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CHANGES IN AGRICULTURAL INTENSIFICATION IN BANGLADESH: A LONGITUDINAL AND REGIONAL ANALYSIS

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Abstract

The paper presents a longitudinal analysis of the changes in cropping intensity and adoption of modern technology in Bangladesh based on time series data and presents a spatial analysis of such changes among different regions of Bangladesh. Intensity of cropping, application of chemical fertilizer and expansion of cultivation of high yielding crop varieties have been used as parameters to measure agricultural intensification. The analytical method used in this study is the Pearson's product-moment correlation coefficient (r_s) to determine such relationship. The correlation studies reveals a positive significant relationship between population growth and agricultural intensification.

Key words: Population, Agricultural intensification, Agricultural change.

Introduction

Food production has increased in Bangladesh in the recent years although domestic food production still falls short of the requirement. The introduction of modern technology, improvement of rural infrastructure and the increasing population pressure have brought about considerable changes in cropping pattern and production practices in recent years.

During the post-independence period from 1971-72 to 1991-92, the food production increased from 112.55 lakh tons to 200.68 lakh tons i.e. 78.0 percent increase in 21 years of independence. This tremendous increase in food production after independence, has been possible due to increase in HYV food cropped area (36 percent), fertilizers used (400 percent) and application of irrigation (Sattar, 1993).

Objectives

The association between population pressure and components of agricultural intensification is the general context of this study. It is postulated here that population pressure causes demand for food crop leading to an increase in agricultural intensity which was possible through modern agricultural technology: irrigation, chemical fertilizer, HYV

seeds and pesticide. The main objective of the paper is to find an association between population pressure and agricultural change in the post liberation period (`973-1991). For 1971 and 1972 detailed accurate data is not available because of political turmoil and hence is not incorporated in detail. Towards this goal the specific objectives are to assess:

1. Cropping Intensity, both
a) Intercensal cropping intensity, and their
b) Regional and longitudinal variations.
2. Trends in adoption of Modern Agricultural Inputs and finally.
3. To correlate Intensity of Cropping of components of moder technology, namely, Irrigation, Chemical Fertilizer, Distribution of Pesticides and Improved Seed.

Methodology

The methodology adopted for this study includes collection, processing and analysis of data. Data on population and agricultural variables were collected from secondary sources. To collect relevant information, different data sources have been used. Most of the data used for the present study were derived from the published materials, such as census bulletins, agricultural census, statistical yearbook of agriculture, as well as other reports, books and journals. The study area includes all the erstwhile districts of Bangladesh. For comparison over time, data on population and agricultural variables were collected for different time periods and regionwise data were used for regional analysis.

To find out the relationship between variables, correlation analysis has been used. The extent of correlation is established by standard statistical technique, as well as by graphical representation. As the data on agricultural variables are available on the basis of old districts, population density was calculated for 1991 on the basis of greater districts.

Results and Discussion

Cropping Intensity : Cropping intensity represents the ratio between total gross cropped area and net area under crops. It indicates the extent of use of land under crops for growing more than one crop in the same land. It is an useful index of regions effort to respond to combat its mounting population pressure by making the maximum use of a parcel of land. Increased pressure on land compels the farmers to use the same land for more than one crop. As per capita cultivated area declines with the growth of population, the farming class increases the intensity of cropping in order to compensate for that decrease particularly when horizontal addition to the agricultural area is not possible (Ahmed, 1988). This is why the relationship between population pressure and cropping intensity occupies a focal position in a study of the inter-relationship between population and agricultural change. A positive correlation between population pressure and cropping intensity is fundamental to Boserup's scheme and this has been amply testified by various studies.

