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PROSPECTS FOR RICE EXPORTS IN AN ECONOMY MOVING TOWARD RICE SELF-SUFFICIENCY: THE CASE OF BANGLADESH

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PROSPECTS FOR RICE EXPORTS IN AN ECONOMY MOVING TOWARD RICE SELF-SUFFICIENCY: THE CASE OF BANGLADESH

By

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1. INTRODUCTION

Two major features of the Bangladesh foodgrain sector have emerged during the past two decades. First, growth of rice production, the main food staple of the country, has been sustained and increasingly stable, as the outcome of adoption of high yielding varieties and modern technology. In conjunction with structural change resulting in a lower population growth and rapid urbanization, the growth of rice production is moving the country towards rice self-sufficiency closing the gap between availability and requirements. Second, an increasingly favorable attitude towards the development of the private market has characterized the policy environment; several restrictions to domestic and international trade present in the past have been withdrawn and numerous public foodgrain distribution programs have been eliminated. This experience in market liberalization has been accompanied by a considerable degree of price stability, improvement in the poverty situation, and accelerated growth of rice production (see Goletti 1994).

These new developments pose various problems to the management of the Public Foodgrain System of Bangladesh. Its role in the future has to be redefined, as many of the assumptions valid in the past do not hold any more. The foodgrain sector is increasingly commercialized, with a declining share of the government in the marketed surplus. The country is now in a better capacity of financing the imports of foodgrains than in the past. The level of rural infrastructure, even though still very low, is developing and performing its facilitating role in the exchange of information and goods, contributing to market integration. It seems that many of the reasons for the continuation of activities of the Public Foodgrain System as conceived in the past are not present anymore.

Sustained growth in rice production, together with accelerated process of urbanization may induce an excess supply of rice, that could result either in a fall of domestic prices, or in an opening to international markets by way of exports. The past mode of operation of the Public Foodgrain System is often questioned, as the effort to stabilize prices is increasingly interpreted to consist in supporting prices through domestic procurement. Mounting public stocks may become a real possibility that raises the problem of how to dispose of them. Since the foodgrain need of the

population may become less urgent, then the opportunity of exporting part of the public stocks should be evaluated. Rice is the preferred staple food for the majority of the world's population concentrated mostly in the developing countries. However, the proportion of rice production that is traded internationally is small and has virtually remained unchanged since the mid-70's. The strategy of exporting rice should be weighed carefully in light of the thinness of the international market, and the domestic effects on production, consumption, and prices.

Urbanization and export orientation will pose numerous problems in terms of marketing infrastructure and services. The Public Foodgrain System will have to adapt to this new environment, showing flexibility and capacity in monitoring the changes under way. The gathering and evaluation of domestic and international market information, the analysis of demographic factors affecting domestic food demand, and an understanding of the constraints to future production growth are central elements in any effective policy strategy.

This paper has two main objectives. First, it explores the likely foodgrain situation of Bangladesh during the 1990's; second, it examines the prospects of rice exports, focusing on the role of the government in assisting a trade oriented policy.

2. DEMAND AND SUPPLY PROJECTIONS

The foodgrain projections presented in this section are based on a simple model that captures various dimensions of the foodgrain system. First, foodgrains are disaggregated into rice and wheat. Second, rural and urban disaggregations are brought into the picture, using the demand parameters estimated in Appendix 1. Third, demand is disaggregated by income quartiles. Finally, the model incorporates the role of distribution of growth which characterizes the process of urbanization.

Demand

The projections reported below disaggregate foodgrain demand with respect to rural and urban areas, with respect to rice and wheat, and with respect to income groups.

Let D^{tk}_{ij} denote the demand for commodity k (rice or wheat) by income quartile i in area j (urban or rural) at time t. The total demand for commodity k at time t is given by D^{tk} where

$$D^{tk} = \sum_i \sum_j D^{tk}_{ij} = \sum_i \sum_j q^{tk}_{ij} \pi^t_{ij} \qquad [1]$$

here q^{tk}_{ij} is per capita demand, and π^t_{ij} is the population at time t of quartile i in location j.

The disaggregation of foodgrain demand is done with respect to the commodity (rice and wheat), the income quartile, and the location (urban and rural).

Let specify q^{tk}_{ij} as follows:

$$q^{tk}_{ij} = \alpha_0 + \alpha_1 \cdot p_{tr} + \alpha_2 \cdot p_{tw} + \alpha_3 \cdot y^t_{ij} \qquad [2]$$

where p_{tr}, and p_{tw} are rice and wheat price, respectively, at time t, and y^t_{ij} is the income per capita at time t of group i in location j. The parameters α_1, α_2, and α_3 vary with the triplet (i,j,k) and are obtained from elasticity figures estimated in Appendix 1, computed at the mean. The effect of other prices and factors is subsumed in the constant term.

Supply

Supply of commodity k at time t is given by S^{tk} where

$$S^{tk} = (1-\delta) \cdot Q^{tk} + Offt^{tk} - Procu^{tk} \qquad [3]$$

Q^{tk} is the production of commodity k at time t, $Offt^{tk}$ is public distribution of commodity k at time t (called offtake from public stocks), and $Procu^{tk}$ is the domestic procurement of commodity k at time t. The parameter δ accounts for feed, wastage, and seed.

To model the response of supply to prices, and technological factors, a simple model derived by Mahmud, Rahman, and Zohir 1993 has been used. First, production is decomposed into yield and acreage as follows

$$Q^{tk} = A^{tk} \cdot Y^{tk} \qquad [4]$$

where A^{tk} is acreage devoted to commodity k at time t, and Y^{tk} is yield of commodity k at time t. Second, acreage response to prices and other factors is modelled as follows. For rice, the best specification showed aggregate rice acreage as a function of rice price and rice yield, that is

$$A^{tr} = A_1 + A_2 \cdot p_{tr} + A_3 \cdot Y_{tr} \qquad [5]$$

where A_1, A_2, and A_3 are coefficients estimated on the basis of elasticities computed at the mean. For wheat, the best specification, involved both rice and wheat price, and lagged acreage, as follows:

$$A^{tw} = A_{1w} + A_{2w} \cdot p_{tw} + A_{3w} \cdot p_{tr} + A_{4w} \cdot A^{t-1\,w} \qquad [6]$$

where A_{1w}, A_{2w}, A_{3w}, and A_{4w} are coefficients estimated using the elasticities from Mahmud, Rahman, and Zohir 1993.

The previous formulation leaves the growth of yield exogenously determined. The assumptions regarding yield growth are stated in a later section.

The behavior of public distribution and of procurement is also assumed to be exogenously determined. In the case of rice, offtake and procurement in the base year are taken to be equal. The initial value of procurement is equal to 4.2 percent of total production. In a later section, different behavior of the government concerning domestic procurement of rice is formulated. Moreover, in

this model the economy is assumed closed, with no trade in foodgrains allowed. This assumption is going to be removed in a later section. Finally, note that in the specification of supply, initial private stocks are not included.

3. EQUILIBRIUM AND GROWTH ASSUMPTIONS

Equilibrium

In equilibrium, prices adjust to equalize supply and demand. For each commodity and for each time period, the following equation holds:

$$D^{tk} = S^{tk} \qquad [7]$$

By expressing demand and supply in terms of prices, one obtains the following equation for each commodity k:

$$\Sigma_i \Sigma_j q^{tk}_{ij}(p_{tr}, p_{tw}) \cdot \pi^t_{ij} = S^{tk}(p_{tr}, p_{tw}) \qquad [8]$$

Assumptions about Growth of Population, Income, and Yield

In this model population growth, income growth, and yield growth are exogenously determined. Moreover, explicit assumptions on the behavior of the public distribution net of domestic procurement have to be done.

