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DEVELOPMENT PROGRESS AND REGIONAL VARIATIONS IN BANGLADESH AGRICULTURE

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Abstract

The purpose of this study is to evaluate the progress and regional variations in agricultural development. The secondary data were used and collected for the years 1980-81 to 2002-03 from the `Statistical Yearbooks of Bangladesh', `Yearbook of Agricultural Statistics' and census of different years. The study was conducted during the period from September 2006 to February 2008. Methodological framework of ranking, indexing, principal component analysis and composite index of development were formulated. An empirical analysis was done for twelve mutually exclusive agro-ecological zones by assigning various indicators of agricultural development. Level of development of these zones was classified according to low, medium and high developed regions using hierarchical positions of the regions. The remarkable progress of rural literacy rate, ratio of agricultural workers to population, number of farmer's co-operative societies and per capita regional domestic agricultural products in two decades was observed in different regions. Wide disparities in the level of agricultural development had been observed across the regions. The hierarchical position of the regions reveals that `Old Himalayan Piedmont Plain and Tista Floodplain', 'Karatoya Floodplain and Atrai Basin', 'Brahmaputra- Jamuna Floodplain', `Middle Meghna River Floodplain' and 'Chittaging Coastal Plain and St. Martin's Coral Island' were the high developed regions in Bangladesh. For minimizing disparities among the agro-ecological zones and to promote balanced agricultural development, the resources should be distributed on the basis of equity. efficiency, productivity and sustainability.

I. INTRODUCTION

Agriculture occupies an important place in the economic life of Bangladesh because it provides the key to economic growth. With 76.57 percent of the total population in rural areas spread over 87928 villages in Bangladesh maybe described as village economy (BBS. 2001). The total cultivable area is around 9.7 million hectares and there are a little more than 14.5 million cultivators. Major agricultural products are rice, jute, wheat, potato, pulses, sugarcane, tea,tobacco etc. Tea, leather and frozen shrimp are also major foreign exchange earners. Agriculture, to a large degree based on subsistence farming, is still with 16.98% share in the GDP and around 63% of the total labour force (BBS, 2005). About 84 percent of the total population live in rural areas and are directly or indirectly engaged in a wide range of agricultural activities. Thus, the economy of Bangladesh is primarily an agriculture-based rural economy and its development heavily lies on the development of agriculture. As such, a very high priority has been accorded to the programmes of agricultural Development with a view to accelerating the tempo of economic development in the country.

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The overall agricultural development in Bangladesh conceals considerable regional differences because of farming practices, techniques, availability of irrigation facilities, attitude of the farmer etc. in different parts of the country. The differences in agricultural productivity among the regions to some natural phenomena, such as, rainfall, temperature, humidity and some other agro-ecological features which are relatively less favourable in the lagging regions. It is not only the natural phenomenon but also government policies in the past relating to agricultural extension, input distribution, institutional credit facilities, agricultural co-operatives, and some basic/institutional inefficiency are the causes of backwardness in productivity in the lagging regions. Productivity differences also may due to the government policies in allocating subsidized inputs such as chemical fertilizers, irrigated water, high yielding varieties of seeds, pesticides etc. The agricultural extension facilities of a productive region may cause to deprive the lagging regions to some extent.

Regional disparities in agricultural development show that there is scope to boost up the pace of agricultural development and thereby that of economic development in the country with area specific agricultural development programmes and policies. The poor economy of the country cannot afford to contend with low rate of agricultural yields in view of heavy pressure of population on agriculture. There is obviously high degree of inequality in the distribution of land and small and marginal holdings constitute most of the operated area. Net cultivated area per farm household was decreased from 1.23 ha in 1977 to 0.61 ha in 1996 (BBS, 1996). Agriculture and allied activities have registered a slow growth rate and acted as a limiting factor to the growth of other sectors. The annual rate of increase of total cereal production between 1990-91 and 1998-99 was only 1.43 percent (Quddus *et al.* 2004).

A number of studies had done using several techniques to measure the regional disparities based on agricultural development abroad. Minhas and Vaidyanathan (1965) used additive decomposition model to conduct several studies and Nath (1970) developed an index of economic development and comparison of ranks in agricultural productivity increases. Nowshirvani (1970) used analysis of covariance approach, Easter *et al.* (1977) used the technique of error component model, and Rajan and Prakash (1979) used coefficient of concentration analysis of variance and Sharma (2003) examined emerging trend of regional disparities using coefficient of variation. Iyengar, *et al.* (1981) made use of composite dynamic index of development and Dadibhavi (1982) made use of the principal component analysis to analyse inter-taluka disparity.

The studies in Bangladesh (Thomas, 1980; Huq, 1983; Jabber, 1977 and Hossain, 1977) gave some light on regional variations in agriculture, but none of them undertook detailed study to this vital issue. Most of their claims were not supported by detailed empirical and quantitative evidence. A detail study was by Hossain (1987) only for productivity differences in major regions of the country. Very recent, Sarker and Islam (1999) studied regional differences of agriculture development but they considered indicators not covered all possible means of development. While the above brief overview of theories concerning regional development is not exhaustive, it does not provide sufficient guidelines for the formulation of government policy.

Considering the coverage of the study and the depth of analysis made, the present study may deserve importance. It would be of interest to measure the level of agricultural development in agricultural sector at regional level and this knowledge can serve as a useful preliminary guide to measure economic development. The relative level of development in agricultural sector of a region will help to identify appropriate strategies of development. The issue of widening regional disparities is a growing concern for balanced development across the major agro-ecological regions in Bangladesh as a development strategy. Balanced development of agriculture is crucial for reducing inter-regional disparities. Thus, a detailed study was undertaken i) to know the development progress in agricultural workers and agricultural economy in different regions; ii) to determine the level of disparities in agricultural development across the regions; and iii) to classify the regions according to their extent of agricultural development.

II. METHODOLOGY

Sources of Data

Time series data of different crops, area irrigated, fertilizer used etc. were gathered mainly by district and then aggregated them according to the twelve combined agro-ecological regions. Secondary data were collected from different published sources. The main sources were the Statistical Yearbook of Bangladesh of different years, Yearbook of Agricultural Statistics of Bangladesh of different years, Population Census, 1981 and 2001, Agricultural Sample Survey of Bangladesh - 2005, Data Base of ministry of Agriculture (MOA), 2005.

Selection of Regions

Agricultural productivity as well as agricultural development varies in different regions of the country. Different regions of a country varied according to agricultural attributes, which is determined by agro-ecological conditions of attributes like land type, fertility condition, river basin, irrigation facilities, etc. The regional disparities were analysed by considering a stable r4gional base of homogeneous agro-ecological zones. Such zonations scheme would provide a base to explain the effects of agro-ecological conditions as well as agricultural development. Agricultural, especially, district wise crop data are available. Bangladesh consisted 30 agro-ecological zones (AEZ) those are overlapping with each other. For convenient of the study, two to three AEZs were combined for a region. A total number of 12 mutually exclusive regions have been considered for the study. Their characteristics have followed the characteristics of the AEZs. Each region was the aggregate of a number of administrative districts.

