cent. Large farms covering above 30 per cent of the cultivable area obtain in Patuakhali, Sylhet, Khulna, Rajshahi, Dinajpur, Kushtia and Pabna. Patuakhali, with 36.18 per cent of the area under large farms tops the list. Comilla comes last in order with the corresponding figure of 8.51 per cent. It may be noted that Comilla happens to have the smallest percentage of the number of large farms in Bangladesh.

3.3 **Tenancy in Bangladesh**

In Bangladesh, the predominant tenancy arrangement is sharecropping. Under this tenancy system, gross output is shared equally between the tenant and the landowner, while most of the cost of cultivation is borne by the tenant.[1] Pure tenants, that is those who rent out the entire holding are rare. Next to owner farming, which is practised on 82

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1. Mahabub Hossain, "Nature of Tenancy Markets in Bangladesh Agriculture", Journal of Social Studies 3 (No.1), Dhaka University, 1979.

per cent of the total cultivated area, share cropping occupies the most important tenancy system with about 16 per cent of the total acreage under it, and encompassing 25 to 50 per cent of all farmers in the country.[2] The 1977 Land Occupancy Survey finding that as high as 89 per cent of the total tenanted land was under share tenancy, further highlights its overwhelming importance in Bangladesh.[3] Arrangements under share tenancy is such that the tenant has to bear the full risks of production, own and supply most of the means of production such as draft animals, plough and other agricultural implements. The share croppers also bear the full cost of inputs, i.e. seed, fertilizers, pesticides and irrigation facilities Table 3.7 shows the ratios of inputs supplied by the landowner and the tenant household in the case of share cropping arrangements.

The table shows that seeds, fertilizers, pesticides and irrigation facilities are provided by the share cropper in more than 99 per cent cases. As for institutional credit, land as collateral is essential. Further, due to bureaucratic banking system, the sharecroppers, particularly the

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2. Zaman, M.Raquibuz, "Sharecropping and Economic Efficiency in Bangladesh", The Bangladesh Economic Review, 1(2), Dhaka, 1973.

3. Momin, M.A. "Impact of Agrarian Structure on Agricultural Growth", Journal of Rural Development, Vol 10(3) NIRD, Hyderabad, 1991.

TABLE 3.7

Proportion of supply of agricultural inputs by Landowner and Tenant households, 1977

Item	Landowner percent of total	Sharecropper percent of total	Total
Seed	0.59	99.41	100
Fertilizer	0.36	99.64	100
Irrigation facilities	0.03	99.97	100
Pesticides	0.22	99.78	100

Source: Bangladesh Bureau of Statistics, 1977.

poorer tenants among them, generally do not have access to institutional credit. Another tendency which has been unfavourable to the sharecroppers is their replacement by hired labour. It happens mostly in those cases where tubewell irrigation has come into existence. The sharecropper who used to work on the land before it was irrigated are evicted. With modern irrigation, land owners find it more beneficial to organise production on irrigated land with wage labour, even when sharecroppers may be willing to accept as little as 25 per cent instead of the normal 50 per cent of

the crop as their share.[4] It is clear that share cropping system in Bangladesh is an exploitative type of arrangement. The insecurity of tenure and unfavourable terms and conditions in such a system of tenancy act as a disincentive for the sharecropper in regard to adequate investment for agricultural development.

Disincentive effects of share tenancy can be assessed if performance on own land compared to that on rented land under the same cultivator (Owner-cum-sharecropper) is examined as in table 3.8.

TABLE 3.8

Adoption of HYV on owned and rented land for mixed tenant farmers by season, 1982

Seasons	Owner-cum-tenant farmers	
	% of own land under HYV	% of rented land under HYV
Aus	38.8	36.1
Aman	42.1	35.1
Boro	82.6	89.0
All seasons	49.8	46.5

Source: Hossain, Mahabub (1987), BIDS, Dhaka.

4. Vylder, Stephen de, "Agriculture in Chains - Bangladesh: A case study in contradictions and constraints'", Zed Press, London, 1982.

It is seen from the table that in all seasons taken together tenants allocated smaller proportion of land under HYV in rented land compared to this owner land. Season-wise, during the *aman* and *aus* seasons, the tenants allocated smaller proportion of their rented land under modern variety crops compared to their own land. Only during the *boro* season, tenants grow HYV more on rented land compared to own land. This may be due to a stipulation by the landowner that land can be rented only if it is cultivated by modern varieties. It follows that if share tenants were allowed to make production decisions freely, he would allocate less of labour and other inputs in the rented land and would thus produce a sub-optimal output. Sharecropping, thus, is one of the chief factors responsible for constraining agricultural growth in Bangladesh.

3.4 **Fragmentation of Holdings**

Another aspect of the agrarian structure of Bangladesh which, hinders agricultural development in general and adversely affects farm productivity, in particular, is that the holdings are highly fragmented. Although, in recent years, through a series of policy interventions, the average number fragments has declined, in each farm size categorises, yet holdings still remain highly fragmentized. Table 3.9 shows the average number of fragments per farm holdings.

TABLE 3.9

Average number of fragments per farm households

Size group (acres)	1977	1983-84
Small holdings (under 2.5 acres)	5.9	4.6
Medium holdings (2.5 to 7.49 acres)	11.5	11.3
Large holdings (7.5 and above acres)	20.4	19.4
All holdings	9.6	7.0

Source: Bangladesh Bureau of Statistics, 1986

The table shows that the average number of fragments for all holdings together was 9.6 in 1977 which declined to 7 in 1983-84. Similarly the average number of fragments in 1977 were 5.9, 11.5 and 20.4 for small, medium and large farms respectively. These numbers come down to 4.6, 11.3 and 19.4 respectively in 1983-84. The declining number of fragments hardly detracts from the fact that smaller holdings cannot offer much scope for large and lumpy investment and cannot economically employ modern farm machines and implements if the number of fragments is still large. The fragmentation of holdings is thus another agrarian constraint in Bangladesh holding up the process of agricultural transformation.

From the foregoing analysis, one can observe that the agrarian structure of Bangladesh is one of the important factors responsible for the relatively low level of agricultural development in the country. Several aspects of this structure emerge in this chapter:

1. Land ownership is concentrated in the hands of a minority: about 10 per cent of the rural households own more than half of the country's cultivable land.
2. The average size of landholding is small and has been declining over time (e.g. from 3.5 acres in 1977 to 2.3 acres in 1983-84): according to the 1978 Land Occupancy Survey of Bangladesh, the average operational holding was 2.5 acres.
3. Sharecropping is the mode of cultivation on approximately 20 to 25 per cent of the operated area. It adds its own share of agrarian bottlenecks as far as small and marginal tenant far operators are concerned. The terms of sharecropper tenancy, more pointedly the cost sharing arrangements between the tenant and the landlord, seem to operate to the disadvantage of small leasing-in farm operator.
4 Land holdings are highly fragmented. In 1983-84, the average number of fragments for all holdings taken together was 7.0.

Thus the inequitious agrarian structure is not conducive to the adoption of capital intensive techniques which are important for enhancing the productivity of agriculture. This is one of the main factors constraining agricultural growth in Bangladesh.

CHAPTER IV

GROWTH AND STABILITY IN THE FOOD SECTOR

This chapter seeks to examine and analyse the variability in the cropped area, production and yield, with respect to important foodgrain crops grown in Bangladesh. All possible data available for the country as a whole and for its regions have been used for this analysis. The analysis is confined to rice, wheat, an important pulse crop (gram) and total cereal production; the latter is the summation of rice, wheat, jowar, barley, bajra, maize and other *kharif* cereal crops. Semi-logarithmic trend lines have been fitted for relevant Bangladeshi data for foodgrain area, production and yield for two time periods viz 1969-70 to 1976-77 (the first phase of the introduction of new technology) and 1977-78 to 1991-92 (the second phase of modern technology). For measuring relative variability, the coefficient of variation has been worked out.[1] In addition to this, the percentage change in the coefficient of variation in Period II over Period I has been computed to know the pattern of change over time in the instability of the variables studies. The

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1. The coefficient of variation (C.V.) here does not confirm to the standard one used in statistical literature. The C.V. was estimated for the detrended series separately for each period using $CV_t = CV\sqrt{1-\bar{R}^2}$ where $\bar{R}^2$ is the adjusted coefficient of determination.

year to year change showing the annual variability in area, production and yield has also been given. Finally, parabolic and linear trend lines have been fitted to regional data for assessing the inter-regional disparity in the production of foodgrains. More pointedly, this chapter, concentrates on the following aspects:

(i) The extent of instability in foodgrain area, production and yield between the two periods under study, both at the aggregate and disaggregated levels.

(ii) Growth rates in area, production and yield for important foodgrains between the two time periods for Bangladesh as a whole.

(iii) Annual variability i.e. percentage change over the preceeding year, in area, production and yield of major foodgrains.

(iv) Inter-district variation in the production and yield of important crops over the entire time period under study.

4.1 **Variability in Foodgrain Production, Area and Yield**

Table 4.1 sets out the relative variability in the area, output and yield for all the three varieties of rice as well as for total rice. Since, rice is the predominant foodgrain in Bangladesh and is grown throughout the year, its analysis has been done variety-wise.

TABLE 4.1

Coefficient of Variation for Area, Output and Yield for Rice Crops in Bangladesh

Crops	Variables	High Yielding Variety			Local Variety		
		CV_t* in Period I+	CV_t in Period II ++	Change in CV in Period II over period I	CV_t in period I	CV_t in Period II	Change in CV in Period II over period I
Aman	Area	48.31	13.68	-71.68	6.84	8.82	36.11
Rice	Production	47.14	15.82	-66.44	13.42	10.57	-21.24
	Yield	14.84	6.71	-54.78	8.9	10.93	22.81
Aus	Area	18.02	13.62	-24.42	6.12	16.74	173.39
Rice	Production	19.65	11.32	-42.39	10.00	9.13	-8.72
	Yield	7.33	6.59	-10.10	5.5	5.9	7.27
Boro	Area	19.50	9.80	-49.74	11.29	5.95	-47.30
Rice	Production	18.68	10.63	-43.09	14.02	14.67	4.64
	Yield	4.49	6.31	40.53	4.54	11.65	156.61
Total	Area	25.41	5.67	-77.69	5.22	6.55	25.47
Rice	Production	23.38	6.25	-73.27	12.02	5.96	-50.42
	Yield	8.90	3.09	-65.28	7.24	6.94	-4.14

* CV_t is trend corrected coefficient of variation given by $CV\sqrt{1-\bar{R}^2}$

\+ Period I = 1969-70 to 1976-77

++ Period II= 1977-78 to 1991-92

In other words, the summer and the rainy season crops of *aus* and *aman* (*kharif* crops) and the dry season *boro* poddy (*rabi* crop) have all been individually looked at.

Table 4.1 clearly shows that the coefficient of variation of acreage for the High yielding variety (HYV) of total rice witnessed a dramatic decline from 25.4 per cent in

Period I to a mere 5.7 per cent in Period II - a fall of nearly 78 per cent. For all the three HYVs of rice also, viz *aman*, *aus* and *boro*, there was a decline in the relative variability of area cropped in the second period over the first. The decline was the highest for *aman* paddy in which case the coefficient of variation fell from 48.3 per cent in Period I to 13.68 per cent in Period II. The results of the percentage change in the coefficient of variation between the two periods brings out that instability declined considerably in Period II over Period I. In other words, as technology matures, and gets spread over wider areas and across wider mass of cultivating households, allocation to high yielding varieties does not have to change much on year-to-year basis, as it does during the initial years of technology arrival.

The local varieties, however, present a different picture. For total rice acreage, instability actually increased, *albeit* marginally, from 5.2 per cent in 1969-70 to 1976-77 to 6.6 per cent during 1977-78 to 1991-92. Local varieties of *aman* rice and *aus* rice also witnessed a 36 per cent and 73.4 per cent increase in relative instability in cropped area respectively. Local *boro* has been the only one to have undergone a decline in its coefficient of variation over the two periods. Moreover, the decline has been quite

substantial with the coefficient of variation falling from 11.3 per cent in the first period to about 6 per cent in the second period. However, the relative variability of acreage for the local varieties is smaller then HYVs as reflected in the small coefficients of variation. The contrasting behaviour of acreage, between high yielding and local varieties of rice, clearly testify to the instability-reducing capability of the former when their adoption grows over time. The magnitude of coefficient of variation for acreage, in Period II over that in Period I, does have its counterpart in production as we see below. Increasing acreage stability in this sense, therefore, implies increasing production stability.

The instability in productivity for the high yielding variety of total rice was quite high in the first period. In the later period, however, there was a substantial decline of as much as 65.3 per cent in the coefficient of variation. For both HYV *aman* and HYV *aus* also, the relative variability in yield declined in the second period. In particular, *aman* showed a steep decline of 54.8 per cent in its coefficient of variation. A contrasting picture is presented by HYV *boro*, where the relative variability in yield increased from 4.49 per cent between 1969-77 to 6.31 per cent in 1977-78. Nevertheless, absolute magnitude for

HYV *boro* are so low that it does not warrant any conclusion either for or against increased instability.

The variability in yield for both total rice (local variety) and all the three varieties of local rice showed an increase in the second period compared to the first. *Boro* rice, in particular, showed a tremendous increase in its coefficient of variation -- 156.6 per cent. The relatively unstable character of *boro* yield and production (analysed below) during the second period stems from the fact that cultivation of *boro* rice has gradually extended beyond the irrigated area available during the dry season. As *boro* is cultivated during the dry winter season, its production and yield are crucially dependent on controlled irrigation and complementary inputs. Any divergence and this happens quite often - is likely to inject variability. The interaction of all the factors explain the relatively unstable character of *boro*.

The levels of production variability in respect of all the HYVs of rice including that of total rice showed a sizable decline in the second period over that of the first. For HYV rice as a whole the decline in production variability has been the highest vis-a-vis those of the individual varieties.

For the local variety of total rice, local *aman* and local *aus*, there was a decline in relative instability in production in the second period. However, production variability went up marginally for local *boro* in the second period. This was expected to be so since there was such a phenomenal increase in yield variability of this variety in the latter period.

TABLE 4.2

Cefficient of Vriation for Aea, Poduction and Yield for Wheat, Gram and Total Cereals

Crops	Variables	CV_t in Period I	CV_t in Period II	Change in CV in Period II over period I
Wheat	Area	93.95	19.19	-79.96
	Production	29.85	27.16	-9.01
	Yield	20.68	10.34	-50.00
Gram*	Area	6.50	20.52	215.69
	Production	13.44	22.52	67.56
	Yield	7.53	6.83	-9.30
Total Cereals	Area	4.68	2.92	-37.61
	Production	10.97	3.62	-67.001
	Yield	6.12	4.06	-33.66

* Due to non-availability of data, the terminal year for gram and total cereals is 1990-91.

Table 4.2 gives the coefficient of variation for area, production and yield in respect of wheat, gram and total cereals. A substantial decline in the variability of

cropped area under wheat is indicated in the second period. The coefficient of variation of the wheat acreage declined by almost 80 per cent, from 94 per cent in Period I to 19 per cent in Period II. The relative variability in the production of wheat also declined in the second period. This decline, however, was much lesser in magnitude, compared to acreage. The coefficient of variation for wheat also witnessed of decline during 1977-92. Thus, from all conceivable angles, wheat shows a lesser degree of instability in the second period.

Coming to gram, it was only yield that witnessed a fall in the coefficient of variation. This decline, too, was marginal. For both acreage and production of gram there was a substantial increase in the variability. Particularly, the cropped area saw a tremendous increase of 215.7 per cent. Perhaps, the opposite behaviour of wheat is a plausible explanation for the gram profile, both being the competing *rabi* crops.

For total cereals, the scenario is much better than for gram. From each of the acreage, yield and production viewpoints, a decline in the relative variability in the second period is a distinct feature of Bangladesh agriculture. In particular, the formidable decline of 67 per cent in the coefficient of variation for production needs to be underlined.

To sum up, it is evident that the variability in area production and yield of all HYV rice crops except *boro* has gone down in the second period. For, the local varieties, however, the picture is a mixed one with most of the variables showing increased instability during the period 1977-92. However, in general the relative variability in area, production and yield for local varieties is smaller than the HYVs as reflected in their small coefficients of variation. Wheat and total cereals have also undergone a decline in the relative variability in cropped area, production and yield. The only crop to have shown a dismal performance has been gram with both acreage and output showing tremendous increases in instability as we move to late seventies and eighties. In a regime of technological expansions and switchovers to more productive crops from less productive ones, the latter are bound to be relegated to less important enterprises. Accordingly, acreage decisions as well as input-use decisions get more and more pivoted on the other set of 'rising' crops. Instability on acreage and yield fronts is, therefore, natural to follow.