Intercensal Cropping Intensity : Intercensal cropping intensity depicts the trend in cropping intensity of Bangladesh through time. Intensity of cropping increased from 150.90 in 1969-70 to 171.70 in 1990-91. During 1971-72 period intensity of cropping was lowest (142.89), after that it was maintaining a regular growth. By 19977-78 once again it reached the level of 1969-70, and went on increasing till 1982-83, when it was 154.66 and then declined to 152.18 in 1984-85. From 1985-86 cropping intensity has been increasing at a faster rate. Thus the

Table 1. Changes in Cropping Intensity by Different Regions of Bangladesh. 1979/80 to 1990/91

District	79/80	80/81	81/82	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	Variation Percentage points 79/80-90/91
Bangladesh	153.43	153.71	152.86	153.96	152.18	154.40	159.44	166.75	168.19	168.42	171.70	18.27
Bogra	161.67	162.31	166.57	175.52	174.03	184.54	186.21	180.22	182.08	180.99	201.91	40.24
Ranpur	185.21	184.58	184.89	185.88	188.73	191.88	181.80	194.41	196.08	196.57	198.25	13.04
Comilla	169.43	169.88	171.73	169.70	163.86	169.49	168.64	190.42	190.46	195.12	197.79	28.36
Mymensingh	173.63	174.12	181.99	188.29	189.40	198.14	198.15	102.99	192.80	192.19	197.01	23.38
Jamalpur	169.01	172.36	172.01	172.12	175.19	169.18	196.43	194.32	196.47	195.71	196.28	27.27
Kustia	127.00	138.28	141.67	138.14	147.39	149.16	165.40	188.03	178.92	182.25	191.26	64.26
Jessore	149.83	144.47	142.69	141.34	130.97	135.15	139.52	162.94	182.08	180.99	190.27	40.44
Pabna	153.34	154.83	154.12	162.43	156.69	157.13	177.12	182.13	178.92	182.25	187.06	3.72
Dhaka	153.34	154.83	154.12	162.43	156.69	157.13	177.12	182.13	178.92	182.25	187.06	33.72
Chittagong	159.05	157.29	157.50	158.35	162.33	155.40	161.26	175.07	174.20	177.30	181.27	22.22
Faridpur	152.48	146.70	156.29	160.34	154.90	165.06	165.14	184.48	185.20	180.71	178.40	25.92
Dinajpur	145.09	151.14	143.69	139.93	138.78	136.17	135.81	161.67	165.56	169.24	172.32	27.23
Noakhali	163.15	154.93	152.18	152.36	155.24	154.87	162.06	168.78	172.15	170.49	171.74	8.59
Tangail	186.37	200.16	193.35	181.03	171.31	171.36	177.07	175.95	176.67	168.42	170.63	-15.74
Kishoregonj	171.87	171.78	172.59	163.01	164.79	161.53	156.87	163.87	175.07	166.32	161.77	-10.10
Khagrachari	136.52	134.46	140.11	124.64	122.86	126.32	136.47	128.57	128.30	129.17	152.38	15.86
Barisal	144.31	148.80	138.03	142.70	143.03	146.64	149.12	139.17	140.40	139.62	149.11	4.80
Sylhet	144.70	145.70	148.26	145.07	135.64	141.46	146.10	159.67	162.51	157.08	146.72	2.02
Rajshahi	125.56	122.48	127.21	132.06	131.08	132.27	127.73	137.86	140.23	148.36	143.08	17.52
Bandarban	-	-	-	126.19	118.37	112.50	139.35	119.12	117.65	121.43	142.86	16.67
Patuakhali	131.06	133.14	132.24	13.88	133.98	140.56	144.56	134.51	133.99	137.56	141.72	10.66
Rangamati	-	-	-	131.34	134.33	129.85	133.33	139.24	137.35	132.97	133.94	2.06
Khulna	128.38	131.30	125.94	127.38	127.24	130.99	131.15	131.05	165.56	169.24	132.37	3.99

Sources: BBS Monthly Statistical Bulletin of Bangladesh, Feb. 1983.
BBS Statistical Yearbook of Bangladesh, 1991..
BBS Bangladesh Census of Agriculture and Livestock, 1983-84, Vol II.
BBS Bangladesh Yearbook of Agricultural Statistics of Bangladesh,1992. pp. 254.

$$\text{Intensity of cropping} = \frac{\text{Total Cropped Area}}{\text{Net Cropped Area}} \times 100.$$

inputs use reveals that mechanization has already reached rural areas: more than 3,434,200 acres are under low lift pump (LLP), Shallow Tubewell (STW) and Deep Tubewell (DTW) (Table-2). This is an increase of 171.3 percent over 1972-73. Irrigation has been central to development of agriculture and intensification of crop culture in Bangladesh. Demand for other complementary inputs of modern agricultural production namely, fertilizer, pesticides, improved seeds etc. all tend to increase as irrigation development takes place. The extent to which the potential could be realized depends largely on the development of irrigation facilities. Yearwise distribution of fertilizer and irrigation (Table-2) shows clearly that increase in fertilizer distribution follows closely with the increase in irrigated area. This conforms earlier studies (Ahmed, 1988) that one percent increase in irrigation would lead to one two percent increase in fertilizer and seed demand.

