PN-ABS-126
ISN 89570

# FOODGRAINS IN BANGLADESH
# PAST TRENDS AND PROJECTIONS TO YEAR 2000

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(USAID Contract No.: 388-0027-C-00-9026-00)

March 1990

## EXECUTIVE SUMMARY

The structure of the Bangladesh economy is changing, with the share of agricultural GDP declining and that of industry and services increasing. Yet agricultural growth is still sluggish, even in comparison with other low income countries in Asia.

The distribution of income is showing a deteriorating trend in rural areas. At the same time the nutritional standards, even if quite low, are improving. Also improving is the value of rural wages in terms of rice.

Foodgrains production has been characterized by higher growth in the 80's than in the 70'. This higher growth has also been accompanied by higher stability. Growth of production has been achieved through the use of high yielding varieties, expansion of irrigated land, fertilizer use and infrastructure improvement. Most of the expansion of modern technologies has taken place in the winter crops, namely boro rice and wheat. There is still room for improvement in aman and aus rice. The process of productivity growth has not created a growing disparity of rice yields among regions, indicating that the diffusion of modern technologies has not been uneven.

Foodgrains imports have shown a slight tendency to disentangle from food aid, as the capacity of Bangladesh to service its imports has improved.

Prices of foodgrains have shown an increased stability in the 80's as a result of changed pattern of seasonality and better management of stock policy than in the 70's.

The projection of foodgrain gaps between nutritional standards and domestic production in year 2000, indicate a maximum gap of 3.3 million

metric tons (mmt). Most of the gap, 2.2 mmt, is due to wheat (see Tables 40 and 41). The "medium" projection indicates a negligible surplus of foodgrains of 0.199 mmt, with an associated rice surplus of 1.9 mmt.

The projection of excess demand in year 2000 is 2.9 mmt (see Table 48). The middle projection is 1.3 mmt. If the processes of urban and income growth are taken into account, the projections of foodgrain deficit are altered considerably. The maximum deficit for year 2000 becomes 1.2 mmt, and the middle case exhibits a surplus of 0.236 mmt (see Table 49). This discrepancy with the aggregate projections without taking into account urban growth is due mainly to the fact that urban growth is accompanied by a changing diet pattern characterized by relatively less emphasis on foodgrain. If the foodgrain demand disaggregation is carried further to incorporate both rural and urban areas and both rice and wheat, the resulting situation for year 2000 appears as basically characterized by overall self-sufficiency in foodgrains (see Tables 56 and 57). The overall self-sufficiency hides the asymmetry between large rice surpluses and wheat deficit.

It has also been found that taking into account age disaggregation would not alter the above projections for year 2000 considerably.

## I. National Accounts

From a comparison with other low income Asian countries it appears that Bangladesh has had the lowest growth rate of agricultural GDP (see Table 1). Because of the large share of agriculture in GDP, that also implies a lower growth of GDP. Other low income countries such as India and Indonesia have experienced higher growth of both GDP per capita and agricultural GDP, so that they have ended their heavy reliance on food imports. From a casual inspection of Table 1 it appears that agricultural growth has a positive effect on economic growth. This last points has been confirmed with a cross country study by Hwa 1983.

The share of agriculture in total GDP is declining steadily in the period 1972/73 to 1988/89, from 60 per cent to 43 percent (see Tables 2 and 3). Industry share increases from 10 percent to 17 percent and services share increases from 30 percent to 40 percent.

The growth rate of agricultural GDP is 2.5 percent, which is slightly higher than the growth rate of population for the same period (which is equal to 2.4 percent). Within agriculture, livestock is the only dynamic factor, growing at 4.6 percent. Industry and services grow at 6.5 percent and 6.1 percent respectively. Total GDP growth is 4.3 percent (see Table 4).

## 1. Income Distribution and Poverty Indicators

The overall income distribution of income as measured by the Gini coefficients does not show any sizable movement (see Table 5). In the rural areas it seems there is a deterioration of income distribution. This remark is supported by the analysis of Kuznet ratios of the top five percent incomes to the bottom 40 percent. These ratios show that

BLE 1: INTERNATIONAL COMPARISONS

| | PER CAPITA GNP IN 1988 US $ | SHARES IN GDP IN 1988 % | | | GDP 1980-88 % | GDP GROWTH RATES % | | |
|---|---|---|---|---|---|---|---|---|
| | | Agri-culture | Industry | Services | Growth | Agri-culture | Industry | Services |
| ow Income | | | | | | | | |
| angladesh | 170 | 46 | 14 | 40 | 3.7 | 2.1 | 4.9 | 5.2 |
| ndia | 340 | 32 | 30 | 38 | 5.2 | 2.3 | 7.6 | 6.1 |
| hina | 330 | 32 | 46 | 21 | 10.3 | 12.4 | 11.0 | 11.3 |
| ri Lanka | 420 | 26 | 27 | 47 | 4.3 | 2.7 | 4.4 | 5.3 |
| akistan | 350 | 26 | 24 | 49 | 6.5 | 4.3 | 7.2 | 7.4 |
| ower-iddle ncome | | | | | | | | |
| ndonesia | 440 | 24 | 36 | 40 | 5.1 | 3.1 | 5.1 | 6.4 |
| hilippines | 630 | 23 | 34 | 44 | 0.1 | 1.8 | -1.8 | 0.7 |
| hailand | 1000 | 17 | 35 | 48 | 6.0 | 3.7 | 6.6 | 6.8 |
| ordan | 1500 | 10 | 25 | 65 | 4.2 | 6.0 | 3.6 | 4.4 |
| yria | 1680 | 38 | 16 | 46 | 0.5 | 0.5 | 1.4 | 0.2 |
| pper-iddle ncome | | | | | | | | |
| orea, Rep. | 3600 | 11 | 43 | 46 | 9.9 | 3.7 | 12.6 | 8.9 |
| ingapore | 9070 | 0 | 38 | 61 | 5.7 | -5.1 | 4.5 | 6.6 |

JRCES: World Development Report, 1990.

TABLE 2: GROSS DOMESTIC PRODUCT OF BANGLADESH BY SECTOR AT CONSTANT PRICES OF 1972-73.

| Year | AGRICULTURE | | | | INDUSTRY | SERVICES | GDP | POPULATION | GDP PER CAP | DEFLATOR GDP |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Crops | Fishery | Livestock | | | | | | |
| | 000' Tk | 000' Tk | 000' Tk | 000' Tk | 000' Tk | 000' Tk | 000' Tk | million | Tk/cap | |
| 1972/73 | 2610 | 1976 | 287 | 223 | 455 | 1324 | 4389 | 74.3 | 59.1 | 100 |
| 1973/74 | 2882 | 2235 | 288 | 227 | 521 | 1525 | 4928 | 76.4 | 64.5 | 142 |
| 1974/75 | 2853 | 2221 | 289 | 230 | 740 | 1497 | 5090 | 78 | 65.3 | 246 |
| 1975/76 | 3186 | 2547 | 288 | 232 | 775 | 1808 | 5769 | 79.9 | 72.2 | 185 |
| 1976/77 | 3090 | 2445 | 288 | 228 | 833 | 1942 | 5865 | 81.3 | 72.1 | 178 |
| 1977/78 | 3357 | 2600 | 291 | 316 | 850 | 2127 | 6334 | 83.7 | 75.7 | 231 |
| 1978/79 | 3308 | 2615 | 210 | 330 | 1045 | 2269 | 6622 | 85.6 | 77.4 | 260 |
| 1979/80 | 3313 | 2607 | 209 | 339 | 994 | 2402 | 6709 | 87.7 | 76.5 | 295 |
| 1980/81 | 3490 | 2763 | 210 | 347 | 1069 | 2605 | 7164 | 89.6 | 80.0 | 325 |
| 1981/82 | 3522 | 2744 | 222 | 368 | 1102 | 2598 | 7222 | 92.1 | 78.4 | 367 |
| 1982/83 | 3685 | 2879 | 237 | 376 | 1109 | 2689 | 7483 | 94.4 | 79.3 | 385 |
| 1983/84 | 3744 | 2912 | 239 | 383 | 1201 | 2855 | 7800 | 96.8 | 80.6 | 448 |
| 1984/85 | 3779 | 2946 | 244 | 392 | 1275 | 3036 | 8090 | 99.2 | 81.6 | 515 |
| 1985/86 | 4008 | 3154 | 246 | 402 | 1304 | 3181 | 8493 | 101.7 | 83.5 | 547 |
| 1986/87 | 4002 | 3136 | 249 | 412 | 1398 | 3415 | 8815 | 104.1 | 84.7 | 613 |
| 1987/88 | 3966 | 3080 | 253 | 422 | 1488 | 3547 | 9001 | 106.6 | 84.4 | 655 |
| 1988/89 | 3977 | 3080 | 254 | 433 | 1565 | 3670 | 9212 | 109.1 | 84.4 | 706 |

SOURCES: Statistical Yearbook, various issues, BBS.

NOTES: 1. Growth rate of population is based on census figures for 1974 and 1981.
2. Industry includes manufacturing, construction, gas and energy, mining and quarrying

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TABLE 3: SECTORAL SHARE OF GDP (in percent terms)

| YEAR | AGRICULTURE | CROPS | INDUSTRY | SERVICES |
|---|---|---|---|---|
| 1972/73 | 59.5 | 45.0 | 10.4 | 30.2 |
| 1973/74 | 58.5 | 45.4 | 10.6 | 30.9 |
| 1974/75 | 56.1 | 43.6 | 14.5 | 29.4 |
| 1975/76 | 55.2 | 44.1 | 13.4 | 31.3 |
| 1976/77 | 52.7 | 41.7 | 14.2 | 33.1 |
| 1977/78 | 53.0 | 41.0 | 13.4 | 33.6 |
| 1978/79 | 50.0 | 39.5 | 15.8 | 34.3 |
| 1979/80 | 49.4 | 38.9 | 14.8 | 35.8 |
| 1980/81 | 48.7 | 38.6 | 14.9 | 36.4 |
| 1981/82 | 48.8 | 38.0 | 15.3 | 36.0 |
| 1982/83 | 49.2 | 38.5 | 14.8 | 35.9 |
| 1983/84 | 48.0 | 37.3 | 15.4 | 36.6 |
| 1984/85 | 46.7 | 36.4 | 15.8 | 37.5 |
| 1985/86 | 47.2 | 37.1 | 15.4 | 37.5 |
| 1986/87 | 45.4 | 35.6 | 15.9 | 38.7 |
| 1987/88 | 44.1 | 34.2 | 16.5 | 39.4 |
| 1988/89 | 43.2 | 33.4 | 17.0 | 39.8 |

NOTES: Calculations based on figures of Table 2.

TABLE 4: SECTORAL GROWTH OVER 1972-73 TO 1988/89

| SECTOR | GROWTH % |
|---|---|
| AGRICULTURE | 2.53 |
| CROPS | 2.55 |
| FISHERY | -1.10 |
| LIVESTOCKS | 4.76 |
| INDUSTRY | 6.74 |
| SERVICES | 6.30 |
| GDP | 4.41 |
| POPULATION | 2.43 |

NOTES: Calculations based on figures from Table 2.

TABLE 5: INCOME DISTRIBUTION AND POVERTY INDICATORS, 1973/74 TO 1985/86

| | | 1973/74 | 1981/82 | 1983/84 | 1985/86 |
|---|---|---|---|---|---|
| **Income Distribution** | | | | | |
| % of income accruing to: | | | | | |
| Bottom 40% | Rural | 19.1 | 18.8 | 19.2 | 19.9 |
| | Urban | 17.8 | 16.1 | 18.9 | 19.2 |
| Lower Middle 40% | Rural | 38.4 | 38.8 | 38 | 36.2 |
| | Urban | 38 | 36 | 37.9 | 37.9 |
| Upper middle 15% | Rural | 26.5 | 25.6 | 24.6 | 23.7 |
| | Urban | 26.6 | 27 | 27.8 | 26.1 |
| Top 5% | Rural | 16 | 16.8 | 18.1 | 21.4 |
| | Urban | 18.6 | 20.9 | 16.9 | 18 |
| Gini Coefficient | Rural | 0.35 | 0.36 | 0.35 | 0.36 |
| | Urban | 0.38 | 0.41 | 0.37 | 0.37 |
| Kuznet Ratio | Rural | 83 | 89 | 94 | 107 |
| | Urban | 104 | 130 | 90 | 94 |
| **Poverty Incidence** | | | | | |
| % of population with daily calorie per person | | | | | |
| below 2122 calorie | Rural | 83 | 74 | 57 | 51 |
| | Urban | 81 | 66 | 66 | 56 |
| below 1805 calorie | Rural | 44 | 52 | 38 | 22 |
| | Urban | 29 | 31 | 35 | 19 |

SOURCES: Based on Household Expenditure Surveys, BBS.

NOTES: Kuznet ratios are defined as the ratios of the percentage of income accruing to the top 5 percent and the percentage of income accruing to the bottom 40 percent.

the distribution of incomes in rural areas is becoming more skewed, especially because the top incomes are gaining against the middle incomes and the middle upper incomes.

Also interesting is that for 1983/84 and 1985/86 the Household Expenditures Surveys show the ratios of the top five percent to the bottom 40% to be lower for urban areas than for rural areas. This last remark would contribute an additional explanation to the migration flow from rural to urban areas, Not only urban areas offer an higher expected income to perspective migrants from rural areas, but also the status of each income holder vis à vis the rest of society, is not going to deteriorate as much as in the rural areas.

The percentages of people with daily calorie intake per person below the standards of 2122 calorie and 1805 calorie are declining, pointing to an improved nutritional situation for the overall population. This remark is also supported by an analysis of the rural wages in terms of rice prices, which has been increasing during the past decade (see later section on prices and wages).

## III. Major Crops Production Trends

Cereals. Rice production is growing at 2.5 percent over the period 1974/75 to 1986/87, at a rate higher than the population growth rate estimated at 2.32% according to the latest Census figures. Yield rates are also increasing, mainly due to increasing yields of aman, boro, and wheat (see Tables 6 and 7).

TABLE 6: TREND OF MAJOR CROPS DURING 1969/70 TO 1986/87

| | Acreage Growth (%) | T-stat. | Production Growth (%) | T-stat. | Yield Growth (%) | T-stat. |
|---|---|---|---|---|---|---|
| Total Rice | 0.5 | 4.33 | 2.3 | 8.64 | 1.8 | 9.41 |
| Aman | 0.4 | 2.97 | 2.1 | 7.02 | 1.7 | 7.09 |
| Aus | -0.5 | -2.44 | 0.9 | 2.09 | 1.4 | 5.24 |
| Boro | 3.5 | 8.69 | 4.7 | 7.19 | 1.2 | 3.43 |
| Wheat | 13.2 | 11.24 | 20.8 | 12.43 | 6.8 | 7.57 |
| Pulses | 4.6 | 3.58 | 3.8 | 2.69 | -0.7 | -3.40 |
| Oilseeds | 3.5 | 3.79 | 3.2 | 3.01 | -0.4 | -1.01 |
| Condiments | -0.4 | -2.81 | -1.1 | -3.61 | -0.7 | -2.42 |
| Tea | 0.2 | 1.68 | 3.9 | 3.97 | 3.7 | 3.66 |
| Sugarcane | 0.7 | 2.38 | 0.5 | 1.18 | -0.2 | -1.66 |
| Tobacco | 0.9 | 1.87 | 1.3 | 2.11 | 0.4 | 1.81 |
| Jute | -0.7 | -0.81 | 0.7 | 0.66 | 1.4 | 4.59 |
| Cotton | 3.9 | 2.18 | 11.5 | 3.61 | 7.3 | 4.89 |
| Potatoes | 0.9 | 3.40 | 1.0 | 3.10 | 0.2 | 1.19 |
| Chillies | -1.0 | -3.70 | -1.8 | -4.67 | -0.8 | -3.03 |

NOTE: Production, Acreage and Yield figures come from the Statistical Yearbook, BBS.

