

# **Getting Agriculture Moving Once Again: Strategic Options for Post-HYV Agriculture in Bangladesh**

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## EXECUTIVE SUMMARY

Bangladesh agriculture has over the last thirty years been basically a rice-dominated crop agriculture. The output growth has been very substantial and characterised by increasing dependence on the dry period irrigated *boro* HYV and of late hybrid rice; the change-over to *boro* HYVs largely through conversion of the land from the overlapping *aus* season the prospects which are now limited; and largely static absolute acreage but variable output from wet period *aman* rice.

Several challenges are now facing agriculture. Not only it will have to ensure food security, help in poverty reduction, stabilize the incomes of the farmers, satisfy consumer preferences and also to contribute to overall growth of the economy but this will have to be achieved under several major constraints. These are related to various climate and weather-induced risks, ecological and public health issues, ever falling size of farms and land-man ratio, global competition and also high and volatile prices of essential inputs such as fertiliser and oil as well as high (falling now, though) international and domestic foodgrain prices;

Bangladesh may in this situation have three core longer term strategic choices before her. These include (a) technology generation to widen the choice to farmers (for stabilization of income through diversification) as well as development of varieties and farming systems and related agronomic practices suited to different and changing ecological conditions, (b) reaching information about new technology to farmers through an effective extension system and (c) development of marketing (domestic as well as exports) as more of income-elastic commodities are expected to be produced.

In the short run, a more clearly focused inputs subsidy policy may need to be adopted. Several options may be defined depending whether the subsidy needs to be targeted or universal as well as whether both fertiliser and diesel subsidy may be given and whether it be given in cash or through a pricing system.

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## **PREAMBLE**

### **The basic research problem**

Agriculture (defined broadly), despite its fall in importance in GDP in recent years (see later), remains otherwise extremely important due to its role in food security, and as the major source of employment and livelihood to the greatest number of people in Bangladesh as well as its contribution through forward and backward linkages with the rest of the economy. Yet, it has suffered a long relative neglect in policy intervention as well as investment by the public sector. Given the price shocks experienced over the last one and a half years, particularly due to food prices first spiraling upwards and subsequently sliding down very substantially over the last few months, time has now come to give the sector a fresh look to understand the possibilities of and constraints to the further development of the sector for it to play a core strategic role in the over-all growth process in the economy as well as contributing to the eradication of poverty. The present study tries to do so by examining the efficacy and outcomes of previous policies and interventions and suggesting new (or may be not so new) directions to the sector.

### **Terms of reference for the study**

The ToR for the study, in addition to policy recommendations, cites the need to examine five types of issue which are as follows:

- i. Review of evidence of relative importance of various types of factors in growth of agriculture
- ii. Review of impact of various policies
- iii. Issue of fertiliser subsidy and the pricing
- iv. Differential benefits of fertiliser and diesel subsidy
- v. How to maintain incentives for agriculture as well as balance the interests of private agents vis-à-vis the State particularly regarding intervention in the output market through procurements and imports

The ToR implies that the first set of issues that needs attention is that of the factors that determine one way or other the developments and changes in agriculture. We therefore discuss in a generic manner first these issues and then examine those in Bangladesh that need close attention.

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## **FACTORS BEHIND AGRICULTURAL GROWTH**

### **Broad issues**

The level of agricultural output and its growth depends on a host of factors, not all of which may be critical or binding, at any given point in time or in any given country. These may be broadly listed as under:

natural resource endowments i.e., the physical environment within which the farm sector operates;

organisation of production (farm size distribution, tenurial relationships on land);

means of production (capital, technology) and background factors upon which these depend such as agricultural support systems (research and extension system, agricultural skill and education, marketing system, credit);

policy environment (input and output pricing policies, various macroeconomic policies including trade issues which may determine the profitability of agriculture through the movements in the rural-urban terms of trade); and

the demand (intermediate and final) for agricultural output.

The list of issues that need to be attended to is thus potentially long, although in any given country and time all of them may not be critical to be considered. Furthermore, the present discussion and treatment of the issues is also constrained by what is available in the literature. In case we believe that certain issues are important but not treated well empirically, we will basically only flag the importance of the issue. In any case, a highly schematic diagram depicting these broad and other background factors is shown in Fig. 1 in Annex 1.

### **Analytical method**

We begin with an analysis of the record of the growth of agricultural output and productivity, both temporally and spatially. Available time series data as well as regional information from the available literature will be utilised for the purpose. This will be followed by an investigation of the factors that may have contributed to the changes in productivity and output and if the presence or absence of any of them may have constrained the growth of the sector or may do so in future. For the purpose of this paper, we intend to analyse and emphasise as far as possible the key roles of technological change, input and output prices and the nature and extent of demand.

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One hypothesis could be that the growth and pace of agriculture depended on its profitability. We will therefore try to make a counterfactual analysis of agricultural profitability in the context of high input and output prices and try to understand the implications for future agricultural growth and support to agriculture such as subsidy. Another way to look at the profitability is by examining the prices of output and inputs such as major fertiliser types, diesel and electricity for irrigation.

In agriculture, the question of technology may be approached from basically two angles, land-saving technology or labour-saving technology. Particularly, in case of the land-saving technology, the problem probably begins with that of the quality as well as the type of seed (HYVs vs hybrid). So far as is known, the problem of availability of quality seed may be quite a constraint to agricultural production. We will come back to this issue later on.

The other type of technological change is the increasing capitalization of agriculture to save labour. Question is had this been beneficial in terms of raising output or equity? Previously, it had been shown that this had been beneficial in increasing cropping intensity and by implication in output growth (Mandal and Asaduzzaman: 2002).

#### *Policy issues*

In discussing the factors contributing to growth, we shall refer to the policies that made the interplay of the above factors possible. Input subsidy policy, particularly in fertiliser and also the earlier irrigation deregulation policies will be noted. We shall try to discuss the contribution of the diesel subsidy policy and its nature in influencing agricultural output growth<sup>1</sup>. The emphasis will be mainly on the crop subs-sector and again mostly on rice because of the general paucity of data on and analyses of other crops and sub-sectors in agriculture.

One particular aspect that needs to be investigated is the issue of fertiliser use which has been influenced by the low and subsidized prices of nitrogenous fertiliser such as urea the subsidy being provided indirectly through subsidized sale of natural gas to domestic urea factories as well as through subsidizing dealer prices for imported fertiliser with the hope that the dealers will pass on the subsidy on to the farmers by charging lower than the price of import.<sup>2</sup> This is important to the policy maker for two reasons.

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<sup>1</sup> This may not be exactly possible at least at present because the government had announced diesel subsidy much after actual rice planning had taken place.

<sup>2</sup> This year, certain changes have been made to the system which will be discussed later.

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The first one is that subsidising imported urea particularly when its international price is high leads to budgetary pressure. On the other hand, subsidy on urea keeps its relative price low skewing its demand in its favour against TSP and Potash, two of the other major fertiliser in use in the country. The use of fertiliser may not therefore be balanced with adverse impact on output. One therefore needs to examine the desirability of the present fertiliser subsidy including the issue of the fertiliser distribution system and their revision for a more timely availability and balanced use of fertiliser.

*Agricultural R&D and Extension Systems in the Public Sector*

Two particular support service policies in the public sector and their actual practice need to be examined for their critical role in generating technology and their dissemination. These are the R&D system as reflected in the NARS and the extension services. Furthermore, we also would like to examine the issue of credit policies and credit disbursements as far as available data will allow.

*Distribution of subsidy benefits and procurement prices*

The issue of subsidy also brings to the fore the trade-offs between welfare vs incentives and needs to be examined in the light of access to inputs and actual benefits obtained by various groups of farmers. Similar question arises regarding the distribution of benefits of procurement prices. These results need to be balanced with the incentives that farmers may have received due to the price rises last year and whether subsidies are still needed to encourage the farmers to raise productivity. This then ties up with the counterfactual analysis that we have intended to do as stated earlier.

*State vs private sector in the input and output market intervention*

Both the State and the private sector are involved in the input and output markets. In the case of fertiliser and seeds, particularly hybrid seeds, the private sector plays a key role. In domestic procurement while the Government holds the stock, it is the millers through whom the bulk of the procurement is made. One may question if the floor price announced by the Government is paid to the farmers? Or, in other words, do millers reap the margin and farmers really do not get much benefit?

Similarly, the efficacy of the imports under private licenses or by the State may be examined given the present high food prices and the need to build up stocks. Given that the private sector and the State may have different objectives (of profit for the former and people's welfare in case of the latter), how can one reconcile the two?

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So far we have not referred to the issue of marketing of output. In case of cereals, the market is known to behave more or less efficiently, at least so far. This conclusion needs to be revised if we consider other non-cereal food, both crop and non-crop, which are often perishable. An examination of the present marketing system is necessary and the constraints it imposes on the whole agricultural system needs to be assessed for future policy directions.

#### *Non-crop agriculture*

Non-crop agriculture, particularly, fisheries and, livestock and poultry are major sources of food, employment and livelihood to many. The balanced development of agriculture can not take place without the growth of these sectors. Furthermore, the nature of demand of non-cereal food indicates that their demand is going to increase in future as income increases. We intend to show estimates of income elasticity of different types of food based on the data from the HIES 2005 and examine the issues of demand more clearly.<sup>3</sup>

#### *Recommendations for future of agriculture*

The assessment of the critical nature or the relative importance of the various factors that have been discussed above may now be put together. This we intend to do in the framework of the future desirable rate of growth of agriculture in a globalised framework. We would like to assess what the immediate and medium to long run problems are. The final recommendations for agricultural growth and the distribution of the benefits of growth will depend on these assessments.

One particular issue related to these recommendations is if and how far the present move towards continuous use of land for agricultural production may be feasible and if it is desirable particularly on the ground of sustainability.<sup>4</sup> We will also briefly examine here if the recommendations imply any specific action within the framework of a globalised trade regime under WTO rules and negotiations. Furthermore, we would also like to indicate how Bangladesh's agriculture may have to face new challenges due to climate change.

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<sup>3</sup> One may argue that this may not be a very relevant issue given the surge in output prices witnessed last year which is enough of an incentive for producers. However, the surge may not last for all the time to come and indeed it has not as the present tumbling of prices have shown. And in any case, the development of non-crop agriculture is a long-term strategic issue and thus needs to be aligned with long-run demand only a small part of which may be demand for own consumption by producers (subsistence demand).

<sup>4</sup> There is not much of a literature on land use sustainability or land degradation. For somewhat dated analysis and estimates see Asaduzzaman and Toufik (1997). There is now a major project on sustainable land management under the Ministry of Environment and Forest. It is yet to take-off, however.

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### **Data and information**

The time allowed for the present study precludes any primary survey. The main sources of information shall be published and unpublished documents and data. Wherever secondary data needs to be analysed more in-depth, given that the disaggregated data are available, we will do so like the estimation of income elasticity or the construction of the counterfactual.

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## BROAD TRENDS IN THE ECONOMY AND AGRICULTURE

### Agriculture's contribution to GDP

National income in Bangladesh at one time originated mainly in agriculture. This is no longer the case. Agriculture now contributes only just about a fifth of the GDP with manufacturing industry accounting for another 15-16 percent. Much of the rest is due to various services, trade and transport being the most important among them.