Table 2. Yearwise Distribution of Fertilizer and Irrigated Area(1972-90)

Year	Fertilizer (in 000m. tons)	Irrigated Area under LLP, STW, DTW (in 000 acres)
1972-72	3890.2	1265.8
1973-74	685.9	1393.2
1974.75	279.3	1418.4
1975-76	465.1	1466.3
1976-77	538.1	1211.9
1977-78	732.2	1741.1
1978-79	695.0	2035.6
1979-80	790.6	2204.8
1980-81	879.8	2224.0
1981-82	829.2	2504.9
1982-83	966.8	3100.4
1983-84	1130.3	2740.7
1984-85	1269.2	3103.3
1985-86	1153.6	2852.7
1986-87	1324.0	3187.0
1987-88	1514.1	2629.2
1988-89	1654.8	-
1989-90	2042.8	3434.2

Hamid : A data Base on Agriculture and Foodgrains in Bangladesh, PP. 303-321.

The Correlation Analysis :

In order to find out correlation between cropping intensity and population density and agricultural variables, an analysis based on Pearson's product-moment correlation co-efficient (r_s) was done. Results of correlation analysis are presented in Table 3.

Population Density and Cropping Intensity: The present study examines that growing population

pressure provides a stimulus for technological change in agriculture which increases cropping intensity. Thus not only an increase in population pressure causes an increase in agricultural intensity but also the latter is interrelated with other agricultural variables like irrigation, chemical fertilizer and pesticide. The cropping intensity when is compared with the population density shows that high population density areas are also high cropping intensity areas. The first 10 districts of cropping intensity contain the first 8 districts of population density. The high population density districts are Dhaka, Comilla, Chittagong, Jamalpur, Pabna, Bogra, Rangpur and Mymensingh. Again low population density areas (Khulna, Patuakhali, Bandarban, Chittagong Hill Tracts, Sylhet, Rajshahi) are also low cropping intensity areas. This has been shown diagrammatically (Fig.1)

Table 3. Correlation coefficients of population density, cropping intensity and agricultural variables.

Variables	r_s value	Correlation Analysis of Variables
Population Density and Intensity of Cropping	+0.7	fairly strongly correlated
Intensity of Cropping and Improved Seed	+0.60	fairly strongly correlated
Intensity of Cropping and Irrigation area	+0.53	fairly moderately correlated
Intensity of Cropping and Chemical Fertilizer	_0.38	weekly correlated
Intensity of Croppimg and Distribution of Pesticide	+0.37	weekly correlated

From the r_s value of population and agricultural variables the present analysis reveals that population density and intensity of cropping are positively correlated with r_s value of +0.7. This indicates that population density is strongly correlated with cropping intensity. The relationship between intensity of croping and agricultural variables are also positive, r_s value being 0.60 for improved seed, 0.53 for intensity of cropping and irrigated area, 0.38 for intensity of cropping and chemical fertilizer, 0.37 for intensity of cropping and pesticides distribution. This indicates that cropping intensity is strongly correlated with improved seed (HYV), moderately correlated with irrigated area and weekly correlated with chemical fertilizer and pesticide distribution.

Association between population density, agricultural cropping intensity, and agricultural variables could be shown through scatter diagram.

Relationship between cropping intensity and agricultural variables:

Fig. 2 presents scatter diagram showing the association of cropping intensity with population density, irrigated area, chemical fertilizer and pesticide distribution for 21 districts of Bangladesh. A few revealing patterns of association are discernible from the scatter diagram: (1) A group of 8 districts-Dhaka, Comilla, Jamalpur, Pabna, Kushtia, Bogra, Rangpur and Mymensingh having the

overall picture indicates a trend towards higher intensity (Hamid, 1991).