TABLE 7: Trend of Major Crops During 1974/75 to 1986/87

| | Acreage Growth (%) | T-stat. | Production Growth (%) | T-stat. | Yield Growth (%) | T-stat. |
|---|---|---|---|---|---|---|
| Total Rice | 0.5 | 4.33 | 2.5 | 8.97 | 1.9 | 7.74 |
| Aman | 0.5 | 3.31 | 2.0 | 6.19 | 1.5 | 5.17 |
| Aus | -1.0 | -4.95 | -0.2 | -0.38 | 0.9 | 2.69 |
| Boro | 4.2 | 5.94 | 6.8 | 7.07 | 2.5 | 6.03 |
| Wheat | 15.4 | 7.67 | 20.3 | 7.18 | 4.2 | 3.27 |
| Pulses | 8.7 | 4.49 | 8.7 | 4.17 | -0.0 | -0.08 |
| Oilseeds | 6.3 | 4.29 | 6.7 | 5.20 | 0.4 | 1.44 |
| Condiments | -0.7 | -4.32 | -0.3 | -0.60 | 0.4 | 1.07 |
| Tea | 0.5 | 5.34 | 2.2 | 4.49 | 1.7 | 3.25 |
| Sugarcane | 1.3 | 4.03 | 0.8 | 2.58 | -0.5 | -3.50 |
| Tobacco | -0.3 | -0.40 | -0.1 | -0.09 | 0.2 | 0.55 |
| Jute | 2.4 | 2.01 | 4.3 | 3.43 | 1.8 | 4.10 |
| Cotton | 10.9 | 4.72 | 23.2 | 4.79 | 11.1 | 4.36 |
| Potatoes | 0.4 | 1.31 | 1.1 | 2.58 | 0.6 | 4.35 |
| Chillies | -1.4 | -4.83 | -1.2 | -2.79 | 0.2 | 0.46 |
| Fruits | 1.6 | 5.91 | 1.0 | 4.96 | -0.6 | -1.78 |
| Vegetables | 2.1 | 10.18 | 2.6 | 6.28 | 0.4 | 1.38 |

NOTE: Production, Acreage and Yield figures come from the Statistical Yearbook, BBS.

Note that yield rates of dry season crops (boro and wheat) are much higher than for aman and aus. In the most recent years though, the potential for aman and aus rice yields is expanding whereas for boro and wheat seems to have reached a ceiling (see Table 8). The scope for expansion of area devoted to wheat also seems to be exhausted.

Non Food Crops. In order to assess the role of non food crops as competing with food crops in terms of acreage, jute, cotton, tea and tobacco are considered. Cotton has shown a tremendous increase in both production and yield rates (related to the growth of the textile industry). Tobacco has been stagnant, whereas tea has shown a satisfactory growth rate in production and yield.

Pulses have shown a remarkable growth in production, achieved mainly through acreage growth. This movement is quite welcome, given the important contribution of pulses to calorie intakes. One would expect that this movement be also accompanied by a more active research policy, directed to yield improvement.

Potatoes (including sweet potatoes) and fruits have shown a weak growth of production. Vegetables growth of production has been sustained at 2.6 percent mainly due to acreage growth. A natural hypothesis is that such a growth of vegetable production is related to urban growth. It is mainly in cities that a more diversified diet, including vegetables, occurs.

TABLE 8: YIELDS OF MAJOR CEREALS

| Year | Total Rice mt/acre | Aman mt/acre | Aus mt/acre | Boro mt/acre | Wheat mt/acre |
|---|---|---|---|---|---|
| 1969/70 | 0.464 | 0.468 | 0.35 | 0.872 | 0.348 |
| 1970/71 | 0.448 | 0.417 | 0.363 | 0.904 | 0.354 |
| 1971/71 | 0.425 | 0.426 | 0.316 | 0.795 | 0.36 |
| 1971/72 | 0.417 | 0.396 | 0.314 | 0.85 | 0.303 |
| 1972/73 | 0.48 | 0.474 | 0.365 | 0.855 | 0.357 |
| 1973/74 | 0.459 | 0.445 | 0.363 | 0.784 | 0.37 |
| 1974/75 | 0.492 | 0.495 | 0.382 | 0.806 | 0.58 |
| 1975/76 | 0.474 | 0.481 | 0.379 | 0.781 | 0.646 |
| 1976/77 | 0.515 | 0.52 | 0.397 | 0.828 | 0.734 |
| 1978/79 | 0.506 | 0.518 | 0.411 | 0.728 | 0.896 |
| 1979/80 | 0.499 | 0.495 | 0.374 | 0.855 | 0.756 |
| 1980/81 | 0.545 | 0.534 | 0.428 | 0.917 | 0.736 |
| 1981/82 | 0.489 | 0.485 | 0.421 | 0.979 | 0.721 |
| 1982/83 | 0.543 | 0.513 | 0.393 | 1.001 | 0.853 |
| 1983/84 | 0.557 | 0.535 | 0.415 | 0.967 | 0.932 |
| 1984/85 | 0.579 | 0.562 | 0.383 | 1.005 | 0.876 |
| 1985/86 | 0.586 | 0.574 | 0.402 | 0.969 | 0.781 |
| 1986/87 | 0.588 | 0.553 | 0.436 | 0.982 | 0.755 |

SOURCES: Statistical yearbook, BBS

## IV. Foodgrains Growth and Stability

1. The Context of Production. Rice in Bangladesh is produced seasonally. Within one year there are three main crops denoted aman (October, November, December), boro (March, April, May, June) and aus (July, August, and September). Traditionally, aman has represented the biggest crop. In the last few years, though, boro has been increasing very rapidly from a 16 percent share of total foodgrains production in 1969/70 to an estimated 39 percent share in 1989/90, due to high yielding varieties (HYV) and the diffusion of irrigated facilities. Aus and aman shares have declined accordingly, with a higher decline for the case of aus, whose cropping season is partly overlapping with the boro season. Rice production is now more evenly distributed during the year, implying less need for storage than in the past, since arrivals in the market occur more smoothly.

Over the 21 year period 1969/70 to 1989/90 total rice production is growing at 2.43 percent (exponential growth rate), with the 80's showing a higher growth rate than the 70's (see Tables 9 and 10). The aggregate rice figures hide the fact that most of the growth of rice production in the 80's was due to the growth of boro production, which is the dry season crop, constituted by HYV (see Table 11).

Wheat has witnessed a remarkable growth over the two decades of the 70's and 80's. The 80's have shown a downward trend in production, indicating the limitation to further improvement in the expansion of this crop. The Kakwani growth (see Appendix 1) rates point out an increased stability characterizing the production growth of the 80's with respect to the 70's. This is the case, even though the 80's have

TABLE 9: GROWTH RATES OF FOODGRAINS

| | 1970/90 | 1970/80 | 1981/90 |
|---|---|---|---|
| Method Used: Semilogarithmic Time Trend | | | |
| Aman | 1.51 | 2.23 | -0.03 |
| Boro | 6.12 | 0.95 | 9.95 |
| Aus | 0.46 | 1.68 | -1.65 |
| Wheat | 16.36 | 23.36 | -1.5 |
| Total Rice | 2.43 | 1.87 | 2.45 |
| Total Grains | 2.83 | 2.33 | 2.21 |
| Method Used: Average of Growth Rates = R(0) | | | |
| Aman | 1.15 | 1.03 | 0.4 |
| Boro | 8.42 | 4.36 | 12.95 |
| Aus | 0.14 | 0.14 | -1.75 |
| Wheat | 14.27 | 26.49 | -1.37 |
| Total Rice | 2.49 | 1.01 | 3.21 |
| Total Grains | 2.67 | 1.55 | 2.86 |
| Method Used: Kakwani Growth Rates = R(2) | | | |
| Aman | 0.27 | -0.02 | -0.3 |
| Boro | 5.66 | 0.5 | 11.72 |
| Aus | -0.88 | -1.2 | -2.19 |
| Wheat | 8.22 | 19.49 | -3.83 |
| Total Rice | 1.91 | 0.2 | 2.97 |
| Total Grains | 2.11 | 0.73 | 2.65 |
| Loss of the Total Growth Rates due to Fluctuations | | | |
| Aman | 0.88 | 1.05 | 0.7 |
| Boro | 2.76 | 3.86 | 1.22 |
| Aus | 1.02 | 1.35 | 0.44 |
| Wheat | 6.05 | 7.01 | 2.47 |
| Total Rice | 0.57 | 0.81 | 0.25 |
| Total Grains | 0.56 | 0.82 | 0.21 |

NOTE: The method of computing Kakwani growth rates is explained in the text.

TABLE 10: GROWTH RATES EXCLUDING 1971/72 AND 1972/73

| | 70's and 80's | 70's | 80's |
|---|---|---|---|
| Method Used: Semilogarithmic Trend | | | |
| Aman | 1.25 | 2.07 | -0.03 |
| Boro | 6.79 | 0.5 | 9.95 |
| Aus | -0.09 | 0.77 | -1.65 |
| Wheat | 16.34 | 31.34 | -1.5 |
| Total Rice | 2.33 | 1.47 | 2.45 |
| Total Grains | 2.74 | 2.09 | 2.21 |
| Method Used: Average of Growth Rates = R(0) | | | |
| Aman | 1.22 | 1.16 | 0.4 |
| Boro | 9.12 | 4.91 | 12.95 |
| Aus | -0.08 | -0.35 | -1.75 |
| Wheat | 15.61 | 32.57 | -1.37 |
| Total Rice | 2.66 | 1.03 | 3.21 |
| Total Grains | 2.86 | 1.71 | 2.86 |
| Method Used: Kakwani Growth Rate = R(2) | | | |
| Aman | 0.35 | 0.09 | -0.3 |
| Boro | 6.62 | 1.21 | 11.72 |
| Aus | -0.74 | -0.98 | -2.19 |
| Wheat | 9.52 | 26.51 | -3.83 |
| Total Rice | 2.23 | 0.47 | 2.97 |
| Total Grains | 2.45 | 1.15 | 2.65 |
| Loss in Growth Rates due to Fluctuations | | | |
| Aman | 0.87 | 1.07 | 0.7 |
| Boro | 2.5 | 3.7 | 1.22 |
| Aus | 0.66 | 0.63 | 0.44 |
| Wheat | 6.09 | 6.06 | 2.47 |
| Total Rice | 0.42 | 0.56 | 0.25 |
| Total Grains | 0.41 | 0.56 | 0.21 |

NOTES: The 70's are the period 1969/70 to 1979/80, excluding 1971/71 and 1972/73. The 80's are the period 1980/81 to 1989/90.

TABLE 11: SHARE OF CROPS IN TOTAL PRODUCTION

| Year | Aman | Boro | Aus | Wheat | Total Rice |
|---|---|---|---|---|---|
| 1969/70 | 58.3 | 16.0 | 24.9 | 0.9 | 99.1 |
| 1970/71 | 53.4 | 19.8 | 25.8 | 1.0 | 99.0 |
| 1971/72 | 57.6 | 17.6 | 23.7 | 1.1 | 98.9 |
| 1972/73 | 55.8 | 20.7 | 22.7 | 0.9 | 99.1 |
| 1973/74 | 56.6 | 18.8 | 23.7 | 0.9 | 99.1 |
| 1974/75 | 53.5 | 20.0 | 25.5 | 1.0 | 99.0 |
| 1975/76 | 55.1 | 17.9 | 25.3 | 1.7 | 98.3 |
| 1976/77 | 58.4 | 14.0 | 25.5 | 2.2 | 97.8 |
| 1977/78 | 56.6 | 17.1 | 23.7 | 2.6 | 97.4 |
| 1978/79 | 56.1 | 14.6 | 24.8 | 4.4 | 95.6 |
| 1979/80 | 54.7 | 18.2 | 21.0 | 6.1 | 93.9 |
| 1980/81 | 53.2 | 17.6 | 22.0 | 7.2 | 92.8 |
| 1981/82 | 49.4 | 21.6 | 22.4 | 6.5 | 93.5 |
| 1982/83 | 49.7 | 23.2 | 20.0 | 7.2 | 92.8 |
| 1983/84 | 50.5 | 21.3 | 20.5 | 7.7 | 92.3 |
| 1984/85 | 49.3 | 24.3 | 17.3 | 9.1 | 90.9 |
| 1985/86 | 53.1 | 22.8 | 17.6 | 6.5 | 93.5 |
| 1986/87 | 50.1 | 24.3 | 19.0 | 6.6 | 93.4 |
| 1987/88 | 46.7 | 28.7 | 18.2 | 6.4 | 93.6 |
| 1988/89 | 41.4 | 35.2 | 17.2 | 6.2 | 93.8 |
| 1989/90 | 41.9 | 39.3 | 14.4 | 4.5 | 95.5 |

NOTES: Computations based on Table 20.

witnessed two of the worst floods of the century. One of the main reason for this added stability of yearly production is the negative correlation between aman and boro production, indicating some kind of intrayear compensating mechanism (see Tables 12 and 13).

## V. Irrigation, Fertilizers, Modern Varieties and Infrastructure

Irrigated area in Bangladesh has been growing at 4.4 percent over the period 1972/73 to 1987/88 (see Table 14). The biggest share of irrigated land is devoted to foodgrains production and is around 90 percent of total irrigated area. There has been a bias toward foodgrains against other crops, the share of irrigated land of which has been declining from 13 percent in 1972/73 to 8 percent in 1987/88.

Within foodgrains, boro has been attracting most of the irrigated land, even though the growth of irrigated land devoted to Aman and Aus has been higher.

Fertilizer distribution has been increasing quite rapidly, at an exponential growth rate of 10.8 percent.

HYV acreage, namely that part of total acreage devoted to high yielding varieties, has been growing for total grains from 11 percent of total area in 1972/73 to 37 percent in 1987/88. While basically most of boro and wheat are of HYV type, there is still a broad scope for expansion of high yielding varieties for aus and aman (see Table 15).

Infrastructure measured by lenght of roads has been growing at 7.8 percent over the period 1972 to 1986 (see Table 16).

TABLE 12: RICE AND WHEAT PRODUCTION TRENDS: 1969/70 TO 1989/90

| | AMAN | BORO | AUS | WHEAT |
|---|---|---|---|---|
| Constant | 8.709 | 7.3 | 7.931 | 4.411 |
| Trend | 0.015 | 0.059 | 0.005 | 0.151 |
| R-square | 0.577 | 0.810 | 0.081 | 0.817 |
| SER | 0.082 | 0.183 | 0.098 | 0.456 |

NOTES: 1. The estimation is based fitting a semilogarithmic equation with a trend.
2. The time period is 1969/70 to 1989/90.