4.2 **Annual Variability in Area, Yield and Production**

Table 4.3(A) shows the year to year variability in the area, production and yield of *aman* rice. It is clear from

the table that the series of cropped area under *aman* is punctuated by yearly ups and downs. The annual fluctuations for *aman* HYV during 1969-77 were greater in terms of frequency and amplitude as compared to the second period i.e. 1977-92. In particular, the years 1970-71, 1971-72 and 1972-73 showed astronomical increases of 585 per cent, 213 per cent and 120 per cent respectively in the *aman* HYV acreage. In the other hand, the years 1974-75 and 1976-77 showed a considerable decline in cropped area. The tremendous increase in cropped area during 1970-73 is indicative of the initial euphoria associated with the introduction of new agricultural technology. However, as expected, the tempo of this increase could not be maintained and the rate of increase began to slow down and sometimes, even underwent an absolute decline.

In the second period, barring the year 1977-78, all the years registered an increase in *aman* HYV acreage, though in differing magnitudes. In particular, the years 1978-79 and 1989-90 witnessed a marked increase of 56.14 per cent and 37.06 per cent respectively over the previous years.

Acreage under local *aman* was marked by frequent upswings and downswings in both the periods. In the second period, nine out of the fifteen years saw a decline in cropped area with a maximum decline of 32.5 per cent in the

TABLE 4.3(A)

Annual Variability in Cropped Area, Production and Yield in respect of Aman Rice

Year	Aman Rice					
	High Yielding Variety			Local Variety		
	Area	Production	Yield	Area	Production	Yield
Period I						
1969-70	-	-	-	-	-	-
1970-71	+585.20	+476.06	-15.93	-5.54	-16.40	-11.49
1971-72	+213.03	+228.68	+5.00	-10.66	-9.75	+1.01
1972-73	+120.38	+40.73	-36.14	+1.99	-9.38	-11.14
1973-74	+48.19	+99.67	+34.74	-5.12	+4.19	+9.82
1974-75	-39.35	-45.29	-9.79	+1.16	+1.66	+0.49
1975-76	+11.02	+12.86	+1.66	+5.15	+19.72	+13.85
1976-77	-23.95	-25.72	-2.34	+3.48	+2.73	-0.73
Period II						
1977-78	-45.86	-37.5	+15.33	-1.62	+13.96	+15.84
1978-79	+56.14	+50.60	-3.54	+2.82	-3.54	-6.18
1979-80	+30.67	+13.43	-13.19	+1.07	-12.67	-13.59
1980-81	+3.23	+13.18	+9.65	+2.39	+11.80	+9.19
1981-82	+3.03	-12.93	-15.49	-0.82	-8.91	-8.16
1982-83	+21.50	+27.28	+4.76	-3.68	+2.10	+6.0
1983-84	+5.63	+8.69	+2.90	-0.92	+3.52	+4.48
1984-85	3.32	+9.21	+5.69	-4.6	-1.83	+2.91
1985-86	+12.74	+12.85	+0.10	+3.62	+6.80	+3.06
1986-87	+8.40	+4.61	-3.50	-0.5	-0.64	-0.13
1987-88	+1.35	+0.92	-0.43	-32.48	-13.36	+28.32
1988-89	+21.81	+12.15	-7.94	+15.84	-17.48	-28.77
1989-90	+37.06	+59.14	+16.11	+5.68	+24.38	+17.70
1990-91	+17.44	+16.74	-0.59	-3.81	-9.00	-5.39
1991-92	+10.09	+11.69	+1.49	-5.86	-5.72	+0.15

year 1987-88. In the other years during this period, annual variability was in the range of 0.5 per cent to 6 per cent approximately. It may be noted that the amplitude of fluctuations for HYVs were much more than that of the local variety.

The series of output deviations for HYV *aman* is almost identical to that of acreage. This is quite understandable because, for the entire 22-year period under study, year-to-year fluctuations in area witnessed tremendous increases thereby leading to large increases in output. Like acreage, the frequency of fluctuations was greater in the first period. The second period saw an almost continuous increase in production of HYV *aman* except for the years 1977-78 and 1981-82 which registered a decline.

For the local *aman* variety, output fluctuations were more pronounced in the second period. Although no clearly discernible pattern exists, yet, it seems, on an average every two or three years of decline in output was followed by one or two years of increase in the second period. In the first period, the first three years of continuous decline were followed by four consecutive years of increase.

Unlike *aman* acreage and output, yield of both HYV and local *aman* witnessed frequent ups and downs in both the periods. However, the amplitude of fluctuations was greater

for the HYVs than the local variety and within HYVs, it was greater during Phase I (1969-77).

Table 4.3(B) shows the year to year change in cropped area, production and yield of *aus* rice. Unlike HYV *aman*, the area under HYV *aus* presents a different picture. The first period in this case saw much lesser fluctuations than the second period. In Period I, HYV *aus* acreage registered tremendous increases in all years except the terminal year. The second period, however, was associated by increasing fluctuations in cropped area though the amplitude of fluctuations was not so high.

The ups and downs for the local *aus* variety was higher in the first period compared to the second period. In the second period, the first six years saw fluctuations in cropped area of varying magnitudes. Thereafter i.e. from 1983 onward there has been a continuous decline in the local *aus* acreage.

Coming to HYV *aus* production, the first period was one of continuous increase till 1975-76. The second period, however, saw more frequent fluctuations. Local *aus* production saw frequent ups and downs in both the periods, though, the frequency of fluctuations was higher in the second period. On an average, during Period II every one or two years of decline was followed by a year of increase and so on.

TABLE 4.3(B)

Annual Variability in Cropped Area, Production and Yield of Aus Rice

	Aus Rice					
	High Yielding Variety			Local Variety		
Year	Area	Production	Yield	Area	Production	Yield
Period I						
1969-70	-	-	-	-	-	-
1970-71	+86.04	+89.21	+1.70	-7.09	-5.17	+2.08
1971-72	+51.15	+23.59	18.24	-13.6	-19.66	-14.06
1972-73	+35.63	+26.92	-6.42	-3.02	4.89	-1.93
1973-74	+101.62	+128.66	+13.75	+1.38	+14.91	+10.61
1974-75	+112.28	+82.28	-14.13	-2.64	-10.61	-8.19
1975-76	+29.01	+23.39	-4.35	+5.89	+0.96	+3.53
1976-77	-3.24	-3.77	-0.55	-6.94	-7.86	-0.93
Period II						
1977-78	+9.31	+7.40	-1.75	-3.07	-0.76	+2.38
1978-79	+7.58	+6.45	-1.05	+1.57	+7.23	+5.57
1979-80	-5.42	+13.55	-8.60	-6.49	-14.91	-9.00
1980-81	+21.56	+32.27	+8.81	-0.03	+9.96	+10.00
1981-82	+19.27	-8.14	-22.98	+3.93	-1.04	-4.77
1982-83	-18.19	-8.43	+11.92	+0.99	-1.19	-2.17
1983-84	+5.65	+7.91	+2.14	-1.48	+2.15	+3.69
1984-85	-8.24	-14.66	-7.15	-5.88	-11.65	-6.14
1985-86	+4.72	+6.80	+2.16	-3.01	-1.33	+1.73
1986-87	+12.36	+4.49	-7.01	-4.76	+14.22	+19.92
1987-88	-8.00	-7.49	+0.55	-2.98	-2.91	+0.07
1988-89	-15.75	-17.91	-2.57	-1.04	+1.20	+2.26
1989-90	-14.33	-14.98	-0.76	-15.71	-13.09	+3.12
1990-91	+3.27	+12.90	+9.33	-8.77	-13.24	-4.89
1991-92	+13.27	+11.39	-1.66	-13.85	-13.58	+0.31

The year to year change in productivity of both HYV *aus* and local *aus* was associated with very frequent fluctuations of varying amplitudes. However, the amplitude was larger for the HYVs than for the local varieties. Thus from table 4.3(B) it emerges that the performance of *aus* paddy with respect to annual variability in cropped area, production and yield has been quite discouraging.

Table 4.3(C) gives the annual variability in cropped area, production and yield of the *rabi* rice crop i.e. *boro*. The annual fluctuations in HYV *boro* acreage were much more for the first period than the second period. The first period saw some large increase in HYV *boro* acreage particularly the years 1979-71, 1972-73 and 1973-74, when cropped area went up by nearly 48 per cent, 37 percent and 34 per cent respectively. But there were some large declines also, particularly in 1976-77 when there was a fall of 23.5 per cent in cropped area. However, in the second period the fluctuations for area under HYV *boro* appear to have been smoothened out with all the years, except 1983-84, showing an increase in acreage. The years 1981-82, 1982-83, 1984-85, 1987-85 and 1987-88 registered an increase of over 20 per cent over the previous year.

TABLE 4.3(C)

Annual Variability in Cropped Area, Production and Yield of Boro Rice

	Boro Rice					
	High Yielding Variety			Local Variety		
Year	Area	Production	Yield	Area	Production	Yield
Period I						
1969-70	-	-	-	-	-	-
1970-71	+47.89	+38.22	-6.53	-2.19	-3.74	-1.58
1971-72	-7.2	-18.67	-12.37	-11.37	-23.19	-13.34
1972-73	+36.78	+38.74	+1.43	-3.19	-5.34	-2.23
1973-74	+33.68	+20.26	-10.04	-15.19	-16.62	-1.69
1974-75	+12.10	+1.09	-9.82	+8.77	+1.95	-6.27
1975-76	-2.65	+0.27	+3.00	+0.68	+4.94	+4.23
1976-77	-23.46	-26.89	-4.47	-38.06	-46.16	-13.07
Period II						
1977-78	+19.79	+24.56	+3.98	+44.21	+81.49	+25.85
1978-79	+1.72	-19.64	-8.82	+4.69	-34.41	-37.35
1979-80	+5.69	+22.23	+15.65	-10.14	+30.32	+45.02
1980-81	+4.14	-9.67	-13.27	-2.71	+15.76	+18.98
1981-82	+24.95	+52.08	+21.71	-2.07	-0.61	+1.50
1982-83	+22.51	+22.75	+0.20	-12.85	-19.01	-7.08
1983-84	-10.8	-7.67	+3.52	-5.05	+0.06	+5.38
1984-85	+25.88	-16.67	-7.31	+2.75	+8.83	+5.92
1985-86	+1.06	+2.58	-1.55	-7.02	-19.45	-13.38
1986-87	+9.82	+9.79	-0.03	-2.57	-4.69	-2.17
1987-88	+22.21	+20.07	-1.75	-2.64	+1.38	+4.13
1988-89	+37.26	+32.19	-3.70	+1.12	-6.52	-7.56
1989-90	+4.29	+7.38	+2.97	+16.14	+21.04	+4.22
1990-91	+2.56	+2.54	-0.03	-5.02	+9.31	+15.09
1991-92	+3.64	+7.70	+3.91	+1.83	-0.04	-1.84

On the local *boro* front, both the first and the second periods were characterised by frequent ups and downs in cropped area, though the frequency of fluctuations was relatively more for the second period. In this period, nine out of the fifteen years saw a decline in cropped area. The largest increase in local *boro* acreage of 44 per cent in 1977-78 was followed by another year of 55 per cent increase. Thereafter the next five years saw a continuous decline in area, with a meek reversal only in 1984-85. From 1988-89 onwards, the frequency of fluctuations again increased.

For HYV *boro* production the frequency of fluctuations was moderate during both the periods. Given the asymmetrical time periods under study, it is difficult to pin point exactly in which period the fluctuations were more frequent. In the first period, following the first two years of alternate increase and decrease, were four consecutive years of increase in HYV output. The last year, however, showed a substantial decline. In the second period, till 1983-84, the ups and downs were quite frequent. From then on, there was a continuous increase for the remaining years. For the local *boro* production also, no clear pattern is discernible though fluctuations were quite frequent in both the periods.

The first period witnessed a continuous increase in the initial four years followed by two years of increase and a year of decline. In the second period, on an average, the upswings and downswings changed places every two years or so.

As far as HYV *boro* yield is concerned, both the periods were associated with frequent oscillations. The pattern in the first period was that of two years of decrease followed by an year of increase. In the second period, the initial four years showed frequent fluctuations. For the next three years there was a continuous increase. This followed five consecutive years of decline from 1984-85 to 1988-89. Thereafter, fluctuations again became frequent.

Thus, for *boro* rice, the performance with respect to year to year variability has been impressive only for HYV acreage and HYV production. For the rest of the variables, there has been no discernible change in the frequency of fluctuations over the two time periods.

Table 4.3(D) shows the annual variability in cropped area, production and yield of total rice over the two time periods. As expected the area under HYV of total rice increased tremendously in the first period. However, this increase ceased in 1974-75 and thereafter the frequency of fluctuations went up. In Period II, however, the pattern has been remarkable in the sense that practically for each year there was an increase in HYV acreage.

TABLE 4.3(D)

Annual Variability in Cropped Area,
Production and Yield of Rice

	Total Rice					
	High Yielding Variety			Local Variety		
Year	Area	Production	Yield	Area	Production	Yield
Period I						
1969-70	-	-	-	-	-	-
1970-71	+74.45	+58.15	-9.34	-5.85	-12.23	-6.78
1971-72	+35.62	+19.12	-12.16	-9.32	-13.97	-5.13
1972-73	+70.61	+38.65	-18.74	-0.08	-7.81	-7.74
1973-74	+45.48	+58.83	+9.18	-2.75	+5.16	+8.13
1974-75	-6.75	-14.06	-7.83	+0.23	-2.01	-2.23
1975-76	+8.29	+8.97	+0.63	+5.14	+15.79	+10.13
1976-77	-18.91	+21.14	-2.75	-2.57	-3.5	-0.95
Period II						
1977-78	-5.04	+0.59	+5.94	-0.43	+13.00	+13.48
1978-79	+13.96	+7.94	-5.28	+2.51	-3.17	-5.54
1979-80	+8.85	+9.22	+0.35	-1.98	-11.35	-9.56
1980-81	+8.43	+6.55	-1.74	+1.39	+11.63	+10.09
1981-82	+16.74	+15.33	-1.21	+0.55	-6.57	-7.09
1982-83	+9.99	+16.48	+5.90	-2.64	-0.17	+2.54
1983-84	-2.34	-0.84	+1.54	-1.27	+2.30	+4.32
1984-85	+10.52	+8.44	-1.88	-4.72	-3.56	+1.21
1985-86	+4.16	+3.02	-1.09	+1.04	+3.40	+2.33
1986-87	+9.88	+7.41	-2.25	-1.89	+2.25	+4.21
1987-88	+9.42	+10.24	+0.75	-22.51	-10.27	15.79
1988-89	+23.55	+20.29	-2.64	+8.82	-12.24	-19.36
1989-90	+11.47	+17.98	+5.83	-1.10	+13.39	+14.65
1990-91	+7.87	+7.89	+0.02	-5.31	-8.87	-3.76
1991-92	+6.96	+9.37	+2.26	-7.67	-6.98	+0.75

Coming to HYV production, the first period saw continuous increase with a break in 1974-75. In the second period too, there was an uninterrupted increase in HYV rice production uptil 1983-84. It declined marginally by 0.84 per cent in 1983-84 but the tempo of continuous increase readily got resumed throughout the remaining years of Period II. For the production of local variety rice, the fluctuations were much more frequent than those in HYVs, in both the periods. During the second period, in every three years, there was atleast one year of increase followed by decrease or vice versa.

The scenario for yield of both HYVs and local rice varieties is more or less the same as with *aman*, *aus* and *boro*. Even though there has been a remarkable smoothening of fluctuations for HYV total rice acreage and production, its effect has not spread to yield. The year to year ups and downs in yield has continued to be very frequent. Thus one may conclude that whatever fluctuations have taken place in production, these have been more due to fluctuations in yield rather than in area.

Table 4.4 gives the annual variability in cropped area, production and yield of wheat and gram. In the first phase of the introduction of new technology, wheat acreage experienced a continuous increase except the year 1972-73 when

acreage declined by more than 5 per cent. In Period II, there was again a steady increase in wheat area till 1980-81. In 1981-82 and 1982-83, the cropped area declined marginally and then again the increase was resumed. In 1985-86, there was a substantial decline in wheat acreage of 20.1 per cent. Overall, the frequency of ups and downs in wheat acreage was more in the second phase than the first phase.