Each of the regions is not equally endowed by the nature with their geographical areas. The regions `Old Himalayan Piedmont Plain and Tista Floodplain' (HPTE) and 'Brahmaputra Jamuna Floodplain' (BM have some similarities among land type, soil type and fertility conditions and they comprise together 22.4 percent of the country's geographical area. Land type, and soil type were different in the regions `Ganges Tidal Floodplain' (GTF). Area, population density and literacy rate were also varied in different regions. The names of the regions and included districts are as follows:

Names of the agro-ecological regions	Symbol	District included in the region
Old Himalayan Piedmont Plain and Tista Floodplain	HPTF	Dinajpur, Panchagar, Thakurgaon, Rangpur, Gaibandah, Nilphamari, Kurigram,Lalmonirhat
Karatoya Floodplain And Atrai Basin	KFAB	Rajshahi, Nawabgonj, Naogaon, Natore, Bogra, Joypurhat
Brahmaputra- Jamuna Floodplain	BJF	Jamalpur, Sherpur,Tangail, Mymensingh, Kishoregonj, Netrakona
High Ganges River Floodplain	HGRF	Pabna Sirajgonj, Jessore, Jhenaidah, Magura, Narail, Kustia, Meherpur Chuadanga
Low Ganges River Floodplain	LGRF	Faridpur, Rajbari, Gopalgonj Madharipur, Shariatpur
Ganges Tidal Floodplain	GTF	Barisal, Bhola, Jhalkati, Pirojpur, Barguna, Patuakhali, Khulna, Bagerhat, Satkhira
Sylhet Basin and Surma-Kusiyara Floodplain	SBSKF	Sylhet, Sunamgonj, Moulavi Bazar, Habigonj
Middle Meghna River Floodplain	MMRF	Comilla, Chandpur, Brahmanbaria
Lower Meghna River and Estuarine Floodplain	LMREF	Noakhali, Feni, Lakshmipur
Chittagong Coastal Plain and St. Martin's Coral Island	CCPSI	Chittagong, Cox's Bazar
Eastern Hills	EH	Bandarban, Rangamati, Khagrachhari
Greater Dhaka	DHAKA	Dhaka, Gazipur, Manikgonj, Munshigonj, Narayangonj, Narshingdi

Selection of Development Indicators

A group of twelve indicators relating to development of agriculture have been selected to examine the regional variations in agricultural development based on crop sector among the twelve major regions of Bangladesh. All the indicators relate to adoption of modern technology and the government played an active role in promoting this technology. Irrigation, fertilizer consumption and high yield variety seeds are the vital input in agricultural production, facilitate the use of other modern inputs and improves cropping intensity. Food-grains productivity and number of agriculture workers also represent the direct developmental indicators. Per capita domestic products from agriculture, rural literacy rate, number of cooperative society are also the indirect development indicators of agricultural development and they are termed as socioeconomic indicators of the development. Following indicators together would significantly development in the agricultural sector as a whole.

'Rural literacy rate' in percent of total population (RLR),

'Per capita regional domestic agricultural products' in million taka (PRDAP),

'Share of regional domestic agricultural products' in percent (SRDAP),

'Farmer's cooperative society' number/100 sq. km. (FCOS),

'Percentage of net cropped area to total geographic area' (NCAGA),

'Cropping intensity' in percent (CI),
'Area under HYVs as a percentage of total cropped area' (AHYGCA),
'Area irrigated to total cropped area' in percent (AIGCA),
'Consumption of chemical fertilizer' in kg/ha (FCKH),
'Food-grain productivity' in metric ton/ 100 ha (FPMT),
'Agriculture workers' in number/ 100 ha of GCA (AWHH),
'Net cultivated area per 100 agriculture workers' in ha (NCAAW)

Analytical Techniques

In order to calculate the value of most of the indicators two points of time, the early 1980s (three years average of 1980-81, 1981-82 and 1982-83) and the early 2000s (three years average of 2000-01, 2001-02 and 2002-03) were taken. But three years data were not available for a few indicators and hence only the data of base year was used for that particular indicator. The choice of indicators inevitably depends upon the purpose and the availability of data. Having chosen a large number of indicators, the problem arises as how to combine the multiple indicators having different types of scales (or unit of measurement) so as to give a common index of development, which would reflect the true picture of development in the economy. The computed values of indicators according to regions are presented in Appendix Table 1 for early 1980s and in Appendix Table 2 for early 2000s. The most commonly used techniques for aggregating development indicators are ranking, indexing, principal component analysis and composite agricultural development indicator.

Ranking method:

Regions were arranged in descending order of magnitude of each indicator and were assigned ranks from the highest value. That is, the region having the highest value obtained the first rank. The ranks for all indicators were aggregated to arrive at the total rank. Kendall (1939) was one of the earliest users of ranking method adopted the average mean of the ranks of indicators as the ranking coefficient in this exercise 'rank total' has been considered as indicator of development. The lowest value of the 'rank total' indicates the highest level of development. The rank pertaining to the ith region for the jth variables can be written as R_{ij} and the final index of development of ith region was calculated simply as follows:

$$I_i = R_{i1} + R_{i2} + \dots\dots\dots + R_{im} = \sum_{j}^{m} R_{ij} \quad (1)$$

Where m is the number of development indicators

Indexing method:

In this method the indicators of different scales are made scale free by dividing the values of the indicators either by their average or by some pre-determined values. The scale free values for each unit or region are added to arrive at an ultimate index. Sometimes, indicators may also be converted into percentage form or to a common base of 100, so thet they can be combined. This type of indexing was utilized by the Chakravarty Committe (1981) as a second alternative method. In the present study, the value of each indicator was expressed as a percentage of the national average value. The indices of the indicators were aggregated and the corresponding average for each region was calculated and considered as the index of development of each region. The region having a higher index value reveals a higher level of development.

Principal component analysis:

The most common approach for construction of indices is to work out the first principal components that would explain an adequate percentage of total variation. The first principal component score for the ith region can be defined as

$$S_{1i} = C_{11}X_{i1} + C_{12}X_{i2} + \dots\dots\dots\dots + C_{1p}X_{ip} \qquad (2)$$

Where, $C_{11}, C_{12}, \dots$ are the component loadings
$X_{i1}, X_{i2}, \dots$ are the elements of p-component vector.

If X_{ij} denotes the value of the jth indicator for ith region, the scaled variable y_{ij} may be defined as $y_{ij} = x_{ij} / \bar{x}_j$, where $\bar{x}_j$ denotes the mean of the jth indicator. Let l_{kj} denotes the kth component loading vector for jth indicator, then the score for ith unit is calculated as (Bhuyan, 2005).

$$S_{ki} = \sum_{j=1}^{m} l_{kj} y_{ij} \qquad (3)$$

Where m is the number of indicators.