For the country as a whole, *population* at time t is given by:

$$\pi^t = \Sigma_i \Sigma_j \pi^t_{ij} \qquad [9]$$

The overall population growth rate is denoted by ν so that

$$\pi^t = \pi^{t-1} \bullet (1+\nu) \qquad [10]$$

The distribution between rural and urban areas is given by

$$\pi^t = \pi^t_r + \pi^t_u \qquad [11]$$

where π^t_r and π^t_u are rural and urban population at time t, respectively. Given an outmigration rate ρ from rural areas to urban areas, the urban population at time t is evolving as follows:

$$\pi^t_u = \pi^{t-1}_u (1+\nu+\rho\frac{1-u_{t-1}}{u_{t-1}}) \qquad [12]$$

where u_{t-1} is the urban population rate at time t-1, that is $u_{t-1} = \pi^{t-1}_u/\pi^t$. The rural population is the residual $\pi^t_r = \pi^t - \pi^t_u$. The population of each quartile i in any location j grows at the same rate, and is given by:

$$\pi^t_{ij} = 0.25 \bullet \pi^t_j \qquad [13]$$

Three cases are considered in the simulation exercises. The high growth case corresponds to a yearly population growth of 2 percent, the medium growth is 1.86 percent, and the low growth rate is 1.5 percent. The high growth is consistent with the growth rate for the 1980's as derived by the 1991 Census (see BBS 1992). This high growth is expected to decline further as a result of structural changes such as urbanization, education and income growth, and increasing participation of women in the labor force. The outmigration rate from rural to urban areas is assumed to be equal to 1 percent (see also Chowdhury and Shahabuddin 1992).

For income growth, the assumption is that each quartile grows at the same rate within the same location. The distribution between urban and rural areas may be different. Because of the process of urbanization, the distribution of growth is affecting the demand for food very critically.

In correspondence to the same aggregate income growth there are infinite paths of demand growth, each associated to a different growth of income in rural and urban areas. To illustrate the consequences of the distribution of growth between urban and rural areas a matrix is constructed, whereby in one case growth is distributed equally and in the other case urban areas growth is faster than in rural areas. The second hypothesis is the most likely one since it is related to the process of urbanization, originated by migration from rural areas (see Todaro 1976).

Therefore, income growth is affected both by the level of growth and the distribution of growth across rural and urban areas. In the simulations, three levels of aggregate income per capita growth are considered, corresponding to 1, 2, and 3 percent, respectively. For each level, two distributional assumptions are considered. In the first assumption, growth takes place equally in rural and urban areas. In the second assumption, urban growth of income per capita is 30 percent higher than in rural areas. The second assumption is consistent with the actual growth of the urban-rural income differential as indicated by the Household Expenditure Surveys in 1983/84, 1985/86, and 1988/89 by Bangladesh Bureau of Statistics (see BBS 1991).

For rice yield, the assumptions are of high growth, equal to 2.5 percent, medium growth, equal to 2.3 percent, and low growth, equal to 2.1 percent. Note that these assumptions are cautious with respect to the yield growth of 2.7 percent in the 1980's and with respect to other studies such as Islam 1989, Goletti and Ahmed 1991, Chowdhury and Shahabuddin 1992. These growth assumptions are consistent with the large scope in yield improvement in the Aman crop, and continuation of expansion of Boro acreage, since only 40 percent of cropped area is currently devoted to high yielding varieties. Wheat yield growth is assumed constant and low. It is set equal to 1 percent, in agreement with the limited scope for further expansion of wheat production (see Mahmud, Rahman, and Zohir 1993).

The parameters and assumptions used in the simulation are reported in Appendix 1.

4. RESULTS OF PROJECTION ANALYSIS

Informed opinion may differ as to the realism of each of the assumptions on which the projected growth rates are based. However, a comparison of different scenarios may still be useful. To guide this comparison, and to state the perception about the likelihood of different scenarios, each assumption has been assigned a given probability (see Appendix 1). Based on these priors, expected values of demand were determined both for rice and wheat.

The results are reported in table 1 showing a situation in year 2000 characterized by a rice surplus of 157 thousand metric tons and a wheat deficit of 1535 thousand metric tons when prices are kept at the initial level. When prices are allowed to respond, the excess demand is zero, and prices of rice and wheat ares going to decrease by 2 and 12 percent, respectively, over the decade. The reason for the bigger decrease in the case of wheat is the negative income elasticities of demand for this commodity. Total foodgrain consumption is increasing for all income groups except for urban rich. However, as a consequence of the mostly urban biased growth, urban poor are benefitting from growth more than rural poor.

In order to gain better understanding of the model, it is useful to consider also a high growth scenario, where rice yields are growing at 2.5 percent over the decade, and a low growth scenario, where rice yields are growing at 2.1 percent. The results in table 1 show that rice prices may vary between 4 percent below and 2 percent above the initial level of 388 Taka per Maund. Wheat prices always decline, between 12 percent and 8 percent below the initial level of 299 Taka per Maund.

In conclusion, price changes are going to be quite modest in the case of rice, whereas they will be slightly more appreciable in the case of wheat. In any scenario, most groups are going to gain out of growth of production, and particularly so the lower urban quartiles.

Implications for Price Support Policy

In the analysis of the previous scenarios, the behavior of the government was kept constant at the initial levels in the simulation period. The main conclusion of the analysis, namely that rice

prices are not going to change significantly during the decade of the 1990's has some important implication for price support policy. The recent fall in rice prices after the Boro harvest of 1992 has risen the concern that growth of production will result in a precipitous fall of rice prices that would hurt farmers. As a countervailing policy measure, procurement of rice has been proposed. It is useful to see what different assumptions about procurement policy will entail for prices and public stocks. Since almost all procurement in Bangladesh is in the form of rice two different assumptions about the growth of rice procurement are made in equation [3]. In the first case, procurement is assumed to grow at 2.5 percent with respect to the initial case of no zero growth; in the second case it is assumed to grow at 5 percent per year. As table 2 shows, the effect on rice prices in both cases are quite marginal. However, the increase of public stocks is quite remarkable. In the case of moderate growth of procurement, the increase in stock will be almost 900 thousand metric tons, representing an increase of 157 percent with respect to its initial average level of 570 thousand metric tons; for accelerated procurement growth, resulting in an increase of just a 2.3 percent of rice price, the increase of public stock would be of 1.9 million metric tons, which would pose capacity problems given the current space availability constraints of public storage facilities.

The main conclusion seems to be that even massive increase in procurement would result only in modest price changes. However, this massive increase in procurement will pose formidable problems in terms of both storage capacity and accompanying mounting fiscal cost.