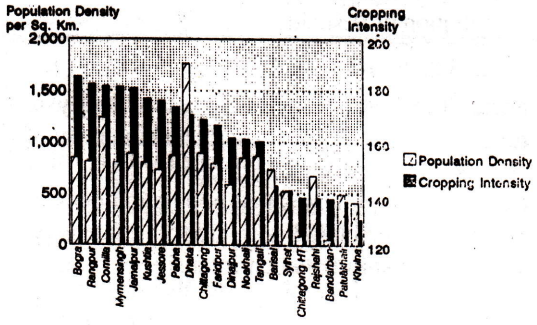
Regional and Longitudinal Variation in Intensity of Cropping: An analysis of variation in intensity of cropping through time in different regions in Bangladesh shows the detailed picture and gives a better understanding of the country's regional problem. Table 1 indicates that during the period 1979-80 to 1990-91 variation in intensity of cropping ranged from -15.74 percentage points in Tangail to 64.26 percentage point in Kustia. Three districts-Kustia, Jessore and Bogra recorded highest (more then 40) increase in intensity of cropping percentage point. These three districts are facilitated by the Ganges Kobadak project. Eight districts recorded 20 to 39.99 percentage point increase in intensity of cropping. The districts are Dhaka (39.53), Chittagong (22.22, Jamalpur (27.27), Dinajpur (27.23), Pabna (33.72), Faridpur (25.92), Mymensingh (23.38), and Comilla (28.36). Most of these districts are facilitated by different kinds of irrigation. Ten districts recorded an increase of 2 to 19.99 percentage point in intensity of cropping. The districts are Rajshahi (17.52), Bandarban(16.67), Khagrachari (15.86), Rangpur (13.04), Patuakhali (10.66), Noakhali (8.59), Barisal (4.80), Khulna (3.99), Rangamati (2.06), and Sylhet (2.0). Intensity of cropping percentage point showed declining trend in Tangail (-15.74) and Kishoreganj (-10.10).

Districts showing less than the national average intensity of cropping in all the census years are Khagrachari, Barisal, Sylhet, Rajshahi, Bandarban, Patuakhali, Rangamati and Khulna. It may be mentioned here that Khulna, Barisal, and Patuakhali are affected by salinity and the rest are under unfavourable physiographic conditions since a large percentage of these districts are hilly.

Out of 11 census years taken for intercensal comparison, Rangpur has shown highest intensity of cropping in 5 census years, Mymensingh in 4 census years, Jamalpur in one census year and Borga in one census year, showing more than 30 percent high intensity of cropping than national average intensity of cropping for each census year.

Use of Modern Agricultural Inputs :

Intensity of cropping requires major modification in the cropping environment in the country. It is related to improvement in irrigation, use of fertilizer, pesticides, improved seeds etc. At the centre of this effort to increased agricultural productivity and intensification of agriculture are the improvements in irrigation and water control. Analysis of time series data on macro level



Compiled From: B.C.S. Yearbook of Agricultural Statistics of Bangladesh, 1992.
B.B.S. Preliminary Report: Population Census, 1991.