If the first component fails to explain more than 50 percent of total variation, the second component would be included for calculation of component scores. As the second component explains a significant proportion of total variation, it represents another dimension of development that is needed to capture while computing the development index. Therefore, a weighted average of the first two components, wherein the proportion of variance explained, was used as weights were employed. Thus, the index of development (or score) was calculated with the help of the first component loading using both the first and second component sets of loadings. The combined component scores (CCS) were calculated as follows:
The score for the ith unit is

$$CCS_i = W_1 S_{1i} + W_2 S_{2i} \qquad (4)$$

Where $W_1 = V_1/(V_1+V_2)$ is the proportion of variance explained by the first component with the variance value V_1 and
$W_2 = V_2/(V_1+V_2)$ is the proportion of variance explained by the second component with a variance value V_2.
S_{1i} and S_{2i} are the first and second component scores, respectively for the ith unit or region.
The CCS is considered as a composite index of development and it has less explanatory power than the first component.

Composite agricultural development indicators (CADI)

Weights are taken as inversely proportional to the variation in the respective indicators of development so that the large variation in an indicator does not unduly dominate the contributing of the indicators. The results by using the composite index of development (CDI) developed by Iyengar and Sudarshan (1982) gave the far different results compared to the ranking, indexing and PCA methods. Thus, more precise results were obtained by weighting the values of indicators in place of scaled values. From the matrix of values of indicators, Y = (I_{ir}), we may construct a measure for the level of development for different regions as follows:

$$y_r = w_1 I_{1r} + w_2 I_{2r} + ... + w_m I_{mr} = \sum_{ir}^{mn} w_i I_{ir} \qquad (5)$$

Where, I_{ir} = value of the ith indicator in the rth region;
i = 1, 2, 3, ..., m is the the indicators of agricultural development;
r = 1, 2, 3, ..., n is the regions of the country;

w's ($0<w_i<1$ and $w_1 + w_2 + w_3 + ... + w_m = 1$) are arbitrary weights reflecting the relative importance of the individual indicators.

More rational view would be to assume that the weights vary inversely as the variation in the respective indicators of the agricultural development. More specifically, it assumes:

$$w_i = \frac{k}{\sqrt{Var(y_i)}} \qquad (6)$$

Where,

$$k = \left[\Sigma \frac{i}{\sqrt{Var(y_i)}} \right]^{-1} \qquad (7)$$

If y_1, y_2, ... y_n are independent, then the overall regional index, y_r and its variance as follows:

$$Var(y_r) = \Sigma w_i^2 \, Var(y_i) \qquad (8)$$

Distance analysis:

After getting the 'rank total', 'index' and 'component score' by three different methods of ranking, indexing and PCA, regions have been arranged in the hierarchical order of development and classified into 'high', 'medium', and 'low' levels of development. For each of the levels four regions were decided, as there were twelve regions that were classified into three levels.

An ambiguous State is assigned to a cluster 'i' if its Euclidean distance (calculated based on scores or indices) is near to centre of cluster i than any other cluster 'j' i.e. if

$$d_i^2 < d_j^2 \qquad (9)$$

Where $d_i^2 = \sum_{k=1}^{p} (S_{ik} - x_k)^2$, S_{ik} is the average scores of ith cluster, x_k is the score/index vector of the region and 'p' is the number of methods considered (here, p = 3). Some departure from the procedure of Mitra *et al.* (1981) has been made by not recalculating the centroid of the cluster after every allocation. In most of the cases (except in social infrastructure group), only a few regions had to be classified into a priori groups based on three methods. Averages of the scores / ranks/ index for unambiguously classified regions for each category of 'high', 'medium' and 'low' groups were calculated at first and considered as central values. The derived 'rank total' of ranking method, 'average index (in percentage form)' of indexing method and 'composite scores' of PCA method have been considered as three variables for calculating Euclidean distances. Thus, for every unclassified State, d_i^2 has been calculated from the central values of 'high', 'medium' and 'low' groups and denoted by d_h^2, d_m^2 and d_l^2, respectively. If $d_h^2 < d_m^2 < d_l^2$, then the region has been classified as 'high' level of development.

III. RESULTS AND DISCUSSION

Inter Regional Variations in Population Characteristics and Economic Progress

There are some populations' characteristics that might have played a vital role in the regional variations in the agricultural development. Population density and literacy rates are the important ones and both of them increased significantly in the period of last two decades. Table 1 reveals that the density of population was highest in Dhaka and the second highest in 'Middle Meghna River Floodplain'. The density of population was lowest in Chittagong Hill Tracts followed by Sylhet basin and coastal regions because they were lagging regions. As for literacy rate the region 'Brahmaputra-Jamuna Floodplain' was the most lagging region during both the period 1980-81 and 2000-01. The coastal and the hill tracts regions occupied the top ranks, especially, in 1980-81 but literacy rate could not help in agricultural development very much because of lagging region. Rural literacy rate also is an indicator of agricultural development and it increased significantly in the period of last two decades (Table 1). Coastal region was the best region as a rural literacy rate followed by the 'Lower Meghna River and Estuarine Floodplain' and 'Greater Dhaka'. The ecological constraints, those lie in these regions might be a factor for the variations in agricultural development. Rural literacy rate had increased remarkably in 2000-01 compared with 1980-81 for all the regions. The highest increment (23.6% in 20 years) in 'Greater Dhaka' because of capital city is situated in this region and hence there had enough scope of rural education. The lowest increment (15.2% in 20 years) was observed in 'Chittagong Hill Tracts' because of very lagging region. Further social value and education might be less emphasized in this region compared to other regions.

Ratio of agricultural workers to population had also increased remarkably in 2004-05 compared with 1980-81 for all the regions (Table 1). This increment was much higher in North Bengal, Faridpur and Chittagong Hill Tracts because of low labour cost and more progress of agricultural development. Highly significant increase of ratio of agricultural workers in two decades interpret that rural people are more involved in agriculture production and it is an important indicators of agricultural development. 'Chittagong Coastal Plain and Martin's Coral Island' and 'Greater Dhaka' regions showed very low increment of ratio of agricultural workers to population due to vast increment of population. Number of farmer's cooperative society per 1000 square kilometer varied in different regions in both the periods. This number was increased remarkably in 'Brahmaputra- Jamuna Floodplain', 'Old Himalayan Piedmont Plain and Tista Floodplain' and 'Low Ganges River Floodplain' whereas the number decreased in 'Chittagong Coastal Plain and St. Martin's Coral Island' over the periods of last two decades. Overall increment of this number was highly significant (Table 2).