5. RICE PRODUCTION AND EXPORT MARKET

Over the period 1975-90 world rice exports averaged only 4.1 percent of total production, making the international market for rice very thin (Table 3). During the same period world production grew at a rate of 2.67 percent compared to a 2.57 percent growth achieved in export. Table 4 shows that the five major exporting countries together achieved an annual export growth of 4.75 percent during 1975-90. There is, however, a wide variation among the growths of the concerned countries, with the one extreme of -7.08 percent for Myanmar, and another extreme of 39.46 percent

for Vietnam. Thailand is the other country whose export growth of 8.6 percent exceeded the average growth attained during the period. Besides Myanmar, the growth rate of U.S.A. and Pakistan were below average, at 0.61 percent and 2.54 percent, respectively. Comparison with the world scenario shows that the export growth of 4.75 percent for major exporting countries by far exceeds the overall growth of 2.57 percent achieved in world export over the corresponding period. The growth of market share of the first five exporters has been steady from 57.3 percent during 1975-79 to 71.1 percent in 1985-90. Moreover, the proportion of export to milled production for the major exporting countries grew at the rate of 2.12 percent over the 1975-90 period compared to a negative growth of 0.1 percent for the world as a whole. This demonstrates that the major exporters are generally well equipped to tackle a sluggish world market. Also, they do better compared to other competitors when the world market experiences a boom.

It is interesting to note that the rate of growth of rice production of Bangladesh relative to the major five exporters during 1975-90 is surpassed only by Vietnam and Myanmar; the same holds true for yield growth (see table 5). However, in the five years period 1985-90, Bangladesh growth of both rice production and yield has been higher than for the first five exporters, including Vietnam.

6. WORLD VIS A VIS DOMESTIC RICE PRICES

Rice Varieties

Key to export are the rice prices of different varieties traded in the domestic markets. The analysis of prices of these varieties and of comparable international grades will help determine their competitiveness in the international market. Thai prices for the regular rice have been chosen for comparison with the similar varieties of Bangladeshi rice as Thailand is the single largest exporter of such rice and for its proximity of geographical location. Similarly, prices of Pakistani Basmati rice have been used for comparison with that of Bangladeshi aromatic varieties.

Thai export standards classify rice into different grades based largely on such physical properties as length of grain, degree of milling, percentage of broken and damaged grain, colored

grain, moisture level, and impurities. Such standards or any other specifications for grading rice are practically non-existent in Bangladesh. Rice in Bangladesh is classified into three broad categories based on the growing seasons for the crop, namely, Aus, Aman and Boro. All species of aus and boro rice, except the species called Pajam, are generally regarded as coarse chiefly due to the short and bulky shape of the grains. Pajam is regarded as a medium variety rice. It is the Aman season when more diverse qualities of rice are produced. Aman rice can be classified into four categories - special aromatic, fine, medium and coarse (see figure 1).

Two sets of prices, export parity and import parity, for Thai rice have been used for comparison with the wholesale rice prices in Bangladesh. Thai Free on Board (FOB) prices for the grades involved have been multiplied by a factor of 0.85 to arrive at the export parity prices, which basically are estimates of wholesale prices for those Thai grades plus any export levy charged by the Thai government. An assumed zero export levy for Bangladesh posits the prices on a par with each other. For the aromatic varieties, only export parity prices for Pakistani Basmati rice have been used for the comparison since Bangladesh is unlikely to import such high valued rice in the near future.

For computing import parity prices, first a shipping cost of $20 per metric ton has been added across the board to obtain estimates of Cost and Freight (C&F) prices for the same Thai varieties. Then the C&F prices have been multiplied by a factor of 1.15 to determine their import parity prices, which are again literally estimates of wholesale prices for those grades in Bangladesh markets when imported. The purpose is to bring the Thai FOB prices on an equal term with that of Bangladesh prices for the selected grades.

Export Parity and Import Parity vis à vis Domestic Wholesale Prices

From the comparison of prices of fine Aman variety with Thai 5 percent broken rice (see table 6) it emerges that over the seventeen years between 1975 and 1991 the domestic prices have exceeded export prices by 27 percent. A similar behavior holds for prices of high yielding variety (HYV) rice, generally considered as coarse rice, which has been compared with the Thai 25 percent super.

The prices of Kalizira and Kataribhog, two of the best aromatic rice varieties, have been compared with that of export parity prices for Pakistani Basmati rice. Shapewise both are slender but Kalizira is short whereas Kataribhog is long. The ratios for this special variety aromatic rice appears to be a lot more encouraging than the ratios for any of the regular varieties. For most of the years the prices were below the export parity prices for Basmati rice. Kataribhog rice presents the most promising picture. Better ratios for this variety are explained by the relatively low price it commands in the domestic market. Although Kataribhog is a long variety, price is lower as it contains less aroma than Kalizira.

It is apparent from the above analysis that only the two aromatic varieties have an immediate prospect in the international market. Prices of the regular varieties are not presently competitive to international market prices for the comparable varieties.

The comparison between the fine Aman rice domestic prices and the Thai 5 percent broken import parity price shows that over most of the period 1975-90 the ratio of domestic wholesale to import parity prices were below 100 percent, implying that imports were not commercially feasible during most of those years. Prices for HYV, which is generally regarded as coarse rice in Bangladesh, have been compared with the Thai 25 percent super rice. The results of the analysis is similar to the case of Aman rice, pointing out that during this period commercial imports of rice were not viable (see table 7).

Price Fluctuations in Domestic vis à vis International Markets

Variability of domestic prices has declined substantially in the past two decades. Both measures of inter-year variations and intra-year variation shows this decline. The decline has also characterized international and border prices during this period (see table 8). However, inter-year variability of domestic prices has declined more than for international and border prices, whereas intra-year variability has been at approximately the same level. In the 1980's, domestic prices have been more stable than either international or border prices. As it was seen in the previous subsections, domestic prices of coarse rice, the most common variety of rice in Bangladesh, were

among import and parity prices, suggesting that there were not major incentives to trade rice. The existence of a large band for import and export parity prices did not prevent domestic prices to maintain a long term relation with border prices, as the analysis of cointegration in Goletti 1994 has shown.

Looking at the seasonal pattern of domestic versus international rice prices, table 9 shows that price differences are the lowest in December for both the fine and medium varieties. Understandably so as December happens to be the peak month for Aman harvest, which contributes most to the aggregate production of fine and medium rice. The highest level of differences are observed in October and September for the fine and medium rice, respectively. These two months precede the Aman harvest and are regarded as lean months in terms of rice supply in the domestic markets. Overall, the differences are relatively lower between December and March for either being the period of Aman harvest or for being closer to it. This suggests that the period between December and March will be the most favorable for Bangladesh to export fine and medium variety rice. One can draw similar conclusion with respect to aromatic rice as most of the domestic aromatic rice is also produced during the Aman season. Price differences for coarse rice are likely to behave differently from those of fine and medium varieties as a large portion of coarse rice is produced during the two other rice growing seasons -Boro and Aus.

7. SWAP OF RICE FOR WHEAT

The likely situation for foodgrains in the 1990's is one whereby rice excess supply may persist together with wheat excess demand. With a view to attaining food self sufficiency, it is then interesting to ask the following question, initially posited by Chowdhury and Aziz(1988):

How would the foodgrain sector be affected if the surplus of rice is swapped for wheat in the world market?

Of particular interest is the determination of the effects of rice exports on production, consumption, and prices. To address this question a simple trade model is proposed. The model

builds upon Bernard (1989), but it incorporates different rice qualities, and cross price elasticities both for demand and supply. The basic structure of the model follows.