Fig. 1 Cropping Intensity and Population Density 1990-1991

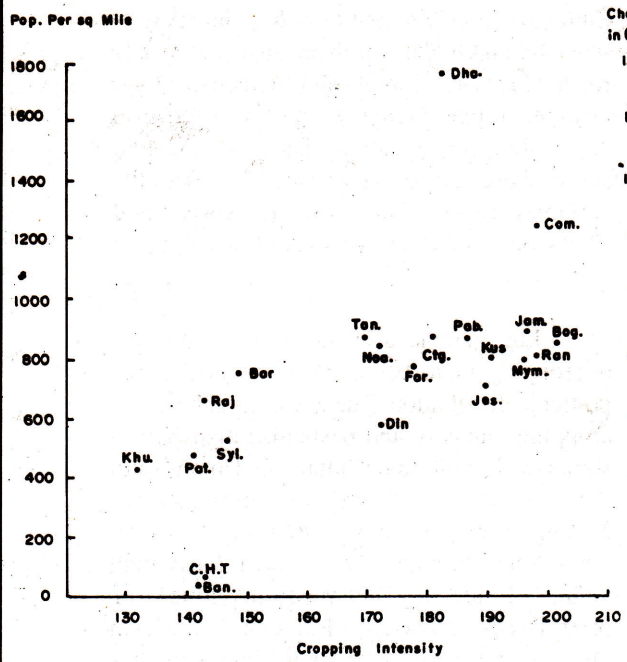


FIG. 2a

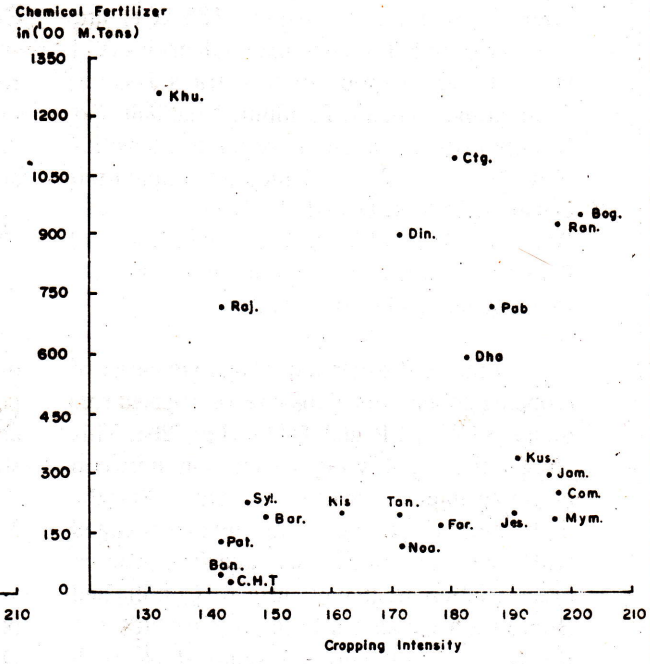


FIG. 2c

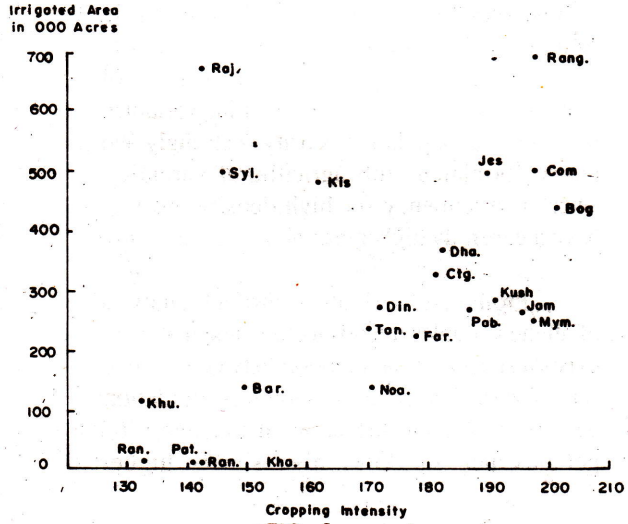


FIG. 2b

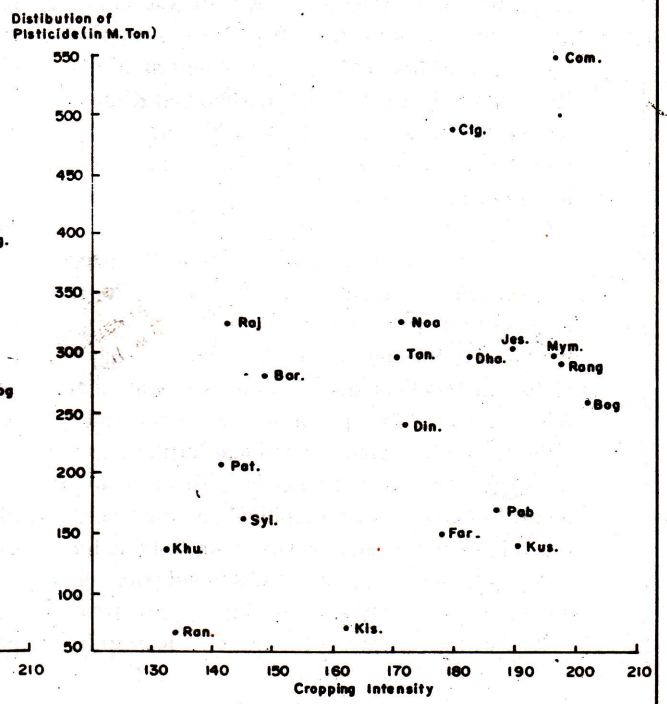


FIG. 2d

Fig.2 **SCATTER DIAGRAMS**

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highest cropping intensities (183-201) are associated with high population densities (811 to 1761), (2) a group of 6 districts Jessore, Chittagong, Tangail, Faridpur, Noakhali and Dinajpur shows medium cropping intensities (146.72 to 181.27) and medium population density (525 to 891), and (3) a set of 5 districts-Barisal, Rajshahi, Sylhet, Khulna and Patuakhali shows low cropping intensities and low population density (Fig. 2a).

First 10 districts according to intensity of cropping contain first 7 districts of irrigated area under STW, LLP and DTW (Fig. 2b). This shows the significant association between cropping intensity and irrigated area, that the high values of cropping intensity is associated with high values of irrigated area. The patterns of association are that (1) Jessore, Comilla and Bogra high values for both the variables, (2) Rajshahi, Kishoreganj and Sylhet shows high values in irrigated area but low values of cropping intensity while (3) Kushtia, Jamalpur and Mymensingh have high values of cropping intensity but low values of irrigated area, (4) Rangamati, Patuakhali, Bandarban and Khulna have low values of both the variables. It may be mentioned that population density is also very low in these districts.

Association between chemical fertilizer and cropping intensity is shown in Fig. 2c. It shows that first 10 districts of cropping intensity contains seven districts of higher chemical fertilizer distribution. It reveals that Khulna is an exception to the norm since although it ranks first in chemical fertilizer use, in cropping intensity it ranks last. This can only be explained by its geographical circumstances i. e. a large part of the district is not suitable for cultivation due to salinity of water and poor soil and population density is also low. The patterns of association are (1) Bogra, Rangpur, Chittagong and Dinajpur have high intensity of cropping and higher fertilizer distribution, (2) Kushtia, Jessore, Comilla and Mymensigh have medium cropping intensity but lower fertilizer distribution, (3) Faridpur, Tangail, Noakhali and Kishoreganj has lower values for both the variables and (4) Patuakhali, Bandarban and Chittagong Hill Tracts have very low values for both the variables.