For total wheat production, the picture is almost a replica of the cropped area under wheat. In the first period, all the years showed an increase in production except the year 1972-73 when the production fell by 22 per cent. In the second phase the first eight years saw a continuous increase in production. In some of the years, the increase was tremendous (42 per cent in 1978-79 and 67 per cent in 1979-80). After 1984-85, there was a break in this steady increase and the frequency of ups and downs went up.

As far as wheat yield is concerned, Period I saw productivity increases of large amplitudes reaching levels as high as 57 per cent (1975-76). Moreover the first period had much lower year to year fluctuations than Period II. The

TABLE 4.4

Annual Variability in Cropped Area, Production and Yield of Wheat and Gram

Year	Total Wheat			Gram		
	Area	Production	Yield	Area	Production	Yield
Period I						
1969-70	-	-	-	-	-	-
1970-71	+5.09	+6.36	+1.20	+4.85	+14.54	+9.63
1971-72	+1.02	+3.02	+1.90	-1.93	-11.18	-9.44
1972-73	-5.61	-22.16	-17.53	-16.02	-31.37	-18.28
1973-74	+2.54	+21.95	+8.92	-7.51	+5.91	+14.51
1974-75	+2.31	+5.22	+2.84	+0.27	-9.18	-9.43
1975-76	+19.09	+86.93	+56.96	-3.04	+0.16	+3.30
1976-77	+6.63	+18.92	+11.53	+3.23	+4.44	+1.17
Period II						
1977-78	+18.05	+34.13	+13.62	+1.92	+8.45	+6.61
1978-79	+40.13	+41.91	+1.31	-1.79	-3.63	-1.88
1979-80	+63.63	+66.53	+1.77	+2.90	-9.19	-11.76
1980-81	+27.12	+6.17	+0.45	+1.13	-2.33	-3.42
1981-82	-3.03	+10.75	-5.05	-8.46	-5.00	+3.76
1982-83	-2.75	+15.05	18.31	+1.49	+11.20	+9.48
1983-84	+1.27	+10.59	+9.21	+131.97	+115.86	-6.95
1984-85	+28.54	+20.81	-6.02	-13.74	-6.49	+8.41
1985-86	-20.1	-28.74	-10.83	-4.19	-4.40	-0.82
1986-87	+8.23	+4.65	-3.31	+0.06	+5.31	+5.28
1987-88	+2.17	-3.99	-6.02	-0.62	-8.75	-8.18
1988-89	-6.25	-2.49	+4.01	-0.27	-11.31	-11.06
1989-90	+5.71	-12.92	-17.62	+0.10	+6.03	+5.91
1990-91	+1.16	+12.84	+11.55	-6.22	+1.01	+7.87
1991-92	-4.06	+6.05	+10.54	-	-	-

second phase saw the initial four year, experience continuous increases in productivity. Thereafter, the frequency of fluctuations increased. From 1984-87, there was a continuous decline in wheat yield. During 1989090, yield fell by 17.6 per cent. Thus, unlike total rice, frequency of year to year fluctuations in area and production have been greater for wheat during the second period.

Coming to gram, both the periods were marked by a considerable decline in its acreage with only a few years in between showing an increase. However, the year 1983-84 showed a very large increase of 132 per cent over 1982-83. Thereafter, the process of decline continued though at a decreasing rate. Displacement of the existing area under pulses to accommodate irrigated *boro* rice and wheat was one of the reasons for the large declined in its acreage. Moreover, both gram production and yield have also been associated with greater frequency of fluctuations during both the periods.

Table 4.5 gives the annual variability in cropped area, production and yield of total cereals. Area under total cereals also showed recurrent fluctuations. In the first period, four of the eight years showed a decline while in the second period seven out of the fifteen years showed a decline. However, compared to gram, the decline was much

less pronounced. Though rice and wheat experienced tremendous increases in acreage since 1969, it has been offset by the poor performance of pulses and as a result, the performance of total cereals has not been that impressive.

The annual variability in total production of cereals has been lesser in the second period, compared to the first. In Period II, baring the years 1979-80, 1981-82, 1987-88 and 1990-91, all the others years experienced an increase.

The picture for yield of total cereals again is a dismal one. The frequency of fluctuations has been high in both the periods. Thus the intensification of new technology has not been able to reduce the year to year variations in yield. It may be noted that for all the crops considered here, the frequency of yield fluctuations has been quite high in both the periods.

In brief, the year to year variability in the cropped area, production and yield for all the crops considered here reveal a mixed picture. For total rice and all its individual varieties, except *aus*, there has been smoothening of yearly ups and downs in the acreage and production of HYVs only, as we move from the seventies to the eighties. For the local varieties, however, the annual variability seems to have gone up for area and production. As far as yield is concerned, there has been an increased frequency of

TABLE 4.5

Annual Variability in Cropped Area, Production and Yield of Total Cereals

Years	Area	Production	Yield
Period I			
1969-70	-	-	-
1970-71	-3.82	-6.99	-3.30
1971-72	-6.55	-10.80	-4.57
1972-73	+4.10	+1.21	-2.78
1973-74	+2.53	+19.23	+16.29
1974-75	-0.81	-5.03	-4.31
1975-76	+11.16	+14.03	+2.58
1976-77	-8.94	-7.65	+1.42
Period II			
1977-78	-0.76	+9.84	+10.68
1978-79	+4.06	+0.17	-3.74
1979-80	+0.89	-0.47	-1.35
1980-81	+4.82	+15.72	+10.40
1981-82	+1.04	-4.94	-5.92
1982-83	-0.04	+5.02	+5.06
1983-84	+0.55	+2.62	+2.09
1984-85	-0.88	+2.82	+3.74
1985-86	-0.21	+0.07	+0.28
1986-87	+2.12	+2.08	-0.03
1987-88	-2.52	-0.25	+2.32
1988-89	-1.25	+0.62	+1.89
1989-90	+2.51	+13.86	+11.08
1990-91	-3.91	-2.67	+1.28

fluctuations in most cases, both for HYVs as well as local variety. Wheat shows greater annual variability in area production and yield. For total cereals, except for production, there has been an increase in the frequency of fluctuations for the other two variables. Thus on the whole, annual variability seems to have reduced only with respect to rice.

4.3 **Annual Growth Rates in Area, Production and Yield**

Table 4.6 sets out the exponential growth rates in acreage, production and yield of rice in Bangladesh and the separate varieties for the two sub-periods of the study. One can see that for HYV *aman*, HYV *boro* and HYV total rice, the growth in cropped area and production, have gone down substantially in Period II. However this picture could be misleading as the growth rates in the first period for *aman* are not very reliable. As we have already seen, the years 1979-70 to 1976-77 was a period of tremendous increases in cropped area and production. This was reflective of the initial euphoria associated with the advent of the Green Revolution. It is, but natural that such high increases in area and production could not be sustained and gradually the increases began to slow down. Thus, it was because of the

TABLE 4.6

Compound Rates of Increase in Area, Production and Yield of Rice

(per cent per annum)

Crop	Period	High Yielding Variety			Local Variety		
		Compound Growth Rate*			Compound Growth Rate		
		Area	Production	Yield	Area	Production	Yield
Aman	I	55.62	48.21	-4.99	-1.54	-0.84	o.68
	II	12.81	12.48	-0.29	-2.74	-1.79	0.95
Aus Rice	I	59.40	51.82	-5.00	-1.67	-3.24	-1.54
	II	-0.60	-2.43	-1.82	-3.73	-2.16	1.54
Boro Rice	I	13.60	6.90	-6.20	-8.35	-13.50	-4.75
	II	11.49	11.80	0.34	-2.57	-1.30	1.19
Total Rice	I	26.89	19.14	-6.50	-1.92	-2.32	-0.39
	II	9.50	9.60	0.08	-3.00	-1.83	1.16

* Compound rates were calculated by fitting semi-logarithmic trend lines.

steep increases in the initial years that Period I rendered such a high growth rate. Moreover, for *aman*, and total rice, Period I was associated with very frequent fluctuations in all the three variables. For HYV *aus* rice, the growth rate in the second period had fallen to reach a negative figure of -0.6 per cent and - 2.4 per cent for area and production respectively. Though the growth rates for HYV *aus* area and production in Period I are quite unreliable for reasons mentioned above, negative growth rate in the

second period implies that the performance of *aus* rice has been poor. This could partly be due to the encroachment or replacement of low yielding, high and medium high land *aus* by other summer crops.

The productivity trends for the HYV *aman* and HYV *aus* rice show a negative growth rate in the second period. Amongst the two, *aus* shows the higher magnitude of negative growth rate. The decline in productivity could be attributed to a lack of development of new varieties suited to farmers conditions.

The productivity performance of *boro* HYV has been impressive. From a negative growth rate of - 6.5 per cent per annum in the first period, it increased to 0.34 per cent in the second period. Moreover, *boro* also experienced an increases in its growth rate of production from 7 per cent to nearly 12 per cent. In terms of acreage, *boro* has not done too badly either. Between the two periods it declined marginally from 13.6 per cent to 11.5 per cent. Hence, the overall performance of HYV *boro* vis-a-vis HYV *aman*, HYV *aus* and total rice has been much more encouraging. For total rice (HYV) also the growth rate of yield has gone up in the second period but only upto an unimpressive figure of .09 per cent per annum. Growth rates of production and area

under total rice (HYV) has gone down in Period II though the decline has been more for area than production.

Coming to the local varieties, the growth rate of total rice along with its separate varieties showed negative rates in area and production for both the periods. For *aman*, *aus* and total rice the growth rates in acreage were lower in the second period compared to the first period. However, for *boro*, the growth rates though negative were substantially lower in the second period. For production, barring *aman*, all the others have had lower growth rates in the second period, *albeit*, negative. Surprisingly, the yield trends for the local varieties has been better than the HYVs. All the three rice varieties as well as total rice showed an increase in the growth rate of yield and for all the cases, the growth rates were positive in Period II.

Table 4.7 gives the annual growth rates of area, production and yield of wheat, gram and total cereals. Wheat acreage, production and yield increased dramatically in the first period at a rate of 13.4 per cent, 12.23 per cent and 8.43 per cent respectively. In fact, during the seventies, the main thrust in cereal production came from the winter crops of *boro* and wheat. Particularly wheat production expanded from 0.01 tons in 1973-74 to 0.8 m tons in 79-80. The large increase during this period has been the result of

the intensive wheat production programme and distribution of domestically produced wheat seeds. In the second period, however, the growth rates were not so impressive but still remained positive at 5.4 per cent, 4.2 per cent and 0.74 per cent respectively for acreage, production and yield. From being an unimportant crop, wheat now occupies 22 per cent of the *rabi* crop area including that of *boro* paddy.

TABLE 4.7

Compound Rates of Increase in Area, Production and Yield of Wheat, Gram and Total Cereals

Crop	Period	Compound Growth Rate		
		Area	Productiion	Yield
Wheat	I	13.44	12.23	8.43
	II	5.36	4.18	0.74
Gram*	I	-4.75	-7.82	-2.92
	II	6.33	6.08	-0.23
Total* Cereals	I	0.49	1.62	1.12
	II	0.44	2.53	2.08

* For gram and total cereals, the terminal year is 1990-91 and not 1991-92

The growth rates for all the three variables for gram were negative in the period 1969-77. The recent impressive growth and high achievements in food production were attained often at the expense of other crops through relocation and displacement of existing crop land. For pulses,

among other reasons the irrigated *boro* paddy largely led to its decline. In the second period (1977-91), however, gram seemed to have recovered from it earlier plight and registered a substantial growth rate of 6.3 per cent and 6.08 per cent in acreage and production respectively. Yield continued to show a negative growth rate.

Total cereals seemed to have fared quite well on the whole. Both production and productivity witnessed a substantial increase in production and productivity. On the area front, there was a marginal decline from 0.49 per cent in 1969-77 to 0.44 per cent during 1990-91.

To sum up the growth scenarios, it is evident that all HYVs of rice except HYV *aus* have fared quite well in terms of area and production. The productivity performance has however not been very satisfactory. Only *boro* seems to have registered a considerable increase in its yield growth rate. For the local varieties, the picture is a contrasting one with the yields showing an improvement in their growth rates while area and production still registered negative figures. For wheat, there has been a slow down in the tempo of its increase in area, production and yield in the second period. Total cereals seems to have done quite well with growth rates increasing for production and yield in the second period, while area showed a slight decline. From the

above, it can be inferred that had the performance of pulses been as positive as that of rice and wheat, the growth rates for total cereals would have been much higher. Though rice and wheat achieved quite high growth rates, its effect seems to have been watered down by the poor show of pulses to make growth rates in total foodgrains not so impressive.

4.4 Inter-regional Analysis of Variability

In this section, production and yield variability for rice are examined for each district for both HYV and local variety and then compared for time periods and between districts. Secondly, variability of foodgrain yield and production are examined within districts and compared for different seasons and varieties of crops and between districts. Table 4.8 shows the relative variability in total rice production and yield for Bangladesh regions between 1969-77 and 1978-92 based on variety of crops.

As can be seen from the table, significant inter-district differences exist in the variability of HYV rice production ranging from 11.5 per cent in the Hill Tracts to 77.6 per cent in Jessore. However, on the whole the variability of HYV rice production seems to have declined for most of the districts except Rajshahi, Pabna, Jessore,

Barisal and Faridpur in Period II compared to period I. For the local varieties however variability in rice production has increased over the period for most of the districts. Only Dinajpur, Khulna, Barisal, Sylhet and Chittagong seem to have experienced a decline in the relative variability in production.

Turning to the question of overall yield variability between districts one can see that it ranges from 4.7 per cent to 36.4 per cent for HYVs and 8 per cent to 32.05 per cent for local varieties. The table also shows that in the second period relative variability in HYV rice yield has gone down for most of the districts with the exception of Pabna, Barisal, Dhaka and Hill Tracts where variability in HYV yield has gone up. For the local varieties however, there has been an increase in the relative variability for majority of the districts. Only Rajshahi, Jessore, Khushtia, Tangail, Noakhali, Chittagong and Hill Tracts have experienced a decline in yield variability of local rice.

TABLE 4.8

Relative Variability in Foodgrain Production and Yield: Bangladesh Regions, 1969-77(Period I) and 1977-92 (Period II)

Regions	Production				Yield			
	HYV		Local		HYV		Local	
	I	II	I	II	I	II	I	II
Dinajpur	69.20	66.58	14.52	12.42	12.38	5.85	7.62	9.00
Rangpur	56.97	55.52	4.46	18.06	16.14	4.88	8.04	8.79
Bogra	59.83	50.40	8.64	36.14	24.71	16.41	6.97	18.22
Rajshahi	58.44	73.59	6.14	22.61	18.26	7.09	10.77	9.27
Pabna	60.60	60.64	13.50	34.97	13.71	15.84	9.66	19.62
Kushtia	54.76	49.24	10.67	13.62	17.95	9.40	12.64	20.69
Jessore	44.33	77.57	11.55	24.03	15.12	7.23	11.80	11.01
Khulna	48.76	39.59	8.79	4.44	27.24	11.24	19.32	8.95
Barisal	40.18	68.85	19.38	16.22	20.12	21.03	18.04	32.05
Mymensingh	52.64	17.61	18.41	25.17	13.19	6.08	10.92	22.60
Tangail	51.00	30.05	38.75	29.65	15.46	8.33	27.06	8.85
Dhaka	35.34	32.61	6.75	27.29	15.27	18.66	7.05	29.56
Faridpur	34.80	60.38	8.21	15.11	15.31	9.75	10.36	24.34
Sylhet	54.08	39.28	16.28	14.46	25.78	11.88	11.21	13.81
Comilla	45.45	38.43	16.26	22.22	18.29	4.70	11.64	22.50
Noakhali	63.12	21.80	12.33	7.80	22.13	12.07	11.55	8.13
Chittagong	47.94	21.61	20.02	16.30	19.58	18.43	9.13	8.28
Hill Tracts	54.18	11.52	25.79	30.47	24.12	36.41	16.42	16.04

Note: I = Period I (1969-70 to 1976-77)
II= Period II (1977-78 to 1991-92)

Table 4.9 sets out the variability in foodgrain production by season i.e. *rabi* or *kharif* and by variety. The table indicates that the aggregate regional production of HYV foodgrains is relatively more fluctuating than that of

TABLE 4.9

Variability in Foodgrain Production by Season and Variety, Bangladesh Regions, 1969-70 to 1991-92

	Mean Production Level('000' acres)				Coefficient of Variation (%)			
Regions	Rabi	Kharif	HYV	Local	Rabi	Kharif	HYV	Local
Dinajpur	113.9	665.1	184.4	525.3	85.3	15.5	67.0	14.1
Rangpur	239.0	1117.9	384.3	888.7	81.7	10.1	67.4	12.5
Bogra	181.7	455.6	331.4	310.3	88.1	12.4	93.8	21.9
Rajshahi	234.7	674.0	279.4	582.2	64.3	13.9	82.5	17.5
Pabna	166.8	288.0	135.4	263.7	69.5	20.2	77.7	26.7
Kushtia	83.9	235.1	96.4	153.2	35.8	30.2	76.4	22.0
Jessore	140.7	547.4	245.5	408.3	95.1	17.7	96.1	18.0
Khulna	54.5	528.1	115.8	467.9	43.4	22.7	45.6	19.4
Barisal	97.6	629.1	189.8	553.5	35.7	18.2	21.6	24.1
Mymensingh	146.4	843.5	284.5	640.6	37.2	34.1	28.5	43.0
Tangail	166.8	241.1	168.5	222.0	59.8	34.3	55.0	33.2
Dhaka	309.9	446.2	316.3	401.2	40.6	14.9	39.0	19.8
Faridpur	169.1	377.3	126.5	383.8	69.1	10.1	82.0	14.3
Sylhet	400.0	714.8	271.1	832.8	22.4	12.9	38.1	19.4
Comilla	355.1	679.2	456.4	518.3	45.0	13.2	50.8	23.1
Noakhali	151.9	517.6	267.0	411.8	45.4	13.6	34.8	13.7
Chittagong	235.7	524.1	436.7	332.1	21.2	15.1	27.8	16.8
Hill Tracts	22.9	79.8	58.7	44.8	22.1	11.7	49.9	42.2

Note : Rabi includes boro rice and wheat and kharif includes aus and aman rice.
The break up of HYV and local variety is only for total rice.

the local varieties with the exception of Barisal region where HYV production is relatively less variable than local variety foodgrain production. For the HYVs, coefficient of variation ranges between 20.7 per cent to 96.2 per cent while the range for the local variety is much smaller with 12.5 per cent and 43 per cent as the upper and lower limits. Thus the Green Revolution does not appear to have reduced

varietal yield when one takes into account the entire period i.e. from 1969-1992.