There are three goods: two qualities of rice, "high" and "low", and wheat. The superscripts h, l, w, denote high, low, wheat, respectively. Demand and supply of the three foodgrains depend on the prices of the three goods. Income effects are assumed within the functional forms, and therefore are not mentioned explicitly. The government exports rice of good quality, and the exported quantity of rice is denoted by X. It swaps X for a quantity M of wheat in the international markets, using world prices of rice and wheat, denoted by wo^r, and wo^w, respectively. Let the letter D denote demand, S supply, and p domestic price.

Demand

$$D^h = D^h(p^h,p^l,p^w) \quad [14]$$

$$D^l = D^l(p^h,p^l,p^w) \quad [15]$$

$$D^w = D^w(p^h,p^l,p^w) \quad [16]$$

Supply

$$Q^h = Q^h(p^h,p^l,p^w) \quad [17]$$

$$Q^l = Q^l(p^h,p^l,p^w) \quad [18]$$

$$Q^w = Q^w(p^h,p^l,p^w) \quad [19]$$

Equilibrium

$$Q^h(p^h,p^l,p^w) = D^h(p^h,p^l,p^w) + X \quad [20]$$

$$Q^l(p^h,p^l,p^w) = D^l(p^h,p^l,p^w) \quad [21]$$

$$Q^w(p^h,p^l,p^w) + M + FA = D^h(p^h,p^l,p^w) \quad [22]$$

where FA is foreign aid assumed to be received all in wheat.

Swap Condition

$$wo^r \cdot X = wo^w \cdot M \qquad [23]$$

The endogenous variables of the system given by equations [14] to [15] are domestic prices p^h, p^l, p^w, and imports of wheat M. The exogenous variables are world prices wo^r, wo^w, and rice exports X.

The model is used to study the effect of exporting an amount X on prices, quantities consumed and produced, and total foodgrain consumption.

The comparative statics of the model does not allow to derive clear cut conclusions. Only for the case of zero cross effect the results are unambiguous . In this case the price of high quality rice increases and the price of wheat decreases when exports increase, leaving the price of low quality unaltered. This is basically the same result that one obtains when only one quality of rice is considered, as in the Bernard (1989) model.

To study the effects of exporting different qualities of rice the model [14] to [22] is solved numerically by specifying the demand and supply functions as linear logarithmic, with the coefficients of the linear terms interpreted as cross price elasticities.

Results of Simulations

Some of the parameters needed to implement the model empirically are not readily available; hence an informed guess is required. The assumptions relative to these parameters must be clearly stated. Sensitivity analysis with respect to these parameters helps to understand the robustness of the results. In the case of demand elasticities, for high quality rice, educated guesses have taken into account the parameters of the higher urban income groups. Similarly, for low rice quality, the parameters of the lower rural income groups have been taken into account. For supply elasticities, the major effects are assumed to go from rice price to wheat production and not vice-versa, at least when aggregate rice is considered.

The baseline of the exercises uses the 1989/90 level of production, availability, and prices. All foreign exchange earned from the export of rice is assumed to be spent to import wheat. All the baseline figures are given in Appendix 1.

Table 10 reports the results. The main conclusion is that once cross price elasticities for wheat and rice are taken into account, there is a tendency for the aggregate foodgrains price to go up, and this is most evident for wheat and the high quality rice. The reason is that the demand for wheat increases as a result of higher prices of rice and very high cross price elasticities with respect to rice price. Therefore, domestic aggregate price of foodgrains may go up, even though total foodgrain consumption increases as a result of rice for wheat swaps in the international market. By exporting 200,000 metric tons, total foodgrain consumption goes up by approximately 0.8 percent, that is by 147,000 metric tons with respect to the baseline case of no exports.

Higher foodgrain prices affect the distribution of food consumption of different income groups. High income groups are most likely to consume high quality rice, and therefore they will be mostly penalized. Low income consumers will not be affected negatively by higher prices of foodgrains, as long as they consume mostly lower rice quality. The reason is that consumption of wheat will more than compensate for any loss in rice consumption.

Note also that foodgrain consumption increases with the magnitude of supply and demand elasticities. As the commercialization of rice production increases, supply elasticities are also expected to go up, implying that bigger gains in total foodgrain consumption are expected from similar swap arrangements.

In summary, the export of moderate quantities of high quality rice has positive effect on aggregate foodgrain consumption, without compromising the food security of the poor.

8. PRECONDITIONS OF RICE EXPORTS

Besides competitiveness of prices, there are a few other important elements which should be appraised before undertaking export of rice. The focus of this section is on marketing infrastructure, and quality and grading.

Marketing Infrastructure (storage, milling, and transportation

The storage facilities presently available in the private sector are unsuitable for long term storage of foodgrains, and can at best be used for storing rice for short periods following its procurement at different points of the surplus producing areas (see Jahangir and Goletti 1992). Renting a part of government-owned warehouse facilities may help mitigate the immediate space and quality problems with regard to storage. In the long run, however, construction of more warehouses of standard specifications will be necessary to ensure delivery of good quality rice in the world market. The government may encourage the process by amending and simplifying banking regulations on credit facilities to the private sector entrepreneurs for construction of warehouses.

A vast majority of the existing milling facilities are incapable of producing internationally acceptable rice quality. The rice mills in Bangladesh are generally classified into three categories - husking, major, and automatic.

Husking mills, mostly found in rural areas, are only capable of separating the husk from the paddy. Bran is separated manually to obtain the final product. The rice so obtained still holds parts of brans due to lack of polishing under the process. Thus, the translucency in the rice, considered to be an important criterion for determining quality of rice in the world market, suffers. Percentage of broken grains, another important quality criterion, also turns out to be higher as such rice mills use stone hullers.

The major rice mills use a two stage process for milling rice. In the first stage, the husk is separated from the paddy. In the second stage, the bran is separated and the rice is polished to obtain clean rice. Some of these rice mills specialize in milling special variety aromatic rice, mostly in areas where production of such rice is concentrated. They do a fairly decent job. There is,

however, still much room for improvement. Just by switching from stone huller, they presently use, to rubber huller the percentage of broken rice can be further minimized. Some modernization may also be necessary to improve polishing quality of these mills.

In the automatic rice mills, parboiling, drying, milling and polishing are all done by the machines with minimal human touch. Most of these mills were set up around late 1970's and early 1980's and therefore have modern machineries capable of producing internationally acceptable quality of rice. There were 77 such rice mills in 1988 (BBS 88). Their capacity ranges between 16 to 24 metric tons per 8-hour shift. A conservative estimate, which uses the lower end of their capacity range, puts the annual total capacity of these rice mills at 1.2 million metric tons in three shifts. Consistent with other industries, 330 operational days in a year has been considered for obtaining the estimate. The capacity of these rice mills are presently underutilized due largely to higher cost of milling and limited demand for bulk milling. It is economically infeasible for these mills to process a less than optimal quantity of rice in one run. This idle capacity can be put to beneficial use once export of rice becomes a viable venture.

Adequate transportation facilities are already available for moving rice from the producing areas to the ports. Different means of transports - road, water and railway - are used for moving foodgrains from one place to another. Road transports, i.e. trucks, appear to be the most popular means of transportation used for the purpose. They are popular for being faster as well as less prone to pilferage. The scope of using waterways, the next most popular means of transporting rice, is limited as many of the traditional routes used for carrying foodgrains in bulk during the rainy season are rendered non-navigational in the dry season. However, country boats are still a popular means of transporting rice for being cheaper and also for being the only means of transportation in the remote riverine areas. The railway happens to be the most despised means of transportation for its high rate of pilferage and misplacement of wagons.