Fig. 2d indicates that the first 10 districts of cropping intensity contain first 6 districts of pesticide distribution. The association between cropping intensity and pesticides distribution shows (1) Comilla and Chittagong demonstrates the high values of both the variables (2) Mymensingh, Rangpur, Bogra, Jessore, Dhaka, Noakhali and Tangail have fairly high values of intensity but medium values for pesticides distribution. (3) Rajshahi, Barisal and Dinajpur have lower cropping intensity, but medium to low pesticides distribution. (4) Khulna and Rangamati have both values lower.

Conclusion

A positive correlation between population pressure, cropping intensity and agricultural variables has been amply testified by this study. It is interesting to note that in general the high values of population density has been associated with high values of cropping intensity. The analysis of the variables indicates that population density is strongly and partly correlated with agricultural variables. There is a tendency for high density areas to have a generally higher cropping intensity.

From results obtained through analysis of all the variables it tends to conclude that there exists a significant association between the two sets of variables. Districts showing population density more than the national average (760 persons per sq. km.) also shows higher

cropping intensity than the national average of 171.70 in 1990-91 period. The districts showing higher population densities in the central region have not only high cropping intensities but also make a grater use of modern agricultural technology particularly modern irrigation technology as well as districts, tertiary hills and Pleistocene terraces are low population areas, have lower irrigated area, lower fertilizer and pesticide distribution as well as lower cropping intensity. It could be suggested here that in some of these districts intensity of cropping could be increased through increasing agricultural inputs.

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