Rabi foodgrain production is relatively more variable than *kharif* for all the districts. However, within the districts there is high disparity in the relative variability of *rabi* crop also. The coefficient of variation is very high (above 80 per cent) for the districts of Dinajpur, Rangpur, Bogra and Jessore. For Rajshahi, Pabna, Kushtia, Tangail and Noakhali it varies between 45 per cent to 70 per cent. For the rest of the regions, the relative variability is with sylhet showing the least variability of 22.04 per cent with.

For the *kharif* season, the relative variability in production amongst the districts is not as high as *rabi* and also does not vary so much among the districts. For this crop, the relative variability ranges from 10 per cent to 34 per cent .

Table 4.10 gives the relative variability in foodgrain yield by season and by variety for the period 1969-70 to 1991-92. In a majority of regions, the relative variability in *kharif* yield is less than that in *rabi* yield. However, for the regions of Pabna, Khulna, Tangail, Dhaka, Faridupur, Comilla and Noakhali *rabi* season yields are less variable than those during the *kharif* season. For the *rabi* season,

the maximum variability is shown by Mymensingh (31.14 per cent) while Dhaka shows the least variability (9.8 per cent). On the other hand, Faridpur exhibits the maximum relative variability in the *kharif* season yield while the least variability is shown by Rangpur.

Variability in food grain yield in term of HYV and local variety for the entire period under study shows a different picture when compared to table 4.9. For nine districts, the local varieties show a greater variability in yield while 8 of the districts show that HYVs have lower yield variability. Thus when HYVs and local varieties are compared for the entire period, HYVs seem to be more variable than yield while on an annual basis, the opposite picture seems to be true.

TABLE 4.10

Variability in Foodgrain Yield by Season and Variety, Bangladesh Regions, 1969-70 to 1991-92

Regions	Coefficient of Variation (%)			
	Rabi	Kharif	HYV	Local
Dinajpur	13.08	12.82	9.51	11.75
Rangpur	12.27	11.43	12.89	11.26
Bogra	18.63	15.90	19.67	16.71
Rajshahi	19.01	16.79	15.00	11.50
Pabna	21.43	21.97	15.19	21.15
Kushtia	29.46	23.60	17.12	20.90
Jessore	16.61	15.53	14.38	12.27
Khulna	11.38	18.32	20.20	17.43
Barisal	31.14	13.98	24.70	32.93
Mymensingh	31.14	15.65	14.34	19.37
Tangail	11.63	23.73	13.41	17.51
Dhaka	9.75	26.31	19.24	28.01
Faridpur	20.75	23.84	13.95	22.15
Sylhet	15.81	11.52	23.71	13.21
Comilla	10.14	20.09	12.55	21.53
Noakhali	14.20	14.75	19.93	14.59
Chittagong	14.46	12.37	19.65	14.35
Hill Tracts	22.45	20.66	32.54	21.32

The inter-regional disparity in the production of rice, wheat and total cereals has been shown in graphs 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6. It is clear from graph 4.1 that the inter regional disparity in the production of HYV *aman* rice has not shown any significant decline. Between the years 1977 to 1979 there was a considerable decline in the relative variability amongst the districts. However, it was very temporary with 1979-80 again showing a sharp increase.

For the local variety, however, some decline has taken place in the coefficient of variation.

For *aus* rice also, both HYV and local varieties have shown very little decline in the inter regional disparity. For HYV *aus* rice, in particular, variability levels shot up in the years 1973-74, 1974-75 and 1988-89.

For HYV *boro* rice the picture has been a different one. Inter-district disparity has declined substantially over the 23 year period to settle at 57.1 per cent in 1991-92 from 93.3 per cent in 1969-70. However, the local *boro* variety has seen tremendous inter regional disparity. For this variety the coefficient of variation has been more than 200 per cent for most of the years.

Inter regional disparity for wheat has also witnessed a fair decline from 137 per cent in 1969-70 to 94 per cent in 1991-92. Moreover, for wheat the decline in relative variability had been continuous till 1985-86. The next year saw a slight increase in the variability. However, the decline resumed in the next year only to begin increasing again although marginally.

For total cereals there was a considerable decline in the inter-regional disparity till 1985-86 with a few years of marginal increase in between. However, from 1986-87 onwards, the coefficient of variation began to rise and by

1990-91, it had reached 49.06 per cent. Nevertheless, a decline in the relative disparity of nearly 21 per cent has taken place since 1969-70.

We have observed varying patterns of inter-district disparity in respect of the individual crops considered in the study. It may perhaps be useful to examine the temporal profile of these inter-district disparities a bit more intimately. One good way of looking at their temporal behaviour is to fit trend functions to each time-series of inter-district disparity. This is what follows next.

On examining the scatter of graph 4.1, it was apparent that a parabolic function ($\alpha + \beta T + \tau T^2$) would best describe the trends in the inter-district disparity for *aman* production. The exercise yielded the following results.

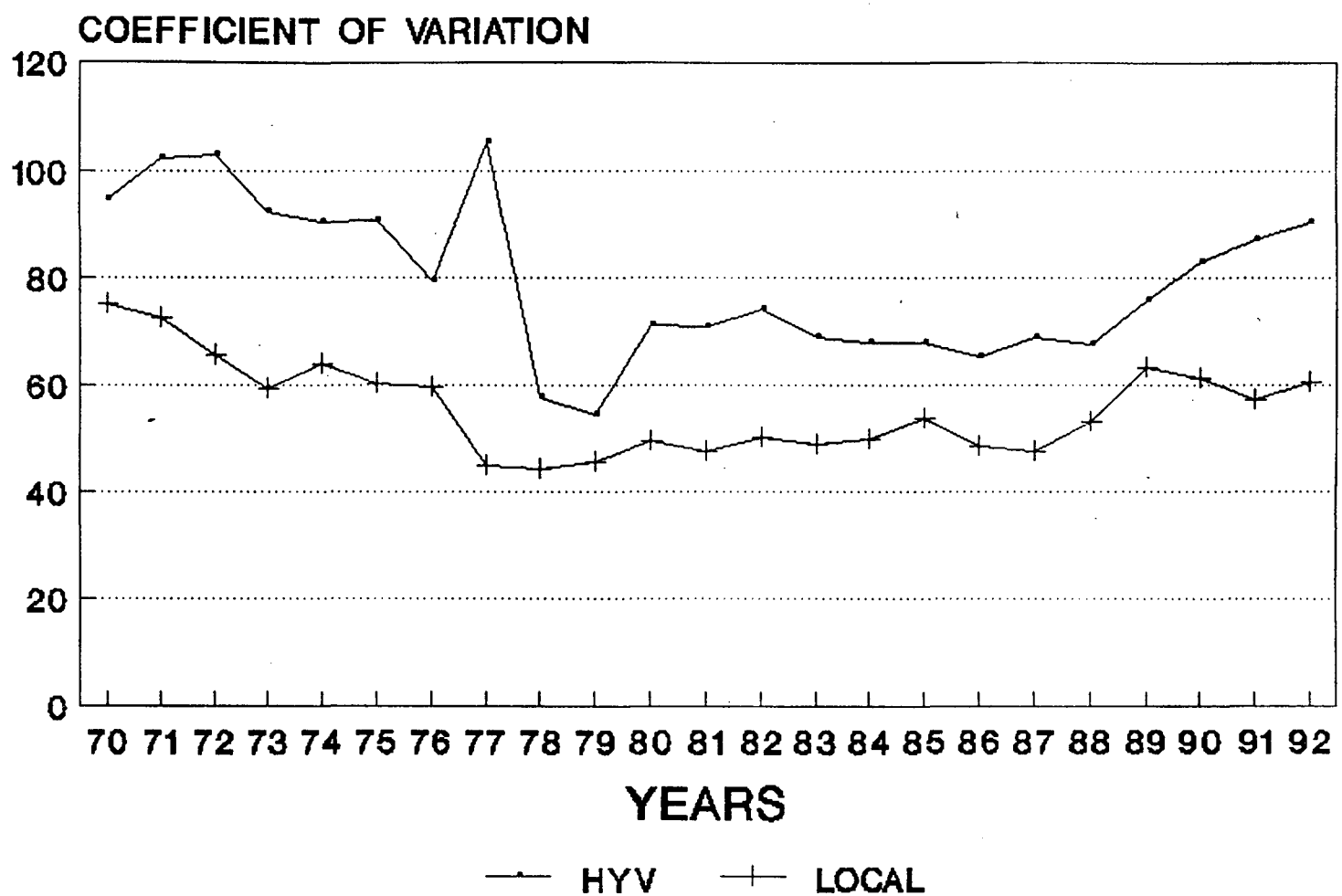
$$CV_{Aman,\ HYV} = 114.53 - \underset{(-5.62)}{6.655}{}^{*}T + \underset{(4.98)}{0.238}{}^{*}T^2 \qquad \bar{R}^2 = 0.604$$

T = Time

$$CV_{Aman,\ local} = 79.32 - \underset{(-8.72)}{4.753}{}^{*}T + \underset{(8.16)}{0.179}{}^{*}T^2 \qquad \bar{R}^2 = 0.779$$

It is clear from the above that in the case of HYV *aman* rice, the initial declining trend in the inter-district disparity reversed itself into an increasing trend after a few years. For the initial decade or so, Aman HYV production has experienced a decline in the inter-district disparity. However, as the new technology intensified itself and got scattered over larger areas in Bangladesh, an increase

GRAPH 4.1
INTER-DISTRICT VARIATION IN PRODUCTION OF AMAN RICE



in the disparity seems to have emerged. One reason for this seemingly paradoxical situation could be that in the initial years, technological adoption was too low to render any significant technological gap amongst the regions. With accelerated adoption this technological gap got more and more prominent so as to render an increasing trend in the inter-district disparity. For the local variety of the crop, a reversal of trends has taken place approximately every decade or so.

In addition to this the correlation coefficient between the coefficient of variation of Aman HYV production and Aman local production was worked out. A very high correlation of 0.71 is seen between the two, thereby clearly implying that the factors affecting the disparity in HYV production and local production are the same. Aman, being a monsoon crop, rainfall could be one of the factors.

It is interesting to see that weather factors would not leave HYV technology unaffected. The effect of rainfall shows itself as much profoundly in HYV *aman* paddy as in the case of local *aman* paddy. As we see a little latter, this is not the case in respect of HYV *boro* against local *boro*, presumably because the weather effect does not intervene in the case of this winter (rabi) crop. The technological edge

of HYV *boro* over local *boro* is absolutely clear compared with the relative position between HYV *aman* and local *aman*.

For *aus* rice also, a quadratic trend was fitted and the following equations were arrived at

$$\text{C.V.}_{\textit{Aus, HYV}} = 110.70 - \underset{(-2.94)}{4.461^{*}T} + \underset{(2.39)}{0.147^{*}T^{2}} \qquad \bar{R}^{2} = 0.32$$

$$\text{C.V.}_{\textit{Aus, Local}} = 69.06 - 1.82^{*}T + 0.06^{*}T^{2} \qquad \bar{R}^{2} = 0.19$$

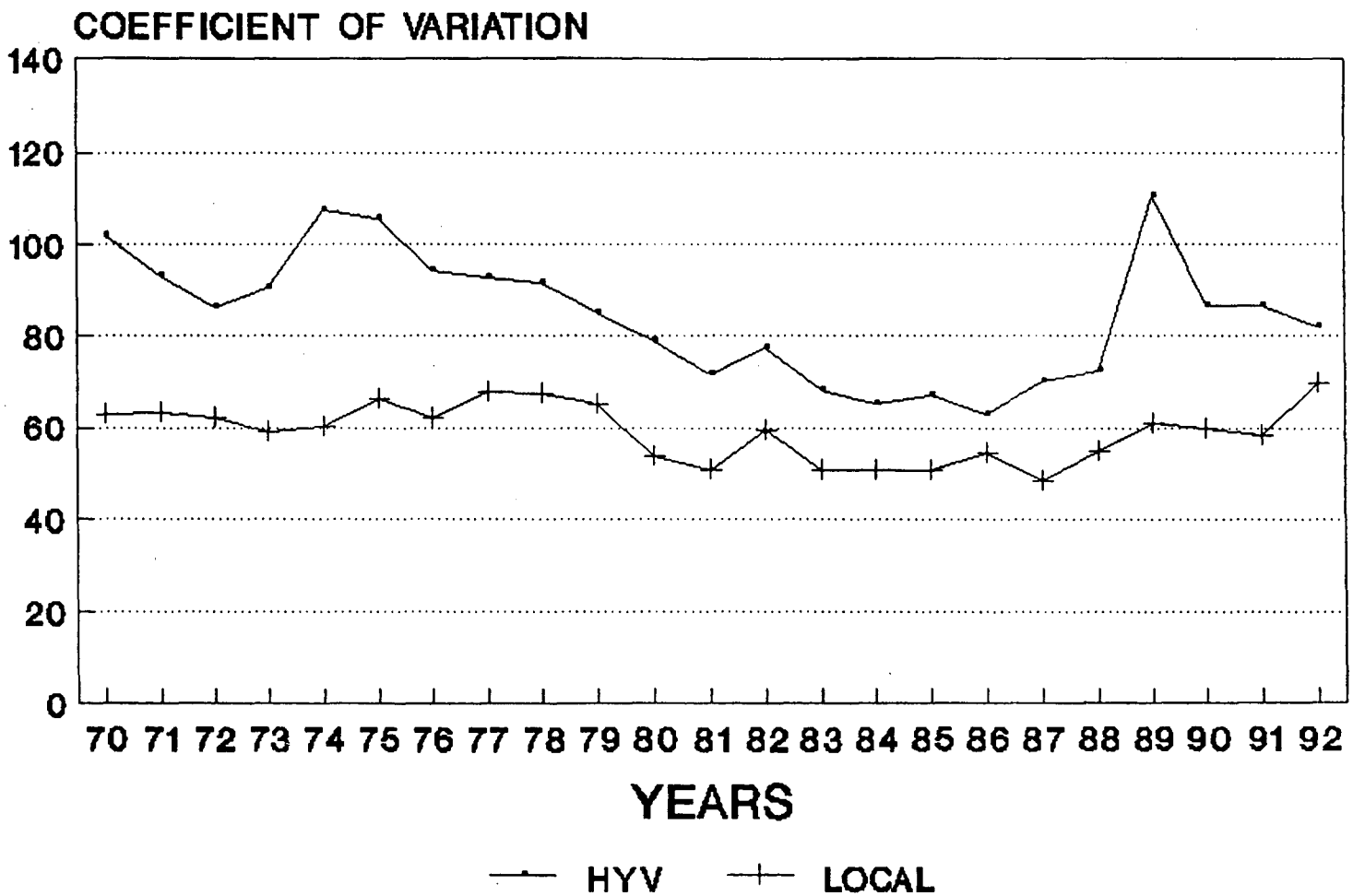
* Significant at 0.05 level.