Carrying cost of foodgrains can be considerably minimized by improving the management of the railway and water transport networks. However, a basic infrastructural facility like

transportation encompasses a much larger area than foodgrain transportation and should therefore be addressed keeping the overall economic development of the country in perspective. Movement of foodgrains, including rice, will benefit in the process.

Quality and Grading

As Bangladesh shifts to a marginally surplus in rice production, more attention should be given on improving the quality of rice with a particular eye on the world market (see Kaosa-ard and Juliano 1991). The international rice market is very skeptic about the ability of temporary or new exporters to deliver rice of specified quality (Siamwalla and Haykin 1983). Because of this credibility gap, such exporters face a great deal of difficulty in disposing of their surplus stock in the world market. Hence, overall quality control of rice should receive utmost attention before export is undertaken.

It is, however, difficult to generalize consumer preference for cooking quality as well as shape and length of rice. It varies from country to country and even among the different types of consumers within a country. For example, high-income consumers in Bangladesh prefer fine grade rice of soft texture and non-sticky nature as opposed to the preference of non-sticky coarse rice of hard texture by the low-income consumers (Toquero 1991). Countries contemplating to enter the world market with fine to special quality rice should focus on developing intermediate-amylose (20-23 percent) rices with high recovery rate of head rice (whole grain). Intermediate amylose together with medium gel consistency (41-60 mm) guarantee cooking quality of non-sticky soft texture in rice. Chalkiness and shape are the two other quality aspects the researchers or the breeders for that matter can improve upon through varietal developments.

At present there exists no grading system of milled rice in Bangladesh. It is therefore essential that the country establishes a grading system before it undertakes export of rice. It is not necessary that the grades to be introduced in Bangladesh have to match perfectly with that of Thai or American standards. Some latitude can be used in determining the physical features of standardizing rice based on the varietal and milling features of the rice produced in Bangladesh. For

example, stipulated grain composition for Thai 5 percent broken rice is: 25 percent of extra long grain (with a tolerance of 5 percent more), 35 percent of long grain (with a tolerance of 5 percent more or less), and the rest shall be of medium grain for which not more than 10 percent of short grain are allowed (SGS 1982). For the fine variety Bangladeshi rice, which has been compared with that of Thai 5 percent broken rice, almost 100 percent long grain can easily be guaranteed as they are processed, milled and sold by genetic varieties. Absence of extra long grain in such a standardization is likely to be more than compensated by uniform size and shape of the grain.

Two other Bangladeshi varieties, medium and coarse, have similar advantages over their compared Thai grades. As for the special aromatic variety, compared with Pakistani Basmati rice, Kalizira is short and slender but highly fragrant and Kataribhog is long. They are not comparable in length to Basmati rice which is extra long. However, the chemical properties they possess or their genotype which determine cooking quality and the aroma in the rice may be superior to Basmati rice. A large proportion of the market for Basmati rice is in the Middle East where consumers prefer Pilaf rice, treated with butter and vegetable oil (Eve 1973). Both the Bangladeshi aromatic varieties, Kalizira in particular, apparently have all the qualities of ideal Pilaf rice. As a matter of fact, Kalizira and white Kataribhog rice are used by the Bangladeshi consumers as Pilaf rice for cooking special dishes. Therefore while standardizing the aromatic varieties of rice, emphasis should be given on the properties which make them ideal fragrant Pilaf rice.

9. CONCLUSIONS

In view of the likely surplus situation of rice and accompanying wheat deficit by the end of the decade, it is important to explore the possibility of exporting Bangladeshi rice in the international markets. One of the main factors affecting competitiveness is going to be the quality of the rice exported. This observation motivated the analysis of import and export parity prices compared to domestic prices of different qualities of rice. Using the available information, it was shown that there is a scope for exporting aromatic varieties of rice, namely Kalizira and Khataribhog, to compete in

the international market for Basmati rice. It was also shown that cross price effects among different varieties of rice and wheat are important determinants of the impact of swapping rice exports for wheat imports in the international markets. Rice swaps increase foodgrains consumption, mainly through increased consumption of wheat. Rice exports increase the domestic prices of foodgrains, including wheat. As long as the level of exports is low, namely less than 200,000 metric tons, the overall price and consumption effects are small. For higher level of exports, however, price increases may become relevant.

The feasibility of exporting rice depends on a set of policy measures. First of all, policy should create favorable conditions for the development of export markets, raising many of the objections present in the past. The recent abolition of anti-hoarding laws and trade restrictions are positive steps in the right direction. The process of export is to be kept simple to avoid any inordinate delay in completing paper works. Second, the existing infrastructure and equipment affecting transportation, storage, and milling should be updated and expanded. Third, a grading system should be introduced, to raise the average quality of rice consumed domestically, and to enhance the likelihood of exporting successfully in the international market. Finally, the opening of the international market should be done gradually, so that the negative effects deriving from instability imported from outside could be absorbed smoothly.

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Table 1. Expected values of foodgrain Excess Demand, Prices, Consumption, and Growth in year 2000.

	Expected Value	Expected Value Under Assumption of High Rice Yield Growth	Expected Value Under Assumption of Low Rice Yield Growth
Excess Demand in Year 2000 (Thousand metric tons)			
Rice	-157	-593	275
Wheat	1535	1535	1535
Foodgrain	1377	941	1810
Price in year 2000 (Taka/maund)			
Rice	384	371	397
Wheat	263	263	278

	Expected Value in Year 2000		Expected Value in Year 2000 Under Assumption of High Rice Yield Growth		Expected Value in Year 200 Under Assumption High Rice Yield Growth	
	Foodgrain Consumption (grams/day/cap)	Growth (%)	Foodgrain Consumption (grams/day/cap)	Growth (%)	Foodgrain Consumption (grams/day/cap)	Growth (%)
Rural Quartile 1	442	0.93	448	1.11	435	0.76
Rural Quartile 2	532	1.19	541	1.39	523	0.99
Rural Quartile 3	565	0.81	572	0.97	557	0.65
Rural Quartile 4	561	0.17	567	0.30	554	0.04
Urban Quartile 1	443	1.16	451	1.38	435	0.94
Urban Quartile 2	504	1.44	518	1.80	490	1.09
Urban Quartile 3	483	0.52	488	0.64	478	0.40
Urban Quartile 4	433	-0.09	437	0.00	430	-0.18

Source: Computed by author based on data from Statistical Yearbook of Bangladesh, various issues, and Household Expenditure Survey, BBS (1991).

Note: A negative sign in excess demand refers to expected supply greater than expected demand. High rice yield growth is 2.5 percent; low rice yield growth is 2.1 percent.

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Table 2. Effects of Different Rice Procurement Scenarios.

VARIABLES	INITIAL CONDITIONS	EXPECTED VALUES IN YEAR 2000		
		Scenario 1: Rice Procurement Growth: 0 Percent	Scenario 2: Rice Procurement Growth: 2.5 Percent	Scenario 3: Rice Procurement Growth: 5 Percent
Price of Rice (Taka Per Maund)	388	384	390	397
Price of Wheat (Taka per Maund)	299	263	269	277
Increase in Rice Stock (Thousand Metric Tons)	0	0	895	1918
Ratio of Rice Procurement to Production (Percent)	4.2	3.4	4.1	5.3

Source: Computed by author based on data from Statistical Yearbook of Bangladesh, various issues, and Household Expenditure Survey, BBS (1991).