Table 1. Changes of some vital population characteristics related to agricultural development in different regions

Regions	Density of population			Literacy rate (%)			Rural literacy rate (%)			Ratio of Agricultural workers to population (%)		
	1980-81	2000-01	Change in 20 years (%)	2000-01	1980-81	Change in 20 years (%)	1980-81	2000-01	Change in 20 years (%)	1980-81	2004-05	Change in 20 years (%)
HPTF	601	844	40.4	19.2	69.8	50.6	17.3	37.2	19.9	22.4	34.5	12.1
KFAB	599	861	43.7	21.4	42.8	21.4	19.5	40.1	20.6	19.6	36.9	17.3
BJF	698	896	28.4	17.5	37.2	19.7	16.5	33.0	16.5	21.2	31.2	10.0
HGRF	660	919	39.2	20.4	43.1	22.7	17.8	40.7	22.9	18.7	29.9	11.2
LGRF	692	864	24.9	21.3	42.0	20.7	20.0	40.0	20.0	19.8	35.6	15.8
GTF	460	544	18.3	32.2	54.8	22.6	29.8	49.9	20.1	16.4	27.1	10.7
SBSKF	445	627	40.9	19.9	45.0	25.1	18.1	36.1	18.0	19.9	26.4	6.5
MMRF	1043	1371	31.4	23.7	44.1	20.4	22.2	42.6	20.4	18.8	22.3	3.5
LMREF	699	879	25.8	26.5	44.3	17.8	25.5	47.8	22.3	14.1	24.6	10.5
CCPSI	736	1068	45.1	27.9	49.4	21.5	23.6	42.1	18.5	10.6	12.2	1.6
EH	57	101	77.2	21.5	48.1	26.6	15.6	30.8	15.2	23.1	36.8	13.7
DHAKA	134	2326	73.5	31.3	56.5	25.2	21.2	44.8	23.6	11.2	12.2	1.0
Total	605	839	38.7	23.8	45.3	21.5	17.3	37.2	19.9	17.9	26.4	8.5
Value of paired t	2.231* (167.22)			9.894** (2.48)			27.551** (0.72)			6.192** (1.53)		

*indicates significant at $p < 0.05$ and ** indicates significant at $p < 0.01$
Figures in the parentheses are the values of standard error of mean

Inter regional variation in agricultural progress could also be seen from the variations in regional domestic agricultural products (RDAP) per capita. This includes variation due to agricultural productivity and land-man ratio. Per capita RDAP for the country as a whole was around Tk.1250 in the early 1980s and around Tk.3443 in the early 2000 (Table 2). It increased at the rate of 8.8 percent per annum. Among regions, per capita agricultural income was higher in the hill tracts during both the periods due to low density of population. Highly significant increase of per capita regional domestic agricultural products (PRDAP) in 20 years and remarkable increase was observed in the regions 'High Ganges River floodplain', 'Lower Meghna River and Estuarine Floodplain' and 'Low Ganges River Floodplain'. Increase of share of regional domestic agricultural products was not remarkable in most of the regions but it was decreased in some regions.

Table 2. Progress in per capita food-grains production, GDP from agriculture and farmer's co-operative societies in different regions

Regions	Farmers Co-operative Societies (No./1000 sq km)			Per capita regional domestic agricultural products (Tk)			Share of regional domestic agriculture products (%)			Per capita Food-grain production (Kg)		
	1980-81	1980-81	Change in 20 years (%)	1980-81	2004-05	Per year change (%)	1980-81	2000-01	Change in 20 years (%)	1980-81	2004-05	Per year change (%)
HPTF	279	499	78.5	1515	5019	9.3	13.5	12.7	-6.0	236	273	0.6
KFAB	419	543	29.6	1310	5105	11.6	9.6	10.9	13.5	190	310	2.5
BJF	329	716	117.6	1319	5001	11.2	13.9	14.9	7.2	221	246	0.5
HGRF	333	469	40.8	1135	4883	13.2	10.1	12.2	20.8	152	218	1.7
LGRF	275	494	79.6	1073	4421	12.5	4.7	5.0	6.4	95	171	3.2
GTF	211	348	65.0	1307	5006	11.3	13.0	13.2	1.5	170	170	.0
SBSKF	186	265	42.5	1437	4736	9.2	7.5	6.8	-9.3	226	200	-0.5
MMRF	447	637	42.5	1053	4015	11.3	6.6	7.0	6.0	159	161	.0
LMREF	174	241	38.5	1147	4986	13.4	4.0	4.9	22.5	188	115	-1.5
CCPSI	228	202	-11.4	1181	3996	9.5	6.0	5.8	-3.3	151	122	-0.8
EH	06	40	*	5698	6188	0.3	3.9	1.3	-66.7	150	128	-0.6
DHAKA	446	611	37.0	779	1804	5.3	7.2	5.3	-26.4	79	67	-0.6
Value of paired t	4.696** (30.73)			9.418** (320.35)			00 (0.39)			0.881 (15.51)		

In spite of having poor agricultural base and inadequate infrastructure there has been remarkable progress in production. The progress of per capita food-grains production in some of the regions ('Karatoya Floodplain and Atrai Basin', 'High Ganges River Floodplain' and 'Low Ganges River Floodplain') was a considerable extent because of low increase of population and use of high yielding inputs (Table 2). Some of the regions showed negative increment of per capita food-grains production mainly due to increase of vast population. For example, 'Lower Meghna River and Estuarine Floodplain' region shows very low per capita food-grains production in 2004-05. This is because population was 3.82 million in 1980-81 and it had increased to 5.84 million in 2004-05 and the net cropped area reduced to 257 thousand hectare in place of 345 thousand hectare. The region 'Chittagong Coastal Plain and St. Martin's Coral Island' and 'Greater Dhaka' also showed negative results most probably due to increase of their vast city population. The lower value of paired t-statistic (0.881) indicates that increment of per capita regional food-grains production was not significant.

Regional Disparities Based on Agricultural Indicators

A perusal of data on most of the indicators reflects a tremendous improvement in the use of modern agricultural inputs and other indicators over the past two decades. Average percentage of net cropped area to total geographic area decreased from 60.75 in 1980-83 to 56.14 in 2000-03, while the average cropping intensity increased from 152.33 percent in 1980-83 to 178 percent in 2000-03 (Table 3). Average area under high yield variety as a percentage of total cropped area increased from 26.7 percent to 52.6 percent i.e. doubled in 20 years, while average percentage of area irrigated to total cropped area increased from 18 percent to 29 percent i.e. 1.6 times over two decades. Average number of workers per thousand hectare of total cropped area increased from 1239 in 1980-83 to 3229 in 2000-03. The disparity among the regions (as measured by CV) was pronounced in respect of most of the indicators except 'cropping intensity', 'agricultural workers' and 'net cultivated area per workers' during both the periods. The values of CV of the indicators 'area under HYVs as a percentage of total cropped area', 'area irrigated to total cropped area', 'food-grain productivity' and 'per capita regional domestic products from agriculture' reduced sharply during the study period (Table 3). In general, the disparity got declined in case of most of the indicators over the two decades.