On derivating the above, the value of T was calculated as 15.2 for both HYV and unlocal variety. From the above equations, it can be seen that for both *aus* HYV and *aus* local variety, there is a turn around in the inter-district disparity after nearly one and a half decade. The correlation coefficient for the variation in production between the two varieties of *aus* worked out to be quite high at 0.70. It follows that the factors contributing to the inter-district variation in *aus* production were similar for both HYV *aus* and local *aus* rice.

Following the graphs for *boro* rice, total rice, wheat and total cereals a linear trend ($\alpha + \beta T$) was fitted in each case. The following equations were obtained.

$$\text{C.V.}_{\textit{boro, HYV}} = 96.46 - \underset{(7.26)}{1.669^{*}T} \qquad \bar{R}^{2} = 0.70$$

GRAPH 4.2
INTER-DISTRICT VARIATION IN PRODUCTION OF AUS RICE



C.V. *boro*, local = 197.53 + 0.134 T (0.165) $\bar{R}^2 = 0.05$

C.V. rice, HYV = 78.34 - 1.280* T (-6.24) $\bar{R}^2 = 0.63$

C.V. rice, local = 59.54 - 0.629* T (-3.205) $\bar{R}^2 = 0.30$

C.V. wheat = 138.45 - 2.465* T (-10.71) $\bar{R}^2 = 0.84$

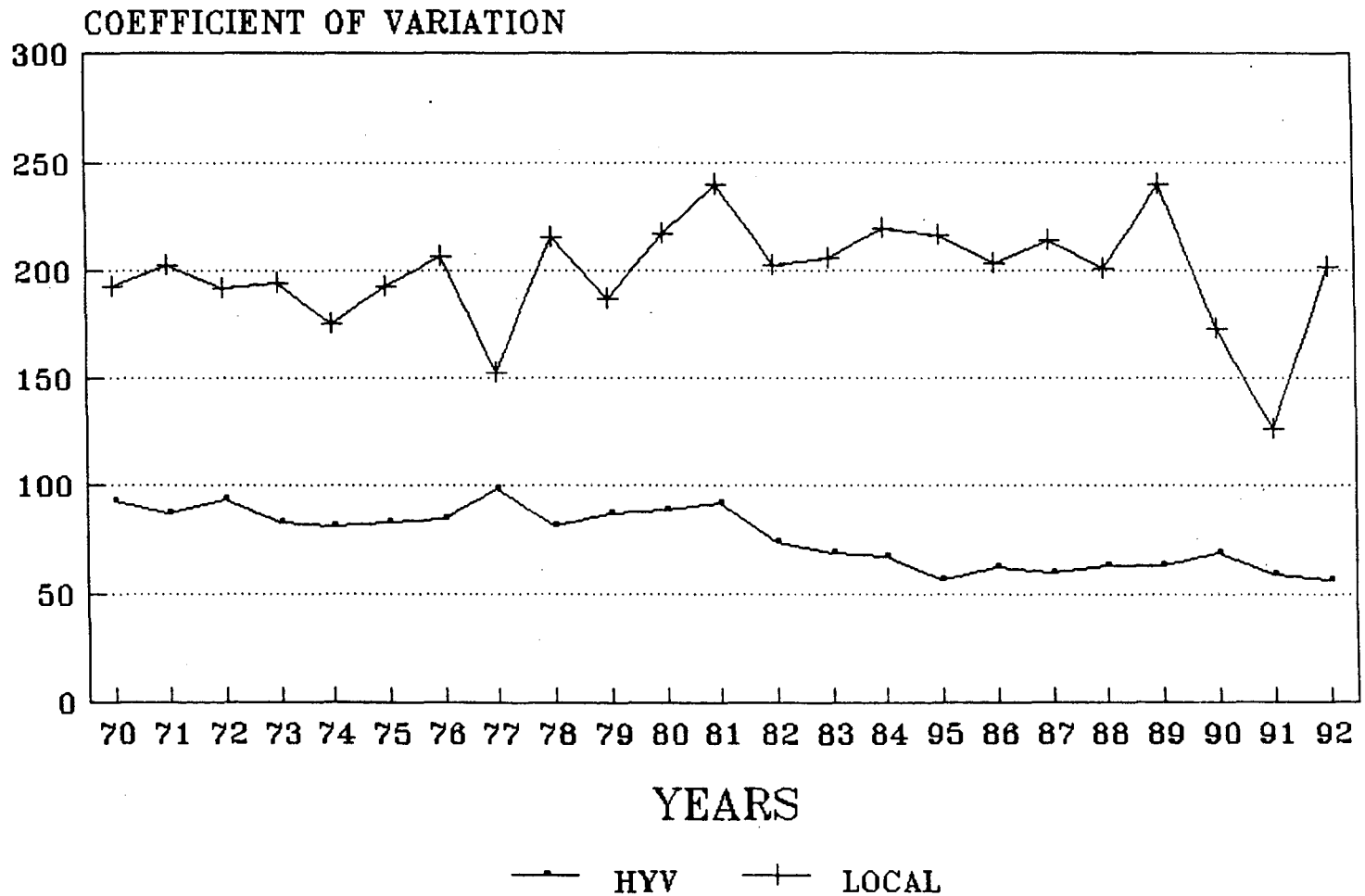
C.V. cereals = 58.08 - 0.975* T (-4.91) $\bar{R}^2 = 0.52$

* Significant at 0.05 level.

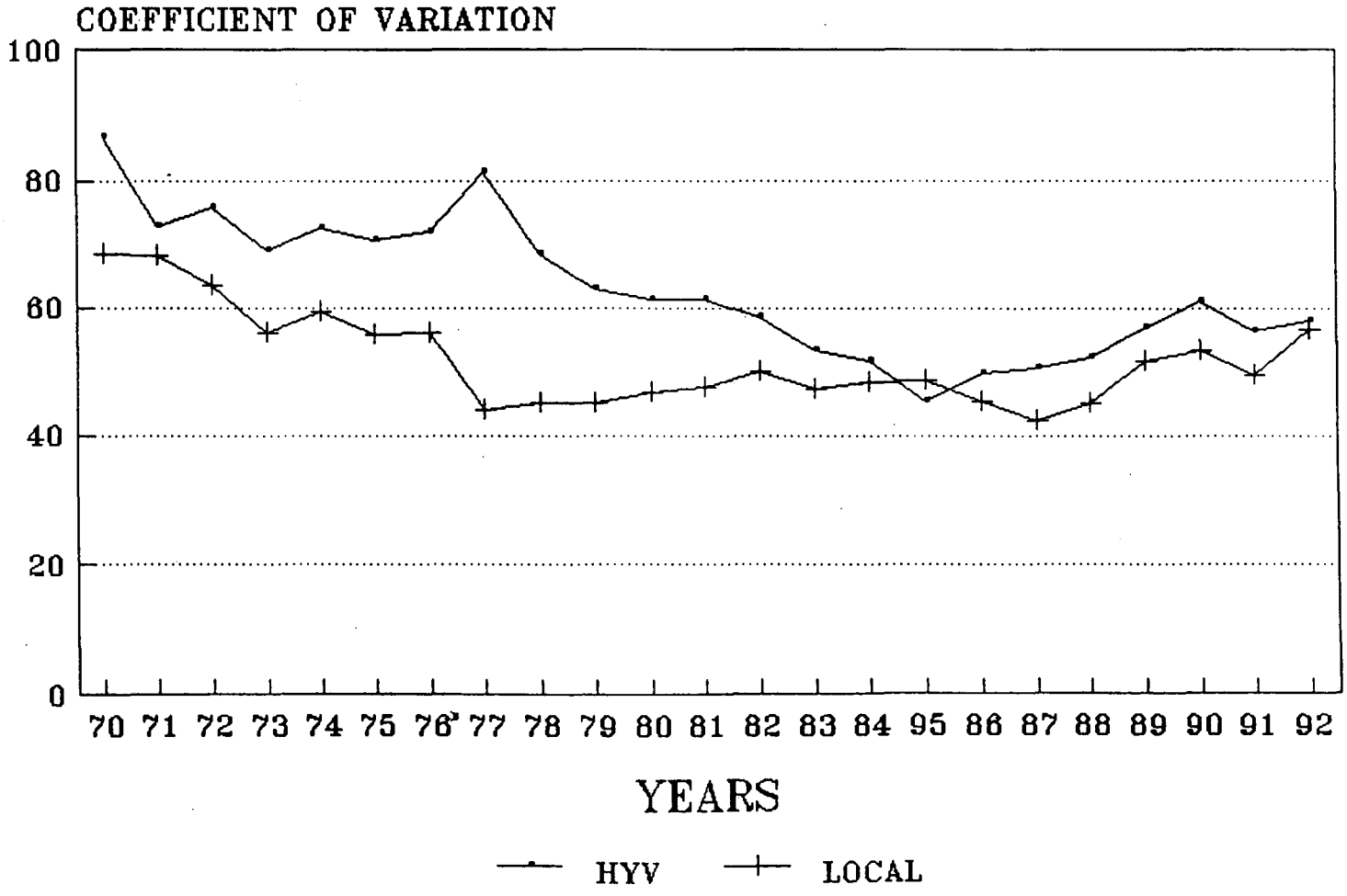
HYV *boro* clearly shows a declining linear trend thereby implying that the variation in its production amongst the districts has been declining over time. For the local *boro* variety, however, the inter-district disparity has witnessed neither a significant increase nor a decline; the degree of initial disparity somehow lingers on. To lend further support to the above observation, we discover a correlation coefficient of -0.085 between the disparity graph of HYV *boro* and that of local *boro*. Clearly, the two crop technologies have been moving independently.

For both the HYV and local varieties of total rice, a linear trend can be seen in the inter-district variation. Correlation coefficient between the two worked out to be 0.63. Clearly, the high correlation coefficients for *aman*

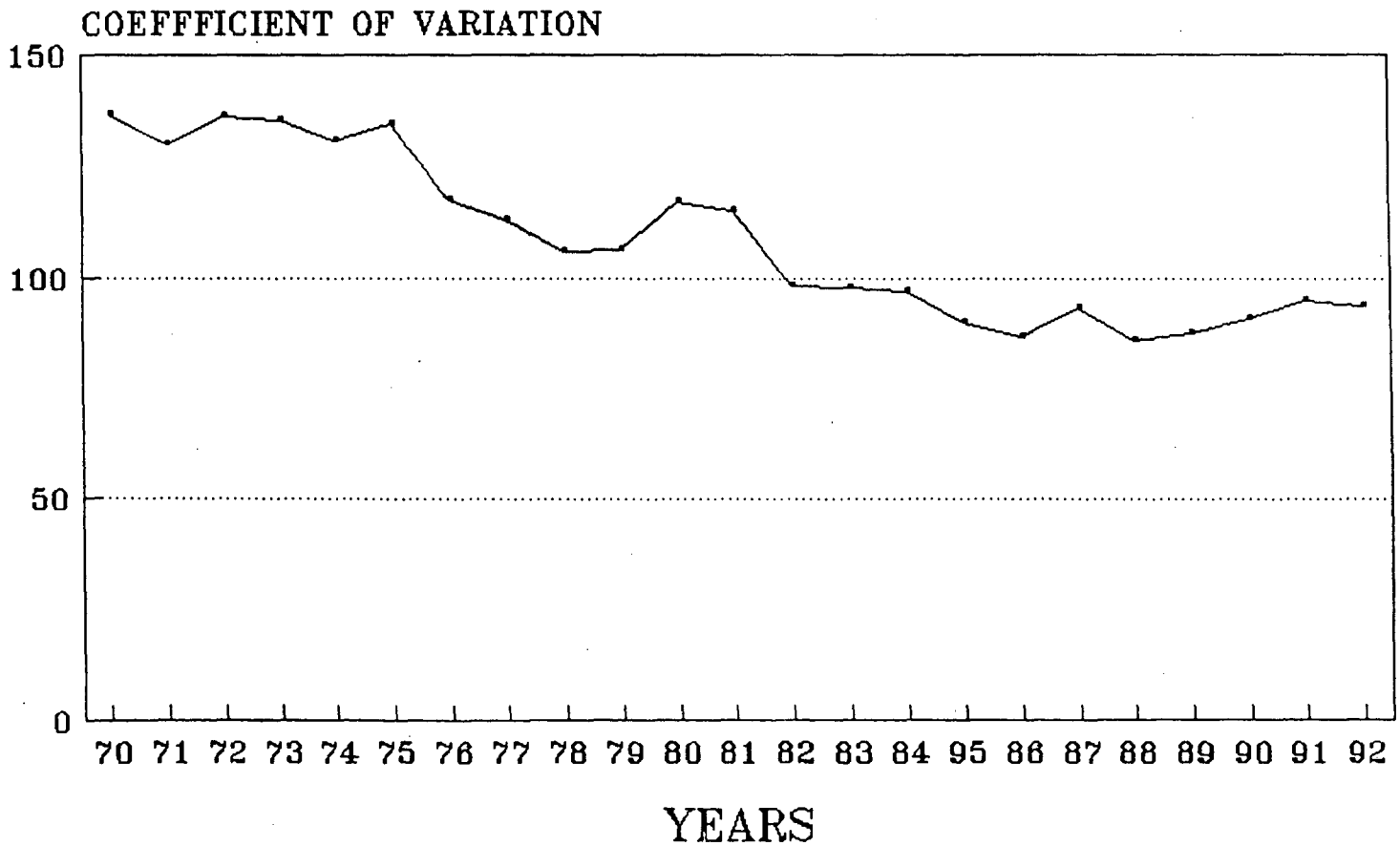
GRAPH 4.3
INTER-DISTRICT VARIATION IN PRODUCTION OF BORO RICE



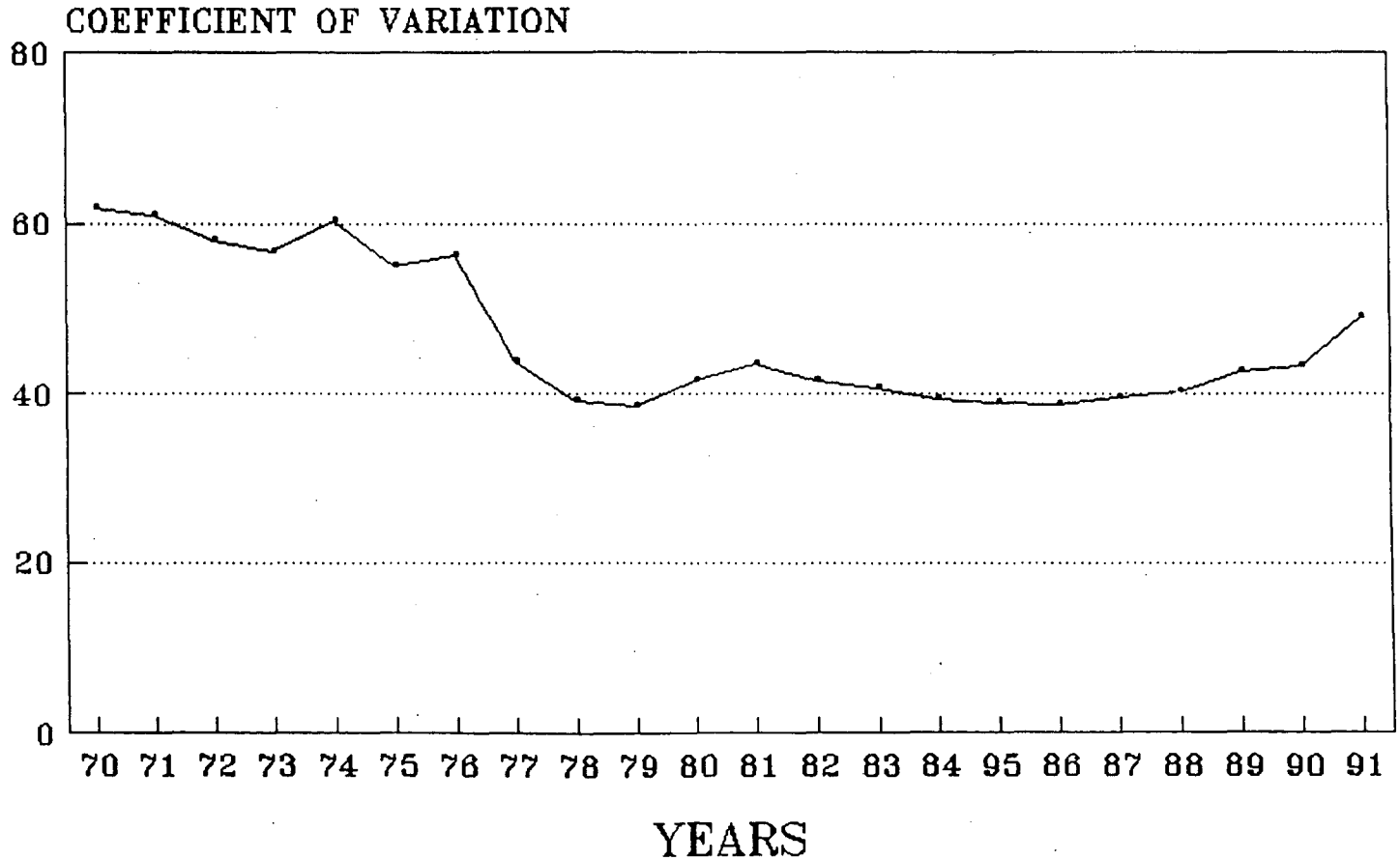
GRAPH 4.4
INTER-DISTRICT VARIATION IN PRODUCTION OF TOTAL RICE



GRAPH 4.5
INTER-DISTRICT VARIATION IN WHEAT PRODUCTION



GRAPH 4.6
INTER–DISTRICT VARIATION IN PRODUCTION OF TOTAL CEREALS



and *aus* have exerted their influence so as to offset the effect of *boro* and render a significant correlation for total rice.