Table 3. Ratio of world exports to world milled production of rice.

	Production			
	Paddy Rice	Milled Rice	Exports	Export/Production Ratio
	('000 MT)		('00 MT)	(percent)
1975	359124	239416	77176	3.2
1976	350151	233434	89114	3.8
1977	371801	247867	108239	4.4
1978	387732	258488	95595	3.7
1979	377363	251575	116335	4.6
1980	399201	266134	129555	4.9
1981	412025	274683	130605	4.8
1982	423956	282637	120467	4.3
1983	451517	301011	115017	3.8
1984	469425	312950	128720	4.1
1985	472019	314679	114080	3.6
1986	471315	314210	130190	4.1
1987	464993	309995	129461	4.2
1988	490609	327073	121848	3.7
1989	517565	345043	148969	4.3
1990	518508	345672	120440	3.5
Annual trend growth rate [%]:				
1975-90		2.67	2.57	-0.1
1975-79		2.01	8.91	6.9
1980-84		4.16	-1.4	-5.57
1985-90		2.3	1.76	-0.56

Source: All production data from FAO Agrostat database, trade data from FAO up to 1989. 1990 trade data from ERS, USDA, rice situation and outlook report 1991. Milled rice figures have been obtained by applying a factor of 66.67 percent to paddy rice production.

Note: Trend growths have been computed using semi-logarithmic linear trend equation fitted to the time series data based on the least square method.

Table 4. Rice export levels, market shares, and ratios to milled production of major exporters.

Year	Thailand	U.S.	Pakistan	Vietnam	Myanmar	Total
			--(percent)--			
Annual Growth Rates of Exports						
1975-90	8.6	0.61	2.54	39.46	-7.08	4.75
1975-79	19.56	2.24	14.85	23.15	8.29	10.42
1980-84	11.4	-9.83	-0.14	194.71	4.39	2.41
1985-90	2.86	5.04	-0.57	65.45	-30.38	5.36
Average Market Shares						
1975-90	29.2	21.0	8.4	1.8	4.4	64.7
1975-79	20.5	23.2	8.2	0.3	5.1	57.3
1980-84	28.5	21.2	8.7	0.3	5.8	64.4
1985-90	37.1	18.9	8.2	4.2	2.6	71.1
Market Share Annual Growth Rates						
1975-90	6.04	-1.96	-0.05	63.67	-9.7	2.18
1975-79	10.67	-6.63	5.83	-87.4	-0.76	1.51
1980-84	12.8	-8.52	1.24	142.86	5.93	3.85
1985-90	1.12	3.23	-2.38	63.94	-32.61	3.59
Average rice exports as a percentage of milled production						
1975-90	28.94	59.39	30.86	1.96	6.15	20.54
1975-79	20.16	61.16	27.04	0.46	7.76	18.32
1980-84	28.96	62.12	32.80	0.36	7.68	20.90
1985-90	36.23	55.63	32.43	4.55	3.53	22.10
Annual growth rates of rice exports as a percentage of milled production						
1975-90	6.45	-0.87	1.68	45.63	-10.12	2.12
1975-79	17.56	0.31	8.91	-79.29	4.50	8.17
1980-84	7.73	-2.75	-1.06	145.09	2.90	-0.22
1985-90	2.77	1.20	-0.87	60.49	-29.87	3.98

Source: FAO Agrostat database. ERS, USDA, Rice Situation and Outlook Report, October 1991.

Note: Growths rates have been computed using semi-logarithmic linear trend equation fitted to the time series data based on the least square method.

Table 5. Paddy rice production and yields of major exporting countries and Bangladesh.

Year	Thailand	U.S.	Pakistan	Vietnam	Myanmar	Bangladesh
			(percent)			
Annual growth rate of paddy rice production						
1975-90	2.16	1.47	0.85	4.15	2.91	2.5
1975-79	2.07	1.95	5.9	-0.38	3.75	1.02
1980-84	3.68	-7.09	0.93	7.45	1.46	1.66
1985-90	0.06	3.83	0.34	3.91	-0.65	4.71
Average paddy rice yields			(MT/Hectare)			
1975-90	1.95	5.58	2.41	2.50	2.69	2.12
1975-79	1.81	5.09	2.35	2.03	2.03	1.88
1980-84	1.97	5.27	2.53	2.43	3.01	2.07
1985-90	2.04	6.24	2.37	2.94	2.98	2.37
Annual growth rate of paddy rice yields			(percent)			
1975-90	1.07	1.83	-0.06	3.41	3.3	42.30
1975-79	0.47	-0.22	0.96	-2.78	6.03	1.13
1980-84	2.23	1.84	0.14	7.24	2.63	2.54
1985-90	-0.68	0.38	-1.84	3.07	-1.21	4.63

Source: FAO Agrostat data base. 1990 data from ERS, USDA.

Note: Trend growths have been computed using semi-logarithmic linear trend equation fitted to the time series data based on the least square method.

Table 6. Average domestic, international, and export parity prices of various rice varieties.

Period	Domestic Wholesale Price	International Market Price	Export Parity Price	Domestic Price as % of Export Parity Price
		Fine Rice		
1975-91	8205	7622	6478	127
1975-80	4821	5455	4637	108
1981-86	8240	7734	6574	132
1987-91	12225	10086	8573	145
		HYV Coarse Rice		
1975-91	6723	6739	5728	119
1975-80	4067	4869	4138	103
1981-86	6845	6971	5926	121
1987-91	9763	8703	7398	134
		Aromatic Kalizira Rice		
1975-91	12089	16856	14327	87
1975-80	7102	9907	8421	92
1981-86	12140	18464	15694	78
1987-91	18011	23264	19775	91
		Aromatic Kataribhog Rice		
1975-91	10699	16856	14327	77
1975-80	6286	9907	8421	81
1981-86	10745	18464	15694	69
1987-91	15941	23264	19775	81

Sources: A Data Base on Agriculture and Foodgrains in Bangladesh (1947/48-1989/90) August 1991, Mohammad Abdul Hamid Ph.D.; Directorate of Agricultural Marketing; Ministry of Agriculture; World Rice Statistics 1990, International Rice Research Institute (IRRI). Kalizira and Khataribhog are based on 1991 wholesale prices collected from eight dealers based at Badamtali market, Dhaka and used to extrapolate prices in previous years by using factors in inter-year fluctuations in fine aman rice prices. International prices for basmati rice are from the Rice Export Corporation of Pakistan.

Notes: Domestic prices of fine are for fine variety aman rice. International fine prices are f.o.b. for Thai 5% brokens. International prices comparable to domestic HYV are f.o.b. for Thai 25% super. International prices comparable to the special aromatic varieties are for Pakistani Basmati rice. Export parity prices have been obtained by multiplying international market prices by a factor of 0.85. The remaining 0.15 accounts for cost and profit margin of the exporter.

TABLE 7- Average domestic, international, and import parity prices of various rice varieties.

Period	Domestic Wholesale Price	Domestic International Market Price	Import Parity Price	Price as % of Import Parity Price
		(Taka per Metric Ton)		
		Fine Rice		
1975-91	8205	7622	9355	88
1975-80	4821	5455	6642	75
1981-86	8240	7734	9534	90
1987-91	12225	10087	12396	100
		HYV Coarse Rice		
	1975-91	6723	6739	834081
1975-80	4067	4869	5968	71
1981-86	6845	6971	8657	82
1987-91	9763	8703	10806	91

Sources: A Data Base on Agriculture and Foodgrains in Bangladesh (1947/48-1989/90) August 1991, Mohammad Abdul Hamid Ph.D.; Directorate of Agricultural Marketing, inistry of Agriculture; World Rice Statistics 1990, International Rice Research Institute (IRRI). 1990-91 data are from IRRI.