TABLE 13: CORRELATION MATRIX OF CROPS RESIDUALS FROM TREND REGRESSION

| | AMAN | BORO | AUS | WHEAT |
|---|---|---|---|---|
| AMAN | 1.00 | -0.40 | 0.63 | 0.58 |
| BORO | | 1.00 | -0.39 | -0.55 |
| AUS | | | 1.00 | 0.53 |
| WHEAT | | | | 1.00 |

NOTE: Based on computations of Table 16.

TABLE 14: SHARE AND GROWTH OF IRRIGATED AREA BY CROP

| | Share 1972/73 (%) | Share 1986/87 (%) | Share 1987/88 (%) | Growth 1973/73 to 1987/88 (%) |
|---|---|---|---|---|
| Total Rice and Wheat | 87 | 90 | 92 | 4.6 |
| Aus | 4 | 7 | 5 | 7.4 |
| Aman | 9 | 9 | 7 | 5.2 |
| Boro | 74 | 62 | 71 | 3.0 |
| Wheat | 13 | 12 | 8 | 2.0 |
| Other Crops | 13 | 11 | 8 | 2.9 |
| Total Irri. Area | | | | 4.4 |

NOTES: Computations based on Table 22.

TABLE 15: SHARES OF HYV ACREAGE (in percentage terms)

| YEAR | Total Grains | Total Rice | Aus | Aman | Boro | Wheat |
|---|---|---|---|---|---|---|
| 1972/73 | 11.1 | 11.1 | 2.3 | 9.8 | 44.7 | 17.8 |
| 1973/74 | 15.7 | 15.7 | 4.3 | 14.5 | 56.0 | 14.1 |
| 1974/75 | 14.9 | 14.7 | 8.9 | 9.2 | 56.7 | 26.4 |
| 1975/76 | 15.7 | 15.0 | 10.3 | 9.7 | 55.9 | 58.8 |
| 1976/77 | 13.9 | 12.9 | 11.3 | 7.3 | 57.5 | 72.9 |
| 1977/78 | 13.3 | 12.0 | 12.2 | 4.0 | 53.8 | 83.3 |
| 1978/79 | 15.5 | 13.6 | 12.8 | 6.2 | 55.9 | 89.1 |
| 1979/80 | 22.7 | 19.7 | 13.2 | 14.6 | 63.0 | 94.8 |
| 1980/81 | 25.4 | 21.3 | 15.6 | 15.9 | 64.4 | 96.6 |
| 1981/82 | 25.8 | 22.2 | 15.0 | 15.9 | 68.9 | 96.7 |
| 1982/83 | 28.2 | 24.8 | 15.1 | 17.9 | 75.4 | 95.9 |
| 1983/84 | 28.3 | 24.9 | 15.9 | 17.7 | 76.1 | 96.4 |
| 1984/85 | 31.5 | 27.2 | 15.9 | 18.9 | 78.1 | 97.1 |
| 1985/86 | 31.0 | 27.6 | 16.9 | 19.5 | 79.1 | 96.7 |
| 1986/87 | 33.0 | 29.5 | 18.7 | 20.6 | 81.1 | 96.7 |
| 1987/88 | 35.6 | 32.1 | 17.9 | 21.4 | 83.3 | 96.6 |

NOTES: Computations based on figures from Statistical Yearbook, BBS.

TABLE 16: ROAD KILOMETERS BY TYPE OF ROADS, 1972 10 1986

| YEAR | High Type | Low Type | Total |
|---|---|---|---|
| 1972 | 3610 | 566 | 4176 |
| 1973 | 3697 | 566 | 4263 |
| 1974 | 3771 | 566 | 4337 |
| 1975 | 3787 | 566 | 4353 |
| 1976 | 3851 | 566 | 4418 |
| 1977 | 3983 | 566 | 4550 |
| 1978 | 4076 | 566 | 4643 |
| 1979 | 4197 | 634 | 4831 |
| 1980 | 4284 | 1407 | 5691 |
| 1981 | 4323 | 2268 | 6590 |
| 1982 | 4777 | 2655 | 7432 |
| 1983 | 5131 | 2866 | 7997 |
| 1984 | 5359 | 4028 | 9387 |
| 1985 | 6215 | 4159 | 10374 |
| 1986 | 6503 | 4682 | 11185 |

SOURCES: Statistical Yearbooks, BBS.

The growth is mainly due to low type road construction. It is interesting how this factor might explain the relative integration of both rice markets and technological diffusion across regions.

Growth Rates of Roads:

High type = 4.03 %

Low Type = 20.13 %

Total = 7.80 %

VI. Technological diffusion in rice production among regions in Bangladesh.

It has been shown above that rice production in the 80's has been more stable than in the 70's according to the Kakwani index. The production figures used to construct the Kakwani index are yearly production at the national level. One may wonders whether the process of aggregation hides the fact that regional growth has been more unstable. In particular, one important aspect of growth of production is whether or not productivity is diffusing across regions of Bangladesh in a balanced way.

Rice production goes on in every region of Bangladesh. The yields of rice production differ widely across regions. One of the main reasons for this variety of yields across regions is the different rate of adoption of technological change. Technological change in ri production is associated to the use of modern varieties of seed which are usually termed high yielding varieties (HYV) and to the use of modern inputs such as fertilizers and irrigation.

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One interesting set of questions to ask is the following. Is it possible to detect a diffusion of modern technology over time and across regions? How is the process of technological diffusion affecting the gap between more and less productive regions? Is such a gap increasing? Can we reject the hypothesis of divergence of yield rates across regions?

To answer these questions the behavior of rice yields across regions and over time has been examined (see Tables 17, 18, 19, and 20). Moreover, an econometric model has been estimated which allows to test the hypothesis of increasing the productivity gap between regions (see Appendix 2 and Table 21).

The main conclusions are:

i) Productivity growth and initial levels of productivity are not associated. That implies that the gap between more and less productive regions is neither diverging nor converging.

ii) Irrigation and high yielding varieties play an important role in explaining growth. Fertilizer distribution does not play such a big role. This may sound surprising, given the positive effect of fertilizer application on yield rates found in experiment station. Neyertheless it is important to recall that in the estimation only fertilizer distribution per acre per region has been considered, and this has been the case because no data were available related to fertilizer use.

Therefore, we may conclude saying that the productivity growth process in Bangladesh has not deteriorated the gap between more and less productive regions.

TABLE 17: RICE YIELDS STATISTICS BY REGION: 1977/78 TO 1986/87

| REGION | Average Q/ha | Standard Deviation Q/ha | Max Yield Q/ha | Min Yield Q/ha | CV % |
|---|---|---|---|---|---|
| CHITTAGONG | 19.7 | 0.9 | 21.2 | 18.1 | 11.8 |
| CHITTAGONG H.T. | 17 | 2 | 19.8 | 14.1 | 29.3 |
| COMILLA | 14.9 | 0.6 | 15.6 | 14 | 3.3 |
| NOAKHALI | 14.4 | 1 | 15.7 | 12.7 | 16.8 |
| SYLHET | 13.1 | 0.8 | 14.3 | 12 | 14.5 |
| DHAKA | 14.6 | 0.8 | 15.5 | 13.2 | 13.4 |
| FARIDPUR | 9 | 1.1 | 10.8 | 7.7 | 28.8 |
| JAMALPUR | 12.8 | 2 | 15.5 | 8.3 | 39.3 |
| KISHOREGANJ | 15.8 | 0.9 | 17.1 | 14 | 14.7 |
| MYMENSINGH | 14.3 | 1 | 16.5 | 12.6 | 17.9 |
| TANGAIL | 13.7 | 1.4 | 15.5 | 11.8 | 24.5 |
| BARISAL | 12.1 | 0.5 | 12.6 | 11.1 | 9.6 |
| JESSORE | 11.9 | 1.6 | 14.4 | 10.4 | 33 |
| KHULNA | 13.2 | 1 | 15.4 | 12 | 19.6 |
| KUSHTIA | 11.4 | 1.9 | 14.1 | 8.4 | 41.7 |
| PATUAKHALI | 12 | 0.7 | 13.4 | 11.2 | 15.3 |
| BOGRA | 15.6 | 2 | 18.8 | 12.7 | 31.8 |
| DINAJPUR | 13 | 1.1 | 14.6 | 11.6 | 21.5 |
| PABNA | 11.3 | 1.3 | 13.1 | 9.2 | 27.9 |
| RAJSHAHI | 12.4 | 1.2 | 14.5 | 10.8 | 23.4 |
| RANGPUR | 13.4 | 1.3 | 15.6 | 11.5 | 24.1 |

SOURCES: Based on data or rice yield by region, from Statistical Yearbook, BBS.

TABLE 18: REGIONAL TRENDS OF RICE PRODUCTION per acre: 1977/78 TO 1986/87

| REGION | Growth % | T-value | Yield Q/ha |
|---|---|---|---|
| CHITTAGONG | 1 | 2.4 | 18.8 |
| CHITTAGONG H.T. | 3.5 | 6.1 | 15.1 |
| COMILLA | 1.1 | 5 | 14.2 |
| NOAKHALI | 0.1 | 0.2 | 15.7 |
| SYLHET | 0.1 | 0.1 | 14.1 |
| DHAKA | 1.4 | 4 | 13.2 |
| FARIDPUR | 3.4 | 6.1 | 7.7 |
| JAMALPUR | 4.5 | 3.9 | 12.3 |
| KISHOREGANJ | 1.3 | 2.7 | 15.6 |
| MYMENSINGH | 0.6 | 0.8 | 12.6 |
| TANGAIL | 2.6 | 4.2 | 12.9 |
| BARISAL | 0.7 | 1.8 | 12 |
| JESSORE | 3.3 | 4 | 11.4 |
| KHULNA | 1.3 | 2 | 12.5 |
| KUSHTIA | 3.6 | 2.7 | 10.1 |
| PATUAKHALI | -0.8 | 1.4 | 12.7 |
| BOGRA | 4 | 8.5 | 12.7 |
| DINAJPUR | 2.6 | 7.2 | 12 |
| PABNA | 3 | 4.2 | 10.6 |
| RAJSHAHI | 2.8 | 7.2 | 11.6 |
| RANGPUR | 3.1 | 13.3 | 11.5 |

NOTES: Growth rates based on semi-logarithmic curve equations.

TABLE 19: COEFFICIENTS OF VARIATION OF YIELD RATES ACROSS 1977/78 TO 1986/87

| YEAR | C.V. (%) |
|---|---|
| 1978 | 17.9 |
| 1979 | 18.3 |
| 1980 | 19.1 |
| 1981 | 20.8 |
| 1982 | 17.9 |
| 1983 | 19.1 |
| 1984 | 16.8 |
| 1985 | 16.0 |
| 1986 | 16.1 |
| 1987 | 16.4 |

NOTES: Computations based on rice yields by region, from Statistical Yearbook, BBS.

TABLE 20: REGIONAL TRENDS OF FERTILIZER DISTRIBUTION AND IRRIGATED AREA, HYV 1977/78 to 1986/87

| REGION | Fertilizer Distribution Growth (%) | Irrigated Area Growth (%) | HYV acreage growth (%) |
|---|---|---|---|
| CHITTAGONG | 0.3 | 4.8 | 4.7 |
| CHITTAGONG H.T. | 20.5 | 6.6 | 5.5 |
| COMILLA | 1.3 | 6.4 | 2.7 |
| NOAKHALI | 1.8 | -7 | 1.8 |
| SYLHET | 6.5 | -3.6 | 4.9 |
| DHAKA | 8.7 | 5.7 | 3.3 |
| FARIDPUR | 9.6 | 7 | 14.1 |
| JAMALPUR | 14.6 | 14.2 | 7.9 |
| KISHOREGANJ | 4.5 | 0.1 | 5.3 |
| MYMENSINGH | -2.8 | 7.1 | 7.6 |
| TANGAIL | 9.4 | 11.1 | 6.7 |
| BARISAL | 2.2 | -5.6 | 1.1 |
| JESSORE | 10 | 15.5 | 14.1 |
| KHULNA | 11.8 | 3.7 | 5.9 |
| KUSHTIA | 7.3 | 6.8 | 12.4 |
| PATUAKHALI | -5.1 | -12.2 | -5.4 |
| BOGRA | 8.4 | 14.8 | 11.9 |
| DINAJPUR | 8.5 | 11.2 | 18.0 |
| PABNA | 12.6 | 16.4 | 18.4 |
| RAJSHAHI | 9.5 | 9.4 | 17.5 |
| RANGPUR | 10.7 | 20.8 | 14.6 |
| C.V. | 84.1 | 132.4 | |

NOTES: Semilogarithmic rates based on data from Statistical Yearbook.

TABLE 21: GROWTH AND SIZE OF YIELD RATES ACROSS REGIONS

| Growth of Yield is the Dependent Variable | Estimate | T-value | Correlation with Dependent Variable |
|---|---|---|---|
| Constant | 2.23 | 1.83 | |
| Initial Yield (1977/78) | -2.71 | -1.33 | -0.519 |
| Fertilizer Growth | 0.106 | 3.24 | 0.776 |
| Irrigated Area Growth | 0.123 | 3.99 | 0.819 |
| High Yielding Variety Growth | 0.150 | 5.08 | 0.728 |
| Corrected R-square | 0.784 | | |
| F(5,16) | 19.1 | | |
| Durbin-Watson | 1.96 | | |

NOTES: The growth rates have been computed using semilogarithmic trends.

## VII. Yield Response Function

Growth of rice production in Bangladesh can be achieved mainly through increased yield rates. The scope for additional acreage devoted to rice production is very limited. It seems therefore important to study the behavior of yield response function using regional data on rice production in Bangladesh. The assumed yield response function is dependent on fertilizer, irrigation and modern varieties. The way it has been estimated is by pooling time series for different regions of the country. The equation that has been estimated is as follows:

$$y^i_t = \alpha^i + \beta \cdot x^i_t + \epsilon^i_t$$

where $y^i_t$ is the rice yield in region i during time t; $x^i_t$ are variables affecting yield in region i during year t, such as fertilizer distribution, irrigated area and area devoted to modern varieties. The parameters $\alpha$ and $\beta$ are estimated using a fixed effect model (see Judge et al. 1985). Data are relative to rice production during the decade 1977/78 to 1986/87. The results are reported in Table 21c. The fixed effect model has been tested against the restriction that all coefficients $\alpha^i$ are equal. The resulting F statistics is distributed as an $F_{20,186}$. Its value of 2.56 allows to reject the null hypothesis that all coefficients $\alpha^i$ are equal.

The elasticities of rice production with respect to the inputs in the yield response function, computed at the mean are reported in the following table:

TABLE 21a:

| with respect to: | Elasticity of Yield |
|---|---|
| Fertilizer Distribution | 0.073 |
| High Yielding Varieties | 0.182 |
| Irrigation | 0.032 |

The important impact of irrigation is confirming a similar result for growth rates reported in the previous section.

It is interesting to use this model to forecast rice production in year 2000. In order to do that the independent variables have been forecast with a simple log linear trend comuted for each region. The result of the computations are reported as follows:

TABLE 21b:

| | Forecast of Rice Production in Year 2000 (million metric tons) | Growth over the 90's (%) |
|---|---|---|
| no acreage growth | 23.248 | 2.42 |
| acreage growth at 0.6 % | 25.425 | 3.30 |

Therefore, it seems conservative to confine our prediction of rice production in year 2000 assuming growth rates between 2.3 and 2.7 percent, as we do in the next sections.