Table 3. Disparities in agricultural development indicators during two decades

	1980-83			2000-03		
Indicators	Mean	S.D.	C.V.	Mean	S.D.	C.V.
RLR	20.59	4.14	20.11	40.43	5.62	13.90
SRDAP	8.33	3.65	43.82	8.33	4.25	51.02
PRDAP	15.79	13.15	83.28	45.97	10.48	22.80
FCOS	27.78	12.88	46.36	42.21	20.30	48.09
NCAGA	60.77	20.55	33.82	56.14	18.81	33.51
CI	152.33	14.71	9.66	178.00	15.80	8.88
AHYGCA	26.69	14.61	54.74	52.55	18.36	34.94
AIGCA	18.05	10.68	59.17	28.89	11.82	40.91
FPMT	109.33	53.53	48.96	170.69	65.70	38.50
AWHH	12.40	2.12	17.10	32.29	5.17	16.00
NCAAW	54.42	8.54	15.69	20.99	3.48	16.58
CFKH	194.03	140.70	72.51	-	-	-

Rank total, index of development, principal component scores and composite agricultural development indices of twelve regions in agricultural development according to four methods are presented in Table 4. The hierarchical positions of the regions in agricultural development are also presented in Table 5. In the ranking method, 'Middle Meghna River Floodplain' with a total rank of 58 in 1980-83 and that of 47 in 2000-03 shared first position in both the periods. 'Brahmaputra–Jamuna Floodplain' was on the second top position in 1980-83 and on the third position in 2000-03. 'Karatoya Floodplain and Atrai Basin' was on the fourth position in 1980-83 and improved in second top position in 2000-03 (Table 4). Out of 12 regions, 5 regions i.e. north and south-west regions of the country improved in 2000-03 in the ranking method. Other regions except 'Middle Meghna River Floodplain' fall on the lower position in 2000-03. Inter-regional disparity in overall agricultural development was reflected by CV for rank total.

In the indexing method, 'Chittagong Coastal Plain and St. Martin's Coral Island' were on the top and 'Brahmaputra–Jamuna Floodplain' was on the second top positions in 1980-83 and the later one remained on the same position but first one fall in the eighth position in 2000-03. 'Karatoya Floodplain and Atrai Basin' was on the fifth position in 1980-83 and improved in first position in 2000-03 (Table 5). Like 'Brahmaputra–Jamuna Floodplain', 'Middle Meghna River Floodplain' remained on third position and 'Greater Dhaka' on the sixth position in both the periods. All the regions of north and south-west region of the country also improved in 2000-03 compared to 1980-83 in the indexing method. `Eastern Hills' were on the last position for both the methods. The values of CV showed that inter regional disparity in overall agricultural development was not reflected by it for average index because the values of CV were not remarkably different in the two time points.

In the method of `principal component analysis', the first principal component alone explained about 43 percent in 1980-83 and 36.4 percent in 2000-03 of the total variation i.e. the first principal component failed to explain more than 50 percent of the total variance. Thus, the values of first and second principal components were computed and they are presented in Appendix Table 3 including the proportion of variation explained by them. As the first two components taken together explained about 62 and 61 percent of total variance, it was decided to develop combined component scores (CCS) based on first two components scores. Weights were assigned to each set of component scores in proportion to the variance explained by it and the negative sign of loading were ignored in the combination of the first components according to Chatfield and Collins (1980). The combined components scores are presented in Table 4.

Combined component scores of the 12 regions did not much fluctuate in both the periods and also not much difference was observed between two periods due to combination of two component scores. `Middle Meghna River Floodplain' was on the top in terms of agricultural development having an average score of 49.55 in 1980-83 and 'Chittagong Coastal Plain and St. Martin's Coral Island' was on the top ((46.74) in 2000-03. 'Karatoya Floodplain and Atrai Basin' was on the second position (33.20) in 1980-83 and the `Middle Meghna River Floodplain' was on this position in 2000-03, whereas `Old Himalayan Piedmont Plain and Tista Floodplain' was on the third position in both the periods. `Eastern Hills' region continued to be at the bottom of agricultural development and `Greater Dhaka' region on the eighth position in both the periods. `High Ganges River Floodplain', 'Sylhet Basin and Surma-Kusiyara Floodplain' and 'Chittagong Coastal Plain and St. Martin's Coral Island' were remarkably improved in 2000-03 compared to 1980-83.

Any index of development based on multivariate data has its own limitations. A major limitation arises from the assumptions made about the indicators themselves and their weights in the aggregate index. It might be believed that any inter-regional comparison of levels of development would be more efficient when the variability in the composite index is stabilized. Therefore, the study adopts the weighting method for constructing the composite agricultural development index (CADI). The weights of agricultural development indicators at different time periods are shown in Appendix Table 3. The weights are more or less uniform at both the time periods and their values changed according to the variability of the original values of indicators in that period. It reveals that the highest weight was 0.241 in 1980-83 and second highest weight was in 2000-03 for the share of regional domestic agricultural products. The second top weight was 0.212 in 1980-03 and third top weight was 0.157 in 2000-03 for rural literacy rate. The indicator food-grains productivity got lowest weight in both the period and consumption use of fertilizer got also least weight in 1980-03. However, the weights of eight indicators out of twelve were decreased marginally over the time period (Appendix Table 3).

Table 4. Rank total, index of development, principal component scores and composite agricultural development indices of twelve regions in agricultural development over two decades

Region	Rank Total		Index of Development		P C Scores		CADI	
	1980-83	2000-03	1980-83	2000-03	1980-83	2000-03	1980-83	2000-03
HPTF	79	62	93.25	109.21	28.72	38.33	35.89	46.77
KFAB	71	57	105.82	116.03	33.20	32.62	36.19	47.50
BJF	61	59	112.65	114.46	25.20	24.10	37.80	46.73
HGRF	82	64	97.48	108.41	10.72	18.01	35.11	46.00
LGRF	99	88	73.70	88.86	15.85	13.11	32.91	41.86
GTF	89	71	91.36	98.47	14.19	13.77	36.77	45.19
SBSKF	87	82	86.06	95.82	10.78	25.59	34.59	42.75
MMRF	58	47	110.97	112.26	49.55	39.21	39.81	48.48
LMREF	81	78	100.16	89.84	15.66	10.49	37.86	43.59
CCPSI	65	75	116.38	97.02	10.58	46.74	39.77	44.33
EH	89	107	110.66	67.55	10.57	9.07	36.02	33.75
DHAKA	76	70	101.52	102.06	11.46	15.76	37.62	44.50
Mean	78	71.7	100.00	100.00	19.71	23.90	36.70	44.29
S.D.	12.48	15.99	12.47	13.77	12.21	12.66	2.09	3.86
C.V.	16.00	22.30	12.47	13.77	61.65	52.97	5.70	8.71

Table 5. Hierarchical positions of regions according to four methods in agricultural development over two decades