The broad trends of the economy over the recent decade or so indicates that while the trend of GDP has been unmistakably upward, this appears to be shared more by the tertiary services rather than the material producing sectors such as agriculture. The estimated rate of growth of agriculture is the lowest of the rates for all sectors (Table 1).

**Table 1. Rates of growth of sectors and sub-sectors (1997/98-2007/08)**

Sector/subsector	Rate of growth
Agriculture	3.4
<i>Crops</i>	3.1
<i>Livestock</i>	4.6
<i>Forestry</i>	4.7
<i>Fisheries</i>	3.0
Mining	7.3
Industry	6.9
Services	5.9
GDP	5.5

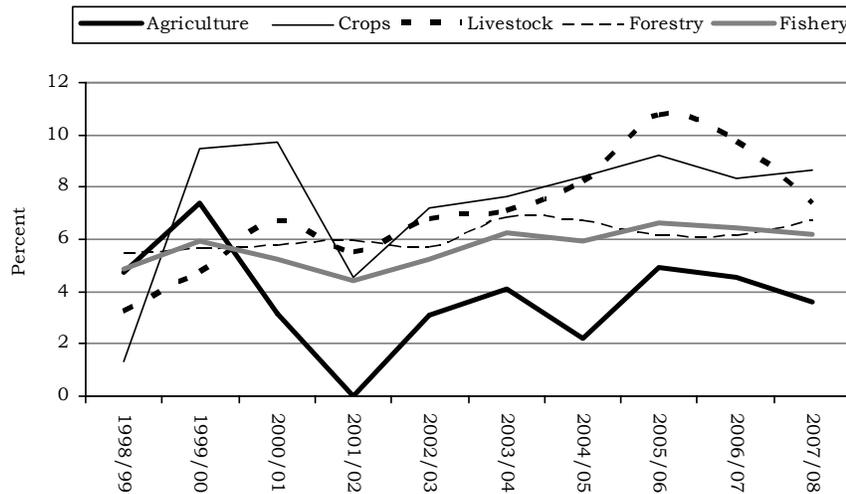
Source: Author's estimates based on official data

### Performance of sub-sectors of agriculture

Within broad agriculture, however, the sub-sectors have behaved differently. Livestock and forestry, for example, have grown at rates almost 50% faster than crops. Given the weight of crops in over-all agriculture, however, whatever happens to crops determines by and large whatever happens to agriculture.

The above rates of growth are rather average long term rates. There are, however, substantial year to year variations in these rates (Fig. 1). Such volatility is most pronounced in case of crops among the sub-sectors which largely sets the pattern for year on year fluctuations in the agricultural GDP.

**Figure 1. Year to year fluctuations in the rates of growth in agriculture and sub-sectoral GDP**



### Dominance of rice

One characteristic of the crop sub-sector that has not changed over the past three decades is the predominance of rice in terms of area. In 2003/04, 2004/05 and 2005/06 the total gross cropped area in the country had been 35.1, 34.8 and 33.9 million acres. Rice alone accounted for 26.7, 25.6 and 26 million acres of the total. That means rice contributed around 75% to the cropped acreage. Whatever happens to rice thus by and large determines what happens to agriculture. As rice is the main staple and accounts for major part of expenditure on food and calorie intake, production, availability and access to rice determine whatever happens to food security. We therefore need to look at the performance of rice crop cultivation somewhat in detail.

### Rice acreage, output and yield

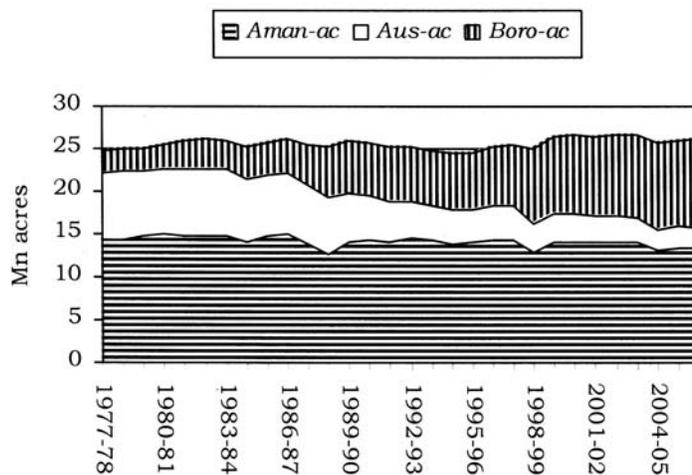
Rice, as is well-known, is grown in three seasons. *Aman* is grown in part-rainfed, part dry season (extending from July/August to December/January), followed by the dry period and irrigated *boro* (over February/March to April/May) and finally, the completely rainfed *aus* season (April/May to August/September). While these seasonal spreads are generally valid, the exact growth period of a particular variety of rice in a particular season and locality may vary and unless the varieties are carefully developed and/or screened, any given piece of land may grow rice at most in two seasons which again is partly determined by the level of the land in relation to flood and soil moisture availability (whether

natural or due to irrigation). What is indicated here is that there is likely to be a trade off between seasons when a farmer wants to grow rice.<sup>5</sup>

Let us now look at the acreages of rice by season (Fig. 2). Three types of conclusion may be made on their basis. First, by and large the total cropped acreage under rice has changed only a little and that only during the recent years. Second, *aman* rice acreage has more or less remained unchanged. Third, and this is the most important, the acreage under *boro* has increased very substantially and that at the expense of *aus*. This means that irrigated rice cultivation has broadly replaced rain-fed rice agriculture.

The basic reason behind this is the fast spread of fertiliser-responsive high-yielding variety (HYV) technology leveraged by controlled water management (either through irrigation and/or flood control) (Fig. 3). This has favoured mainly cultivation of *boro* HYVs and also high-yielding *aman* particularly where flood control infrastructure has helped protect the land from flooding during the pre-flowering stage of rice plants.<sup>6</sup> The result had been the predominance of *boro* rice in total rice output (Fig. 4) and more particularly of *boro* and *aman* HYVs.

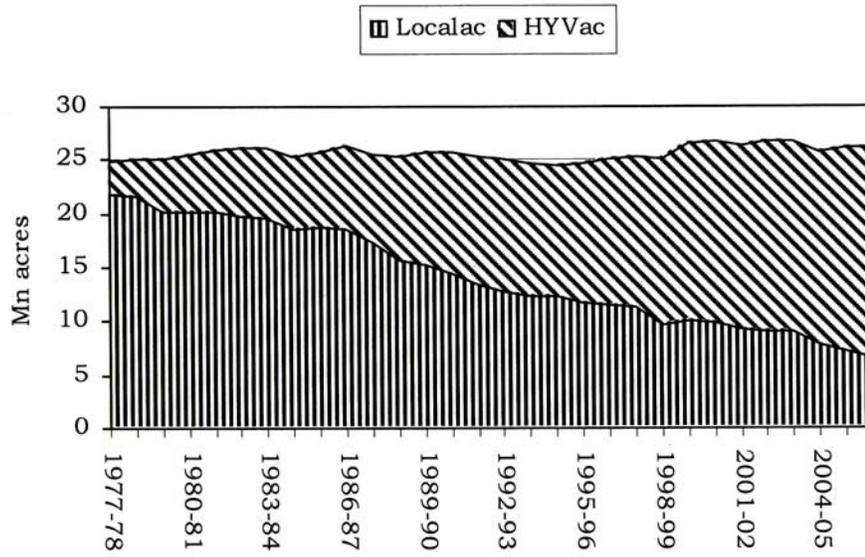
**Figure 2. Rice acreage by season**



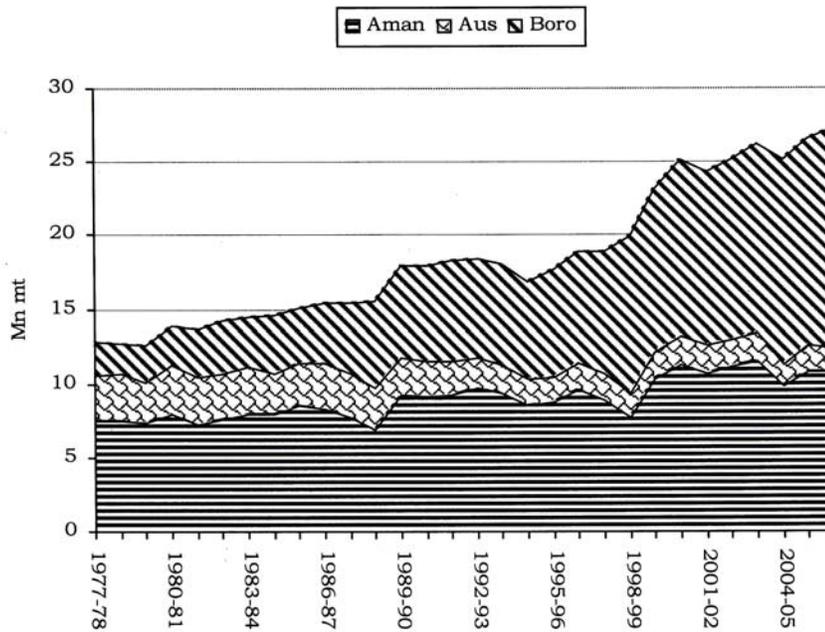
<sup>5</sup> This also allows the farmers to practise various types of cropping patterns allowing for hedge against possible crop output losses as well as the opportunity to scientists to develop more suitable cropping systems for the future. The latter issue is taken up later.

<sup>6</sup> The Flood Action Plan (FAP) studies particularly FAP 12 on Agriculture clearly demonstrated the positive effect of flood control infrastructure on switch from local transplanted aman to HYV transplanted aman varieties. See Asaduzzaman (1994).

**Figure 3. Rice acreage change by variety**



**Figure 4. Rice output by season**

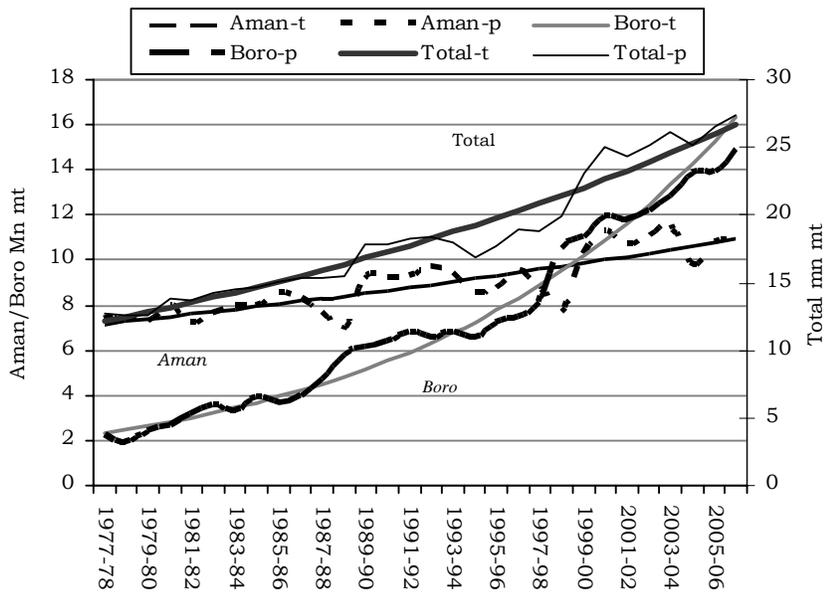


*Trends in output and its variability*

The trends in output for *boro* and *aman* and total rice have been shown in Fig. 5 along with how actual production has behaved around the trend (for the equations of the trend lines see Annex 2). The upward trend of *boro* output is the sharpest of all including that for total output. On the other hand, however, *boro* rice output also exhibits the most year to year variation in output. The coefficient of variation for output for *aman* season is 15.3% and for *aus* it is 26.9%. For *boro*, it is extremely high, 55.2%. What really matters here, however, is the fluctuation downward. In that sense, *aman* appears to suffer more than others (Fig. 6). Two more points may be noted here.