TABLE 21C: Yield Response Function

| | Coefficients | T-statistics | Correlation with Dependent Variable |
|---|---|---|---|
| Chittagong | 0.431528 | 14.38335 | .. |
| Chittagong Hill Tract | 0.380778 | -3.34551 | 0.299921 |
| Comilla | 0.368488 | -2.73701 | 0.112536 |
| Noakhali | 0.386742 | -2.5208 | 0.069085 |
| Sylhet | 0.422697 | -0.28269 | -0.04395 |
| Dhaka | 0.383393 | -1.77431 | 0.084261 |
| Faridpur | 0.314235 | -3.88633 | -0.40505 |
| Jamalpur | 0.401423 | -1.15194 | -0.07012 |
| Kishoreganj | 0.421436 | -0.39449 | 0.198389 |
| Mymensingh | 0.373358 | -3.18575 | 0.063482 |
| Tangail | 0.396861 | -1.28773 | 0.006579 |
| Barisal | 0.401665 | -1.10011 | -0.13551 |
| Jessore | 0.371404 | -2.04464 | -0.14752 |
| Khulna | 0.460004 | 1.029177 | -0.03966 |
| Kushtia | 0.249915 | -4.51283 | -0.19202 |
| Patuakhali | 0.450999 | 0.657554 | -0.13898 |
| Bogra | 0.420677 | -0.41473 | 0.179749 |
| Dinajpur | 0.423477 | -0.27334 | -0.0557 |
| Pabna | 0.347885 | -2.62322 | -0.20321 |
| Rajshahi | 0.392305 | -1.24297 | -0.10393 |
| Rangpur | 0.437147 | 0.20667 | -0.01732 |
| Fertilizer Distribution | 0.98004 | 4.035679 | 0.486953 |
| High Yielding Varieties | 0.399826 | 6.412317 | 0.865943 |
| Irrigated Area | 0.106861 | 1.420229 | 0.434834 |
| | | | |
| Valid Cases | 210 | | |
| Degrees of Freedom | 186 | | |
| Corrected $R^2$ | 0.903 | | |
| Residual Sum of Squares | 0.19 | | |
| F(24,186) | 85.289 | | |
| Durbin Watson | 2.005 | | |

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## VIII. Prices

Nominal prices of both rice and wheat have become more stable from the 70's to the 80's, as it is pointed out by the coefficients of variation of prices, or by the yearly spreads between high and low prices (see Tables 22 and 23). The same is also true for price deflated by the index of manufactured goods prices. The correlation between rice and wheat price is very high (0.96 for nominal prices, and 0.89 for deflated prices). The relative price of rice and wheat is fluctuating around the value of 1.6 with a standard deviation of 0.08 (taking yearly prices of coarse rice and wheat betwen 1973/74 and 1988/89). With respect to manufactured good prices, rice and wheat prices show an upward trend.

The price of coarse rice is increasing with respect to the rural wages, as it is pointed out by a comparison of yearly indeces for rice price and rural wage between 1977/78 and 1988/89 (see Table 24).

Comparing GDP deflators, it is possible to detect that agricultural prices have grown at the same rate as GDP and Services deflators and more than Industry. Within agriculture, crops prices have grown less than either fishery or livestock (see Table 25).

It appears that harvest prices of cereals have grown as the average of harvest prices. The harvest prices of fruits, pulses, spices and vegetables have grown more than the average (see Table 26).

The pattern of rice prices has changed since the 60's. Two main movements have taken place (see Tables 27, 28 and 29). First, the seasonal peak of July in the 60's has been moved 3 months earlier, in April, as a consequence of the expansion of the boro crop, which is

TABLE 22: NOMINAL RICE AND WHEAT PRICES

| Year | Average Rice price | C.V. Rice Price | Spread Rice Price % | Average Wheat Price | C.V. Wheat Price | Spread Wheat Price % |
|---|---|---|---|---|---|---|
| 1972 | 75 | 14 | 49 | | | |
| 1973 | 102 | 24 | 79 | 62 | 35 | 143 |
| 1974 | 211 | 15 | 75 | 141 | 22 | 120 |
| 1975 | 125 | 24 | 95 | 77 | 34 | 157 |
| 1976 | 113 | 11 | 42 | 79 | 12 | 44 |
| 1977 | 138 | 6 | 20 | 92 | 10 | 40 |
| 1978 | 152 | 18 | 68 | 93 | 9 | 36 |
| 1979 | 201 | 8 | 31 | 124 | 15 | 64 |
| 1980 | 168 | 6 | 22 | 110 | 4 | 16 |
| 1981 | 220 | 17 | 69 | 135 | 15 | 48 |
| 1982 | 241 | 6 | 22 | 162 | 9 | 36 |
| 1983 | 262 | 7 | 23 | 168 | 8 | 25 |
| 1984 | 294 | 6 | 23 | 169 | 8 | 29 |
| 1985 | 280 | 7 | 22 | 181 | 7 | 26 |
| 1986 | 340 | 9 | 34 | 209 | 5 | 20 |
| 1987 | 352 | 6 | 17 | 216 | 6 | 22 |
| 1988 | 362 | 5 | 18 | 223 | 5 | 18 |

SOURCE: Monthly Prices from Monthly Statistical Bulletin, BBS
NOTES: Prices are in Taka/Maund. C.V. is the coefficient of variation, computed with monthly prices. Spreads are the percentage difference between the highest and the lowest price of the year.

TABLE 23: RICE AND WHEAT PRICES DEFLATED BY INDEX OF MANUFACTURED GOODS

| Year | Average Rice Price | C.V. Rice Price | Spread Rice Price | Average Wheat Price | C.V. Wheat Price | Spread Wheat Price |
|---|---|---|---|---|---|---|
| 1972 | 0.307 | 14 | 61 | 0 | 0 | 0 |
| 1973 | 0.303 | 21 | 75 | 0.184 | 32 | 114 |
| 1974 | 0.464 | 36 | 198 | 0.307 | 35 | 217 |
| 1975 | 0.293 | 30 | 127 | 0.181 | 39 | 189 |
| 1976 | 0.264 | 9 | 37 | 0.184 | 9 | 38 |
| 1977 | 0.295 | 14 | 58 | 0.197 | 20 | 87 |
| 1978 | 0.326 | 12 | 48 | 0.2 | 9 | 26 |
| 1979 | 0.32 | 9 | 34 | 0.197 | 15 | 71 |
| 1980 | 0.261 | 5 | 16 | 0.17 | 5 | 16 |
| 1981 | 0.308 | 15 | 60 | 0.189 | 12 | 37 |
| 1982 | 0.312 | 6 | 22 | 0.211 | 9 | 40 |
| 1983 | 0.351 | 11 | 42 | 0.225 | 11 | 37 |
| 1984 | 0.372 | 7 | 30 | 0.213 | 10 | 35 |
| 1985 | 0.33 | 5 | 17 | 0.214 | 8 | 26 |
| 1986 | 0.382 | 9 | 34 | 0.234 | 5 | 19 |
| 1987 | 0.38 | 6 | 19 | 0.234 | 6 | 25 |
| 1988 | 0.375 | 3 | 11 | 0.231 | 6 | 16 |

SOURCE: Monthly Prices from Monthly Statistical Bulletin, BBS
NOTES: Prices are in Taka/Maund C.V. is the coefficient of variation, computed with monthly prices. Spreads are the percentage difference between the highest and the lowest price of the year.

Table 24: Yearly Indices of Rice Prices and Rural Wages Base Year: 1977/78

| Year | Rural Wages | Rice Prices |
|---|---|---|
| 1977/78 | 100.0 | 100.0 |
| 1978/79 | 118.8 | 109.9 |
| 1979/80 | 142.2 | 145.6 |
| 1980/81 | 154.6 | 121.7 |
| 1981/82 | 183.2 | 159.3 |
| 1982/83 | 179.0 | 173.9 |
| 1983/84 | 183.1 | 189.2 |
| 1984/85 | 205.8 | 212.8 |
| 1985/86 | 246.0 | 202.6 |
| 1986/87 | 301.8 | 246.1 |
| 1987/88 | 336.3 | 254.2 |
| 1988/89 | 357.5 | 262.0 |

Note:

The indices have been constructed using coarse rice prices from Department of Agricultural Marketing and the Index of Rural Wages, Monthly Structural Bulletin.

TABLE 25: GDP DEFLATOR (1972/73 = 100)

| Year | AGRICULTURE | | | | INDUSTRY | SERVICES | GDP |
|---|---|---|---|---|---|---|---|
| | Total | Crops | Fishery | Livestock | | | |
| 1972/73 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1973/74 | 142 | 149 | 119 | 138 | 140 | 141 | 142 |
| 1974/75 | 276 | 303 | 165 | 180 | 191 | 212 | 246 |
| 1975/76 | 180 | 177 | 201 | 187 | 179 | 199 | 185 |
| 1976/77 | 173 | 163 | 239 | 197 | 176 | 190 | 178 |
| 1977/78 | 238 | 235 | 237 | 245 | 233 | 218 | 231 |
| 1978/79 | 276 | 264 | 327 | 317 | 248 | 244 | 260 |
| 1979/80 | 300 | 286 | 333 | 383 | 296 | 287 | 295 |
| 1980/81 | 312 | 302 | 334 | 358 | 343 | 336 | 325 |
| 1981/82 | 345 | 345 | 344 | 345 | 385 | 387 | 367 |
| 1982/83 | 368 | 362 | 342 | 392 | 403 | 400 | 385 |
| 1983/84 | 452 | 445 | 456 | 435 | 424 | 453 | 448 |
| 1984/85 | 562 | 540 | 598 | 680 | 466 | 477 | 515 |
| 1985/86 | 554 | 487 | 689 | 785 | 506 | 555 | 547 |
| 1986/87 | 549 | 582 | 837 | 798 | 519 | 611 | 613 |
| 1987/88 | 676 | 598 | 957 | 848 | 555 | 674 | 655 |
| 1988/89 | 724 | 644 | 1027 | 913 | 597 | 732 | 706 |

NOTES: Based on Statistical Yearbook, BBS.

TABLE 26: HARVEST PRICE INDEX (BASE YEAR 1976-77)

| Year | Cereals | Beve-rages | Fibres | Fruits | Oil Seeds | Pulses | Spices. | Sugar cane | Vegeta bles | Other Crops | All Groups |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 73 | 58 | 55 | 57 | 52 | 45 | 47 | 38 | 108 | 58 | 122 | 60 |
| 74 | 83 | 82 | 52 | 86 | 89 | 105 | 82 | 57 | 124 | 149 | 86 |
| 75 | 190 | 117 | 87 | 155 | 162 | 131 | 192 | 113 | 166 | 170 | 176 |
| 76 | 108 | 140 | 84 | 144 | 99 | 102 | 102 | 99 | 123 | 100 | 108 |
| 77 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 78 | 117 | 112 | 157 | 158 | 119 | 117 | 133 | 100 | 117 | 117 | 121 |
| 79 | 125 | 153 | 149 | 175 | 129 | 120 | 105 | 119 | 152 | 100 | 129 |
| 80 | 155 | 239 | 100 | 265 | 136 | 156 | 127 | 133 | 178 | 141 | 157 |
| 81 | 159 | 167 | 122 | 302 | 163 | 232 | 230 | 145 | 177 | 151 | 165 |
| 82 | 180 | 179 | 125 | 324 | 140 | 229 | 149 | 158 | 147 | 151 | 179 |
| 83 | 199 | 157 | 193 | 286 | 149 | 225 | 159 | 158 | 148 | 272 | 196 |
| 84 | 230 | 260 | 203 | 273 | 231 | 236 | 287 | 162 | 278 | 336 | 232 |
| 85 | 273 | 286 | 427 | 385 | 198 | 288 | 281 | 186 | 325 | 405 | 284 |
| 86 | 245 | 228 | 212 | 392 | 230 | 445 | 287 | 233 | 325 | 427 | 255 |
| 87 | 309 | 262 | 118 | 496 | 245 | 503 | 375 | 243 | 399 | 433 | 309 |

OURCES: Statistical Yearbook, BBS.

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ABLE 27: EXTENT OF FLUCTUATIONS IN MONTHLY NOMINAL PRICES OF RICE, 1960-84

| Year | Fluctuation | Coefficient of Variation | Month of lowest price | Month of Highest price |
|---|---|---|---|---|
| 1960 | 36.4 | 0.107 | january | june |
| 1961 | 23.8 | 0.055 | january | november |
| 1962 | 16.7 | 0.056 | january | july |
| 1963 | 20 | 0.055 | january | july |
| 1964 | 22.7 | 0.075 | april | october |
| 1965 | 26.1 | 0.083 | january | september |
| 1966 | 61.5 | 0.168 | january | october |
| 1967 | 20.6 | 0.062 | january | june |
| 1968 | 32.3 | 0.108 | february | november |
| 1969 | 29.4 | 0.077 | january | october |
| 1970 | 20.6 | 0.073 | january | june |
| 1971 | 36.4 | 0.102 | january | november |
| 1972 | 82.5 | 0.185 | january | september |
| 1973 | 31.9 | 0.077 | january | april |
| 1974 | 190.9 | 0.318 | january | october |
| 1975 | 73.6 | 0.284 | november | march |
| 1976 | 13.3 | 0.042 | december | january |
| 1977 | 48.5 | 0.114 | january | july |
| 1978 | 13.5 | 0.041 | august | april |
| 1979 | 67.6 | 0.165 | january | july |
| 1980 | 24.7 | 0.101 | december | april |
| 1981 | 29.2 | 0.083 | january | november |
| 1982 | 33.8 | 0.101 | december | april |
| 1983 | 11.3 | 0.036 | august | october |
| 1984 | 18.5 | 0.052 | february | september |
| 1985 | 16.7 | 0.066 | june | april |
| 1986 | 31.7 | 0.082 | january | october |
| 1987 | 23 | 0.062 | january | april |
| 1988 | 16.1 | 0.05 | may | march |
| 1989 | 20.8 | 0.057 | november | april |

NOTES: Fluctuations are the percentage spreads between highest and lowest Index Numbers. Index Numbers of a month are based on the January price as 100 and constructed separately for months in a year.

TABLE 28: COEFFICIENTS OF VARIATION OF MONTHLY RICE PRICES

| Month | 1960-70 | 1971-75 | 1976-86 | 1987-89 | 1971-80 | 1981-89 |
|---|---|---|---|---|---|---|
| January | 0.28 | 0.69 | 0.12 | 0.07 | 0.38 | 0.12 |
| February | 0.26 | 0.74 | 0.13 | 0.08 | 0.42 | 0.12 |
| March | 0.24 | 0.72 | 0.11 | 0.11 | 0.43 | 0.12 |
| April | 0.24 | 0.6 | 0.11 | 0.12 | 0.35 | 0.13 |
| May | 0.24 | 0.47 | 0.09 | 0.12 | 0.28 | 0.13 |
| June | 0.23 | 0.46 | 0.14 | 0.16 | 0.3 | 0.15 |
| July | 0.24 | 0.48 | 0.15 | 0.11 | 0.32 | 0.15 |
| August | 0.26 | 0.45 | 0.15 | 0.15 | 0.31 | 0.15 |
| September | 0.24 | 0.51 | 0.14 | 0.14 | 0.34 | 0.16 |
| October | 0.25 | 0.63 | 0.1 | 0.17 | 0.4 | 0.19 |
| November | 0.27 | 0.54 | 0.08 | 0.18 | 0.33 | 0.19 |
| December | 0.31 | 0.49 | 0.12 | 0.09 | 0.3 | 0.16 |

NOTES: Based on prices from Department of Agricultural Marketing.