Region	1980-83				2000-03			
	Rank	Index	PCA	CADI	Rank	Index	PCA	CADI
HPTF	6	9	3	9	4	4	3	3
KFAB	4	5	2	7	2	1	4	2
BJF	2	2	4	4	3	2	6	4
HGRF	8	8	10	10	5	5	7	5
LGRF	12	12	5	12	11	11	10	11
GTF	11	10	7	6	7	7	9	6
SBSKF	9	11	9	11	10	9	5	10
MMRF	1	3	1	1	1	3	2	1
LMREF	7	7	6	3	9	10	11	9
CCPSI	3	1	11	2	8	8	1	8
EH	11	4	12	8	12	12	12	12
DHAKA	5	6	8	5	6	6	8	7

The CADIs of all the regions showed an increasing trend with the exception of 'Eastern Hills' where the index showed the decreasing trend. The CADIs of 'Middle Meghna River Floodplain' was the highest which is 39.81 and 48.48 in 1980-83 and 2000-03 respectively. The second highest CADIs were in 'Chittagong Coastal Plain and St. Martin's Coral Island' in

1980-83 and in Karatoya Floodplain and Atrai Basin' in 2000-03. The lowest CADIs were ''Low Ganges River Floodplain' in 1980-83 is 32.91 whereas ''Easter Hills' was the lowest in 2000-03 is 33.75. The CADIs showed small variation across the regions compared to other three methods but this variation did not decrease in 2000-03. It clearly indicates that the disparities level of agricultural development across the regions is quite high. The relative change of CADIs during 2000-03 compared to 1980-83 was the maximum in case of Karatoya Floodplain and Atrai Basin' (31.3 percent), followed by 'High Ganges River Floodplain' (31.0) and 'Old Himalayan Piedmont Plain and Tista and Floodplain' (30.3 percent). Those regions belonged to high CADI in early 1980s, the relative change of CADIs low between the two periods such as Brahmaputra-Jamuna Floodplain', Middle Meghna River Floodplain', Lower Meghna River and Estuarine Floodplain', 'Chittagong Coastal Plain and St. Martin's Coral Island' and 'Greater Dhaka'. It was evident that the regions lagging for behind have progressed better than that in other regions.

Extent of Level of Development of the Regions

It was observed from the Table 5 that there was no region, which gave equal position for all the four methods except 'Eastern Hills' in 2000-03. This is mainly because there had far differences in the technique of construction of the four methods and lack of homogeneity among the development indicators. However, 'Karatoya Floodplain and Atrai Basin' showed much improvement in 2000-03 than in 1980-83 for all the methods used. The 'High Ganges River Floodplain', Middle Meghna River Floodplain' and 'Greater Dhaka' regions had been improved for the ranking and indexing methods whereas Karatoya Floodplain and Atrai Basin', Brahmaputra-Jamuna Floodplain' and 'Chittagong Coastal Plain and St. Martin's Coral Island' regions had improved for PCA method over the period of last two decades. There had some similarities in positions for the region 'Middle Meghna River Floodplain' in 1980-83 and regions Brahmaputra-Jamuna Floodplain', 'Ganges Tidal Floodplain' and Chittagong Coastal Plain and St. Martin's Coral Island' in 2000-03.

The regions which were common to top four, middle four and bottom four of all the four methods were unambiguously identified as 'high', 'medium', and low' developed regions respectively with respect to the agricultural development. The remaining regions were the ambiguous or unclassified regions. The classified regions along with unambiguous regions are presented in Table 6 (Part A). It was observed that 'Brahmaputra-Jamuna Floodplain', and Middle Meghna River' were the highly developed regions, whereas 'Greater Dhaka' and Lower Meghna River and Estuarine Floodplain' were the medium and low developed regions respectively in 1980-83. The remaining eight regions were the the ambiguous or unclassified regions. The jOld Himalayan Piedmont Plain and Tista Floodplain', Karatoya Floodplain and Atrai Basin' and Middle Meghna River Floodplain' were the highly developed regions; 'High Ganges River Floodplain', 'Ganges Tidal Floodplain' and 'Greater Dhaka' were the medium developed regions; Low Ganges River Floodplain', Lower Meghna River and Estuarine Floodplain' and 'Eastern Hills' were the low developed regions and the remaining three regions were the ambiguous regions in 2000-03. A large number of regions in 1980-83 and only three regions in 2000-03 were unclassified (clustered) and these were classified into high, medium and low developed regions using the method of "Square of Euclidean Distance".

The number of unclassified regions was eight in 1980-83 and three in 2000-03. This indicates that the development pattern in agriculture become more distinct in the early two thousand than the early 1980s. More importantly, the levels of development identified had the same group of regions irrespective of the methods adopted. In 1980-83, on the basis of the distance criterion, 'Karatoya Floodplain and Atrai Basin' was classified as belonging to the high level of agriculturally developed region. During the same period, 'Old Himalayan Piedmont Plain and Tista Floodplain', 'High Ganges River Floodplain', 'Lower Meghna River and Estuarine Floodplain', 'Chittagong Coastal Plain and St. Martin's Coral Island' and 'Eastern Hills' were classified as medium developed region, whereas 'Low Ganges River Floodplain' and 'Ganges Tidal Floodplain' were categorized as low developed regions. In 2000-03, unclassified regions 'Brahmaputra-Jamuna Floodplain and 'Chittagong Coastal Plain and St. Martin's Coral Island' were classified as belonging to the high level and 'Sylhet Basin and Surma-Kusiyara Floodplain' as a medium level of developed regions (Table 6, Part B).

It was observed that 'Karatoya Floodplain and Atrai Basin', 'Brahmaputra-Jamuna Floodplain and 'Middle Meghna River Floodplain' continued to be members of the high category for all the time, while 'Old Himalayan Piedmont Plain and Tista Floodplain' and 'Chittagong Coastal Plain & St. Martin's Coral Island' were improved from medium category to the high category during the period of two decades. Similarly, 'High Ganges River Floodplain' and 'Greater Dhaka' continued to be members of the medium category for all the

Table 6. Identification of level of development in agricultural regions
Part A. Classification of regions based on hierarchical positions using four methods

Level of Development	1980-83	2000-03
High	BJF, MMRF	HPTF, KFAB, MMRF
Medium	DHAKA	HGRF, GTH, DHAKA
Low	SBSKM	LGRF, LMREF, EH
Unclassified regions	HPTF, KFAB, HGRF, LGRF, GTF, LMREF, CCPSI, EH	BJF, SBSKF, CCPSI

Part B. Classification of regions based on distance analysis

Year	Ambiguous Regions	d_h^2	d_m^2	d_l^2	Ultimate level of Development
1980-83	HPTF	806.60	374.97	475.39	Medium
	KFAB	192.65	516.34	700.78	High
	HGRF	1437.32	58.89	157.51	Medium
	LGRF	3513.23	1308.73	363.18	Low
	GTF	1828.65	279.14	49.56	Low
	LMREF	1068.51	44.42	272.54	Medium
	CCPSI	770.65	348.66	1435.24	Medium
	EH	1544.94	262.29	616.09	Medium
2000-03	BJF	177.36	294.19	2295.96	High
	SBSKF	1136.72	339.16	495.00	Medium
	CCPSI	373.10	1053.64	1785.58	High

time, while 'Lower Meghna River and Estuarine Floodplain' and 'Eastern Hills' were disproved from medium category to the low category in 2000-03. But, 'Ganges Tidal

Floodplain and 'Sylhet Basin and Surma-Kusiyara Floodplain' were improved from low category to the medium category, while 'Low Ganges River Floodplain' continued to be low category for both the time. But no low developed region was improved from 1980-83 to high developed region in 2000-03.