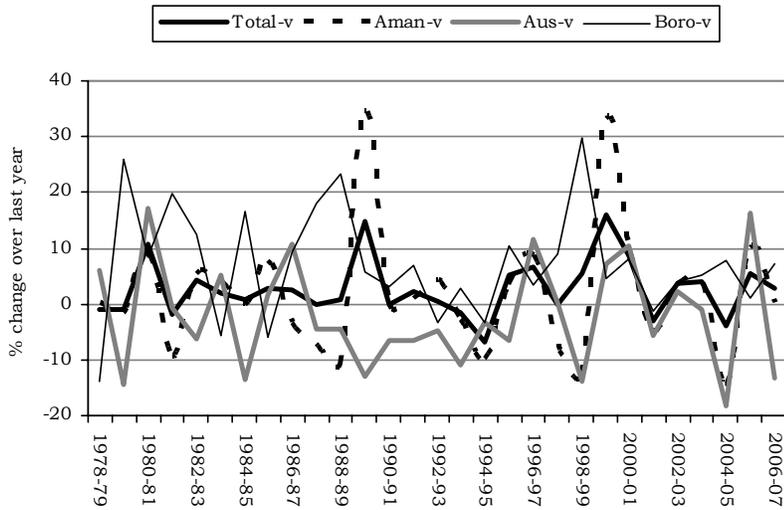
First the output changes in *aus* and *aman* appear to move in tandem and secondly, for downswings in *aus* and *aman* appear to be counterbalanced at least partly by upswings in *boro* (which is not surprising) resulting in a much more muted output changes from year to year for total production.

**Figure 5. Variation in output around the trend lines**



Note: p refers to actual output; t refers to estimated trend-based output

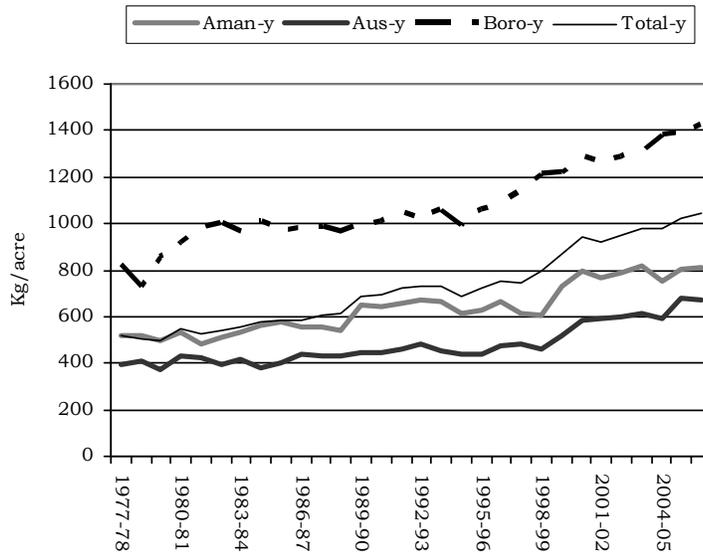
**Figure 6. Year to year changes in rice output by season**



*Yield trends*

As local varieties have been substituted by HYVs, the over-all yield per acre has risen (Fig. 7). Over the three decades since 1977, this has happened in case of all types of rice by season more or less at the similar rate of 1.7% per annum. It also appears from the figure that the rate of growth in yield has risen during the more recent years (also see below).

**Figure 7. Trends in rice yield**



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*Contributory factors behind output growth*

One can now sum up the discussion on rice acreage, yield and output to show the relative contributions of acreage and yield behind output changes. For this we decomposed the rate of growth in output into those of acreage and yield for the various seasonal rice outputs as well as all rice together.<sup>7</sup> For the three decades since 1977, the changes had been as shown in Table 2. What it shows indicate that for rice as a whole, the change in production has been the outcome basically of change in yield. When the whole period is divided into two sub-periods as shown in the table, we find that the contribution of yield has gone up much more substantially in the more recent years while the contribution of area has only slightly increased. For individual seasons the situation had not been uniform.

**Table 2. Components of Change (%) in Rice Output (1977-2007)**

Season	Output change	Area change	Yield change
<i>1977/78-2006/07</i>			
<i>Aman</i>	1.4	-0.3	1.7
<i>Boro</i>	6.8	5.1	1.7
<i>Aus</i>	-2.8	-4.6	1.7
All	2.7	0.1	2.6
<i>1977/78-1991/92</i>			
<i>Aman</i>	1.36	-0.44	1.80
<i>Boro</i>	8.70	7.07	1.62
<i>Aus</i>	-2.17	-3.12	0.96
All	2.63	0.15	2.48
<i>1992/93-2006/07</i>			
<i>Aman</i>	1.65	-0.42	2.07
<i>Boro</i>	6.60	4.04	2.56
<i>Aus</i>	-1.08	-4.30	3.22
All	3.67	0.52	3.14

Source: Estimated by author

Note: Changes refer to rates of growth in percent per annum over the whole and sub-periods

For *aus* there had been a very substantial fall in average area per year only partially compensated for by the rise in yield and that only more recently resulting in an over-all diminution in output over time. For, *boro*, it had been just the opposite. Here while a rise in yield has basically augmented the expansion in area which had taken place at an annual

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<sup>7</sup> To see how the decomposition is made, note that  $Q=AY$  where  $Q$  is quantity of output,  $A$  is area and  $Y$  is yield per unit of area. Taking differentials on both sides, we have

$$dQ = Y dA + A dY.$$

Dividing by  $Q$  on both sides we get,  $dQ/Q = (Y dA)/(AY) + (A dY)/(AY) = dA/A + dY/Y$  i.e., rate of growth of output = rate of growth of area + rate of growth of yield.

The rates of growth may be estimated using conventional semi-logarithmic trend equations.

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rate of more than 7% during the first sub-period, in the second, it has fallen substantially while the yield growth has been much stronger than before. Much of this expansion in area under *boro* had been due to a switch of acreage from *aus* to *boro*. For *aman* too there had been a fall in area which may have contributed to expansion of *boro* by converting the deep water rice land to *boro* but at a much subdued rate than, say, for *aus*. Hence the change in output of *aman* had been by and large a reflection of the rising yield and more so during the second sub-period due to a change over from local transplanted varieties to HYVs.

When the above long term changes are compared with whatever yield changes had been taking place in more recent years, a few conclusions may perhaps be made. First, although the changeover is still occurring, the opportunities for expansion of *boro* area by switching from *aus* may soon more or less come to an end. Any further rise in *boro* output therefore has to come through rising yield as has been observed.<sup>8</sup>

*Aman* appears to be a problematic case. *Aman* land has apparently has no other alternative uses. On the other hand it suffers both from flood or storm damages as well as may suffer from soil moisture stress during the critical flowering period necessitating facilities for supplementary irrigation.<sup>9</sup> As a result of all these, so far the yield of *aman* appears to be almost static while some land is being slowly converted to other uses including possibly *boro* cultivation where deep water *aman* had previously been grown. For *aman*, therefore, there appears to be little hope unless appropriate technological breakthroughs are made in response to the factors that make its yield uncertain.

In fact, the problem is more serious than it may seem because the yield rates of HYVs have been rising rather slowly in recent years. Only the yield of *boro* HYVs (including hybrids) has been growing at a rate of 1.99 percent per annum over the second sub-period. Those of *aus* and *aman* HYVs had been rising much more slowly, at rates of 1.1-1.3%.

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<sup>8</sup> Note that many other crops are grown during the *rabi* season apart from *boro* rice, most importantly among them being wheat among cereals and several other cash crops such as potato and maize. There is thus a possibility that some of the new *boro* rice land may also be at the expense of acreage under such *rabi* crops. An indication of this may be had from the information on newly cultivated crops and crops which has been discontinued as has been reported in the Agricultural Sample Survey of 2005. It shows that while more than 40 thousand and nearly 20 thousand farmers have newly cultivated HYV and hybrid *boro* rice respectively in 2005, the number of farmers discontinuing cultivation of other crops were for local *aus*: nearly 15,000; broadcast *aman*: 3100; wheat nearly 35,000.

<sup>9</sup> Historically failure of *aman* in the past has been the harbinger of famine in Bengal. See Chakrabarti (2004).

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## **Spatial aspects of agriculture**

The over-all growth and resilience of agriculture to deliver the expected output depend, in addition to other issues, on diversity of agriculture both over space and between and within sub-sectors of agriculture. This section shall briefly take up the concerns related to spatial differential in agricultural growth within the country. The next sub-section discusses agricultural and crop diversification.

One way of understanding the spatial differences is to simply look at the cropping intensity. Mandal and Asaduzzaman (2002) found that as a result of the changes in technology and its variation by district, cropping intensity varies substantially between districts from just about 1 crop (98.5 percent) to just about 2 crops (199.6 percent) a year which is influenced by availability of mechanised tillage. The influence of irrigation is similar though somewhat weaker. Rahman (2002) similarly found the growth rates in agriculture to vary between districts from 1.65% to 3.69% for agriculture over 1985/86 to 1994/95.

The Agriculture Sample Survey of 2005 (BBS: 2006) found that the over-all cropping intensity for the rural areas had been 181 percent. Divisions and districts within them, however, varied substantially in intensity of land used for crops. The estimated cropping intensities for divisions and districts within them had been: Barisal (180: districts: 149 - 211); Chittagong (183: districts:150 - 243); Dhaka (176: districts:147 - 204); Khulna (174: districts:135 - 214); Rajshahi (195: districts:171 - 240) and Sylhet (144: districts:131 - 163).

More recent data reveal that in 2006/07, the yield rate of rice varied substantially from as low as just 602 kg (in Patuakhali) to 1146 kg per acre (in Jessore). All districts showing low yield are in the south-western parts of the country. On the other hand, all districts showing more than 1 mt of yield per acre are at present highly irrigated areas of Rajshahi, Bogra, Jessore, Kushtia, Comilla, Chittagong, Dhaka and Mymensingh. Similar differences among districts have been found earlier (MIMAP/BIDS: 2003). These regional differences in growth performance may be important in determining the nature of interventions to stimulate future growth in agriculture, particularly in fine tuning the need for technological change and their diffusion.

These figures do indicate that there may be substantial scopes than at present for raising more crops in various parts of the country. However, this may also mean overcoming various ecological, technical and policy-related barriers which are not precisely known by specific locations (see the next sub-section).