TABLE 29: INDEX OF PURE SEASONALITY IN MONTHLY RICE PRICES, 1960-90

| Year | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 90.4 | 95.2 | 94.8 | 98.7 | 101 | 103.2 | 107.5 | 104.1 | 101.8 | 101.4 | 102.2 | 99.7 |
| 1961 | 90.7 | 95 | 94.9 | 98.6 | 100.7 | 103.1 | 107.4 | 104 | 102 | 102 | 102.2 | 99.8 |
| 1962 | 91.1 | 94.3 | 95.2 | 98.4 | 100.3 | 102.8 | 107 | 103.8 | 102.6 | 102.9 | 102.5 | 100.2 |
| 1963 | 91.4 | 93.2 | 95.1 | 97.9 | 99.9 | 102.5 | 106.5 | 103.9 | 103.3 | 104 | 102.8 | 100.3 |
| 1964 | 91.4 | 92.2 | 95.3 | 97.4 | 99.7 | 102.3 | 106 | 104.3 | 103.7 | 105.1 | 103.4 | 100.3 |
| 1965 | 91.2 | 91.3 | 95 | 96.8 | 99.7 | 102.3 | 105.8 | 105 | 103.9 | 105.9 | 104 | 100.1 |
| 1966 | 90.4 | 90.8 | 94.8 | 96.6 | 100.3 | 102.3 | 105.9 | 105.6 | 103.6 | 106.1 | 104.5 | 99.8 |
| 1967 | 89.4 | 90.4 | 94.4 | 96.8 | 101.1 | 102.7 | 106.3 | 106.1 | 102.9 | 105.9 | 104.6 | 99.1 |
| 1968 | 88.5 | 90.5 | 94.1 | 97.4 | 102.5 | 103.4 | 106.9 | 106 | 101.9 | 105.4 | 104.3 | 98.2 |
| 1969 | 87.9 | 90.4 | 94.3 | 98.2 | 104.3 | 104.1 | 107.1 | 105.6 | 101.5 | 104.6 | 103 | 96.6 |
| 1970 | 87.7 | 90.8 | 95.1 | 99.6 | 106.4 | 104.6 | 106.7 | 104.6 | 101.6 | 103.9 | 101.3 | 94.9 |
| 1971 | 87.9 | 91.1 | 96.4 | 101.7 | 107.6 | 104.7 | 106 | 103.6 | 102.3 | 103.2 | 99.1 | 92.7 |
| 1972 | 88.5 | 92.3 | 98 | 103.8 | 108.1 | 104.3 | 105.4 | 102.3 | 103 | 102.6 | 97.2 | 91.1 |
| 1973 | 89.3 | 93.9 | 99.7 | 105.4 | 107.6 | 103 5 | 105 | 101.4 | 103.8 | 102 | 95.8 | 89.9 |
| 1974 | 90.1 | 95.9 | 100.8 | 106.5 | 106.5 | 102.6 | 105.2 | 100.7 | 104.1 | 101.8 | 95 | 89.4 |
| 1975 | 90.8 | 97.3 | 101.4 | 107 | 104.9 | 102 | 105.4 | 100.5 | 104.2 | 101.8 | 94.8 | 89.3 |
| 1976 | 91.6 | 98.1 | 101.4 | 107 | 103.7 | 101.9 | 105.7 | 100.7 | 103.8 | 101.7 | 94.7 | 89.5 |
| 1977 | 92.4 | 98.2 | 101.5 | 106.7 | 103.4 | 102 | 104.9 | 100.9 | 103.4 | 101.5 | 95 | 89.8 |
| 1978 | 93.3 | 98.2 | 101.7 | 107 | 103.3 | 102.1 | 103.7 | 100.5 | 102.5 | 101.4 | 95.1 | 90.2 |
| 1979 | 94.3 | 98.7 | 102.7 | 107.8 | 103.4 | 101.4 | 101.6 | 99.3 | 102 | 101.4 | 95.6 | 90.8 |
| 1980 | 95.5 | 99.7 | 103.8 | 108.1 | 103.5 | 100.3 | 99.8 | 97.7 | 101.7 | 101.5 | 95.8 | 91.5 |
| 1981 | 96.9 | 101 | 105 | 107.9 | 103.4 | 98.9 | 98.2 | 96.2 | 101.8 | 101.6 | 96.2 | 92.7 |
| 1982 | 98 | 101.7 | 105.6 | 107.4 | 102.7 | 97.7 | 97.5 | 95.4 | 102.1 | 102.1 | 96.3 | 93.8 |
| 1983 | 98.8 | 101.7 | 105.8 | 107 | 101.9 | 96.7 | 97.6 | 95.4 | 102.5 | 102.4 | 96.6 | 94.8 |
| 1984 | 99 | 100.9 | 105.5 | 106.8 | 101 | 96.3 | 98.1 | 96.3 | 102.6 | 102.4 | 96.6 | 95.2 |
| 1985 | 98.8 | 100 | 105.5 | 106.9 | 100.1 | 96.5 | 98.8 | 97.4 | 102.4 | 101.8 | 96.8 | 95.5 |
| 1986 | 98.3 | 99.6 | 105.7 | 107.5 | 99.2 | 96.8 | 99.3 | 98.3 | 102 | 100.8 | 96.9 | 95.5 |
| 1987 | 97.7 | 99.9 | 106.3 | 108.1 | 98.2 | 97 | 99.4 | 98.8 | 101.8 | 100 | 97 | 95.3 |
| 1988 | 97.4 | 100.6 | 107 | 108.8 | 97.4 | 97.1 | 99.1 | 99 | 101.7 | 99.3 | 96.9 | 95.1 |
| 1989 | 97.4 | 101.2 | 107.6 | 108.9 | 96.6 | 97.3 | 99 | 99.1 | 101.7 | 98.9 | 96.9 | 95 |
| 1990 | 97.4 | 101.6 | 107.8 | 108.8 | 96.1 | 97.5 | 98.9 | 99.1 | 101.8 | 98.7 | 96.9 | 95 |

NOTES: This table is based on the seasonality index of Table 27.

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harvested between April and June. Second, the spreads between seasonal high prices and seasonal low prices have been reducing, again because boro production has been gaining in terms of share of intrayear production with respect to both aus and aman crop, so that intrayear production is now more balanced.

## IX. The Public Distribution System

The foodgrains sector in Bangladesh, as in many other developing countries, is characterized by a dual market. The government procures a part of domestic surplus at prespecified prices, called procurement prices; it monopolizes imports, and distributes a part of the public supply on concessional terms to different sectors of the population. In more recent years, the government has also started intervention in the free market through Open Market Sales of foodgrains. In order to sustains these activities (procurement, concessional distribution, imports and Open Market Operations), the government needs to articulate a foodgrains stock policy. The broad concern of stock policy is to guarantee food security at minimum cost.

A. Stocks Until as recently as 1988, the general guidelines of stock policy in Bangladesh followed the recommendations of the World Bank expressed in an influential report written in 1979 (World Bank 1979). That report suggested that total foodgrains stock be 1.5 million metric tons as of July 1 of every year, and 1.2 million metric tons as of November 1. As it has been pointed out by Nuimuddin Chowdhury (Chowdhury 1990) the World Bank's recommendation of a fixed stock on

July 1 of every year misses the point tha the multiple crop pattern of Bangladesh rice cultivation allows for downfalls in production occurring in one crop season to be compensated within the same year (that is what has been the case with the boro and aman crops which are negatively correlated). The recommendations of the World Bank in 1979 appear to be overly cautious, understandably so in light of the severe drought experience of Bangladesh in that year. Nevertheless, in the years following 1981, government stocks have rarely exceeded the levels of 1.2 million tons. This has occurred only 6 times out of 96 months, from July 1981 to June 1989, and only once, in August 1988, have they reached the level of 1.505 million metric tons. Taking into account the population growth, the per capita figures of stock levels have been much smaller than what the World Bank recommended in 1979. This situation has not prevented the stock policy of Bangladesh to be effective in checking seasonal price spreds and stock variability. Both nominal prices of rice and wheat and nominal prices deflated by the index of manufactured goods have become more stable from the 70's to the 80's. The variability of total rice and wheat foodgrains, as measured by the yearly coefficient of variation and by the yearly percentage spread between maximum and minimum stocks, has shown a tendency to decrease (see Tables 30 and 31).

TABLE 30: TOTAL FOODGRAINS STOCKS

| Year | Average Total Stocks | C.V. Total Stocks | Spread Total Stocks | Average Total Stocks Capita | Spread Total Stocks per Capita | Security Days |
|---|---|---|---|---|---|---|
| 1972/73 | 326 | 39 | 271 | 4.368 | 0 | 9 |
| 1973/74 | 238 | 30 | 170 | 3.117 | 173 | 6 |
| 1974/75 | 262 | 41 | 353 | 3.339 | 348 | 7 |
| 1975/76 | 851 | 17 | 61 | 10.618 | 60 | 22 |
| 1976/77 | 583 | 29 | 142 | 7.119 | 146 | 14 |
| 1977/78 | 607 | 17 | 83 | 7.231 | 81 | 15 |
| 1978/79 | 636 | 26 | 180 | 7.416 | 182 | 15 |
| 1979/80 | 665 | 28 | 332 | 7.559 | 329 | 15 |
| 1980/81 | 1227 | 15 | 80 | 13.607 | 78 | 28 |
| 1981/82 | 1029 | 27 | 139 | 11.202 | 142 | 23 |
| 1982/83 | 687 | 17 | 70 | 7.316 | 71 | 15 |
| 1983/84 | 637 | 20 | 80 | 6.639 | 82 | 14 |
| 1984/85 | 817 | 21 | 105 | 8.303 | 103 | 17 |
| 1985/86 | 885 | 14 | 55 | 8.806 | 57 | 18 |
| 1986/87 | 622 | 45 | 337 | 6.062 | 342 | 12 |
| 1987/88 | 920 | 16 | 74 | 8.731 | 73 | 18 |
| 1988/89 | 1208 | 18 | 73 | 11.242 | 76 | 23 |

SOURCES: Monthly Statistical Bullettin, BBS
NOTES: Average Total Stocks are measured in thousand metric tons. Average total stocks per capita are measured in kg per person. C.V. is the coefficient of variation computed with monthly stocks, and expressed in percentage terms. Spreads are the percentage difference between the highest and the lowest stock of the year. Security days expresses the number of days that public stocks would guarantee to the population of Bangladesh for that year a diet of 15.5 ounces of foodgrains.

TABLE 31: RICE AND WHEAT STOCKS IN '000' METRIC TONS

| Year | Average Rice Stocks | C.V. Rice Stocks | Spreads Rice Stocks | Average Wheat Stocks | C.V. Wheat Stocks | Spreads Wheat Stocks |
|---|---|---|---|---|---|---|
| 1972/73 | 44 | 45 | 276 | 282 | 45 | 434 |
| 1973/74 | 38 | 48 | 700 | 201 | 39 | 262 |
| 1974/75 | 62 | 102 | 4700 | 199 | 45 | 313 |
| 1975/76 | 382 | 43 | 181 | 469 | 17 | 80 |
| 1976/77 | 311 | 28 | 161 | 272 | 33 | 158 |
| 1977/78 | 234 | 64 | 530 | 373 | 35 | 200 |
| 1978/79 | 200 | 30 | 182 | 437 | 39 | 250 |
| 1979/80 | 294 | 35 | 533 | 372 | 34 | 313 |
| 1980/81 | 450 | 38 | 187 | 777 | 25 | 116 |
| 1981/82 | 481 | 26 | 158 | 548 | 32 | 148 |
| 1982/83 | 312 | 12 | 46 | 375 | 27 | 143 |
| 1983/84 | 213 | 30 | 239 | 424 | 29 | 172 |
| 1984/85 | 268 | 43 | 388 | 549 | 21 | 113 |
| 1985/86 | 389 | 14 | 57 | 496 | 21 | 126 |
| 1986/87 | 151 | 54 | 508 | 471 | 48 | 548 |
| 1987/88 | 277 | 24 | 121 | 643 | 14 | 74 |
| 1988/89 | 540 | 26 | 152 | 668 | 21 | 116 |

SOURCES: Monthly Statistical Bulletin, BBS
NOTES: C.V. is the coefficient of variation computed with monthly stocks, and expressed in percentage terms. Spreads are the percentage differences between the highest and the lowest stock of the year. Stocks are measured in levels, thousand metric tons.

Both in levels and in per capita terms stocks of foodgrains have been growing since the 70's. A way to gauge the dimension of stocks is to compute the number of days that average stocks held by the government could provide for consumption by the population, taking as a benchmark 491 grams per person per day. The security days provided by the public stocks have been increasing from the low of 9 days in 1972/73 to 23 in 1988/89. The variability of total stocks has shown a tendecy to be reduced during the period 1972/73 to 1988/89. This movement has been accompanied by an increased stability of prices. The correlation between average stocks and the coefficient of variation of prices is -0.28.

One way to gauge the importance of government operations in the foodgrains sector is to consider the ratio of total offtakes to total private availability, the latter being defined as net production (meaning gross production less 10 percent for wastage and feed) plus offtakes minus procurement.

From Table 32 we see that the dimension of government intervention in the foodgrains distribution has been quite substantial ranging between 10 and 20 percent, with an average value for the ratio of total offtakes to total availability equal to 13.8 percent.

TABLE 32: COMPONENTS OF PUBLIC DISTRIBUTION

| Year | Production | Imports | Procurement | Offtakes | Initial Stocks | Availability | Ratio |
|---|---|---|---|---|---|---|---|
| 1972/73 | 10020 | 2861 | 0 | 2236 | 303 | 11254 | 19.9 |
| 1973/74 | 11830 | 1711 | 71 | 1770 | 269 | 12346 | 14.3 |
| 1974/75 | 11224 | 2393 | 128 | 1628 | 215 | 11602 | 14.0 |
| 1975/76 | 12776 | 1479 | 500 | 1619 | 761 | 12617 | 12.8 |
| 1976/77 | 11822 | 817 | 314 | 1366 | 836 | 11692 | 11.7 |
| 1977/78 | 13108 | 1656 | 556 | 1869 | 421 | 13110 | 14.3 |
| 1978/79 | 13232 | 1158 | 352 | 1686 | 600 | 13243 | 12.7 |
| 1979/80 | 13349 | 2799 | 350 | 2297 | 217 | 13961 | 16.5 |
| 1980/81 | 14958 | 1084 | 1026 | 1597 | 795 | 14033 | 11.4 |
| 1981/82 | 14583 | 1229 | 299 | 1947 | 1208 | 14773 | 13.2 |
| 1982/83 | 15312 | 1840 | 192 | 1976 | 615 | 15565 | 12.7 |
| 1983/84 | 15719 | 2069 | 272 | 1997 | 611 | 15872 | 12.6 |
| 1984/85 | 16086 | 2580 | 340 | 2639 | 800 | 16776 | 15.7 |
| 1985/86 | 16083 | 1198 | 361 | 1553 | 1008 | 15667 | 9.9 |
| 1986/87 | 16498 | 1798 | 188 | 2049 | 892 | 16709 | 12.3 |
| 1987/88 | 16461 | 2911 | 360 | 2558 | 619 | 17013 | 15.0 |
| 1988/89 | 16566 | 2138 | 408 | 2868 | 1498 | 17369 | 16.5 |

SOURCE: Statistical Yearbooks, Monthly Statistical Bulletin, BBS
NOTES: All quantities are expressed in thousand metric tons.
Availability is Net Production + Offtakes - Procurement.
Net Production is Production minus 10 percent for feed and wastage.
Ratio refers to the ratio of Offtakes to Availability.