The high developed regions in 2000-03 consist of five agro-ecological zones covering 7 greater districts (Table 7). These regions have fertile soil, comparatively high land, large proportion of irrigated lands, high rural literacy rate and intensive use of modern inputs. The low developed regions in 200-03 consist of 3 greater districts, namely, Faridpur, Noakhali and Chittagong Hill Tracts. The land of first two regions are medium fertile but they are in a backward region of development mainly because they are heavily flood-prone and poor use of modern inputs, especially, low proportion of HYVs and irrigation. The region 'Eastern Hills' is characterized by little irrigation, large proportion of fallow lands, largely single crops land and little employment of modern agricultural inputs. The regions, those were improved from medium developed to high developed and from low developed to medium developed were given more emphasis on land utilization pattern, increase of acreage for high yield variety and use of modern inputs over the two decades.

Table 7. Final selection of agricultural development regions at two time periods

Extent of Development	Time points	
	1980-83	2000-03
High developed regions	Karatoya Floodplain and Atrai Basin Brahmaputra-Jamuna Floodplain Middle Meghna River Floodplain	Old Himalayan Piedmont Plain and Tista Floodplain Karatoya Floodplain and Atrai Basin Brahmaputra-Jamuna Floodplain Middle Meghna River Floodplain Chittagong Coastal Plain and St. Martin's Coral Island
Medium developed regions	Old Himalayan Piedmont Plain and Tista Floodplain High Ganges River Floodplain Lower Meghna River and Estuarine Floodplain Chittagong Coastal Plain and St. Martin's Coral Island Eastern Hills Greater Dhaka	High Ganges River Floodplain Ganges Tidal Floodplain Sylhet Basin and Surma-Kusiyara Floodplain Greater Dhaka
Low developed regions	Low Ganges River Floodplain Ganges Tidal Floodplain Sylhet Basin and Surma-Kusiyara Floodplain	Low Ganges River Floodplain Lower Meghna River and Estuarine Floodplain Eastern Hills

IV. CONCLUSIONS

Agricultural development of different regions in the last 23 years was dependent on different development indicators. Yet, the overall results interpret that some of the regions were found to better positions for the maximum indicators used. The disparity among the regions was declined in case of most of the agricultural indicators over the two decades. On the basis of the methodological technique of regional disparities Karatoya Floodplain and Atrai Basin' and Middle Meghna River Floodplain' continued to be members of the high category for both the time, while 'Old Himalayan Piedmont Plain and Tista Floodplain' and lChittagong Coastal Plain and St. Martin's Coral Island' were improved from medium category to the high category during the period of two decades. Lower Meghna River and Estuarine Floodplain' and 'Eastern Hills' were disproved from medium category to the low category in 200-03, while 'Ganges Tidal Floodplain' and 'Sylhet Basin and Surma-Kusiyara Floodplain' were improved from low category to the medium category. Low Ganges River Floodplain' and continued to be low category for both the time.

Based on the findings, the following are the proposed recommendations for balancing regional disparities with further research to be undertaken: The process of agricultural development in the Low Ganges River Floodplain', Lower Meghna River and Estuarine Floodplain' and 'Eastern Hills', as the study reveals, is slow and unbalanced over the space. Thus, there is a need for taking some immediate steps to put a check in this unbalanced and lop-sided growth of the regional economy and should be given special priority to bridge-up the immense development by the proper agricultural policy. Government intervention should be directed to develop infrastructure, ensure modern inputs supply and price of the agricultural commodities in the low and medium developed regions of the country. The regions, which are less developed, require improvement of various dimensions of different indicators for enhancing their levels of development. So, a sustainable policy needs to be developed and followed to balance the inter-regional inequalities in the level of development in reference to the overall growth of agricultural sector of Bangladesh. Further study is needed to be undertaken taking such indicators that were not included in this study, especially, possible effective agricultural and infrastructural indicators. High value crops like fruits, flowers and allied activities should also be accorded on priority basis. The factors should be identified that are responsible to influence the variations of agricultural growth in different regions for the improvement in agricultural growth. The imbalances between the regions should be measured to formulate the strategies for balanced agricultural development in depressed regions.

The agricultural indicators were assumed to be linearly related; otherwise principal component analysis is not appropriate. In the analysis, no region was regarded as fixed for purpose of comparison. The determination of such standard region or norm would be statistically and conceptually very difficult. Also indicators in this exercise were not being spatially comparable since the sizes of the regions are unequal. In the list of indicators used in this research some very important and highly relevant indicators, such as fertilizer consumption, number of tractors per unit area, number of pump set per unit area, electricity consumption in agriculture, expenditure on agricultural research and education expenditure in extension work and the indicators other than the crop sectors were not included. This is mainly because of non-availability of data at the district level. The factors responsible to influence the variations of agricultural growth in different regions and the measures for imbalances between the regions were not measured due to limitations of fund and time.

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References

BBS, 1996. Agriculture Census. *The Bangladesh Census of Agriculture and Livestock*, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh.

BBS, 2001. Population Census. *The Bangladesh Census of Agriculture and Livestock*, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh.

BBS, 2005. *Statistical Yearbook of Bangladesh*, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh.

Bhuyan, K.C. 2005. Multivariate Analysis and Its Application. New Central Book Agency (P) Ltd. Kolkata, India.

Chakravarty Committee. 1981. Reports on general issues relating to backward areas development, National Committee on the Development of Backward Areas, New Delhi.

Chatfield, C. and A.J. Collins. 1980. Introduction to Multivariate Analysis, Chapman and Hall, London.

Dadibhavi, R.V. 1982. An Analysis of inter-taluka disparity and back wardness in Karnataka State 1975-76. *Indian Journal of Regional Science*. 14(2): 166-73.

Easter, K.W., M.E. Abel and G. Norton. 1997. Regional differences in agricultural productivity in selected areas in India. *American Journal of Agricultural Economics*, 59(2): 257-74.

Hossain, M. 1977. Agrarian structure and land productivity in Bangladesh. Ph.D. thesis, University of Cambridge, England.