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## Diversification of agriculture and crop<sup>10</sup>

Deb (2008) has recently analysed diversification in agriculture (i.e., between subs-sectors such as crops, livestock and others) and in crops (cultivation of various crops). Using a simple measure of diversification (Simpson Index), he has first found that while agriculture in aggregate has diversified over the 1990s, it has stagnated since then.<sup>11</sup> On the other hand, little diversification of crops has taken place since mid-1980s while since 2000 or so the situation has actually and continuously deteriorated. Given this dismal picture, he has also discovered, however, that there substantial inter-district differences in such diversification which he has then tried to explain econometrically. These results are interesting from policy point of view and tie in well with the picture regarding spatial aspects of agriculture as well as future growth prospects under a globalised scenario (see later).

Deb finds that for agricultural diversification the positive impacts are from income, transport network such as roads density, and trade in agriculture. Irrigation availability and ecological factors such as flood exert negative influence while drought has a positive impact possibly because people diversify in places where ecological adverse situations prevail. Influence of irrigation is possibly due to the factor that it pays more in such a situation to concentrate in crop cultivation. For crop diversification results are similar except for irrigation the effect of which is now found to be negative. It is likely that as irrigation is mainly practiced during the *rabi/ boro* season when many other crops are grown, irrigation allows the harvest to be more certain allowing the farmers to reap more benefits from cultivation of other crops and thus diversify.

Policy-wise the most interesting results are the development of transport and thus marketing facilities as well as the infrastructure for encouraging trade in agriculture which demands specific types of facilities as discussed later.

### Inputs into agriculture

So far we have discussed the output of agriculture and the associated acreage and yield. We have seen that the growth has been due to a large scale adoption of HYVs which in turn has been possible, as is well-known, due to expansion of irrigation facilities helping the expansion of *boro* during the dry period. As we have seen earlier, *boro* rice is practically all HYV rice. The expansion of irrigation has been mainly due to the spread of tubewell, particularly shallow tubewell irrigation over

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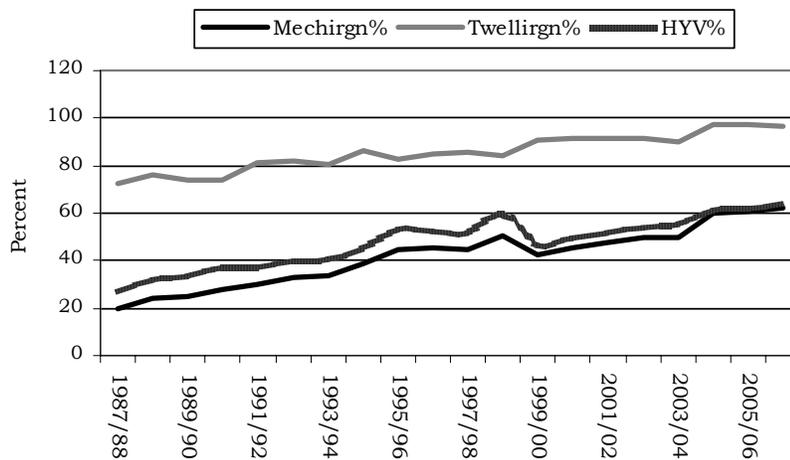
<sup>10</sup> This sub-section draws heavily upon Deb (2008).

<sup>11</sup> There may be a problem here if output or sub-sectoral GDPs have been used at current prices, rather than at constant prices. Deb, has not explicitly stated which prices he has used.

years. Fig. 8 shows the time paths of mechanised irrigation (including canal irrigation) as percentage of net cropped area, tubewell irrigation as percent of total irrigated area and HYV acreage as percentage of total rice area. The correspondence among the three paths clearly indicates that these are intimately related with each other, particularly the spread of mechanised irrigation and the diffusion of HYVs.

Similar relationships between irrigation coverage and HYV cultivation using panel data have also been observed at the micro level. Hossain *et al* (2007) have shown that in their study villages between 1987 and 2000 the percentage of cultivated land under HYVs had risen from 33 to 70% corresponding to an increase in irrigation coverage of cultivated land from 24 to 60%. All the groups of farmers have experienced the rising trend in irrigation and HYV coverage, and more so by the smaller compared to the large ones.

**Figure 8. Spread of irrigation and diffusion of HYVs**



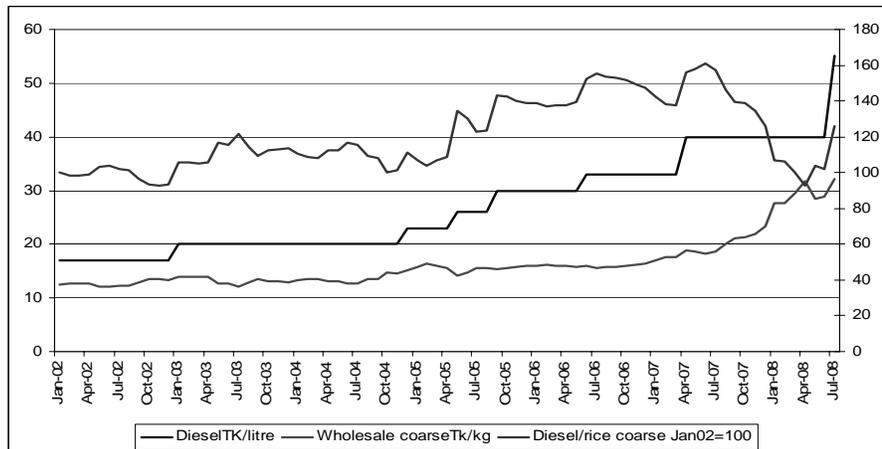
Note: Mechirgn is percent of net cropped area irrigated with mechanised means and from canal water  
Twellirgn is percent of total irrigated area under tubewell irrigation  
HYV% is percent of rice area under HYVs.

Irrigation machines are generally run either with diesel or electricity. Diesel operated shallow tube wells are the norm in most cases (83% of area). Deep tube wells are run mainly with electricity (90% of area). LLPs are run mainly with diesel (82% of area). What these mean is that the prices of diesel and electricity, both absolute and relative to price of rice has some influence on the option for diesel or electricity run irrigation equipments. It may be instructive therefore to look at the price movements particularly of diesel to understand partly the behaviour

related to irrigation fuel choice. Electricity is nominally comparatively cheaper and if power is available farmers go for irrigation machines run with electricity. But given that power availability is not widespread, in most cases farmers have to use diesel.<sup>12</sup>

If we look at the nominal price of diesel (which is set by the government), we find it to be remaining more or less steady over 2002, 2003 and much of 2004 (Fig. 9). But as the nominal price of rice has been changing very little over this period, the relative price of diesel has been more or less steady. One finds a slow but steady rise in acreage under STW and consequently total irrigated acreage. Over 2005 and 2006, the relative prices of diesel began to rise mainly because of upward adjustments in nominal price of diesel. The growth in irrigated acreage slowed down. But as we see over the last year and up to the end of the *boro* period this year, the price of rice continued to rise making relative price of diesel to fall substantially.

**Figure 9. Nominal and relative price movements of diesel**



Source: Authors' estimates based on various information

Note: Left hand Y-scale is in Tk per kg or litre. Right hand scale refers to index with 2002=1000

Electricity prices, in contrast to diesel, held steady in nominal terms as the administered prices have remained unchanged and with rising rice prices, the relative price also began to fall sharply. Both the rising relative price of diesel and falling relative price of electricity combined together to put pressure on the government for introducing diesel

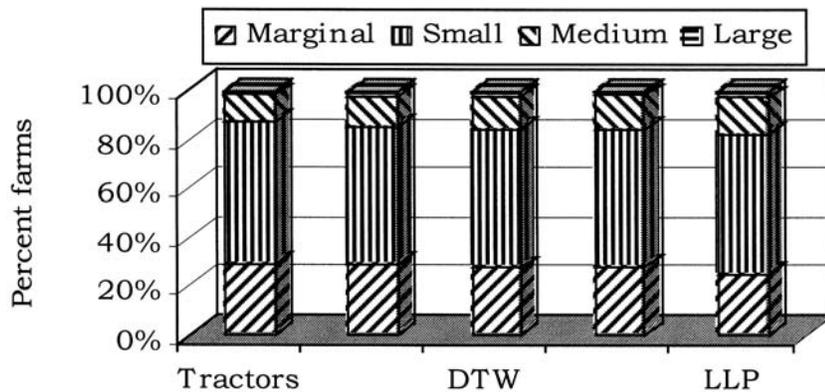
<sup>12</sup> Only around 30% of rural households are electrified according to a survey conducted in 2003 (Asaduzzaman and Lateef: 2005).

subsidy or providing more of electricity connections. We shall come back to this issue later on.

*Capitalisation of agriculture*

Mechanised irrigation is one type of capitalization in agriculture. There are other operations such as tillage where use of mechanised equipments such as power tillers and tractors have become quite common. Fig. 10 which shows the ownership or use of such equipments indicates that their use is quite widespread among marginal and small farmers. Roughly 80 percent of owners or users of various types of tillage and irrigation equipments are in these two categories.

**Figure 10. Ownership/use of capital equipments by farm size (2005)**



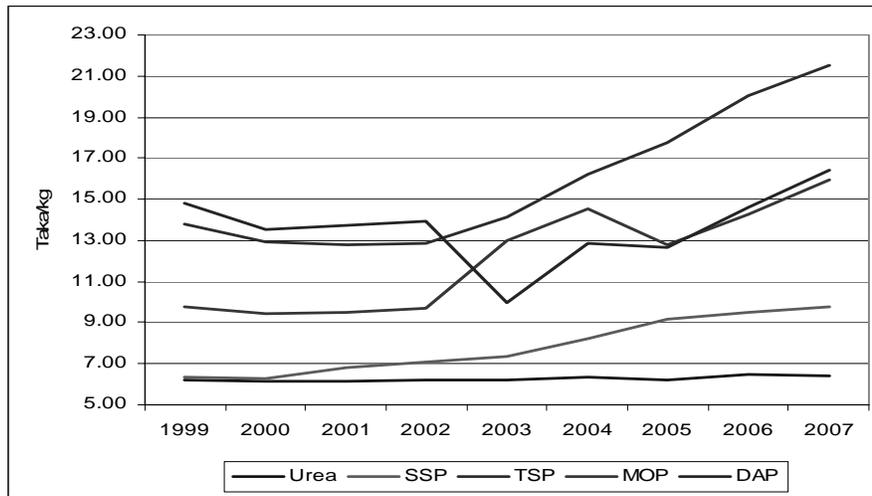
Source: Authors' estimates based on BBS (2006).

*Fertiliser use trends*

The trends in the use of fertiliser by type indicate a healthy growth at the rate of 5.8% for all fertiliser. This is however, mainly a reflection of the weight of urea in total fertiliser sales as well as its rate of growth. Over 1980-2007, urea sales grew at the rate of 6.0% while its sales were 71% of total fertiliser sale in 2006/07. TSP and MoP, the other two major fertiliser in use, contributed just about 10% and 6% of all fertiliser sales.

The nominal price of urea till recently had been fixed at Taka 6 per kg while all other prices showed upward trends (Fig. 11). On the other hand the price relatives between urea and TSP and Urea and MoP have been falling with rising prices for TSP and MoP and stagnant nominal price of urea. This means that there may be a tendency to consume comparatively more of urea than TSP and MoP. Or, in other words, the balance had been against TSP and MoP.