There are three sources of public offtakes: domestic procurement, imports and depletion of government stocks. The relative importance of each of these factors is illustrated by Table 33 from which it is possible to make the following observations. The role of domestic procurement has been greater during the second half of the 70's than in the 80's. The role of imports has always been crucial, with an average ratio of total imports to offtakes of foodgrains equal to 90 percent over the period 1972/73 to 1988/89.

B. Imports

Traditionally, imports of foodgrains in Bangladesh have been monopolized by the government. Only recently, under pressure of PL 480, some private imports have been allowed (see USAID 1988 and USAID 1989). The most powerful factor affecting imports has been food aid, which in turn has been responsive to both public stocks and expected shortfall in production. It seems that imports have not been influenced by world prices. The gap between world and domestic prices of rice has been fluctuating quite a bit, with no clear trend. For wheat, the situation is a little different, because the historically large gap between domestic and world prices has been gradually reduced. Per capita imports of both rice and wheat have not exhibited any definite trend. The biggest arrivals during each year occur in the July-September period, in coincidence with the rainy season.

An interesting feature is the analysis of food dependency ratios (see Table 34). These are the ratios of the value of foodgrains imports and the total of foreign receipts of the country. The foreign receipts of the country are given by exports and by remittances of Bangladeshi

TABLE 33: SOURCES OF PUBLIC DISTRIBUTION

| Year | Procurement | Procurement Ratio | Imports | Impors Ratio | Stocks Change | Stocks Change Ratio | Offtakes |
|---|---|---|---|---|---|---|---|
| 1972 | 0 | 0 | 2861 | 128 | 104 | 5 | 2236 |
| 1973 | 71 | 4 | 1711 | 97 | -29 | -2 | 1770 |
| 1974 | 128 | 8 | 2393 | 147 | 270 | 17 | 1628 |
| 1975 | 500 | 31 | 1479 | 91 | 100 | 6 | 1619 |
| 1976 | 314 | 23 | 817 | 60 | -491 | -36 | 1366 |
| 1977 | 556 | 30 | 1656 | 89 | 165 | 9 | 1869 |
| 1978 | 352 | 21 | 1158 | 69 | -287 | -17 | 1686 |
| 1979 | 350 | 15 | 2799 | 122 | 494 | 21 | 2297 |
| 1980 | 1026 | 64 | 1084 | 68 | 291 | 18 | 1597 |
| 1981 | 299 | 15 | 1229 | 63 | -637 | -33 | 1947 |
| 1982 | 192 | 10 | 1840 | 93 | -93 | -5 | 1976 |
| 1983 | 272 | 14 | 2069 | 104 | 165 | 8 | 1997 |
| 1984 | 340 | 13 | 2580 | 98 | 236 | 9 | 2639 |
| 1985 | 361 | 23 | 1198 | 77 | -209 | -13 | 1553 |
| 1986 | 188 | 9 | 1767 | 86 | -552 | -27 | 2049 |
| 1987 | 360 | 14 | 2911 | 114 | 445 | 17 | 2558 |
| 1988 | 408 | 14 | 2138 | 75 | -495 | -17 | 2868 |

SOURCES: Monthly Statistical Bulletin, BBS.
NOTES: Procurement, imports, stocks changes and offtakes are measured in thousand metric tons. The ratios are measured in percentage terms, and are taken with respect to offtakes. The fiscal year starts in July.

TABLE 34: FOODGRAINS IMPORT BILL

| Year | Rice Imp. 000' mt | Wheat Imp. 000' mt | World Price Rice US$/mt | World Price Wheat US$/mt | Exchange Rate Taka/$ | Exports Crore Taka | Remittances Crore Taka | Food Grains Bill Crore Taka | Foreign Receipt Crore Taka | Food Dependency % |
|---|---|---|---|---|---|---|---|---|---|---|
| 1974/75 | 267 | 2126 | 454 | 161.58 | 13.67 | 342 | 31 | 635.3 | 373 | 170.3 |
| 1975/76 | 389 | 1090 | 310.5 | 151.08 | 14.96 | 480 | 43 | 427.1 | 523 | 81.7 |
| 1976/77 | 192 | 625 | 272.25 | 112.25 | 15.53 | 711 | 90 | 190.1 | 801 | 23.7 |
| 1977/78 | 301 | 1355 | 251.41 | 116.17 | 15.06 | 154 | 171 | 351.0 | 325 | 108.0 |
| 1978/79 | 56 | 1102 | 344.75 | 140.92 | 15.63 | 892 | 218 | 272.9 | 1110 | 24.6 |
| 1979/80 | 717 | 2082 | 400.67 | 172.75 | 14.79 | 1150 | 325 | 956.8 | 1475 | 64.9 |
| 1980/81 | 84 | 1000 | 485.67 | 181.97 | 17.81 | 1334 | 620 | 396.7 | 1954 | 20.3 |
| 1981/82 | 147 | 1082 | 399.67 | 170.65 | 22.17 | 1454 | 772 | 539.6 | 2226 | 24.2 |
| 1982/83 | 316 | 1524 | 282.17 | 159.1 | 24.48 | 1861 | 1422 | 811.8 | 3283 | 24.7 |
| 1983/84 | 185 | 1884 | 277.17 | 153.31 | 25.17 | 2052 | 1376 | 856.1 | 3428 | 25.0 |
| 1984/85 | 695 | 1885 | 218.75 | 148.19 | 27.97 | 2521 | 1034 | 1206.5 | 3555 | 33.9 |
| 1985/86 | 35 | 1163 | 191 | 129.89 | 30.27 | 2717 | 1569 | 477.5 | 4286 | 11.1 |
| 1986/87 | 260 | 1507 | 188.67 | 109.69 | 30.97 | 3064 | 1927 | 663.9 | 4991 | 13.3 |
| 1987/88 | 583 | 2328 | 266.75 | 123.56 | 31.47 | 3700 | 2461 | 1394.6 | 6161 | 22.6 |

SOURCE: Imports come from Monthly Statistical Bulletin, BBS; world prices come from ERS of USDA; exchange rates come from Bangladesh Central Bank Bulletin; the remaining figures from Statistical Yearbook, BBS.

NOTE: Remittances refer to the transfers from Bangladeshi nationals working abroad. The foodgrains import bill is obtained imputing to the imported quantities the world price and converting the amount in Taka. The food dependency is the ratio of the foodgrains bill and the foreign receipts.

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nationals residing abroad. This last components has been growing considerably during the last decade. The foreign receipts of the country measure the ability of the country of importing foreign goods. The food dependency behavior shows that the ability of Bangladeshi to pay for its imports of foodgrains has been growing during the last decade.

At the same time the food aid dependency ratio, namely the ratio of the food aid foodgrains import and the total foodgrains imports has been declining (see Table 35). This tendency has been more pronounced for wheat imports than for rice imports.

## X. Population and Foodgrains Requirements

According to the revised census figures, Bangladesh population has been growing at a yearly rate of 2.26% between 1951 and 1961, at 2.48 percent in the period 1961 and 1974 and at 2.32% between 1974 and 1981 (see Table 36).

It is possible that the peak of population growth rate has been occurring already in the 60's and now, thanks to a number of population control measures and income growth, is declining.

In order to come up with projections of foodgrains requirements, three different hypotheses related to population growth have been done. According to the first hypothesis during the 80's and the 90's, population is assumed to grow at a constant rate of 2.32 percent; in the second hypothesis the growth rate is assumed to decline at a constant rate, so that it is 2.36% in the 80's and 2 percent in the 90's; in the

TABLE 35: FOOD AID DEPENDENCY RATIO

| Year | Rice Ratio | Wheat Ratio | Total Grains Ratio |
|---|---|---|---|
| 1978/79 | 92.6 | 96.0 | 95.8 |
| 1979/80 | 3.4 | 64.5 | 48.9 |
| 1980/81 | 22.6 | 73.8 | 69.8 |
| 1981/82 | 20.8 | 100.0 | 90.9 |
| 1982/83 | 46.4 | 55.3 | 53.7 |
| 1983/84 | 65.4 | 70.5 | 70.1 |
| 1984/85 | 18.1 | 62.2 | 50.4 |
| 1985/86 | 73.0 | 91.1 | 90.5 |
| 1986/87 | 41.4 | 87.4 | 80.6 |
| 1987/88 | 32.4 | 68.5 | 61.2 |
| 1988/89 | 65.6 | 63.4 | 63.4 |
| 1989/90 | 12.1 | 69.3 | 55.4 |

SOURCES: Economic Indicators of Bangladesh, January 1990.
NOTE: The food aid dependency ratio is the ratio between the food imports financed by food aid and grants and the total food imports.

TABLE 36: POPULATION

| Year | Census Population | Revised Figures | Growth Rate |
|---|---|---|---|
| 1951 | 44165 | 44165 | |
| 1961 | 55222 | 55222 | 2.26 |
| 1974 | 71478 | 76398 | 2.48 |
| 1981 | 87120 | 89912 | 2.32 |

SOURCES: Statistical Yearbook, BBS.

third hypothesis the growth rate of 2.4 percent assumed by the World Bank has been considered (see Table 37).

There is a large literature relative to calorie requirements. Most of the literature is directed against the notion of fixed requirement as a cut-off point (Sukhatme 1977,1986; Sukhatme-Margen 1982, Srinivasan 1983, and Osmani 1988). However, in order to assess the quantitative magnitude of undernutrition and poverty, some approximate measures of food requirements are needed. Three such measures are reported below. The first is the one estimated by Knudsen and Scandizzo (1982) at 2020 kilocalories (kcals) per day for the average person of Bangladesh. Chen (1975) calculated energy requirements at only 1589 kcals per day. The Bangladesh Bureau of Statistics, in its Household Expenditures Survey of 1986 argued that 1800 kcals would provide a realistic measure of the extent of poverty.

There are other estimates such as that of the Institute of Nutrition and Food Science (INF) at 2273 kcals/day. Such a big variety is due to different methodologies and perspectives. In order to do broad assessments of foodgrains requirements, the three cases are considered appropriate to explore.

In order to arrive at the foodgrains equivalents the following assumptions have been done:

i. The proportion $\sigma$ of foodgrains calories ($\gamma^f$) in total calories ($\gamma$) is 84 percent.

ii. Rice and wheat shares ( $\sigma^r$ and $\sigma^w$ ) in total foodgrains calories are set at 86 and 14 percent respectively.

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TABLE 37: POPULATION PROJECTIONS (in million).

| Year | H1 | H2 | H3 |
|---|---|---|---|
| 1990 | 110.8 | 109.2 | 111.6 |
| 2000 | 139.7 | 133.4 | 141.8 |

NOTES:
1. H1 : growth rate of 2.32 percent troughout the 80' and 90's.
2. H2 : growth rate of 2.16 percent in the 80's and 2.00 percent in the 90's.
3. H3 : growth rate of 2.4 percent in the 80's and 90's.

iii. The caloric content of 1 gram of rice ($\gamma^r$) is 3.475 kcals and of one gram of wheat ($\gamma^w$) is 3.420 kcals.

Therefore, the total requirement ($q^f$) per person per day is

$$q^f = \gamma\ \sigma(\sigma^r\gamma^r + \sigma^w\gamma^w)^{-1}$$

$$\gamma^f = \sigma^r\gamma^r + \sigma^w\gamma^w$$

$$q^f\gamma^f = \sigma\gamma$$

where

$\sigma = .84$; $\gamma = 2020, 1800, 1589$; $\sigma^r = .86$, $\sigma^w = .14$; $\gamma^r = 3.475$, $\gamma^w = 3.420$ (see Table 38).

In order to assess foodgrains requirements and gaps for the overall population both population data and calorie requirements are needed. The projections of foodgrains requirements for the year 2000 are reported in Table 39.

## XI. Foodgrains Gap between Projected Availability and Requirements

In order to consider food gaps in year 2000 it is necessary to make projections of foodgrain production. Three growth rates for rice production have been considered. "Low" growth is assumed to be 2.3 percent; "average" growth is 2.5 percent, equal to the actual growth rate of rice production between 1975/76 and 1986/87; and "high" growth, equal to 2.7 percent (for a rationale of this assumptions see section VII).

For wheat production, it is assumed to be zero growth during the 90's, with a level of production of 1.5 million metric tons in year 2000. The rationale behind this assumption is that the scope for further expansion of wheat production in Bangladesh is not considered

TABLE 38: FOODGRAINS REQUIREMENTS

| | | kcals/day | grams/day | Oz/day |
|---|---|---|---|---|
| "High" | Knudsen, Scandizzo 1982 | 2020 | 489 | 17.3 |
| "Medium" | BBS 1986 | 1800 | 436 | 15.4 |
| "Low" | Chen 1975 | 1589 | 385 | 13.6 |

NOTE: See bibliography

TABLE 39: PROJECTION OF FOODGRAINS REQUIREMENT IN YEAR 2000
(in million metric tons)

| | Low Calorie | Medium Calorie | High Calorie |
|---|---|---|---|
| Low Population | 18.74 | 21.23 | 23.82 |
| Medium Population | 19.63 | 22.24 | 24.95 |
| High Population | 19.93 | 22.58 | 25.34 |

NOTES: Low, Medium, and High population refer to population projections for year 2000 of Table 6.

very high. In any case, the assumption may be considered as biasing our projections downward.

Foodgrains gaps measure the difference between foodgrains availability and foodgrain requirements; availability of foodgrains are obtained from production figures, taking 10 percent away for feed use and seed.

Table 40 illustrates the scenarios for year 2000. A host of assumptions has been made concerning population growth, calorie requirements, foodgrains share in total calorie requirements, and production growth.

For the "medium" calorie requirements case (1800 kcals per day) the foodgrains gap by year 2000 is going to be anywhere between a 0.56 million tons deficit and a 1.637 million tons surplus. In the "middle" case with population growth at 2.32 percent and rice production growth at 2.5 percent there is going to be no foodgrains deficit. It is worth remembering that these projections have been made taking wheat production growth rate equal to zero and assuming only 1.53 million tons production in year 2000.

From the analysis of the projection of foodgrain requirements the following conclusions emerge. The maximum deficit, corresponding to high population growth, low production growth and high calorie scenario, is of 3.319 million metric tons, of which 1.121 rice and the remaining 2.198 million metric tons of wheat. In the middle case with medium population growth, medium calorie, and medium production growth, there is a 0.2 million metric tons surplus of which 1.963 million metric tons

Table 40: Foodgrains Gaps in Year 2000 (million metric tons)

| | Medium Population | Low Population | High Population |
|---|---|---|---|
| **High Production** | | | |
| High Calorie | -2.093 | -0.958 | -2.475 |
| Medium Calorie | 0.625 | 1.637 | 0.285 |
| Low Calorie | 3.233 | 4.125 | 2.932 |
| **MEDIUM PRODUCTION** | | | |
| High Calorie | -2.519 | -1.384 | -2.901 |
| Medium Calorie | 0.199 | 1.211 | -0.141 |
| Low Calorie | 2.806 | 3.699 | 2.506 |
| **LOW PRODUCTION** | | | |
| High Calorie | -2.937 | -1.801 | -3.319 |
| Medium Calorie | -0.218 | 0.793 | -0.559 |
| Low Calorie | 2.389 | 3.282 | 2.088 |

Notes:

Explanation of the terms Low, High, Medium and Average as referred to calorie, production and population is contained in the text.

are surplus of rice and 1.763 million metric tons of wheat deficit (see Table 41). That suggests that Bangladesh can have rice surplus and yet have wheat deficit.