Notes: Domestic fine prices are for fine variety aman rice and international fine rice prices are f.o.b. for Thai 5% brokens. International prices comparable to domestic HYV Course rice are f.o.b. for Thai 25% super. For computing import parity prices, first a freightcost of $20 per metric ton has been added across the board to derive an estimated C & F price for the concerned Thai grade. Then C & F prices have been multiplied by 1.15 to obtain the import parity prices.

Table 8. Rice Price Variability of Domestic, International, and Border price.

Period	INTER-YEAR VARIATION Coefficient of Variation			INTRA-YEAR VARIATION Coefficient of Variation		
	Domestic Price	International price	Border Price	Domestic Price	International Price	Border Price
70-80'S	14.8	29.5	18.7	10.4	10.1	10.0
70'S	28.1	30.4	19.7	13.9	12.0	12.8
80'S	7.5	14.8	10.9	7.3	8.4	7.5

Source: Computed by the author based on Wholesale coarse rice price from the Department of Agricultural Marketing and 5% broken Thai export prices converted in Taka. from World Rice Statistics.

Note: The 70's refer to 1972-1980.
The 80's refer to 1981-1990.

Table 9. Average percentage difference between domestic and international prices of rice varieties by month.

Month	Domestic Fine/ World Fine	Domestic Medium/ World Medium
	(percent)	
Jan.	25.3	23.8
Feb.	28.1	28.8
Mar.	31.7	32.2
Apr.	37.6	37.6
May	38.2	37
Jun.	37.9	34.9
Jul.	40.2	37.9
Aug.	40.2	37.1
Sep.	45	40.1
Oct.	46.4	39.3
Nov.	33.3	25.8
Dec.	24.8	21.5

Sources: A Data Base on Agriculture and Foodgrains in Bangladesh (1947/48-1989/90), August 1991, Mohammad Abdul Hamid Ph.D. Directorate of Agricultural Marketing, Ministry of Agriculture. Foreign Agricultural Service, USDA.

Notes: Domestic fine is represented by aman fine. Domestic Medium is represented by aman medium. International fine is represented by Thai 5% broken. International medium is represented by Thai 15% broken. The averages are by month for the period, 1982-89.

Table 10. Simulation of rice export swap.

	Demand Elasticities				Supply Elasticities				Percent				Percent
	H	L	W		H	L	W		H	L	W		
High Quality	-0.50	0.0	0.00	High Quality	0.20	0.00	0.00	Price	11.71	0.00	-12.87	Total Foodgrain	0.78
Low Quality	0.00	-0.60	0.00	Low Quality	0.00	0.05	0.00	Demand	-5.39	0.00	14.77	Total Rice Production	-0.02
Wheat, W	0.00	0.00	-1.00	Wheat, W	0.00	0.00	0.60	Production	2.24	0.00	-7.93	Aggregate Rice Price	1.75
High Quality	-0.50	0.10	0.00	High Quality	0.20	-0.50	0.10	Price	12.95	5.28	6.19	Total Foodgrain	0.62
Low Quality Rice	0.20	-0.60	0.00	Low Quality	-0.05	0.05	-0.05	Demand	-5.42	-0.65	17.89	Total Rice Production	-0.19
Wheat, W	1.00	2.00	-1.00	Wheat, W	0.00	-0.60	0.60	Production	2.20	-0.65	0.52	Aggregate Rice Price	6.48
High Quality Rice	-0.50	0.10	0.00	High Quality	0.40	-0.10	0.00	Price	9.95	3.77	1.16	Total Foodgrain	0.94
Low Quality Rice	0.20	-0.60	0.00	Low Quality	-0.10	0.20	-0.10	Demand	-4.28	-0.32	17.04	Total Rice Production	0.16
Wheat, W	1.00	2.00	-1.00	Wheat	0.00	-0.70	0.70	Production	3.48	-0.32	-1.77	Aggregate Rice Price	4.78
High Quality Rice	-0.50	0.10	0.00	High Quality	0.10	-0.03	0.00	Price	15.05	5.74	9.25	Total Foodgrain	0.56
Low Quality Rice	0.20	-0.60	0.00	Low Quality	-0.03	0.01	-0.03	Demand	-6.25	-0.54	17.74	Total Rice Production	-0.25
Wheat, W	1.00	2.00	-1.00	Wheat	0.00	-0.04	0.04	Production	1.27	-0.54	0.13	Aggregate Rice Price	7.14
High Quality Rice	-0.80	0.40	0.00	High Quality	0.20	-0.05	0.00	Price	8.93	1.85	3.09	Total Foodgrain	0.68
Low Quality Rice	0.20	-1.20	0.00	Low Quality	-0.05	0.05	-0.05	Demand	-5.93	-0.49	17.96	Total Rice Production	-0.13
Wheat, W	2.00	3.00	-2.00	Wheat	0.00	-0.60	0.60	Production	1.63	-0.49	0.73	Aggregate Rice	2.94
High Quality Rice	-0.20	0.10	0.00	High Quality	0.20	-0.05	0.00	Price	25.14	7.93	8.94	Total Foodgrain	0.50
Low Quality Rice	0.05	-0.30	0.00	Low Quality	-0.05	0.05	-0.05	Demand	-3.65	-1.16	17.90	Total Rice Production	-0.32
Wheat	0.50	1.25	-0.50	Wheat	0.00	-0.60	0.60	Production	4.19	-1.16	0.56	Aggregate Rice Price	10.57

Source: Computed by author.
Note: Export of high quality rice=200 thousand metric tons.

APPENDIX 1

Table 11 - Rice and Wheat Elasticities.

	Own Price Elasticity		Expenditure Elasticity		Cross Price Elasticity	
	Rural	Urban	Rural	Urban	Rural	Urban
Rice						
Quartile 1	-0.89 *	-1.02 *	0.8 *	0.58 *	0.04	0.26 *
Quartile 2	-0.71 *	-0.76 *	0.71 *	0.43 *	-0.01	-0.18
Quartile 3	-0.55 *	-0.38 *	0.64 *	0.19	0	-0.05
Quartile 4	-0.39 *	-0.5 *	0.03	-0.03	-0.09	0
All	-0.56 *	-0.59 *	0.39 *	0.15 *	0.01	-0.01
Wheat						
Quartile 1	-1.23 *	-2.79 *	-1.37 *	-0.21	3.14 *	3.91 *
Quartile 2	-0.99 *	-2.49 *	0.05	0.33	2.1 *	3.43 *
Quartile 3	-0.49	-0.86	-1	-0.02	1.31 *	2.03 *
Quartile 4	-0.21	0.94 *	-0.19	0.29	1.88 *	0.34
All	-0.82 *	-1.06 *	-0.44 *	-0.01	2.05 *	2.35 *

Source: Computed by author based on Household Expenditure Survey, BBS (1991).

Note: '*' indicates elasticities significant at 90% level.

APPENDIX 1

Table 12. Assumptions for the base year (1990/91) parameters used in the demand and supply projections.