**Figure 11. Nominal price trends of fertiliser**



Source: Authors' estimates based on various information

### *Credit*

In 2005, only about a third of farms were found to have taken any loan (BBS: 2006). The incidence varied little by farm size. The amount of loan per borrowing, however, varied substantially between smaller and larger farms. While marginal and small farmers borrowed Taka 15-16 thousand per farm, the amounts were Taka 25 thousand for medium and Taka 51 thousand for large farms. For loans used for crop cultivation purposes, the marginal and small farms borrowed 10-12 thousand taka per farm while medium and large farms borrowed 21 and 38 thousand taka per farm. However, on a per unit of land basis (net cropped area), the picture had been the opposite. Marginal farms borrowed Taka 4000 or so per acre of net cropped area. It progressively fell to 2000 and 1000 for small and medium farms and less than a thousand for the large ones.

Very recent data from 16 districts indicate that for purchasing agricultural inputs the marginal and small farmers may have much better recourse to credit from institutional sources such as banks, other financial institutions and NGOs/samitis.<sup>13</sup> Sixty two to 87 percent of the total amount borrowed was from institutional sources for farms up to 7.5 acres. It is only for the very large ones with operational holding above 7.5 acres that practically the whole money had been borrowed from moneylenders. The last may have been an atypical case. But what

<sup>13</sup> This information is from recently collected data by the author for analyzing the subsidy on diesel which is on-going.

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matters here is that practically all groups of farmers had access to institutional sources.

Possibly, the large farmers may not need credit so much for their cultivation purposes as they may have their own savings to draw upon while the other farmers rely more on credit. Access to cash whether from own savings or credit may influence the farmer's capacity to purchase inputs such as fertiliser or pay for irrigation water. If so, without firmer information on access to other sources of cash, credit mechanisms and their extent and utilisation, the implications of policy related to subsidy on inputs and their efficacy can not be fully understood. Unfortunately such information for recent periods is lacking.

#### *Role of policies*

Whatever has happened in crop agriculture in Bangladesh has been heavily influenced by several policies related to marketing, pricing and subsidy for fertiliser as well as irrigation equipments and pricing of fuel for running them. In short, there had been several changes over time but on the whole from a tightly administratively regulated market to a far liberalized system to the extent of a short-lived abolition of subsidy on fertiliser.<sup>14</sup> Deregulation of prices of fertiliser and irrigation equipments, abolition of attempts at standardization of irrigation machines, announcing floor prices for paddy and rice for procurement all have been attempted at various times or on a continued basis. While all the impacts, particularly welfare impacts of these policies are not definitively known, the end result had been a very substantial growth in output of rice with concomitant rise in the level of food security.<sup>15</sup> Question is whether such support policies need to be continued, and if so, in what form. These questions will be discussed in later sections.

#### **Organisation of production**

Farming in Bangladesh is organised in innumerable marginal and small farms which are truly tiny by world standards. In 2005, 87 percent farms were identified as marginal (with an operational holding of less than 0.5 acre) and small (with operational holdings between 0.5 and 2.5 acres) (Fig. 12). And they accounted for 59 percent of total operational land. On the other side of the scale 13 percent of farms accounted for 41 percent of operational land. The average size of operational holding had been just 1.48 acres. Even the average size of the largest farms had been only 12.74 acres.

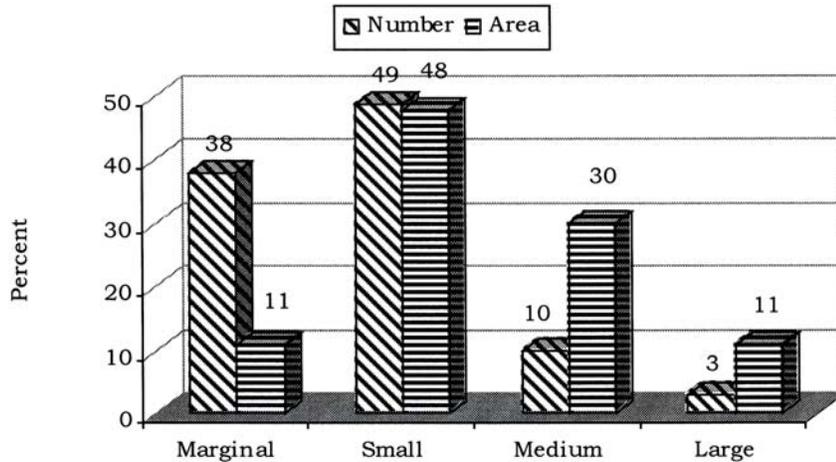
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<sup>14</sup> For a brief but succinct description of the policy changes and the references to the relevant literature see Hossain *et al.* (2007).

<sup>15</sup> Hossain *et al.* (2007) found that the increase in per capita income in farm households cultivating HYVs over 1987-2001 had been rather small, only about 7% of poverty level income. The level of food security and the indirect effects of lower rice prices for poverty reduction had been, however, substantial.

Most (60%) farms are owner operated in the sense that all land they operate is owned by them. Another 37% of farms are part owners and part tenant in that they operate land part of which is owned by them and part rented under some type of contact from others. Only 3 percent farms are pure tenants in the sense that whatever they operate are all rented in from others.

**Figure 12. Size distribution of farms**



Source: Based on BBS (2006).

One may note here that over time there had been a diminution in the average size of operational holding, an increase in the proportion of marginal farms and a decrease in those of the medium and large ones over 1983/84 to 2005. The average operational holding per farm has fallen progressively from 2.26 (in 1983/84) to 1.69 (in 1996) and then to 1.48 acres (in 2005). On the other hand, the proportion of farms operating no more than 0.5 acres has risen from 24 to 28 to 38 percent. Correspondingly the proportions of medium and large farms have dwindled from 30 to 20 and then to 12 percent. The small farms have held on to their share.

Such change in organisation of production indicates the falling access of farmers to land which may consequently lead to restricted access to all other inputs which are based on land such as application of fertiliser. While farm size distribution had at one time been thought to be an important determinant of such access, the relationship may have weakened in more recent times.<sup>16</sup> As Fig.10 has earlier demonstrated

<sup>16</sup> Asaduzzaman (1979) found that even three decades back when HYVs were not widely known, small farm size was no barrier to adoption which was explained more by the pressure of subsistence.

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access to capital equipments or their use is as common among marginal and small farmers as others. Hossain *et al* (2007) also have found that adoption of HYVs is determined less by socioeconomic factors such as farm size and tenure than by technical and bio-physical factors.

One may note here that particularly prior to the large scale adoption of HYVs, there was a hypothesis that land productivity and size of holding are inversely related. The basic argument was that the smaller farms have to eke out a living from whatever land they had and they had the advantage of using family labour on a large scale which had had little opportunity cost. If so, they have to do that now from even tinier land size while the prospects of non-farm activities are now much greater than before wiping out partly the advantage of zero opportunity cost of family labour. On the other hand, as farming become more and more dependent on purchased inputs such as fertiliser, irrigation water and pesticides, the advantage in farming would now lie more with larger farms than the smaller ones because of the former's hypothesized easier access to cash compared to the latter. Whichever way the size-productivity relationship may have moved, the fact remains that the smaller farms can not but have to be more efficient and productive than before. The challenge therefore lies in evolving technology which is affordable to marginal and small farmers without losing the productivity edge under different ecological and natural environmental conditions.

### **A summing up**

The agricultural situation as described and analysed above may now be summed up so that we can highlight the challenges before it in the next section.

- i. First, the growth in agriculture, particularly crop agriculture has been possible due to large scale conversion of land from indigenous varieties to high-yielding varieties
- ii. The conversion to HYVs has been concentrated most overwhelmingly during the dry, irrigated rice culture in the *rabi* season. However, much of this had been due to large-scale conversion of flood-prone *aus* land the scope of which is now more or less limited.
- iii. While the year to year fluctuation in total rice output is not substantial, this is not true for seasonal rice. For *boro*, the variation is the widest but this is due to upward swings. In case of *aman*, on the other hand frequent downswings due to various adverse agro-climatic factors is a cause of concern.
- iv. *Boro* output has increased in previous years largely due to conversion of *aus* land into *boro* land. Now, however, further expansion of output is dependent more on rising yield of *boro*. But

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- yield in case of HYV *aus* and HYV *aman* in particular has been by and large stagnant.
- v. In case of *aus*, there is some scope for raising yield but the over-all output implications are not going to be large. Hence, for continued expansion of output and agricultural growth in crop sub-sector, increasing attention must be given to raising yield and output during the *aman* season. Raising yield during the *aman* season needs to consider circumventing or resolving several problems (see next section).
  - vi. HYV cultivation had been supported by the provision and use of fertiliser and irrigation along with mechanised tillage. Mechanised tillage which is now very widespread has allowed increase in cropping intensity by breaking the time constraints in between seasons.
  - vii. In case of irrigation, the dominant mode now is shallow tubewell irrigation using diesel. DTWs run with electricity are also important.
  - viii. There are problems in fuel choice for mechanised irrigation. The nominal and relative price of diesel has been rising and while those with electricity is stagnant (in nominal terms) or falling (in relation to rice price). There is thus a demand for equalizing the costs through subsidy for using diesel. How far this has been successful remains a big question.
  - ix. For fertiliser, there had been a continued growth in its use. But basically this has been a reflection of rising use of urea due to a fixed nominal price till very recently and thus of a falling relative price of urea while the prices of other fertiliser had been rising and in last year skyrocketed. These led to possible over use of urea and under use of phosphatic and potassic fertiliser.
  - x. All the areas of the country have not performed equally in terms of agricultural growth. This aspect needs some attention now if agriculture has to maximize output and contribute to the economy close to its full potential.
  - xi. Agricultural and crop diversification, also leave much to be desired particularly as such diversification, apart from meeting present and future demand, also help in building resilience of the system and thus withstand the market risks that have been experienced in recent times.
  - xii. Credit, and in general flow of funds, remain a largely unknown issue. This lack of information may hamper the designing of a cost-effective subsidy policy.
  - xiii. Farms in Bangladesh are tiny by world or much of South Asian standard. While land appears to be inequitably distributed, this does not appear to be the case for access to modern inputs nor to credit. But whether the demand for credit is well-met remains a question.

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## CHALLENGES FOR AGRICULTURE

### Challenges

The preceding section has given a broad overview of the past and present situation in agriculture, particularly crop and more specifically rice cultivation. Before we proceed further, we now need to clearly understand the challenges before the sector. These may be formulated as follows:

- a. Agriculture has to contribute to the growth of the economy in general
- b. Agriculture has to ensure food security as an essential element in poverty reduction particularly given the twin pressure of population growth and rising demand due to increase in income (see later).
- c. It must do so in an increasingly unfavourable condition of access to as well as quality of natural resources particularly land and also in places wherever technological development so far had been limited. Furthermore the intensification of some of the problems has to be taken into consideration due to climate change (see later).
- d. In doing so, agriculture has to explore all avenues of potential growth, be it through exploiting technology whether existing off-the shelf or future ones, integration with market, and in the short to medium term various policies which may need to be revisited such as input subsidy, output support and related policies. All such policies also have to keep a balance between the consumers' preferences and profitability of agriculture for the farmer to continue in business *against the backdrop of uncertain and volatile input and output market domestically and internationally*. And the agriculture must also compete with imports to remain a viable occupation for farmers.