These exercises point to a concern for the future of the foodgrains situation of Bangladesh, but not to a bleak prospect. The emerging message seems to be that moderate expansion of foodgrains different from rice, such as wheat, maize, barley could meet the foodgrains needs of the country.

## XII. Distribution of Population and Demand.

It has been argued that the distribution of the population both in terms of location (urban or rural area) and in terms of age structure have important effects on the foodgrains situation of the country. The more urbanized the population, the less is the consumption of foodgrains, and the more diversified becomes the diet. The bigger the proportion of adults in the population, the higher the calorie requirements, implying higher foodgrains requirements. It is interesting to try to assess quantitatively the impact of these two aspects of distribution on foodgrains demand.

### A. Urbanization

In order to do projections about urban population growth (see Table 42), both the natural growth rate of population growth rate and the outmigration rate from the rural to urban areas have to be considered. The growth rate $g^u$ of the urban population is then given by : $g^u = \mu^u + \nu^u$ where $\nu^u$ is the natural growth rate, and $\mu^u$ is the growth of urban

TABLE 41 RICE REQUIREMENT GAPS IN YEAR 2000 (million metric tons)

| | Medium Population | Low Population | High Population |
|---|---|---|---|
| **High Production** | | | |
| High Calorie | 0.051 | 1.027 | -0.277 |
| Medium Calorie | 2.389 | 3.259 | 2.096 |
| Low Calorie | 4.631 | 5.399 | 4.372 |
| **MEDIUM PRODUCTION** | | | |
| High Calorie | -0.374 | 0.601 | -0.703 |
| Medium Calorie | 1.963 | 2.832 | 1.670 |
| Low Calorie | 4.205 | 4.973 | 3.946 |
| **LOW PRODUCTION** | | | |
| High Calorie | -0.792 | 0.183 | -1.120 |
| Medium Calorie | 1.545 | 2.415 | 1.252 |
| Low Calorie | 3.787 | 4.555 | 3.529 |

Notes:
a. Production Growth: High (2.7%), Medium (2.5%), Low (2.3%)
b. Population Growth: High (2.4%), Medium (2.32%), Low (2.0%)
c. Calorie: High (2020), Medium (1800), Low (1589)

TABLE 42: URBAN POPULATION OF BANGLADESH

| Year | Revised Population (million) | Growth of total Population (%) | Urban Population (million) | Urban Pop. Share (%) | Urban Pop. Growth (%) |
|---|---|---|---|---|---|
| 1974 | 76398 | | 6977 | 9.1 | |
| 1981 | 89912 | 2.32 | 14089 | 15.7 | 10.05 |

SOURCES: Statistical Yearbook 1989, BBS.

population due to outmigration. The parameter $\mu^u$ is equal to : $\mu^u = \rho^{ru}(1-\sigma^u)/\sigma^u$ where $\sigma^u$ is the share of urban population and $\rho^{ru}$ is the rate of outmigration from rural to urban areas, assumed to be equal to 0.75 percent. Projections of urban population for the case when the natural growth rate is asssumed to be 2.32 are reported in Table 43.

It is interesting to compare the foodgrains demand projections that are based on a simple aggregate demand model with the projections done taking into consideration the structural change involving urban growth (see Appendix 3 and 4).

The projections without taking into consideration urban growth are reported in Tables 44, 46, and 48. The maximum deficit in these projections is 2,920 million metric tons corresponding to population growth of 2.4 percent, production growth of 2.3 percent and income growth of 5 percent.

The projections done taking into consideration urban growth (see Appendix 3 for explanation ), are reported in Tables 45, 47, and 49. In this case the worst scenario gives a deficit of 1.274 million metric tons in year 2000.

The average difference in growth rate projections between the case when only aggregate foodgrain demand is considered and the case when foodgrain demand is disaggregated into its urban and rural components is about 0.7 percentage point. If such a difference in growth rates is sustained into the 90's, it implies an average difference in foodgrains demand in year 2000 of 1.65 million metric tons.

The general conclusion of the preceding exercises is to reinforce the idea that structural change in the composition of population of

TABLE 43: URBAN POPULATION PROJECTIONS

| Year | Total Population (million) | Growth of total Population (%) | Urban Population (million) | Urban Pop. Share (%) | Urban Pop. Growth (%) |
|---|---|---|---|---|---|
| 1985 | 98.6 | 2.32 | 18.1 | 18.4 | 6.35 |
| 1990 | 110.8 | 2.32 | 24.1 | 21.7 | 5.65 |
| 1995 | 124.4 | 2.32 | 30.9 | 24.9 | 5.03 |
| 2000 | 139.7 | 2.32 | 38.9 | 27.8 | 4.58 |

NOTE:
The outmigration rate from rural to urban areas is assumed equal to 0.75 percent.

Table 44: Growth Rates of Foodgrains Demand in the 90's (in percentage term) without Urban/Rural Disaggregation

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| High population | 3.544 | 3.104 | 2.664 |
| Medium population | 3.499 | 3.059 | 2.619 |
| Low population | 3.432 | 2.992 | 2.552 |

NOTE.
a: Population Growth: high (2.4%), medium 2.32%, low (2.00%)
b. Income Growth: high (5%), medium (4%), low (3%)

Table 45: Growth Rates of Foodgrain Demand in the 90's (in percentage term) with Urban/Rural Disaggregation

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| High population | 2.861 | 2.421 | 1.981 |
| Medium population | 2.821 | 2.380 | 1.940 |
| Low population | 2.749 | 2.309 | 1.869 |

Notes:
a: Population Growth: high (urban 4.88%, rural 1.57%), medium (urban 4.8%, rural 1.5%) and low (urban 4.68%, rural 1.37%). Outmigration rate 0.75%.
b. Income Growth: high (urban 7%, rural 3%), medium (urban 6%, rural 2%), low (urban 5%, rural 1%)

Table 46: Consumption of Foodgrains in Year 2000 (million metric tons) without Urban/Rural Disaggregation

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| High population | 24.943 | 23.869 | 22.841 |
| Medium population | 24.831 | 23.762 | 22.739 |
| Low population | 24.665 | 23.603 | 22.587 |

Notes:
a: Population Growth: high (2.4%), medium 2.32%, low (2.00%)
b. Income Growth: high (5%), medium (4%), low (3%)

Table 47: Consumption of Foodgrain in Year 2000 (million metric tons) with Urban/Rural Disaggregation

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| High population | 23.297 | 22.293 | 21.333 |
| Medium population | 23.203 | 22.203 | 21.246 |
| Low population | 23.038 | 22.045 | 21.096 |

Notes:
a. Population Growth: high (urban 4.88%, rural 1.57%), medium (urban 4.8%, rural 1.5%) and low (urban 4.68%, rural 1.37%). Outmigration rate 0.75%.
b. Income Growth: high (urban 7%, rural 3%), medium (urban 6%, rural 2%), low (urban 5%, rural 1%)

Table 48: Deficit (or surplus) of foodgrains in year 2000 without urban/rural disaggregations (million metric tons)

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| **HIGH PRODUCTION** | | | |
| Very High Population | -2.358 | -1.272 | -0.233 |
| High Population | -2.077 | -1.003 | 0.024 |
| Medium Population | -1.965 | -0.896 | 0.126 |
| Low Population | -1.799 | -0.737 | 0.278 |
| **MEDIUM PRODUCTION** | | | |
| Very High Population | -2.784 | -1.698 | -0.659 |
| High Population | -2.503 | -1.429 | -0.402 |
| Medium Population | -2.391 | -1.322 | -0.299 |
| Low Population | -2.225 | -1.163 | -0.147 |
| **LOW PRODUCTION** | | | |
| Very High Population | -3.201 | -2.116 | -1.076 |
| High Population | -2.920 | -1.847 | -0.819 |
| Medium Population | -2.809 | -1.740 | -0.717 |
| Low Population | -2.642 | -1.581 | -0.565 |

NOTE:

a. Production Growth: High (2.7%), Medium (2.5%), Low (2.3%)
b. Income Growth: Very High Populaation (3.0%) High (5%), Medium (4%), Low (3%)
c. Population Growth: Very High Population (2.6%) High (2.4%), Medium (2.32%), Low (2%)
d. Negative sign denotes a deficit, positive sign denotes a surplus

Table 49: Deficit (or surplus) of foodgrains in year 2000 (million metric tons) with Urban/Rural Disaggregations

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| **HIGH PRODUCTION** | | | |
| High Population | -0.431 | 0.572 | 1.532 |
| Medium Population | -0.336 | 0.662 | 1.619 |
| Low Population | -0.172 | 0.820 | 1.770 |
| **MEDIUM PRODUCTION** | | | |
| High Population | -0.857 | 0.146 | 1.107 |
| Medium Population | -0.762 | 0.236 | 1.193 |
| Low Population | -0.597 | 0.394 | 1.344 |
| **LOW PRODUCTION** | | | |
| High Population | -1.274 | -0.271 | 0.689 |
| Medium Population | -1.180 | -0.180 | 0.775 |
| Low Population | -1.015 | -0.023 | 0.926 |

Notes:
a: Population Growth: high (urban 4.88%, rural 1.57%), medium (urban 4.8%, rural 1.5%) and low (urban 4.68%, rural 1.37%). Outmigration rate 0.75%.
b. Income Growth: high (urban 7%, rural 3%), medium (urban 6%, rural 2%), low (urban 5%, rural 1%)
c. Production Growth: High (2.7%), Medium (2.5%), Low (2.3%)
d. Negative sign denotes a deficit, positive sign denotes a surplus.

Bangladesh, whereas urban population share is increasing rapidly, has deep consequences in the foodgrains situation of the country. Unless more detailed studies on the behavior of foodgrains consumption in rural and urban areas are conducted, and unless deeper analysis of rural urban migration is undertaken, the assessment of overall foodgrains requirements growth should be revised downward by at least seven tenth of a percentage point.

Finally, it is noteworthy to compare the projections of foodgrain gaps (nutritional point of view) with the projection of excess supply (economic point of view). The "economic" projections point to a less bleaker future than the nutritional projections.

In the worst scenario of each set of projections, the nutritional gap is 3.319 million metric tons, whereas the economic excess demand is 2.920 million metric tons (or 1.274 if urban growth is taken into account). The nutritional projections assume no change in pattern of consumption deriving from either urbanization or growth of income.

B. Rice and Wheat disaggregation

Until now, demand projections have been done aggregating both rice and wheat into the composite group called foodgrains. In the projections it was assumed that the income elasticity of foodgrain demand is 0.44 and that the base year (1990) consumption of foodgrains is equal to 17.5 million metric tons, corresponding to 433 grams per day which is very close to the "medium" calorie requirement of 1800 kcals per day per person. It is interesting to compare the foodgrain projections with the projection of rice and wheat demand separately (see

Appendix 4). The base year consumption of rice is 14.73 million metric tons and for wheat is 2.77 million metric tons. These figures are obtained by taking the shares of total foodgrain consumption of 17.5 million metric tons corresponding to rice and wheat intakes of 84 percent and 16 percent respectively. The resulting growth rates, consumption projections and excess supply projections are reported in Tables 50 to 56.

The worst scenario gives a foodgrains deficit of 0.656 million metric tons in year 2000 which is much lower than the corresponding figure for the foodgrain projection done without taking into account both urban/rural and rice/wheat disaggregation. The disaggregation points to the fact that rice is going to be in excess supply, and therefore most of the deficit is really going to be a wheat deficit.

The conclusion that emerges from both types of disaggregation, by commodity and by area, is that foodgrains deficit projections are smaller than in the case when no disaggregation is undertaken.

C. Age Distribution

The tentative conclusion (see Appendix V) is that neglecting the age distribution in the foodgrain demand projection for the year 2000 is not likely to affect the results very much.

TABLE 50: GROWTH RATES OF RICE DEMAND IN THE 90's

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| High Population | 2.637 | 2.248 | 1.858 |
| Medium Population | 2.593 | 2.204 | 1.814 |
| Low Population | 2.515 | 2.126 | 1.736 |

Notes:
a. Population Growth: High (2.4%), medium (2.32%), Low (2.00%)
b. Income Growth: High (5%), Medium (4%), Low (3%)

TABLE 51: GROWTH RATES OF WHEAT DEMAND IN THE 90's

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| High Population | 2.347 | 2.205 | 2.063 |
| Medium Population | 2.285 | 2.143 | 2.002 |
| Low Population | 2.175 | 2.033 | 1.892 |

Notes:
a. Population Growth: High (2.4%), medium (2.32%), Low (2.00%)
b. Income Growth: High (5%), Medium (4%), Low (3%)

TABLE 52: CONSUMPTION OF RICE IN YEAR 2000 (million metric tons)

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| High Population | 19.176 | 18.443 | 17.738 |
| Medium Population | 19.092 | 18.362 | 17.660 |
| Low Population | 18.943 | 18.219 | 17.523 |

Notes:
a. Population Growth: High (2.4%), medium (2.32%), Low (2.00%)
b. Income Growth: High (5%), Medium (4%), Low (3%)

TABLE 53: CONSUMPTION OF WHEAT IN YEAR 2000
(million metric tons)

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| High Population | 3.502 | 3.453 | 3.404 |
| Medium Population | 3.481 | 3.432 | 3.384 |
| Low Population | 3.443 | 3.394 | 3.346 |

Notes:
a. Population Growth: High (2.4%), medium (2.32%), Low (2.00%)
b. Income Growth: High (5%), Medium (4%), Low (3%)

TABLE 54: TOTAL FOODGRAIN CONSUMPTION IN YEAR 2000
(million metric tons) DISAGGREGATING RICE AND WHEAT DEMAND

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| High Population | 22.679 | 21.896 | 21.143 |
| Medium Population | 22.573 | 21.794 | 21.044 |
| Low Population | 22.386 | 21.614 | 20.870 |

Notes:
a. Population Growth: High (2.4%), medium (2.32%), Low (2.00%)
b. Income Growth: High (5%), Medium (4%), Low (3%)

TABLE 55: EXCESS SUPPLY OF RICE IN YEAR 2000
(in million metric tons)

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| HIGH PRODUCTION | | | |
| High Population | 2.339 | 3.072 | 3.777 |
| Medium Population | 2.423 | 3.153 | 3.855 |
| Low Population | 2.572 | 3.296 | 3.992 |
| MEDIUM PRODUCTION | | | |
| High Population | 1.913 | 2.646 | 3.351 |
| Medium Population | 1.997 | 2.727 | 3.429 |
| Low Population | 2.146 | 2.870 | 3.566 |
| LOW PRODUCTION | | | |
| High Population | 1.496 | 2.229 | 2.933 |
| Medium Population | 1.580 | 2.310 | 3.011 |
| Low Population | 1.728 | 2.452 | 3.149 |

Notes:
a: Population Growth: high (urban 4.88%, rural 1.57%), medium (urban 4.8%, rural 1.5%) and low (urban 4.68%, rural 1.37%). Outmigration rate 0.75%.
b. Income Growth: high (urban 7%, rural 3%), medium (urban 6%, rural 2%), low (urban 5%, rural 1%)
c. Production Growth: High (2.7%), Medium (2.5%), Low (2.3%)
d. Negative sign denotes a deficit, positive sign denotes a surplus.