Hossain, M.I. 1987. Regional agricultural productivity differences in Bangladesh. Ph.D. thesis, University of Dhaka. Bangladesh.

Huq, A. 1983. Inter-regional differences in output response to input use for rice production during post-Bangladesh decade. Farm Economy (Proceedings of Conference), 4: 143-155.

Iyengar, I.S. and P. Sudarshan. 1982. A method of classifying regions from multivariate data, *Economic and Political Weekly*, 17(5): 2047-2052.

Iyengar, M.B., M.B. Nanjappa and P. Sudarshan. 1981. A note on inter-district differences in the Karnataka's Development, *Journal of Income and Wealth*, 5(1): 79-83.

Jabber, M.A. 1977. Relative productive efficiency of different tenure classes in selected areas of Bangladesh. *The Bangladesh Development Studies*, 5(1): 17-50.

Kendall, M.G. 1939. The geographical distribution of crop productivity in England, *Journal of Royal Statistical Society*, A. 116: pp 1134.

Minhas, B.S. and P. Vidyanathan. 1965. Growth of crop output in India, 1951-54 to 1958-61. *Journal of the Indian Society of Agricultural Statistics*, 17(2): 230-252.

Mitra, A., S. Mukherji, R. Bose and L. Ray. 1981. Functional Classification of India's Urban Areas: By Factor-Cluster method, 1961-1971, Abhnav Publication. New Delhi.

Nath, V. 1970. Agricultural growth in the 1970s. *Economic and Political Weekly*, 5(52):A134-A144.

Nowshirvani, V. 1970. The regional and cropwise pattern of the growth of per acre output in India. *Bulletin of the Oxford Institute of Economics and Statistics*, 32(1): 59-79.

Quddus, M.A., K, Sen and M. Salimullah. 2004. Performance of crop production in Bangladesh: Growth and regional disparities. *Bangladesh Journal of Agricultural Economics*, 27(2): 57-74.

Rajan, P. and S. Prakash. 1979. Regional inequalities in rural development in Madhya Pradesh. *Indian Journal of Regional Science*, 2(1): 1-14.

Sarker, M. and M.N. Islam. 1999. Regional disparities in the agricultural development of Bangladesh, *Bangladesh J. Agricultural Economics*, 22(2): 43-56.

Sharma, B. 2003. Regional disparities in agricultural labour productivity in the Brahmaputra Valley. Department of Geography, Gauhati University, Assam, India.

Thomas, V. 1980. Regional differences in foodgrain production and distribution in Bangladesh. *The Bangladesh Development Studies,* 8(4): 94-105.

Appendix Table 1. Values of indicators, 1980-83

Regions	RLR	PRDAP	SRDAP	FCOS	NCAGA	CI	AHYGCA	AIGCA	FCKH	FPMT	AWHH	NCAAW
HPTF	17.3	13.5	15.2	27.9	73.2	139	17.6	8.8	57	109	54	177
KFAB	19.5	9.6	13.1	41.9	72.9	137	18.7	14.8	58	117	62	393
BJF	16.5	13.9	13.2	32.9	73.7	180	27.7	16.0	58	112	50	459
HGRF	17.8	10.1	11.4	33.3	77.0	147	16.4	11.2	51	109	62	339
LGRF	20.0	4.7	10.7	27.5	71.2	156	19.7	3.8	40	124	52	34
GTF	29.8	13.0	13.1	21.1	50.5	135	11.9	7.8	119	111	67	109
SBSKF	18.1	7.5	14.4	18.6	53.8	148	13.9	21.2	130	112	61	40
MMRF	22.2	6.6	10.5	44.7	78.8	171	36.7	15.6	158	130	45	231
LMREF	25.5	4.0	11.5	17.4	63.2	146	29.6	37.8	137	106	64	89
CCPSI	23.6	6.0	11.8	22.8	38.2	158	63.6	28.7	197	130	49	222
EH	15.6	3.9	57.0	0.6	8.3	136	40.3	34.7	159	178	41	63
DHAKA	21.2	7.2	7.8	44.6	68.4	145	24.2	16.2	148	151	46	173

Appendix Table 2. Values of indicators, 2000-03

Regions	RLR	PRDAP	SRDAP	FCOS	NCAGA	CI	AHYGCA	AIGCA	FCKH	FPMT	AWHH	NCAAW
HPTF	37.2	12.7	50.2	49.9	68.1	190	67.5	38.9	101	254	21.1	37.2
KFAB	40.1	10.9	51.1	54.3	72.3	169	85.8	49.1	108	276	21.2	40.1
BJF	33.0	14.9	50.0	71.6	68.6	187	62.1	36.2	101	287	21.3	33.0
HGRF	40.7	12.2	48.8	46.9	63.8	198	59.6	39.5	110	319	18.9	40.7
LGRF	40.0	5.0	44.2	49.4	65.0	182	28.3	23.0	82	369	19.2	40.0
GTF	49.9	13.2	50.1	34.8	61.1	180	26.3	10.6	172	300	25.1	49.9
SBSKF	36.1	6.8	47.4	26.5	53.7	145	41.4	28.8	213	319	29.0	36.1
MMRF	42.6	7.0	40.2	63.7	72.9	190	60.5	29.8	230	367	21.8	42.6
LMREF	47.8	4.9	49.9	24.1	51.3	188	41.2	13.5	203	331	21.4	47.8
CCPSI	42.1	5.8	40.0	20.2	35.3	180	72.3	27.7	256	373	20.1	42.1
EH	30.8	1.3	61.9	4.0	6.9	152	37.1	14.3	228	259	15.9	30.8
DHAKA	44.8	5.3	18.0	61.1	54.7	175	48.5	35.3	244	422	16.9	44.8

Appendix Table 3. Principal Component loadings for agricultural development indicators and weights of indicators for CADI method

Development Indicators	Principal Component loadings				Weights of indicators for CADI method	
	1980-83		2000-03			
	Principal Components		Principal Components			
	First	Second	First	Second	1980-83	2000-03
RLR	.038	-.617	.065	.674	0.212	0.157
SRDAP	.702	.067	.808	-.296	0.241	0.208
PRDAP	-.767	.093	-.167	-.902	0.067	0.084
FCOS	.695	.389	.866	.273	0.068	0.044
NCAGA	.901	.164	.891	.172	0.043	0.047
CI	.360	.698	.623	.302	0.060	0.056
AHYGCA	-.629	.442	.577	-.125	0.060	0.048
AIGCA	-.760	-.042	.758	-.070	0.082	0.075
FPTH	-.732	-.031	-.680	.463	0.016	0.013
AWTH	-.786	.348	-.081	.948	0.041	0.017
NCAAW	.504	-.793	.104	-.165	0.103	0.254
CFKH	.522	.527	-	-	0.006	-
Variance explained (%)	42.999	19.048	36.399	24.650		
Extraction sum of square loadings	5.160	2.286	4.004	2.711		

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