### Agriculture as a prime mover of pro-poor growth

Bangladesh has prepared two Poverty Reduction Strategy Papers (PRSP). The first PRSP rightly emphasised agriculture as an essential element in a quest for pro-poor growth. The assumed rate of growth of the economy in the first PRSP implied, based on historical experiences, a growth rate of agriculture (i.e., GDP in agriculture) of around 4.5 percent. In more recent years, the rate of growth of agriculture had been at least one full percentage point less than this desired rate. Question then is: is it possible to jack up this rate of growth and if so what does it imply in terms of growth of sub-sectors and under what conditions. Before

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investigating this issue, we need to point out one more particular challenge which may have a bearing upon the urgency of the matter.

### **Population growth, demand for food and land-man ratio**

Agriculture in Bangladesh is the main source of food. Domestic production has to be supplemented by imports mainly of cereals such as rice and wheat but also of other essential food such as edible oil, sugar, and dairy products including baby food. The demand for all these types of food increases every year due to three factors. First, there is the increase in population which during the last census was estimated to be 1.6%. Secondly, while the rising income will increase the demand for food, it is also true that the income elasticity of food particularly cereals is rather low. But probably more importantly as the poor becomes non-poor due to rising income, it is likely that their pent-up demand may raise their consumption at a much faster rate than others.<sup>17</sup> In such a situation, the total demand may rise faster than what may normally be expected.

An analysis of the data from Household Income and Expenditure Survey 2005 shows that the per capita food grain expenditure has an income elasticity of 0.07 while on a per household basis the elasticity is found to be (adjusted for household size) 0.09.<sup>18</sup> Now assume the average rate of growth of the economy to be at least 6% or so for the next 5-6 years. Adjusting for population increase, this means an average per capita income rise of at least 4.4%.<sup>19</sup> The demand for food grains due to such an average rise in income may then be taken to be 0.3 percent per annum. The over-all demand for food grains therefore may increase by at least  $1.6\% + 0.3\% = 1.9$  or say 2.0% on an annual basis. Keeping in mind the rising demand of the newly non-poor, one can safely assume the rate of growth in demand for cereals to be around 3% or so. For a rate of growth of the economy at 7 and 8% the demand rises may be (including pent-up demand) more than 3%. Against that it may be noted that during the last one decade and a half the rate of growth in rice output had been around 3.7% although one observes substantial year to year fluctuations which means that at the moment Bangladesh is poised rather at a razor's edge in terms of food security based on domestic production. Stability and sustainability of rising output is therefore a major policy concern.

Given the above rising demand, the availability of land for growing food may be fast dwindling. Already utilisation of land for non-agricultural purposes is probably taking out on an average 1% of land every year.

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<sup>17</sup> Note that this is only a hypothesis. Suitable panel data may allow to test if this is indeed the case.

<sup>18</sup> The estimates were made using a double-log transformation.

<sup>19</sup> Rate of growth of per capita income is estimated as rate of growth of GDP *minus* rate of growth of population.

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That means that over time the land-man ratio is falling fast. As Fig. 13 shows, between 1987/88 and 2006/07, the number of persons to be supported on each acre of net cultivated land had shot up from 4.9 persons to just about 7 persons, a whooping increase of 42-43% in a matter of two decades. This means that an increasing agricultural output including food has to be coaxed out of an ever-vanishing area of land unless imports on a vast scale are contemplated.

### **The challenge of climate change**

One of the most serious challenges that Bangladesh agriculture may have to face is the adverse impacts of climate change. While this is not the place for detailed discussion and analyses of the issues involved, very briefly what might happen in the not too distant future (some would argue that the uncertainties have already begun on the ground as problems of pollination in wheat and early or immature flowering of rice have been reported this year) are that the water regime may drastically change with years of too much abundance (heavy floods) and too little (severe droughts) both may be much more frequent than previously.<sup>20</sup> Sea level rise will occur although how fast and how far it would submerge the land along the coast remains debatable due to the coastal defences in the form of dykes and polders. Salinity level, would however, increase and so shall the frequency and severity of coastal cyclones and storm surges.

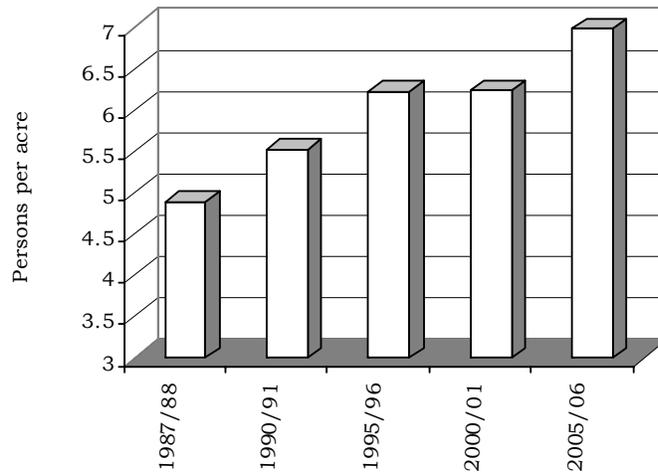
The implications for agriculture are, however, not something completely different from what these may be under a situation without climate change. The implications for research and technological change to develop new types of varieties are basically the same. The only new thing that comes up is the urgency of the necessary actions.<sup>21</sup>

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<sup>20</sup> For summary views on the probable impacts on and possible response options for Bangladesh see the First National Communication of Bangladesh (GoB: 2002), background report on livelihood for preparation of the the NAPA document, Asaduzzaman (2005) and the National Climate Change Strategy and Action Plan (2008), (GoB: 2008).

<sup>21</sup> See GoB (2008) for a list of issues that need attention in agriculture under climate change.

**Figure 13. Trend in man-land ratio**



**Can agriculture deliver the desired rates of growth?**

We ask this question because the challenges to the Bangladesh agriculture are quite daunting while the answer in short to the question is that yes, it can. (BIDS: 2004). The relevant analysis shows that what really matters is future technological change. A rise in factor productivity by 1.5% per annum, for example, implies that the required rate of growth of gross agricultural output has to be only 3.89%. Noting that historically gross output in agriculture has grown at 3.7%, this rate of growth of output may be achieved *if other supportive policy actions are taken and implemented under appropriate institutional mechanisms*. It may also be noted that under such a rate of growth, the required rates for the sub-sectors (except perhaps for livestock) are also very near to or even slightly less than the BAU-no technological change situation.<sup>22</sup> The main results are reproduced in Annex 2.

*Implications of the growth in agriculture in a globalised open economy situation*

If the technological change as assumed above takes place, it has some interesting implications for supportive policies in agriculture. Assuming that the average productivity of agriculture will rise by a total of 20% by

<sup>22</sup>Note that possibly because agricultural goods become cheaper due to growth in efficiency of production, the required rates of growth of non-agriculture also falls under technological change compared to the no technological change situation and is only a little higher compared to the BAU no technological change situation. Thus the growth in agriculture has ramifications not simply for the sector itself but also for the rest of the economy.

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2015 due to the rising factor productivity, an open economy modeling shows that along with a very substantial increase in national welfare, there will be a rise in exports of many of the commodities indicating a *lack of absorption capacity* in the country and the need to create a facilitating environment for marketing in general and export marketing in particular. Furthermore, there will be a fall in imports and prices of most commodities. The modeling results are shown in Annex 2.

The above analyses and discussion point to the need for facilitating technological change in general necessitating an invigorated and effective extension system and the changes towards *diversification* and *high value agriculture* which are lacking in many parts of the country.<sup>23</sup> Particularly if exports increasingly become important there is a need for giving attention to *food safety and food hygiene* and associated sanitary and phyto-sanitary (SPS) measures. This is an extremely important issue and we shall later come back to this point. First, however, we would like to concentrate on the issue of technological change as the core challenge and how this may be met.

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<sup>23</sup> See the earlier discussion on crop diversification as well as later and their implications which are very similar.

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## THE NATURE OF REQUIRED TECHNOLOGICAL CHANGE

### Fine tuning embodied technology

So far the technological change that has taken place in agriculture, particularly in crop cultivation had been the development and popularisation of high yielding varieties which need controlled water, are fertiliser responsive but may be susceptible to various diseases and pest attack.<sup>24</sup> Up to 2001, the rice research system had released 47 improved rice varieties (BRRI: 49; BINA/BAU: 6). Over time, several refinements have been made to the HYV profile.<sup>25</sup>

These include the development of pest and disease resistant varieties, better yielding varieties and probably most importantly shorter maturity variety, particularly suited to *aman* cultivation conditions. Drought resistant varieties help in withstanding moisture stress while appropriately shorter duration varieties help in escaping drought by flowering and being harvested several weeks earlier. A new such variety has now been released and been harvested some 4-5 weeks earlier than “traditional” HYVs. There are also newly developed *boro* HYVs which are somewhat lower-yielding but can be harvested 3-4 weeks earlier than the normal *boro* harvesting time. Some limited success has also been achieved in developing varieties suited to specific ecological niches such as those resistant to salinity. However, all of these still have two basic characteristics inherited from the earlier ones. All need chemical fertiliser to a great extent and a controlled water regime, or in other words, an irrigated condition (except to an extent in case of drought resistant varieties).

In the near future therefore, the issues related to fertiliser use, availability, subsidy and prices and policies and activities facilitating irrigation, particularly given the extremely important contribution of *boro* rice to total rice output remain crucial. Particularly the issues of subsidy for fertiliser as well for diesel and electricity for irrigation become immediate policy concerns. We shall examine these shortly. However, before that we would like to discuss in slightly more detail the technology generation and extension problems in the country.

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<sup>24</sup> Of course, hybrid varieties are becoming increasingly popular but they need fertiliser and irrigation in equal, if not more, measure.

<sup>25</sup> See Hossain *et al* (2007) and Hossain, Bose and Mustafi (2002) for brief but useful descriptions of the rice research system and its release of varieties with in-built traits. See also the references cited therein.

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## Technology generation system

### *Research imperatives*

The National Agricultural Research System (NARS) is at the core of technology generation in the country. Unfortunately, the system as a whole has been much vilified of late due to its inability, perceived or real, to generate new and important technology although the benefits of research may have been substantial.<sup>26</sup> One of the criticisms has been that the system is not demand driven. In any case, the response had been to create funds for research under competitive grants. While one has to reserve comments on the new system because it has just started, one major technology related project of very large size, the National Agricultural Technology Project (NATP) with a price tag of nearly Taka 700 crore apparently has its priorities rather lop-sided against research. Only about a quarter of the money is actually earmarked for research while the rest is to be spent for various other purposes.

What should be the priorities for future research for generation of new technology is clear though. Hossain *et al's* (2007) analysis of adoption of HYVs using panel data during the late nineteen eighties to the turn of the century indicate very clearly that irrigation availability is the most important factor for dry season (i.e., *boro*) HYV cultivation. For wet season (i.e., *aman*) rice, land elevation is important because of the flood hazard that many such areas face. In another study Hossain, Bose and Mustafi (2002) finds that farmers have also some time given up cultivation of HYVs due to salinity intrusion and other factors. The over-all indication had been that biophysical and technical factors are now more important determinants of technology adoption than socioeconomic factors. It may be noted that climate change will exacerbate some of these bio-physical constraints and thus the solution lies in urgent action, not so much different types of action.