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TABLE 36: EXCESS SUPPLY OF FOODGRAIN IN YEAR 2000
(in million metric tons)

| | High Income | Medium Income | Low Income |
|---|---|---|---|
| **HIGH PRODUCTION** | | | |
| High Population | 0.187 | 0.969 | 1.722 |
| Medium Population | 0.292 | 1.071 | 1.821 |
| Low Population | 0.479 | 1.251 | 1.995 |
| **MEDIUM PRODUCTION** | | | |
| High Population | -0.238 | 0.543 | 1.296 |
| Medium Population | -0.133 | 0.645 | 1.395 |
| Low Population | 0.053 | 0.825 | 1.569 |
| **LOW PRODUCTION** | | | |
| High Population | -0.656 | 0.125 | 0.879 |
| Medium Population | -0.550 | 0.227 | 0.977 |
| Low Population | -0.364 | 0.408 | 1.152 |

Notes:
a: Population Growth: high (urban 4.88%, rural 1.57%), medium (urban 4.8%, rural 1.5%) and low (urban 4.68%, rural 1.37%). Outmigration rate 0.75%.
b. Income Growth: high (urban 7%, rural 3%), medium (urban 6%, rural 2%), low (urban 5%, rural 1%)
c. Production Growth: High (2.7%), Medium (2.5%), Low (2.3%)
d. Negative sign denotes a deficit, positive sign denotes a surplus.

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APPENDIX 1. KAKWANI GROWTH RATES

The growth measure proposed by Kakwani is based on an extension of the simple average of yearly growth rates. Specifically, if $r_t = (x_t - x_{t-1})/x_{t-1}$ is the growth rate in year t associated to the time series $(x_t;\ t=0,1,\ldots,k)$, then the easiest measure of growth over k periods is

$$R(0) = \frac{1}{k}\sum_{i=1}^{k} r_i$$

Kakwani goes further trying to incorporate a concern for fluctuations of growth rates into the overall measure of growth. To do this he proposes the following measure

$$R(\epsilon) \begin{cases} = \left[\ \frac{1}{k}\sum_{t=1}^{k}(1+r_t)^{1-\epsilon}\ \right] - 1 & \text{if } \epsilon \neq 1 \\ = \text{Antilog}\left[\ \frac{1}{k}\sum_{t=1}^{k}\log(1+r_t)\right] - 1 & \text{if } \epsilon = 1 \end{cases}$$

where $\epsilon$ is the measure of relative risk aversion which is constant for this specification. If $\epsilon = 0$, then the measure is completetely unconcerned about the fluctuations in the yearly growth rates. This is the case with the simple average R(0) of growth rates. As $\epsilon$ rises more and more importance is attached to these fluctuations. $R(\epsilon)$ is monotonically decreasing in $\epsilon$. It achieves its maximum value at $\epsilon = 0$. Therefore the expression

$$V(\epsilon) = R(0) - R(\epsilon)$$

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measures the loss of the total growth rates due to the fluctuations in the yearly growth rates. In order to compare the growth over two periods, the change in growth rates can be expressed as follows:

$$\Delta R(\epsilon) = \Delta R(0) - \Delta V(\epsilon)$$

This formula has a very simple interpretation. The first term is the pure "growth effect" which measures the change in growth rates when the degree of fluctuations does not vary across periods. The second term measures the "stability effect" and takes into account the degree of fluctuations across periods. Applying this method to Bangladesh foodgrains production data the 80's appear to be "better" than the 70's both in terms of purely growth effect and in terms of steadiness of growth fluctuations.

Without trying to analyze this association further, it is suggestive of a deeper relation between growth and stability.

APPENDIX 2. DIVERGENCE HYPOTHESIS OF YIELD GROWTH RATES.

The divergence hypothesis has been formulated as follows:

For each region i (i=1,...,21) the growth rate of yields, $\beta^i_y$, has been estimated according to an exponential trend as follow:

$$\log y^i_t = \alpha^i_y + \beta^i_y \cdot t$$

where $y^i_t$ is the yield rate of region i at time t.

Similarly, for fertilizer distribution per acre ($f^i_t$), irrigated area percentage ($iap^i_t$), and share of acreage devoted to high yielding varieties ($hyv^i_t$), we can estimate the growth rates $\beta^i_f$, $\beta^i_{irr}$, and $\beta^i_{hyv}$ as follows:

$$\log f^i_t = \alpha^i_f + \beta^i_f \cdot t$$

$$\log iap^i_t = \alpha^i_{irr} + \beta^i_{irr} \cdot t$$

and

$$\log hyv^i_t = \alpha^i_{hyv} + \beta^i_{hyv} \cdot t$$

We then consider the following equation:

(1) $$\beta^i_y = a + b \cdot y^i_0 + c \cdot \beta^i_f + d \cdot \beta^i_{irr} + e \cdot \beta^i_{hyv}$$

The divergence hypothesis states that b > 0.

Note that $y^i_0$ is the initial values for rice yield in region i. Different values for these initial values have been chosen. For values of 1977/78, or 1978/79, or 1979/80 or an average of these three values the results do not change qualitatevely. Namely, b is always found to be statistically not different from zero.

Since fertilizer distribution, irrigated area and use of high yielding varieties are likely to be highly correlated across time, as it is also suggested by their correlation matrix (see Table 57a), equation (1) has been estimated by taking out from each growth variable on the

TABLE 57a: Correlation Matrix of Dependent and Independent Variables

| | Initial Yield | Ferti-lizer Growth | Irriga-tion Growth | HYV Growth | Yield Growth |
|---|---|---|---|---|---|
| Initial Yield average 1977/78 and 1978/79 | 1.00 | -0.28 | -0.35 | -0.55 | -0.47 |
| Fertilizer Growth | | 1.00 | 0.60 | 0.52 | 0.78 |
| Irrigation Growth | | | 1.00 | 0.79 | 0.82 |
| High Yielding Varieties Growth | | | | 1.00 | 0.73 |
| Yield Growth | | | | | 1.00 |

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left hand side the effects deriving from the other subsequent variables, in the following way:

First the two following equations are estimated:

$$\beta^{1}_{f} = A_{f} + B_{f}\beta^{1}_{irr} + C\beta^{1}_{hyv} + \varepsilon^{1}_{f}$$

$$\beta^{1}_{irr} = A_{f} + C\beta^{1}_{hyv} + \varepsilon^{1}_{irr}$$

Then, the estimated residuals are fitted into equation (1) as follows:

(2) $$\beta^{1}_{y} = a + b \cdot y^{1}_{0} + c \cdot \hat{\varepsilon}^{1}_{f} + d \cdot \hat{\varepsilon}^{1}_{irr} + e \cdot \beta^{1}_{hyv}$$

where the ^ denote an estimated value.

Equations (2) related the yield growth acros regions to the initial size of yield, to the growth of fertilizer distribution per acre, after the effect of irrigation and high yielding varieties is taken into account, to the growth of irrigated land, after the use of high yielding varieties is taken into account, and to the use of high yielding varieties.

A different definition of growth has also been used. Instead of considering the semilogarithmic fitted trend, the definition of growth based on the first and last year of the period, has been considered. This is the most commonly used definition of growth in the literature of convergence hypothesis (see Table 57).

TABLE 57: GROWTH AND SIZE OF YIELD RATES ACROSS REGIONS

| Growth of Yield is the Dependent Variable | Estimate | T-value | Correlation with Dependent Variable |
|---|---|---|---|
| Constant | -0.83 | -1.22 | |
| Initial Yield (log of yield in 1977/78) | -1.54 | -1.31 | |
| Fertilizer Growth | 0.066 | 1.30 | |
| Irrigated Area Growth | 0.122 | 2.89 | -0.456 |
| High Yielding Varieties Growth | 0.166 | 4.11 | 0.776 |
| Corrected R-square | 0.686 | | |
| F(5,16) | 11.88 | | |
| Durbin-Watson | 2.04 | | |

NOTES: The growth rates used are based on the log difference between values at the end and values at the beginning of the period 1977/78 to 1986/87.

APPENDIX III. Foodgrains demand projection disaggregating with respect to rural and urban areas.

Total demand D can now be disaggregated into its urban component, $D^u$, and its rural component, $D^r$, as follows:

$$D = D^u + D^r, \text{ and then the growth rate is}$$

$$\hat{D} = \hat{D}^u\sigma^u + \hat{D}^r\sigma^r$$

where the ^ denotes growth rates, and the $\sigma$'s denote the shares of urban and rural demand in total foodgrains demand.

Now for urban demand growth,

$$\hat{D}^u = \hat{U} + \alpha^u(\hat{Y}^u - \hat{U})$$

where U is urban population, $Y^u$ is urban income and $\alpha^u$ is urban income elasticity of foodgrains demand. Similarly, for rural demand growth we have a similar expression:

$$\hat{D}^r = \hat{R} + \alpha^r(\hat{Y}^r - \hat{R})$$

In the projections three scenarios have been specified for population growth, income growth and production growth.

For population growth, the high growth for the overall population is taken to be 2.4 percent in the 90's, with associated urban growth of 4.88 percent and rural growth of 1.57 percent. Similarly, the medium case growth is 2.32 percent with urban and rural growth of 4.8 and 1.5 percent respectively. The low case gives 2.0 percent population growth for the overall population and 4.68 and 1.37 percent for urban and rural population.

For income growth, the high case gives (5,7,3) percent for overall population, urban and rural population; the medium case gives (4,6,2) and the low case gives (3,5,1).

For production growth, the high case gives 2.7 percent, the medium case gives 2.5 percent and the low case gives 2.3 percent.

For the income elasticities, and population shares the following parameters have been used.

$\alpha^u = 0.25$; $\alpha^r = 0.485$ (average of HES 1983/84 amd 1985/86); $\sigma^u = 21.7$ percent and $\sigma^r = 1 - \sigma^u$.

In the above computations the shares of urban and rural consumption of foodgrains are taken equal to the population shares. This is not correct. In fact, the shares of urban consumption of total foodgrains is likely to be lower than the share of urban population. If that is the case the previous computations are biased upward. Since the total demand growth can be expressed as

$$\hat{D} = \sigma^u(\hat{D}^u - \hat{D}^r) + \hat{D}^r$$

it is clear that, as long as the urban foodgrains growth is higher than the rural foodgrains growth, the total demand growth is an increasing function of the share of urban foodgrains consumption in total consumption. A lower value for $\sigma^u$ would put a downward pressure on the total foodgrains projected growth rate.

To get an idea of the value of the urban share of foodgrains consumption, let us denote by $\alpha$ the ratio between average foodgrains consumption per capita in urban and rural areas. Then to get the share $\sigma^u$ of urban consumption let note that

$$\frac{\sigma^u}{1-\sigma^u} = \frac{\alpha \cdot s^u}{1-s^u}$$

and therefore, it is possible to get $s^u$.

Using an average of the values of foodgrains consumption per capita in urban and rural areas from HES, we get $\alpha = .905$, from which $s^u = 20$ percent.

Therefore, the use of the population shares for the consumption share does not seem to produce such a big mistake.

APPENDIX IV: Projection of Foodgrains Demand disaggregating both with respect to rural/urban areas and with respect to rice and wheat.

Let $D^i_j$ denote the demand for commodity j (rice or wheat) in area i (urban or rural). Then, assuming prices to be constant, demand growth can be expressed as follows:

$$\hat{D}^i_j = \hat{P}^i_j + \eta^i_j(\hat{Y}^i_j - \hat{P}^i_j)$$

where D is demand , P is population, Y is income, $\eta$ is income elasticity, and the ^ denotes growth.

Total foodgrain demand is then the sum of its components:

$$D = \Sigma_i\Sigma_j \hat{D}^i_j \sigma^i_j$$

where $\sigma$ is the demand share, namely $\sigma^i_j = D^{ij}/\Sigma_i\Sigma_j D^i_j$.

In order to get projection for foodgrain consumption at time t, we have used the following formulas:

$$D^t = \Sigma_i\Sigma_j D^t_{ij} = \Sigma_i\Sigma_j D^0_{ij}\exp(\hat{D}^i_j t)$$

where the superscripts refer to time.

For a single commodity, the growth of demand, irrespective of area, would be $\hat{D}_j = \Sigma_i D^i_j \sigma_i$

where $\sigma_i = D^i_j/\Sigma_i D^i_j$.

Now to get the figures for growth we need the numbers for the elasticities $\eta^i_j$ and the consumption shares $\sigma^i_j$. For the elasticities we refer to the HES 1985/86 where:

| Income Elasticity of Demand | Urban | Rural |
|---|---|---|
| Rice | .16 | .43 |
| Wheat | .13 | .20 |

The shares $\sigma^i_j$ are based on intakes figures reported in HES 1985/86 and are:

| Demand shares | Urban | Rural |
|---|---|---|
| Rice | 13.30 | 75.81 |
| Wheat | 9.07 | 1.81 |

APPENDIX V: AGE DISTRIBUTION

The data on age distribution are based on the Census figures and are reported in Table 58.

Note that the adult population in the age range of 15-64 is growing at the highest rate 3.2 percent.

In order to get a comparison with the previous exercises of projection of foodgrains demand, the total demand D can be disaggregated into the "old" population (ages 15+) demand $D^o$ and the "young" population (ages 0-15) $D^y$ as follows:

$$D = D^o + D^y$$

Assuming that the consumption of a young person is a fixed proportion $\alpha$ of the consumption of an old person, namely

$$D^y/y = \alpha D^o/o$$

where y is the number of "young" and o is the number of "old", the growth rate of demand of the young is

$$\hat{D}^y = \hat{D}^o - \hat{y} + \hat{o}$$

The growth rate of total demand is then a weighted average of demand growth of old and young:

$$\hat{D} = \hat{D}^o\sigma^o + \hat{D}^y\sigma^y$$

where the $\sigma$'s are the shares of old and young demands in total demand, and the growth of old demand is

$$\hat{D}^o = \hat{o} + \alpha^o(\hat{Y} - \hat{o})$$

where $\alpha^o$ is the income elasticity of demand of the old.

Assuming $\hat{o}$ = 3.2 percent; $\hat{Y}$ = 4 percent; $\hat{y}$ = 2.4 percent; $\sigma^o$ = 53 percent; $\sigma^y$ = 47 percent; $\alpha^o$ = 0.485.

TABLE 58: AGE DISTRIBUTION OF BANGLADESHI POPULATION

| | | 0-14 | 15-64 | 65+ | TOTAL |
|---|---|---|---|---|---|
| 1974 | Population (million) | 34.37 | 34.83 | .23 | 71.48 |
| | Share (%) | 48 | 48.7 | 3.3 | |
| 1981 | Population (million) | 40.60 | 43.56 | .29 | |
| | Share (%) | 46.6 | 50 | 3.4 | |
| | Growth (%) | 2.37 | 3.2 | 3.1 | 2.83 |

SOURCES: Statistical Yearbook 1989, BBS.
NOTE: The Census Figures have not been revised.

With these values the growth rate of foodgrains demand is 3.21 percent. The difference with respect to the figure of 3.06 computed in the absence of age disaggregation is not great (0.15 percent).

The tentative conclusion is that neglecting the age distribution in the foodgrains demand projections for the year 2000 is not likely to affect the results very much.

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