For both wheat and total cereals, a clearly linear trend is visible with the disparity among the districts in their production reducing over time.

4.5 Conclusions

To sum up, the findings in this chapter reveal several important features with respect to the instability in production and yield, following the introduction of the Green Revolution in Bangladesh. For the study, the time period has been divided into two phases: Phase I (1969-70 to 1976-77) and Phase II (1977-78 to 1991-92) Phase I corresponds to the period when technological adoption was very low keyed and was restricted certain pockets of Bangladesh. Phase II corresponds to the period when technological adoption intensified and got spread over larger areas. On examining, national time series data, it was found that, as the new technology intensified and got spread over larger areas and across larger mass of cultivating households, the relative variability in the production and yield of foodgrains actually declined. The above conclusion in terms of rice and wheat may be treated as comprehensive for Bangladesh due to

their overwhelming importance (together they account for more than 80 per cent of the cropped area). Moreover, an analysis of the temporal spread in the variability of production and yield during the two periods, provides an evidence of a reversal of trends. While the first phase of the introduction of new technology is characterised by increasing variability, the latter phase, when the new technology got strengthened and dispersed to more and more areas, is characterised by declining relative variability.

The contrasting behaviour of production and yield between the HYV and local varieties of rice clearly testify to the instability reducing capabilities of the former as their adoption grows over time. While HYVs start with higher coefficients of variation, the relative variability declines rather sharply unlike that of the local variety. It follows that, though, the new technology creates initial destabilising effects in production and yield, there comes about a decline in such variability once the disequilibriating forces get steadily mitigated.

At the regional level also, the HYVs show lower variability in the second period for both production and yield of foodgrains in most of the regions. For the local varieties, on the other hand, in almost all the regions, there has been a increase in the variability of both production as well a

yield in the second period over the first. When compared on a seasonal basis, the winter crops of *boro* and wheat i.e. the *rabi* crops show much greater variability than the Kharif crops.

A declining trend in the inter-district disparity in the production of *boro* rice, total rice, wheat and total cereals is also seen. However, for the other two varieties of rice namely, Aman and Aus, inter-regional differences seem to have gone up after an initial decade of declining disparity.

Thus, from the above, one can conclude that the green revolution has had an ameliorating effect on the relative variability in foodgrain production and yield in Bangladesh. Moreover, there has been a reversal of trends with the first period (when the adoption of new technology was subdued) characrterised by rising trends in variability and the second period (when adoption accelerated) showing declining trends.

CHAPTER V

DOMESTIC PRODUCTION, IMPORTS AND FOOD SELF-SUFFICIENCY

This chapter makes an attempt to assess the recent trends regarding food production, food imports and consumption and to determine the extent to which Bangladesh is nearing food self-sufficiency in recent years. The changing pattern of demand for different foods that will result from a rapidly rising population and increased incomes is also examined. Policy implications of these changes are outlined, including the need to step up foodgrain production and diversify the food basket in years to come, so as to absorb the effect of increasing population on the one hand, and of the incremental diversified demand for food items following increasing levels of per capita income. Perhaps at the present stage of its development, Bangladesh would face no setup on the both these counts for the next decade or so; the demand augmenting effect of increasing income levels during the high income elasticity regimes needs to be underlined in particular.

5.1 **The Concept of Food Self-sufficiency and Food Security**

The objective of attaining self-sufficiency in food has been nurtured by Bangladeshi planners for well over two decades now. It has been the key goal of public policy in

Bangladesh as also in many other developing countries. At this stage, it is in the fitness of things that we define these terms as precisely as possible.

"Food self-sufficiency" is an ambiguous term. Presumably, it is defined with regard to the satisfaction of human demand (related to either income or nutrition) together with the elimination of food imports.[1] It would also be defined as 'food self-reliance' in which case food imports could be paid for by producing/exporting other agricultural and manufactured commodities. In Bangladesh, food self-sufficiency has been usually understood as 'autarky' in foodgrains (effectively rice and to some extent, wheat) in which domestic production must meet domestic demand, irrespective of cost and in which food imports are ruled out, except, perhaps in particularly bad years.[2]

The term 'Food Security' is closely related to food self-sufficiency. Food security has two aspects: national and individual. At the national level, typically it means availability in the country of sufficient stocks of food to meet the national demand (however defined) until such time

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1. Cummings, Ralph W. Jr. "Food Self-sufficiency in India" in S.C. Mathur (ed.) 'Agricultural policy and food self sufficiency', Associated Publishing House, April 1970.

2. Government of Bangladesh, Food Strategies in Bangladesh: Medium and Long term perspectives, Planning Commission, Dhaka, 1989.

as the stock can be replenished from harvests or imports. At the individual level, it means that all members of the society have access to the food they need, either from the market, from their own production or from the Public Food Distribution System (PFDS). Experience in India and other countries has shown that even when national food security is achieved individuals and groups within the country can still go hungry because they do not have the means to obtain food. In the socio-political and cultural context of Bangladesh, foodgrain self-sufficiency in term of production of rice and wheat is more important, at least at present, because government policies aimed at increased agricultural development centre around increased domestic production of rice and wheat to meet its total annual requirement. The concept of self-sufficiency in this context implies that the requirement for human consumption and for seed and feed should be met primarily through production within the country.[3]

5.2 **Determining Food Self Sufficiency**

A balance between domestic production and total domestic requirement usually determines self-sufficiency. The enhanced need for food security entails building national

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3. Clay, E.J. et. al. (1989) "Food strategy in India: Approaches to food strategy in the national resource sector", Relief and Development Institute, London.

food reserves for coping with transitory food gaps. This need for increasing national food stocks arises due to factors such as weather related fluctuations in crop production, crop failure or damages due to floods etc. To get an estimate of the overall requirement, the per capita requirement for food is multiplied by the estimated mid-year population figure. This added to foodgrain reserve requirement would provide overall production level for total food security. More specifically, in any particular year, food requirement is given by P x C x Y / 16 x 2204 where P the population, C is the daily requirement (16 oz.) Y is 365 days (for yearly estimate)[4] This estimation of food requirement is, however, a static one and with growing national income, some change in the demand or some substitution in the consumption basket is bound to take place. In that case, the income elasticity of demand for food has to be taken into account. Another problem arises in determining the minimum daily requirement of calories, proteins, vitamins etc. Food is a composite item, where foodgrains, and other items like milk, meat, fish, vegetables etc. are

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4. Ahmed, Mushtaq, "Bangladesh Agriculture", Ministry of Information, Government of Bangladesh, March 1988.

important. In Bangladesh, fish and pulses are relatively cheaper sources of protein for the bulk of the population.

5.3 Net Availability of Major Food Items

Table 5.1 gives the net production, imports, total and per capita net availability of cereals viz. rice, wheat and minor cereals. The table also gives their respective growth rates for both the phases as well as for the entire time period. As is shown by the table, net production of cereals has gone up by a little over 70 per cent from 1973-74, the net production figures were almost stable following which there was a sudden spurt in production from 1977-78 (beginning of phase II) onwards. As regards imports, till 1979-80, no clear trend is discernible in the sense that some years showed an increase while others witnessed a decrease. Significantly, from 1980-81 onwards, cereal imports saw a continuous increase till 1984-85. Over the entire time period, imports registered a growth rate of 1.01 per cent per annum; while the first few years (1973-74 to 1976-77) saw a decline in the growth rate of cereal imports to the tune of 32.19 per cent, the second period witnessed an increase of 1.36 per cent per annum. Moreover, bulk of the imports consisted of wheat as is very clear from the table. Thus total cereal imports increased in the face of increasing wheat imports.

TABLE 5.1

Availability of Total Cereals

Year	Population (Million)	Net Production '000' Tons	Imports ('000' tons)		Change in Government Stocks ('000'tons)	Total availab-ility	Per capita net availability
1973-74	76.4	10711	1666	(82+1584)	1656	14033	183.7
1974-75	78.0	10164	2558	(266+2292)	1630	14407	184.7
1975-76	79.9	11559	1445	(396+1049)	1318	14322	179.2
1976-77	81.8	10784	795	(196+603)	1131	12710	155.4
1977-78	83.7	13047	1635	(305+1330)	1448	14682	175.4
1978-79	85.6	13068	1181	(57+1124)	1454	15703	183.5
1979-80	87.7	13277	2871	(917+1954)	2171	18319	208.8
1980-81	89.9	14655	1078	(84+994)	2234	16239	180.6
1981-82	91.6	14288	1245	(146+1099)	1766	17299	175.3
1982-83	93.6	14978	1870	(321+1549)	1745	18593	198.6
1983-84	95.7	15378	2134	(165+1969)	1766	19270	201.4
1984-85	99.2	15719	2575	(741+1834)	2229	20523	206.9
1985-86	101.7	15713	1032	(45+987)	1180	17925	176.3
1986-87	104.1	16111	1032	(44+988)	1630	19073	183.2
1987-88	106.6	19139	2920	(588+2332)	2168	24227	227.3
1988-89	109.1	16239	2138	(61+2077)	2524	20901	191.6
1989-90	111.7	18367	1534	(300+1234)	1818	21719	194.4
GROWTH RATE PERIOD I*		1.50	-32.19			-3.07	-5.46
PERIOD II		2.86	1.36			2.78	0.30
TOTAL		3.55	1.01			3.17	0.73

Source: Various issues of statistical year book of Bangladesh.
Growth rates have been calculated by fitting semi logarithmic trend lines)

Note: Figures in parenthesis gives the suce and wheat import breakups respectively

* Period I corresponds to 1973-74 to 1976-77.
Period II corresponds to 1977-78 to 1989-90.

Net availability of cereals grew by 3.17 per cent between 1973-74 to 1989-90. However, in the first period, net availability in actually declined by 3.07 per cent per annum while the second period saw an a growth rate of 2.78 per cent per year. The scenario for per capita availability, however, was not so encouraging. The first period saw a growth rate of (-)5.46 per cent while the second period registered a small but positive growth rate of 0.30 per cent. Overall per capita availability of cereal grew at a meagre rate of 0.73 per cent during the seventies and the eighties.

Table 5.2 portrays the temporal profile of imports, total and per capita net availability of pulses and their respective growth rates for the study period. Between 1973-74 to 1989-90, net production of pulses grew at a rate of 3.42 per cent. There were no imports under pulses till 1984-85. From 1985-86 onwards imports began mounting to reach 124000 metric tons in 1989-90. Aggregate availability grew at 4.85 percent between 1973-90 while the figures for the two times periods were 2.94 and 8.10 percent respectively. On the other hand, per capita availability of pulses has grown at a rate of 2.44 percent, 2.94 percent and 5.65% over the entire time period, first phase and second phase, respectively.

TABLE 5.2

Net Availability of Total Pulses

Year		Population (Million)	Net Production	Imports	Total Availability	Per Capita at Availability
1973-74		76.4	200	-	200	2.6
1974-75		78.0	210	-	210	2.7
1975-76		79.9	208	-	208	2.6
1976-77		81.8	221	-	221	2.7
1977-78		83.7	221	-	221	2.6
1978-79		85.6	216	-	216	2.5
1979-80		87.7	204	-	204	2.3
1980-81		89.9	200	-	200	2.2
1981-82		91.6	196	-	196	2.1
1982-83		93.6	203	-	203	2.2
1983-84		95.7	190	-	190	2.0
1984-85		99.2	188	-	188	1.9
1985-86		101.7	186	2	188	1.9
1986-87		104.1	216	3	219	2.1
1987-88		106.6	530	47	578	5.4
1988-89		109.1	408	39	447	4.1
1989-90		111.7	504	124	628	5.6
GROWTH RRATE	PERIOD I		2.9		2.94	0.76
	PERIOD II		6.8		8.10	5.65
	TOTAL		4.10		4.85	2.44

Source: Same as table 5.1.

Table 5.3 shows net production imports, total and per capita net availability of total foodgrains (cereals and pulses) and their respective growth rates. As indicated in the table, net production increased at a rate of 3.57 per-cent per annum from 1973-74 to 1989-90. Till 1976-77 the increase was sluggish, about 1.53 percent per year, but from phase II onwards it quickened its pace to reach a growth rate of nearly 3.00 per cent. Foodgrain imports decreased at a rate of 32.12 per cent between 1973-77, while it in-creased at a rate of 1.72 per cent and 1.22 per cent per annum between 1973-77 and 1978-90 respectively. Coming to aggregate availability, it grew at a rate of 3.31 percent, -2.98 percent and 3.19 percent between 1973-74 to 1989-90, 1973-74 to 1976-77 and 1977-78 to 1989-90. On the other hand, per capita availability grew at a rate of 0.86 percent and 0.70 percent between 1973-74 to 1989-90 and between 1977-78 to 1989-90. During the first period, per capita availability declined sharply at a growth rate of (-)5.36 percent.

Pursuing Tables 5.1, 5.2 and 5.3 together, we clearly discover that in the case of foodgrains, though net avail-ability has gone in Bangladesh in the second period compared to the first, the increase has been very small in terms of per capita availability. Even when one considers the entire

time period, the increase in per capita availability has been very slow compared to the increase in aggregate availability. Thus in a country that witnessed a fairly high pressure of population expansion, total availability of food is only a cold comfort. Per capita availability languishes at low levels and this in turn, sets into motion many other problems connected with food and nutritional deficiencies.

TABLE 5.3

Net Availability of Total Foodgrains

Year	Population (Million)	Net Production ('000' tons)	Imports ('000' tons)	Change in Govt. Stocks	Net Availability ('000' tons)	Per Capita Availability
1973-74	76.4	10911	1666	1656	14233	186.3
1974-75	78.0	10374	2558	1630	14617	187.4
1975-76	79.9	11764	1445	1318	14530	181.9
1976-77	81.8	11005	795	1131	12931	158.1
1977-78	83.7	13268	1635	1448	14903	178.1
1978-79	85.6	13274	1181	1454	15919	185.9
1979-80	87.7	13481	2871	2171	18523	211.2
1980-81	89.9	14855	1078	2234	16439	182.9
1981-82	91.6	14484	1245	1766	17495	191.0
1982-83	93.6	15181	1870	1745	18796	200.8
1983-84	95.7	15560	2134	1766	19460	203.3
1984-85	99.2	15907	2575	2229	20711	208.8
1985-86	101.7	15899	1034	1180	18113	178.1
1986-87	104.1	16327	1035	1630	19292	184.4
1987-88	106.6	19669	2967	2168	24805	232.7
1988-89	109.1	16647	2177	2524	21348	195.7
1989-90	111.7	18871	1658	1818	22347	200.1
GROWTH RATE	PERIOD I	1.53	-32.19		-2.98	-5.37
	PERIOD II	2.94	1.72		3.19	0.71
	TOTAL	3.57	1.22		3.31	0.86

Source: Same as table 5.1

Tables 5.4 and 5.5 give the rate of growth of aggregate availability and per capita availability of some important food items besides foodgrains. Net availability of meat grew at a rate of 1.91 percent between 1973-74 to 1976-77 which climbed high to a rate of 6.34 percent between 1977-90. The figure was quite high for the period as a whole, about 6.65 percent. Again, as witnessed earlier in the case of foodgrains, when total availability is translated into per capita availability the picture becomes rather disquieting. During the two sub periods, the per capita availability of meat grew at 0.49 percent and 3.87 percent respectively while the entire period saw a growth rate of 4.15 percent.