One particular issue of major public health concern has also to be part of the new technology generation strategy. Arsenic in ground water in many places in Bangladesh is now a reality.<sup>27</sup> Preventing its uptake by plants and/or making it less harmful as well as restricting its entry into the food chain has to be considered seriously by scientists in the research

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<sup>26</sup> Hossain *et al* (2007) have shown that the contribution of the modern rice varieties and by implication of the rice research system which had developed or adapted the varieties to local conditions was 13.1 mn mt of additional rice which could feed 45-46% of population of Bangladesh in 2000.

<sup>27</sup> There is a huge and burgeoning literature on arsenic and its harmful effects in Bangladesh. See in particular the web site maintained by Prof. Richard Wilson ([http://www.phy4.harvard.edu/~wilson/arsenic/arsenic\\_project\\_introduction.html](http://www.phy4.harvard.edu/~wilson/arsenic/arsenic_project_introduction.html)) which keeps a comprehensive list of major works and reports including those on Bangladesh as well as links to other major sites.

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centres. This may be part of the ecology-specific research for technology generation.

Awareness-raising regarding new technology is no longer the issue. The issue now is to bypass and/or overcome biophysical and technical barriers to development of agriculture or adapt the technology to them. That means that technology generation has to be fine tuned to specific regional and ecological characteristics.

In case of *boro*, the need therefore is to lower the costs of irrigation or develop varieties which need less of water and/or fertiliser which not simply ensures a more certain crop but also lowers the cost of production by reducing cost of irrigation and fertiliser. Salinity resistant varieties are also the prime need for the coastal areas particularly if sea level rise materialises as predicted.

In case of *aman*, the need may be to develop varieties which are resistant to moderate flooding and moisture stress. Note here that so far varieties developed for the *boro* season had been adapted from varieties developed in the international research centres while the *aman* varieties are results of basically home-based innovation due to the location and ecology specificity of these varieties (Hossain, Bose and Mustafi: 2002). In any case, one way of avoiding moisture stress is to develop varieties which are of shorter duration so that the crop may be harvested before the onset of the comparatively drier and therefore moisture stressed period during the growth cycle of the plant.

This is important for *aman* because the normal *aman* rice crops flower during October or so and the actual harvest begins several weeks later. It is this period when one may need supplementary irrigation. Already one variety has been developed which can be harvested during October. This avoids thus the need for irrigation and lowers cost of production, farmers get output during a period which is generally one of food scarcity thus helping in poverty alleviation and also providing them a chance to grow some other short duration crops such as early winter vegetables and thus generate additional cash. In fact, if more of short duration varieties suited to *boro* season are developed and there are already some which are harvested about 3-4 weeks earlier than others, similar opportunities may be available to farmers during this season also. Available varieties with such characteristics are thus very popular with farmers even though these are somewhat lower-yielding than others. In fact such cropping system changes may be more beneficial also from the environmental point of view of preserving and improving the soil health.

The fact remains, however, that the research system is not capable, due to institutional and technical factors, to develop and release varieties with superior traits quick enough to provide farmers with wider choice

which is also attributed to factors such as weak research-extension linkage, a public extension system of limited effectiveness and lack of a good seed market in the country (Hossain *et al.* 2001).

*Agricultural extension system*

Generating technology is one thing, getting it to farmers is another. Hossain *et al.* (2007) have shown that extension coverage is extremely important for adoption of technology. Yet, in general the extension system has remained weak. Farmers get to know of the new technology less from the extension agents than through farmer to farmer informal contact (Hossain *et al.* 2007). Attempts have been made recently to improve the system but as alleged, have largely failed for various reasons (Gill *et al.* 2003).

While this is not the place to deliberate on the efficacy of the extension system in the country, the general impression is that it provides only limited service to farmers not necessarily because extension agents do not want to but because of certain institutional characteristics of the system and its operational methods including a general lack of necessary logistics. This is an area which needs immediate attention if the generation of technology has to be effective.

*Issue of crop diversification*

Of late, the prices of many types of food have risen and sometime quite fast. Such price rise, some may argue, would be incentive enough to encourage farmers to produce them. And some of these commodities are also highly income-elastic and consequently their demand is expected to grow over time as average income rises. The data in the HIES 2005 has been used to estimate these elasticities which indicate the following (Table 3):

**Table 3. Income-response of per capita demand by commodity**

Falling demand	Rising demand	Stagnant demand
Cereals (-0.75)	Fish (0.57)	Vegetables (-0.37)
Rice (-0.83)	Milk (1.45)	Pulses (0.31)
Gur (-0.57)	Meat (1.30)	Edible oil (0.02)
	Wheat (0.63)	
	Sugar (1.03)	

Source: Asaduzzaman (2008).

Note: Figures in parentheses are estimated income elasticities.

Those in the last column are all statistically insignificant i.e., not different from zero.

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These results are not unexpected except for one or two.<sup>28</sup> What all these mean is that Bangladesh agriculture over time has to make a much more vigorous attempt to move towards production of non-rice crops, particularly non-rice food crops and non-crop food. We have earlier seen the rather dismal picture related to such agricultural and crop diversification. As these are in general high value products and also sometimes highly perishable, proper marketing system including the development of transport network as well as those related to export marketing is a must for such diversification as also noted earlier.

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<sup>28</sup> There are two apparent surprises here. We expected wheat to be an inferior good and thus its demand to fall with income and edible oil to be income-elastic. For edible oil, it may be that the people being more health conscious than before may be consuming less of it. High prices may also have partly choked its demand. High income elasticity of wheat remains a mystery though.

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## **STRATEGY TOWARDS A POST-HYV AGRICULTURE**

Bangladesh agriculture has depended on HYVs (and of late also on hybrid varieties) and water management through irrigation during the dry period to produce as much as possible given the various constraints within which it had to operate. The basic goal was to raise productivity in rice cultivation. Ensuring food security and raising income will remain the paramount goal in the foreseeable future. The question is how to reach the goal.

The basic answer to this may be of two types. First, in future and as soon as possible, the HYVs or hybrids whichever is considered will have to have other desirable traits (as discussed earlier but also see below) apart from simply being high-yielding. That is the technology for the future shall have to be on a different but related plane. Secondly, it is the farming system whose productivity as a whole has to rise, not just the yield of any particular variety. This is particularly important because of the need to diversify crop and food production both on economic and environmental grounds as discussed earlier. The success in the first makes the attainment of the second that much easier while ensuring food security as well as better stability of income of farmers which is most welcome at times of high market volatility.

### Core strategy

Bangladesh may thus have three strategic choices before her. These include (a) technology generation to widen the choice to farmers as well as development of varieties and farming systems and related agronomic practices suited to different and changing ecological conditions, (b) reaching information about new technology to farmers through an effective extension system and (c) development of marketing (domestic as well as exports) as more of income-elastic commodities are expected to be produced. Policies have to be formulated and/or revised and implemented with a strong political will to make the strategic interventions effective. The political will, rather than statements, have to be reflected in proper planning for necessary programmes with adequate budgetary provisions and strengthening institutional and human resource capacity for implementation. This section shall detail only the technology generation issue for rice. The next section will deliberate on the related policies as well as the other two core strategic issues of extension and marketing in general.

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### Technology generation

The technology generation shall have to consider several imperatives. These are (see also the earlier sub-section 5.1)

- a. development of shorter maturity varieties
- b. development of drought resistant/less water consuming varieties
- c. development of varieties resistant to moderate flood levels
- d. development of salinity resistant varieties
- e. development of varieties with lower or little uptake of arsenic from soil and/water
- f. development of varieties resistant to lodging in case of moderate storms
- g. development of deep water rice which are better-yielding than at present

In each case disease and pest resistance have to be built in. At the same time agronomic practices have to be developed through adaptive research to lower the demand for water and irrigation to lower cost and also withstand drought.

The development of the varieties with desirable traits have to be within existing or newly developed farming systems so that the various new or adapted crops/varieties may be sown/planted at different times or even changed depending upon circumstances from the dependence on *aman/boro* combination to others including a non-rice crop. This will allow farmers to make better choice of the utilisation of his/her resources including land as well as preserve soil fertility. Most importantly, all such varieties/farming systems have to be higher-yielding than before *so that the tinier plots that the farmers now have can still ensure them a living income.*

The priority probably, at least for now, has to be given to development of varieties which are suited more for the *aman* season. For that, varieties may be developed which can be planted somewhat earlier so that it can be grown almost wholly in rainfed condition obviating the need for supplementary irrigation. While one such variety has been released, one needs more of them to suit specific ecological conditions.

There are certainly various varieties under development and may be taken up in future by the scientists. But usually it takes too long to release varieties, sometimes 8-10 years. Add the time for actual adoption by farmers through a weak extension system and the time become too long to be acceptable. One way to cut down this time both for development as well as adoption of varieties, the NARS should be involved in participatory research with farmers as well as private entrepreneurs who are entering related business. This will allow the

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System to understand better the demands of the farmers for particular desirable traits in the varieties in a given ecological setting.

Another way to cut down on development is to have MoUs with suitable research stations outside Bangladesh for trials of varieties developed in the country. Such attempts have apparently been made earlier but could not be put in effect because of paucity of funds.

The method of technology generation should not be confined to the conventional ones. But it may include genetic engineering and other methods. This will necessitate a regulatory system for ensuring bio-safety. Unfortunately, the bio-safety law and regulatory mechanism is yet to develop fully in the country.

The above strategy places a heavy demand on the institutional and human capacity of the NARS. Note that the much touted competitive grants for research programme that has been put in place is more for adaptive and small scale research, not the cutting-edge and possibly larger and longer-term research programme that is being demanded now. For this to be realized, the authorities must take actions now as the NARS suffers from many types of constraints and imbalances including resources, logistics, and working conditions and environment including length of service life and compensation systems. These need to be addressed with utmost urgency if the NARS is to deliver on the demands that are being placed on it.

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## **SHORTER TERM OPTIONS**

### **Issues**

Given that a fuller overhaul of the technology generation and the public extension system would take time even if begun from now on in all earnest, we need to look at the shorter term options for the next 5 years or so. The business of agriculture has to be supported and complemented in various ways. While we discuss below quite a few of these, two core issues of inputs subsidy and availability as well as output price stabilization and distribution for consumer welfare will be emphasized. Other issues will include those of public-private-NGO partnership, seeds, and the impact of volatile (particularly high) prices on costs of production as a guide towards output support and marketing. Some of these are also longer term issues that may impact upon the growth of agriculture.

### **Public-private-NGO partnership in agricultural extension**

One area of immediate attention is agricultural extension. Note that the public extension system which is the largest among such public organisations suffers from several malaise as exemplified in Gill (2003). Removing them will need a hard look at and a systematic overhaul of the system including the work method, logistics, technical facilities, the hierarchy and responsibility system, human resource development and planning (including retirement age and compensation) and the like. The work may start with reexamining the New Agricultural Extension Policy and its revision if need be.

While this will take some time, possibly 5-6 years, the available system will have to reach all available knowledge and technological inventions and innovations to the farmer. Reaching information through all kinds of avenues thus become most important. Not only the public extension system, but the energies of the private and corporate bodies and non-government organisations involved in agriculture related activities needs to be harnessed. A public-private-NGO partnership is called for. How this may be fostered to the benefit of all needs to be investigated thoroughly and immediately.