	Unit	Parameter
Production of rice	(Thousand metric tons)	17852
Production of Wheat	(Thousand metric tons)	1004
Rice Yield	(Metric tons per hectare)	1.71
Wheat Yield	(Metric tons per hectare)	1.67
Population in Base Year	(Million)	108.9
Outmigration Rate	(Percent)	1
Urbanization Rate in Base Year	(Thousand metric tons)	21
Procurement of Rice	(Thousand metric tons)	744
Procurement of Wheat	(Thousand metric tons)	53
Offtakes of Rice	(Thousand metric tons)	744
Offtakes of Wheat	(Thousand metric tons)	1464
Losses due to seed, feed and wastage	(Percent)	7.75
Rice Price	(Taka/maund)	388
Wheat Price	(Taka/maund)	299

Per Capita Intake	RICE		WHEAT	
	Rural	Urban	Rural	Urban
	(Grams/capita/day)			
Quartile 1	340	348	67	54
Quartile 2	414	394	66	53
Quartile 3	466	409	60	53
Quartile 4	504	384	48	53

Source: Computed by author based on data from Statistical Yearbook of Bangladesh, various issues.

APPENDIX 1

Table 13. Assumptions about growth and distribution of exogenous variables.

		(percent)		
		Low	Medium	High
Population growth		1.5	1.86	2.0
Rice yield growth		2.1	2.3	2.5
Wheat yield growth		1.0	1.0	1.0
Distribution of Income Growth		**Rural**	**Urban**	**Total**
	Low	0.58	0.58	1
No Urban Bias	Medium	1.58	1.58	2
	High	2.57	2.57	3
	Low	0.52	0.68	1
Urban Bias	Medium	1.41	1.83	2
	High	2.3	2.99	3

Acreage Elasticities	Rice Price	Wheat Price	Rice Yield	Lagged Wheat Acreage
Rice	0.01		0.15	
Wheat	-0.6	0.6		0.88

Source: Computed by author; Acreage Elasticities from Mahmud, Rahmon, and Zohir (1993).

APPENDIX 1

Table 14. Assumptions for the probability weights of different growth scenarios.

	Probability
Production growth	
Low (2.4 percent)	1/3
Medium (2.7 percent)	1/3
High (3.0 percent)	1/3
Population growth	
Low (1.5 percent)	1/4
Medium (1.86 percent)	1/2
High (2.0 percent)	1/4
Level of per capita income growth	
Low (1 percent)	1/4
Medium (2 percent)	1/2
High (3 percent)	1/4
Distribution of per capita income growth	
No urban bias	1/5
Urban bias	4/5

Source: Computed by author.

APPENDIX 1

Table 15 - Base year (1990/91) parameters used in the swap model simulations

Parameter	Units	Value
Margin of high quality over low quality	(percent)	15
Percentage of total rice production that is low quality	(percent)	85
Percentage of total rice production used for human consumption	(percent)	90
Price of low quality rice coarse rice	(Taka/Maund)	355
Price of high quality rice	(Taka/Maund)	408
Total production of rice	(Thousand Metric Tons)	17852
Production of wheat	(Thousand Metric Tons)	1004
Import of rice	(Thousand Metric Tons)	300
Import of wheat	(Thousand Metric Tons)	1234
International price of rice	(US $/MT)	320
International price of wheat	(US $/MT)	185
Share of total rice imports that are food aid	(percent)	30.4
Share of total wheat imports that are food aid	(percent)	67.7

Source: Computed by author, based on data from Statistical Yearbook of Bangladesh, various issues.
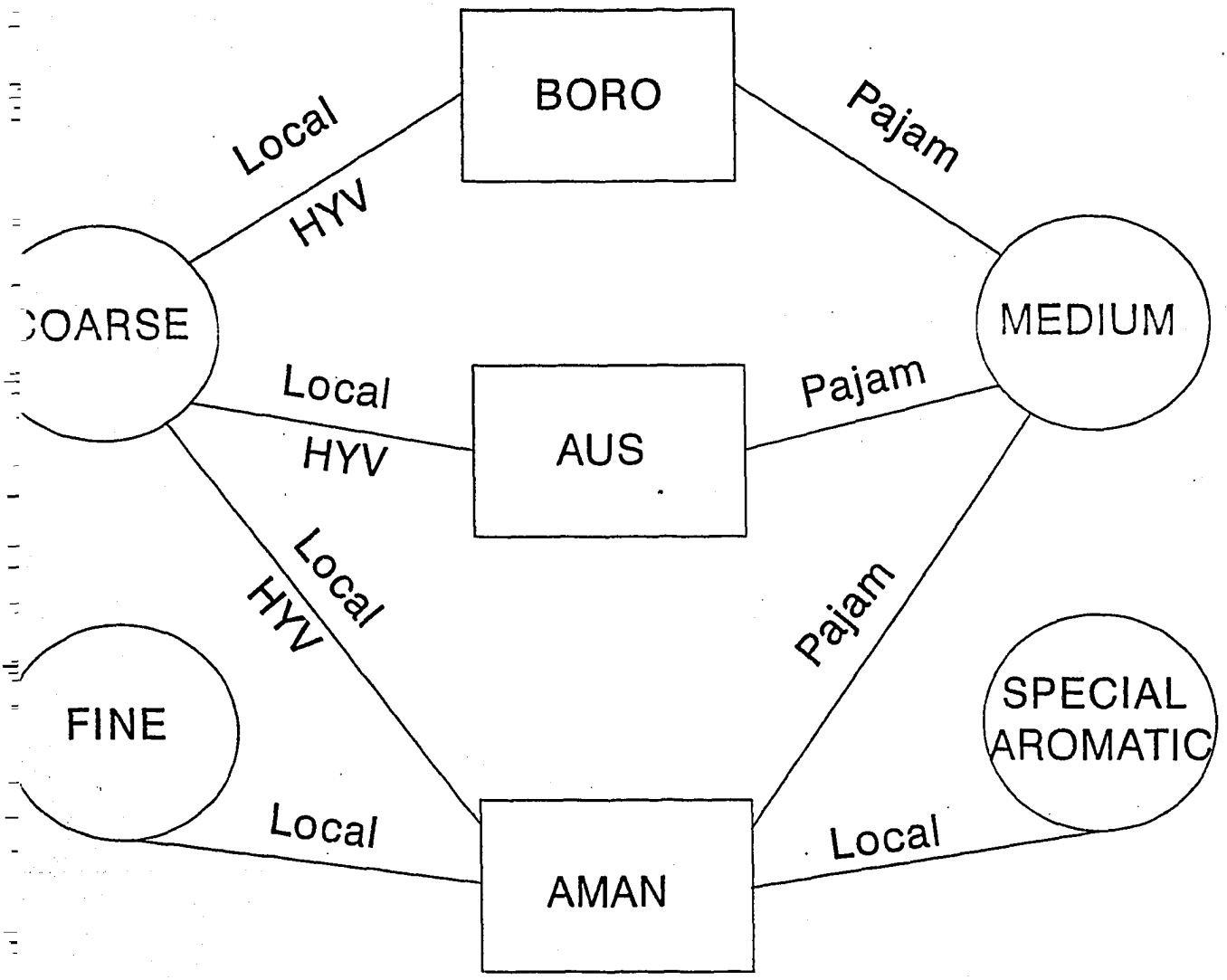
FIG. 1: RICE VARIETIES