The case of milk and milk products seems to be a contrast to that of meat. Net availability of this food item increased at a very sluggish pace of 0.024 percent between 1973-74 to 1989-90 while the per capita availability actually declined to show a growth rate of (-)2.4 percent. During the two periods, the net availability of milk and milk products grew at a rate of 1.33 percent and (-)1.40 percent while per capita availability registered a growth rate of 0.97 percent and -3.91 percent during Periods I and II respectively.

TABLE 5.4

Growth rate of total availability of other important food items.

Year	Meat ('000' M.tons)	Milk and Milk Products ('000' M.tons)	Edible Oil ('000' M.tons)	Sugar ('000' M.tons)	Eggs (Million nos.)
1973-74	174.20	971	122.3	127	693
1974-75	177.45	976	123.4	98	739
1975-76	180.82	984	196.6	158	788
1976-77	184.37	1012	149.4	145	841
1977-78	182.48	1104	193.1	149	896
1978-79	186.96	1140	156.9	132	950
1979-80	191.61	1234	136.2	120	1007
1980-81	317.92	1224	125.2	145	1238
1981-82	339.42	1202	146.9	202	1294
1982-83	354.50	1322	121.2	178	1363
1983-84	384.52	868	126.6	160	1356
1984-85	389.52	988	127.2	92	1085
1985-86	477.40	978	111.8	217	1251
1986-87	489.30	1026	215.6	299	1345
1987-88	328.90	986	632.8	300	1340
1988-89	341.40	1062	164.9	267	1403
1989-90	354.10	1096	424.9	336	1175
GROWTH*	1.91	1.33	1.25	9.15	6.66
RATE	6.34	-1.40	6.70	7.83	2.60
	6.65	0.024	4.47	5.92	4.17

* Estimated by fitting semi-logarithmic trend lines to BBS data.

TABLE 5.5

Per Capita Availability of other important Food Items

Year	Meat (kg.)	Milk and Milk Product (kg.)	Oil (kg.)	Sugar (kg.)	Eggs (Nos.)
1973-74	2.28	12.71	1.60	1.66	9
1974-75	2.28	12.51	1.58	1.26	9
1975-76	2.26	12.32	2.46	1.98	10
1976-77	2.25	12.37	1.83	1.77	10
1977-78	2.15	13.20	2.31	1.78	11
1978-79	2.17	13.30	1.83	1.54	11
1979-80	2.19	14.10	1.55	1.37	11
1980-81	3.55	13.70	1.39	1.62	14
1981-82	3.69	13.10	1.60	2.19	14
1982-83	3.76	14.00	1.29	1.89	14
1983-84	3.97	9.00	1.32	1.65	14
1984-85	3.93	10.00	1.28	0.93	11
1985-86	4.69	9.60	1.09	2.14	12
1986-87	4.70	10.00	2.07	2.87	12
1987-88	3.10	9.20	5.93	2.81	12
1988-89	3.13	9.70	1.51	2.43	12
1989-90	3.17	9.80	3.80	3.00	10
GROWTH*	0.49	0.97	7.80	6.66	4.30
RATE	3.87	-3.91	5.21	5.21	0.44
	4.15	-2.4	3.46	3.39	1.40

* Estimated by fitting semi - logarithmic functions to BBS data.

Net availability and per capita net availability of edible oils showed a better performance than the other products considered hithertofore. The growth rate of net availability decreased from 11.25 percent in Period I to 5.21 percent in Period II. Over the entire period i.e. 1973-90, net availability of edible oils showed a growth

rate of 4.41 percent. It may be noted that of all the food imports flowing into Bangladesh, edible oils occupy a very important position. For instance, in 1987-88, 76.23 percent of the net availability of edible oil was imported. This could be one of the reasons for the better performance in the total availability of edible oil compared to other products largely depending on slowly growing domestic agriculture. Per capita availability, however, decreased from a growth rate of 7.83 percent to 5.21 percent from Period I to Period II. During 1973-90, per capita availability registered a growth rate of 3.46 percent.

Coming to sugar, its net availability grew at a rate of 8.95 percent between 1975-90 while per capita availability increased at a mere 3.4 percent growth rate. Moreover, both net availability and per capita availability declined in the second period compared to the first. The picture for eggs is also more or less similar to that of sugar. Both net total availability and per capita availability saw a decline in their growth rates from 6.66 percent to period I to 2.6 percent in period II and 4.3 percent in period I to 0.44 percent in period II, respectively. Over the whole period, the two variables saw a growth rate o 4.17 percent and 1.4 percent respectively.

From the above, it thus emerges that though net production and net availability have gone up significantly, growth in per capita availability has been very sluggish. Moreover, for most of the commodities, particularly total cereals and edible oil, net availability has gone up largely due to increasing imports. It is, therefore important to look at the pattern of food imports in Bangladesh following liberation.

5.4 **Trends in Food Imports**

Table 5.6 gives the import of some important food items into Bangladesh from 1973-74 onwards. For cereals, imports have been an important source of aggregate availability. In 1974-75, cereals imports were at the peak (18 percent) since this was a year of a major famine which caused widespread loss of life and property. In the rest of the years the figures ranged from 5.4 percent to 15.7 percent. This, however, will seem less encouraging when one looks at the picture presented by edible oil and sugar. Imports under edible oil amounted to 26.2 percent of the aggregate availability in 1973-74. This proportion rose to a high level of 50.8 percent in 1975-76. Despite year-to-year fluctuations, oil seeds imports constituted a very substantial portion of the net availability at one time or the other. In particular

TABLE 5.6

Year	Imports of Selected Food Items in Bangladesh			
	Cereals ('000' tons)	Edible Oil ('000' tons)	Sugar ('000' tons)	Milk ('ooo' M.tons)
1973-74	1666 (11.87)	32.0 (26.17)	39 (30.71)	n.a
1974-75	2558 (17.76)	28.4 (23.01)	-	n.a.
1975-76	1445 (10.08)	99.9 (50.81)	72 (45.62)	1.36 (24.84)
1976-77	795 (6.3)	43.6 (29.18)	6 (4.10)	120 (22.32)
1977-78	1635 (11.14)	71.1 (36.82)	-	120
1978-79	1181 (7.52)	32.5 (20.71)	-	128
1979-80	2871 (15.67)	39.3 (28.85)	-	92
1980-81	1078 (6.64)	24.1 (19.15)	25 (14.91)	112 (15.51)
1981-82	1245 (7.20)	34.3 (23.35)	-	76
1982-83	1870 (9.90)	31.4 (25.91)	-	116
1983-84	2134 (10.05)	22.2 (17.54)	6 (3.80)	148 (18.32)
1984-85	2575 (12.55)	24.3 (19.10)	3 (3.3)	126 (21.93)
1985-86	1032 (5.76)	20.5 (18.34)	133 (61.90)	240 (20.79)
1986-87	1032 (5.41)	129.3 (59.97)	117 (39.13)	284 (22.82)
1987-88	2920 (12.05)	482.4 (76.23)	122 (40.67)	236 (22.82)
1988-89	2138 (10.23)	36.5 (22.13)	157 (59.25)	304 (25.52)
1989-90	1534 (7.06)	(286.9) (63.29)	152 (45.24)	288 (22.84)

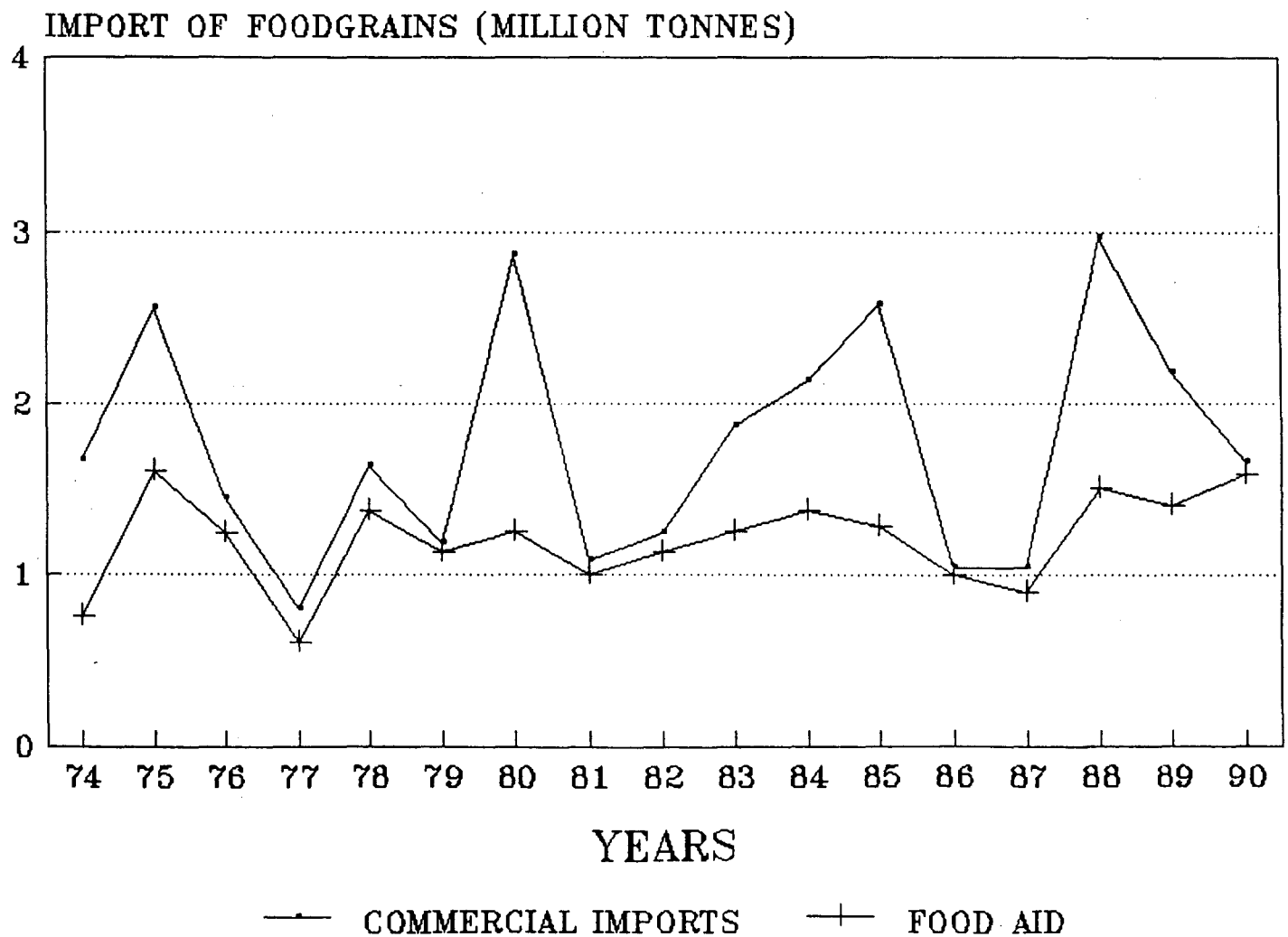
Figures in parenthesis are a percentage of net availability
Source: Statistical Yearbook of Bangladesh (Various issues)
Note: n.a. means not available

the years 1986-87, 1987-88 and 1989-90 had 59.2 percent, 76.2 percent and 63.3 percent of the net availability through imports. Sugar imports also present a grim picture. Though no sugar was imported in 1974-75, between 1977-80 and 1980-82, most of the other years showed that more than 40 percent of the net available sugar was imported. Milk imports have also been making a fairly substantial proportion of its net availability. However, the proportion seems to have come down marginally over the years.

Thus from Table 5.6, it emerges that, despite considerable year-to-year fluctuations imports have shown a rising trend over the period, particularly in the case of edible oil and sugar. Thus, one can conclude that a big proportion of the increase in the net availability (as seen before) is to be attributed to increasing food imports. Self-sufficiency in food has thus far stayed away from Bangladesh.

Since rice and wheat are the predominant foodgrains in Bangladesh, a look at the distribution of cereal imports between commercial imports and food aid would threw further light on the foodgrain import trends in Bangladesh. Graph 5.1 shows the pattern of cereal imports and their distribution between food aid and commercial imports have fluctuated widely from year to year while food aid imports show a more stable pattern. It also brings out a very important feature

GRAPH 5.1
FOODGRAIN INPORTS TO BANGLADESH



of food grain imports to Bangladesh, namely the crucial importance of food aid. It is significant to point out that barely one-third of the total imports constitute commercial imports.

5.5 **Demand for and Supply of Food**

In this section, the rate of growth in the demand for some major food items has been calculated. A comparison is then made with the supply of food. Supply has been segregated into three components viz. net production, imports and net availability. The growth rates are worked out individually for each component. Table 5.7 below gives the rate of growth of demand and supply of rice, wheat and total foodgrain in Bangladesh during 1973-90.

It can be clearly seen from the table that the rate of growth of net production for rice and total foodgrain has been much above the rate of growth of demand for these two commodities. However, the rate of increase in the aggregate availability has been much less than the growth rate of demand with the exception of wheat. Moreover, it can be inferred from the table that imports have played an important role in boasting the total availability for wheat and total foodgrains. The case of rice, on the other hand is a

TABLE 5.7

Growth of demand and supply of food-grains
1973-74/1989-90

(percent)

Foodgrain	Demand*	Supply		
		Net Production	Imports	Net availability
Rice	2.99	3.17	-1.70	2.6
Wheat	2.29	14.6	1.31	3.6
All Foodgrain	2.94	3.57	1.22	3.31

* Based on population growth rate of 2.23 percent and rate of growth of per capita income of 1.61 percent. Income elasticity of demand for rice, wheat and total foodgrains has been taken as 0.47, 0.04 and 0.44 respectively.

Note: Elasticity figures have been borrowed from Mahabub Hossain's paper "Food agriculture and the economy: the next 25 years "published in "Food strategies in Bangladesh: Medium and long term perspectives, Planning Commission, Dhaka.

positive one. Net production is much higher rate than the rate of growth of demand and net availability is not too behind. Moreover, rice imports have gone down substantially. Bangladesh it seems, is fast approaching rice self-sufficiency. The case of wheat is disquieting. Wheat imports have increased by 1.3 per cent per annum thereby boosting total foodgrain imports also, rice and wheat being the two major foodgrain crops of Bangladesh. The very low income elasticity of demand for wheat may be explained by the fact that wheat is not as popular as rice amongst the masses.

Table 5.8 gives the food gap in Bangladesh with respect to rice and wheat. The minimum requirement for foodgrain (mostly rice and wheat) presented for the Bangladesh population from nutritional consideration is 437 grams/capita/day or approximately 15.5 oz/capita/day.[5] Based on this minimum consumption norm, the food gap has been worked out. As is indicated, there have been sharp fluctuations in the food gap with some years showing big increase while others showed a decline.However, on the whole, it is evident that the gap between the foodgrain requirement of the population and foodgrain production has been narrowing over time. It may be encouraging to note that the food gap was the lowest in 1991-92 i.e. 827 thousand metric tons. It was the highest in 1988-89 - the year of the devastating floods that caused large scale damage to crops.

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5. Muqtada, M., "Poverty and Inequality: Trends and Causes" in R. Islam and Muqtada M.(eds.), "Bangladesh: Selected issues in Employment and Development", ILO/ARTEP, New Delhi.

TABLE 5.8

Net production per capita availability and food gap :
Rice and wheat 1973-1992.

('000' M.tons)

Year	Net Production			Requirement*	Total Availability	Per Capita Availability	Food gap
	Rice	Wheat	Total				
1973-74	10718	100	10818	12254	12502	15.81	1436
1974-75	10159	105	10264	12542	11920	14.73	2279
1975-76	11486	197	11683	12831	12983	15.68	1148
1976-77	10577	94	10672	13136	11839	13.97	2464
1977-78	11673	320	11993	13457	13341	15.37	1464
1978-79	11564	444	12009	13777	13502	15.90	1769
1979-80	11466	741	12207	14082	14350	15.80	1875
1980-81	12493	988	13481	14435	14020	15.05	954
1981-82	12794	870	13138	14772	14937	15.67	1634
1982-83	13057	986	13789	15093	15551	15.97	1313
1983-84	13160	1090	14147	15413	15964	16.05	1266
1984-85	13531	1318	14477	15718	16732	16.50	1241
1985-86	13946	938	14469	16865	15661	15.09	1613
1986-87	13811	982	14928	16970	16866	15.90	1561
1987-88	14158	945	14756	17228	16884	15.67	1879
1988-89	16080	751	14909	18130	17434	15.33	2823
1989-90	16066	791	16871	18530	18075	15.72	1677
1990-91	16426	904	16970	18910	18559	15.71	1940
1991-92	16700	959	17385	18212	18714	16.44	827

Food gap = Requirment - Net Production

* Calculated 15.5 oz/person/day.

In sum, this chapter reveals several important features with respect to attaining food self-sufficiency in Bangladesh following the arrival of the green revolution in the mid-seventies. The foodgrain sector seems to have achieved impressive growth rates since mid-seventies compared with

earlier years, in net production and net availability. However, per capita net availability has not been able to keep pace with the ever increasing population, thereby showing a decling secular trend. Moreover, year-to-year fluctuations not with standing, imports of foodgrain have been on the rise. In fact, a significant proportion of the increase in net availability was possible only though an increase in foodgrain imports, mostly wheat.

The situation on the food front has not thus been very pleasing in Bangladesh. No wonder therefore the focus of the government has been rivetted on foodgrains only, as a consequence of which the non-foodgrain sector reflects a scenario of relative policy neglect.

Between 1975-84, of the 25 per cent public investment allocated to agriculture, nearly half was concentrated on development of irrigation facilities, which mostly benefited foodgrains production. Less than 10 percent of the public investment was allocated for fisheries and livestock sectors. Bangladesh being a land scarce country, the levels of direct government involvement for water resource development and flood control to facilitate diffusion of the new agricultural technology must continue first to maintain the

growth of foodgrains at 2.5 - 3.0 percent per annum.[6] More attention should be given to promoting production of non-cereal crops. As the have seen, non-food grain products like milk, sugar, meat and eggs etc. account for much of the total food imports. In fact these imports have helped maintain a certain stability in the supply of the same in the country. In particular, edible oil and sugar imports accounted for more than 50 percent of the net availability of a number of years since early seventies. Moreover, the development of modern technology for rice and wheat has reduced the competitiveness of pulses and oilseeds which are important sources of protein. Additional support is needed for research to develop and popularise suitable HYV seeds of these crops to make them more competitive vis-a-vis HYV rice and wheat.

Another striking features that emerges from the present chapter is that the rate of growth of demand for rice has been more than the rate of increase in the net-availability . However, rate of growth of net production has been much above that of the rate of growth in its de-mand. For wheat and foodgrains however, both net production

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6. Ahmed, Rais Uddin, "Long Term Food Problems of Bangla-desh: Options and Policy direction", in "Food Strate-gies in Bangladesh", Bangladesh Planning Commission, Government of Bangladesh.

and net availability have grown at a higher rate than the demand. Also, the food gap for rice and wheat has shown, on an average a declining trend despite frequent fluctuations.

Thus, even today after two decades of the first announcement of the sufficiency objective, the country's own production is still behind the targets. This does not mean that there has been no development in terms of foodgrain production. Contribution of the new technology to increased production is indeed to be fully recognised, but this has not been enough to attain the level of self sufficiency.

One might also add that, given Bangladesh's declining land resource base, it will be difficult to achieve food self-sufficiency through the production of rice and wheat alone. The one-track focus on rice and wheat to the exclusion of other food crops is unlikely to produce the desired effects. Agricultural production must diversify and further intensify into crops like maize, pulses, potato, coarse cereals, oils, vegetables and fruits. This, in addition to meeting the food requirements of the people, would help improve the nutritional status of the people, improve soil health and productivity. The long-run social gains must receive accelerated policy attention, especially because food situation elsewhere in the world does not promise a very comfortable future.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Prior to the 1950s, Bangladsh lived under a fairly comfortable food situation. However, with limited agricultural land base of approximately 22 million acres, a high rate of population growth on a continuing basis and consequently with a deteriorating land-man ratio, it has been unable to maintain the food-population balance in recent years. With a population growth rate of 2.3 per cent, Bangladesh now supports about 114 million people. The per capita income is one of the lowest in the world (US $150 in 1986) and a sizeable proportion of this is spent on food.

Previously, farmers could obtain additional output primarily by bringing additional land under the plough. With a sort of dead-end having been reached with respect to the cultivable land over the past three decades, that option is now totally closed. Moreover, Bangladesh being very densely populated, the possibility of increasing production through additional use of labour in individual crop varieties also seems to be rather bleak, unless fresh technological breakthroughs in the direction of labour-absorbing crop varieties come up in a big way.

Noting in particular the increasingly limited role that settlement of new lands will play in future agricultural expansion, rapid technological progress was recognised as the key to maintaining the food-population balance in the country. Ingredients of this technological progress or the 'Green Revolution' includes among others, improved High Yielding Variety (HYV) seeds, irrigation expansion, use of chemical fertilizers, pesticides, intensified farming under rainfed conditions and dissemination of knowledge about the use of these modern non-traditional inputs and expected gains to be reaped from their use.

The present study is an attempt to assess the nature and degree of instability in production and yield of food-grains and the extent to which food self-sufficiency has been achieved, following the introduction of the Green Revolution technology in Bangladesh during the early 1970s. For this purpose, a 23-year time series beginning with 1969-70, has been constructed for acreage, production and yield in respect of the important foodgrain crops grown in Bangla-desh. The analysis has been done both at the national level as well as the regional level. Instability has been studied through examining changes in area sown, output levels and yield rates obtained and so on. The crops covered are rice, wheat, total cereals and an important pulse (namely, gram).

Total cereals has been obtained as the summation of rice, wheat, jowar, bajra, maize, barley and other *kharif* cereal crops. Since rice is the most dominant food crop in Bangladesh and is grown throughout the year its analysis has been done in a far more detailed manner than for any other individual crop. In concrete terms, the summer and the rainy season crops of *aus* and *aman* (*kharif* crops) and the dry season *boro* paddy (*rabi* crop) have all been individually looked at.

The instability element has been analysed from different angles. Firstly, on the basis of the adoption intensity of the new agricultural technology, the time span has been divided into two periods; Period I (1969-70 to 1976-77) when technological adoption was rather subdued and Period II (1977-78 to 1991-92) which corresponds to the period of accelerated adoption.

Semi-logarithmic trend lines have been fitted for all the three variables i.e. area, production and yield for both the time periods. For measuring relative variability, co-efficient of variation has been worked out and compared for both the periods. In addition to this, the percentage change in the co-efficient of variation in Period II over Period I has been computed to see the pattern of change over time in the instability of the variables studied. The year

to year change showing the annual variability in area, production and yield has also been worked out. Finally parabolic and linear trend lines have been fitted to regional data for assessing the inter-regional disparity in the production of food grains.

Variability in Foodgrain Production, Area and Yield

The variatbility in the HYV acreage of total rice witnessed a dramatic decline from 25.4 per cent in Period I to 5.7 percent in Period II. For the individual varieties of rice also, the relative variability in acreage declined in Period II over Period I. The decline was the highest for *aman* paddy in whch case the co-efficient of variation fell from 48.3 per cent in Period I to 13.68 per cent in Period II. The percentage change in the co-efficient of variation between the two periods brings out that instability declined substantially in Period II over Period I. In other words, as technology matures and gets spread over wider areas, allocation to HYVs does not change much on year to year basis, as it does during the initial years of technology arrival. In any case, expansion of area under High Yielding Varieties is highly constrained by irrigation facilities which are not very satisfactory in Bangladesh.

The local varieties present a different picture. For total rice, *aus* and *aman* acreage, instability actually increased, in Period II. Local *boro* has been the only one to have undergone a decline in its co-efficient of variation over the two periods. The contrasting behaviour of acreage between HYV and local varieties of rice clearly testifies to the instability reducing capacity of the farmer when their adoption grows over time.

The instability in the yield for the HYV of total rice, HYV *aus* and HYV *aman* also declined in Period II over the first. A contrasting picture is presented by HYV *boro* where the relative variability in yield increased from 4.5 per cent between 1969-77 to 6.3 per cent in 1977-78. Nevertheless, absolute magnitude for HYV *boro* are so low that it does not warrant any conclusion either for or against increased instability. The yield variability for the local varieties of total rice and its individual varieties showed an increase in the second period over the first. *Boro*, in pa;rticular, showed a tremendous increase in its coefficient of variation viz., 156.6 per cent.

The levels of production variability in respect of all the HYVs and local varieties except local *boro* registered a sizeable decline in the second period. Production variabil-

ity went up marginally for local *boro* in the second period. The relatively unstable character of *boro* stems from the fact that cultivation of this crop, has gradually extended beyond the irrigated area available during the dry season. *Boro*, being a *rabi* crop, its production and yield are crucially dependent on controlled irrigation and complementary inputs. Any divergence (which is not so uncommon) is likely to inject variability. The interaction of all these factors explain the relatively unstable character of *boro*. Wheat and total cereals have also undergone a decline in relative variability in cropped area, production and yield. The only crop to have shown a dismal performance has been gram, showing large increases in instability in the later 70s and 80s. In a regime of technological expansions and switch-overs to more productive crops from less productive ones, the latter are relegated to the background. Accordingly, acreage decisions as well as input use decisions get more and more pivoted on the other set of 'rising' crops. Instability on acreage and yield fronts are, thus, bound to follow.

Annual Variability in Area, Yield and Production

The year to year variability in the cropped area, production and yield for all the crops considered in the study reveal a mixed picture. For total and all its indi-

vidual varieties, except *aus*, there has been a smoothening of yearly ups and downs in the acreage and production of HYVs only, as we move from the seventies to the eighties. Both HYV *aman* and HYV *aus* witnessed tremendous increases in area and production during the initial years of Period I. These dramatic increases are indicative of the initial euphoria associated with the introduction of new technology. However, as expected of a post-euphoric situation the tempo of this increase could not be maintained and the rate of increase began to slow down.

For the local varieties, annual variability seems to have gone up for area, production and yield, with increased frequency of fluctuations in Period II.

Wheat also witnessed fairly substantial variability in area, production and yield. The temporal profile of the crop was clearly punctuated by ups and downs of varying amplitude and frequency. In respect of total cereals, there has been an increase in the frequency of fluctuations as far as area and yield rates are concerned. In total terms, annual variability seems to have gone down with respect to rice alone; other crops considered by us are possibly likely to join rice in due course when their production technology matures, commends itself for wider acceptance, and their production base gets insulated from year to year.

Annual Growth Rates in Area, Production and Yield

The growth rates in cropped area, and production for HYV *aman*, HYV boro and HYV total rice have gone down substantially in Period II. However, this picture could be misleading as the growth rates for *aman* in the first period is not very reliable. The steep increase in the initial years of technology arrival rendered such a high growth rate. The performance of *aus* rice has been poor with the growth rates in area and production declining to reach a negative growth rate of -0.6 per cent and -2.4 per cent for area and production respectively. Though the growth rates for HYV *aus* area and production are also unreliable due to reasons mentioned above, a negative growth rate in Period II implies a dismal performance. This could be party due to the encroachment or replacement of low yielding high and medium land *aus* by other summer crops. Only HYV *boro* seems to have registered a considerable increase in its yield growth rate. For the local varieties, the picture is a contrasting one, with the yields showing an improvement in their growth rates while growth rates of area and production still registered negative progress. For wheat, there has been a slow down in the tempo of its increase in area, production and yield in Period II.

The total cereals seem to have done quite well with growth rates inceasing for production and yield in the second period, while area showed a slight decline. The growth rate for all the three variables (viz. area, production and yield) for gram was negative during 1969-77. The recent impressive growth and high achievements in food production were often attained at the expense of other crops through relocation and displacements of existing crop land areas. For pulses, among other reasons, the irrigated *boro* paddy largely led to its decline. In the second period, gram seemed to have recovered in area and production. Yield growth rate, however, continued to be negative.

Inter-regional Analysis of Variability

At the regional level, the variability of HYV rice production and yield seems to have declined for most of the districts in Period II or Period I. For the local varieties, variability in rice production and yield has increased during the period for almost all the districts.

On seasonal basis, *rabi* foodgrain production is relatively more variable than *kharif* for most of the districts. When compared for the entire period, HYVs seem to be more variable than the yield while on an annual basis, the opposite picture seems to be true.

On fitting parabolic and linear functions to the co-efficient of variation amongst the regions, a declining trend emerged in the inter-regional disparity in the production of *boro* rice, total rice, wheat and total cereals is seen. However, for *aus* and *aman* rice, inter-regional differences seem to have gone up after about a decade of initial declining disparity.

The correlation co-efficient between the HYV and local varity of each rice crop was worked out for the co-efficient of variation in their respective production. Total rice, *aus* and *aman* showed a significant correlation between their HYV and local variety counterparts. Thus, for these crops factors affecting HYV production, significantly affects local prodcution. For *boro* rice, HYV and local varieties had no correlation at all.

Our analysis thus shows that the Green Revolution has had an ameliorating effect on the relative variability in foodgrain production and yield in Bangladsh. In fact, there has been a reversal of trends, with the first period (when technological adoption was subdued) characterised by increasing trends in variability and the second period (When technological adoption picked up) showing declining trends. One of the most important impacts of the Green Revolution in Bangladesh has been a marked increase in cropping intensity

(Ch.II table 2.15) each year. Thus the extra croppings in each year in most cases should be able to smoothen out any variability during the original cropping period and thereby add stability in annual production and yield. Even though absolute variability might show an increasing tendency, increased annual average production and yield can bring about a decline in relative variability. Moreover, the accelerated use of ingredients of the HYV package namely, fertilizers, irrigation etc. might have also supplemented the moderating impact of multiple cropping. In the case of Bangladesh, these factors appear to have taken on a significant role with the result that the Green Revolution has had a stabilising impact on the relative variability of production.

The Problem of Food Self-sufficiency

For the analysis of self-sufficiency in food, the splitting up of the time span is as follows: Period I (1973-77) and Period II (1978-90). The war years have been excluded from the analysis. The study seeks to assess the recent trends regarding food production, food imports and consumption. The rate of growth of demand for food has also been determined and compared with the rate of growth of supply. Supply component has been further split into net

production, imports and total availability. The food crops considered here are rice, wheat, pulses and total foodgrains. In addition to this some other food items namely meat, milk, edible oils, sugar and eggs have also been looked into.

In the case of foodgrains as well as other food products, the total availability has gone up considerably in Bangladesh in the second period compared to be first. However, the increase has been very small in terms of per capita availability. Even when one considers the entire time span, the growth of per capita availability has been very slow compared to that of aggregate availability. Thus, in a country that witnesses a purely high pressure of population expansion, total availability of food is only a cold comfort. Per capita availability languishes at low-levels and this, in turn, sets in motion many other problems connected with food and nutritional deficiencies.

Moreover, for most of the commodities, imports, have been an important source of aggregate availability. Despite considerable year to year fluctuations, imports have shown a rising trend over the period, particularly edible oils and sugar. However, for rice there has been a continuous decline in its imports, thereby implying that Bangladesh has been moving in a sustained way towards rice self-sufficincy.

The rate of growth of demand for rice betwen 1973-90 was 2.99 per cent against a growth rate of 3.2 per cent in net production over the same period. Imports for rice declined by 1.7 per cent per annum. For a country characterised by chronic food deficit, this is a remarkable achievement. Even though the cuntry will continue to import wheat through the 1990s (wheat imports grew at 1.3 per cent per annum between 1973-90) the gap between foodgrain requriements of the population and foodgrain production is narrowing. This seems to be the result of the growth of production coupled with declining growth of population.

It may be said that given Bangladesh's declining land resource base, it will be difficult to achieve food self-sufficiency through the production of rice and wheat alone. The one -track focus on rice and wheat, to the exclusion of other food crops is unlikely to produce the desired effects. Agricultural production must diversify and further intensify into crops like maize, pulses, potato, coarse cereals, oils, vegetables and fruits. This, in addition, to meeting the food requirements of the people would help improve the nutritional status of the people, improve soil health and productivity. The long run social gains must receive accelerated policy attention, especially because, food situation elsewhere in the world does not promise a comfortable future.

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