Given the above, there is at least one area where immediate attention may be paid because this falls within the government's avowed aim of creation of a digital Bangladesh. This relates to the use of Information and Communication Technology (ICT) for extension. While the private sector and the NGOs have gone somewhat along the road, and extended

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their helping hand to the public bodies to work together, the desired response from the latter is still rather muted. While this is true that the use of ICT in agricultural extension is not that easy and may have to cross many hurdles including the problem of mind set of public officials, the sooner concerted efforts are made along this line the better. It must be understood that e-extension will not substitute for conventional extension, but will supplement it in many and new ways.

### **Issue of seeds**

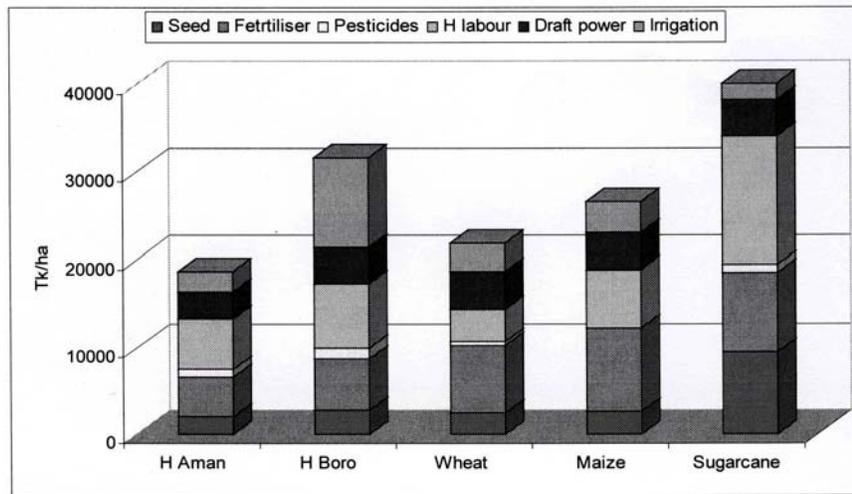
Several inputs are essential in present day crop agriculture. Quality seed is a prime need. This is particularly true in case of hybrid varieties of rice. The problems of production and preservation of good quality seed needs to be investigated clearly and appropriate measures taken for ensuring quality seed supply at affordable price to farmers. The seed certification system needs to be made full proof. But there are many legal, regulatory and institutional hurdles that need to be crossed in doing so.

### **The counterfactual**

As prices of fertiliser and also of oil have skyrocketed last year, so have the prices of rice world wide as well as within the country. What do these therefore, mean in terms of profitability of rice cultivation and the incentives to the farmers? This is important for understanding the case for subsidy. We use a counterfactual analysis for this.

Note that the price of rice since then has come down, and so have the prices of fertiliser as well as of oil. Hence the counterfactual may not probably be much of a guide to the future but note that the impact of previous high prices are still reverberating through the economy and putting budgetary pressures on the public exchequer as much of the existing present stocks of food and fertiliser had been procured from abroad at previous high prices. But before going into the counterfactual, let us take a look at what the “normal” costs of production had been during the *boro* period. This is shown in Fig 14.

**Figure 14. Cost structure of irrigated crops**



Source: Based on BIDS (2007)

Note for the time being only the case of HYV *boro*. The per ha cost is shown to be more or less Taka 30,000 or nearly Taka 12 thousand per acre. This is now nearly Taka 33,000 per acre if cost adjustments based on higher prices are made. This probably would be even higher because while the major items of cost are irrigation, fertiliser and hired labour, we have made adjustments only for fertiliser and irrigation costs, not for human labour.

In any case if we use the figures for fertiliser prices and also the usage rates as indicated by farmers, the cost of production of HYV *boro* paddy comes to just about Taka 14 per kg and of cleaned rice Taka 21 per kg.<sup>29</sup> There is a problem here, however. The usage of fertiliser may not be the desired optimum one and probably would have been higher if the availability had not been so much constrained. In that sense, the cost of production probably would have been higher by another 10% or so, i.e., paddy would have cost Taka 16.5/kg to produce and the cost of production of rice would have gone up in a similar fashion but by somewhat less than 10 percent. Adjustments for human labour would raise the costs of production further.

We may make a cursory evaluation of the procurement prices that have been announced by the Government after the last *boro* season. It appeared that the procurement drive did not succeed well until the

<sup>29</sup> One of the on-going studies of the author indicates the cost per kg to be Taka 16 or so.

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government revised the price of procurement upward. To begin with the prices offered appeared to be higher than what the costs of production had been. Yet, the procurement was rather slow. With hindsight it now appears that surplus farmers have not released all their stock in anticipation of even higher market prices. When the prospect of following *aman* rice seemed quite bright, they tried to release the stock which resulted in a slump in the price of rice even before the *aman* harvest has been fully realized.

The other problem related to procurement is that the Government procures not so much from farmers directly, though this is not prohibited. Various rules (such as allowable moisture content, but not easily verifiable in practice) constrain the farmers from taking their produce to the procurement centres. To reach the targeted procurement as quickly as possible and also for ease of administration, the Government procures from the millers who have a kind of monopsonistic hold over farmers while buying paddy and a kind of alleged monopolistic hold over the local administration while selling rice. These institutional mechanisms need to be probed well and relevant policy decisions taken and implemented if farmers are to be provided with remunerative prices. As prices in the market indicate, farmers may still make profit at the prevailing rate or it may even come down if the millers are made to behave properly. What it means in terms of policy is that both the inputs subsidy (for lowering costs of production) and the output price support (for ensuring minimum incentive prices) have to be considered together for a unified and consistent support to agriculture.

Output price support through establishing a floor price is in fact is just one element of the over-all public food distribution system (PFDS). Thus while we are arguing for integrating inputs subsidy and output price support, what it means in terms of trade offs with other objectives of PFDS, namely ensuring food security of low-income consumers, emergency relief and food stock management are largely unknown. Then again given that procurement is easier and more predictable for *boro* rather than *aman* rice (due to the latter's susceptibility to natural hazards), maintaining stocks (procurement and release in a dynamic context of demand) at "proper" level is no easy job as large anticipatory stocks may have to be maintained even during *aman* harvest which is followed in a few months' time by the potentially more bountiful *boro* harvest and thus creating a serious problem of stock storage and management. Probably, it would be better then to provide the support to farmers (if needed) more through inputs subsidy and use procurement prices rather as a signal for the Government's readiness for market stabilization. If this results in lower level of stocks, it has the danger of massive food insecurity as happened last year. But, the remedy probably

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lies not in holding large stocks but faster action in times of need so that stocks may be built up quickly.<sup>30</sup>

### **Fertiliser availability, price and subsidy issues**

#### *Availability and supply*

Whatever technology is developed in the future, fertiliser would still be needed and for that a proper fertiliser policy including its pricing becomes important. There are several issues related to fertiliser. Particularly during the last two years as before, farmers' main grievance had been the supply and availability, not so much price. Problems arose particularly with non-urea fertiliser which has to be basically imported. The availability and supply crisis was actually not unique these two years.

Every year in general prices shoot up in specific months (February-March coinciding with the planting of *boro* rice, and during July-August/September coinciding with *aman's* early vegetative period). Evidently these are months when supplies become tight. What is puzzling is that despite the pattern being repeated almost every year, the government fails to ameliorate the situation through allowing timely imports or availability. Discussion with MoA officials indicates that there is a failure in planning and its implementation due to certain bureaucratic procedures in relation to finance and release of funds for imports.

Regarding supply of fertiliser, it may be noted that Bangladesh has 6 urea factories and 1 TSP factory. Roughly half of urea and 2/3rds of TSP as well as the whole of MoP is imported. All domestic factories are pretty old and beyond their technical life. As a result the domestic production has been falling over time. There are substantial factory to factory variations in efficiency. Thus while most plants produce 1 ton of urea with 30 mn cft of gas, there are two factories which use 50-59 mn cft to do so. Furthermore, while the gas consumption in urea factories are rising at a rate of 3%, urea sales are rising at a lower rate of 2.7%. This means that over time the production is becoming more inefficient.

The problem of supply may thus be summed up as year to year *ad hoc* arrangements for imports which is blamed on estimation delays by the DAE for crop acreage and consequent fertiliser needs. The issue of

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<sup>30</sup> In 2007, despite repeated calls, given the developments in the inputs and the grain markets and that successive floods already made *aman* rather uncertain, the Government was rather slow in getting its acts together. Had it acted more decisively earlier, it could avoid the erosion of consumer confidence in the government's ability to arrest rising prices as well as procure internationally fertiliser and rice much more cheaply.

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minimum strategic reserve (given the technical problems of doing so beyond a certain period) has apparently never been seriously considered either for finished products or for critical raw materials such as rock phosphate. The whole bureaucratic system of procurement also needs to be streamlined for importing strategically important goods such as fertiliser.<sup>31</sup>

#### *Fertiliser distribution issues*

Over time the fertiliser distribution system has seen various changes from complete public sector monopoly to complete free market and now back to some kind of public and private partnership with a partly regulated market. The regulatory mechanisms and associated subsidies on imported fertiliser are not appropriately or competently handled, however, resulting in private fertiliser distributors allegedly getting their reimbursements rather late and farmers being charged higher prices than the price set by the Government. Furthermore, there is another anomaly.

The Industries Ministry is in charge of allocation of fertiliser including imports whereas the Ministry of Agriculture is the user. This author believes that the Industries Ministry should have as little role as possible as this only adds to the delays in procurement and ultimate distribution.

Now coming to the issue of subsidies, it must be noted that there are subsidies in various forms on fertiliser. First, natural gas which is the feed stock for manufacturing urea is supplied at a subsidized rate to the urea factories. Secondly, till recently while the domestic production cost was Taka 6,800 per mt of urea, the dealers' price was Tk 4,800 which was sold, theoretically speaking at Tk 6/kg or Tk 6000/mt to farmers. International price of urea was far higher last year, varying at one time or other from say US\$ 350-500/mt or even more, yet the imported urea was sold at the same rate as domestic urea entailing huge subsidy. Imported non-urea fertiliser attracted a 15% subsidy but the actual total subsidy varied from year to year depending on prices (there has been some changes in the system since the new Government has come to power which is described later).

The distribution system suffers from several problems and maladjustments. One is dealer storage problem and also of appointing fewer dealers than are necessary. Problems have been compounded due to licensing under political patronage. More dealers have been appointed since the Interim/Caretaker government has come to power, yet complaints persist regarding availability.

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<sup>31</sup> There are cases when even after finalizing all formalities at the high level; the actual imports have been delayed for institutional and jurisdictional anomalies or problems.

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What all these mean in terms of actual benefits flowing to farmers of the subsidy. One may note here that fertiliser is absolutely essential for crops to grow and hence availability must be ensured. If it is not available, the subsidy is as good as useless. That is why farmers clamor more for supply rather than grumble about prices. Yet, prices should be the indicator of the shortages of supply and on that recent information based on FGD's in 64 villages during the fag end of the last year's *boro* season is instructive.<sup>32</sup>

For urea the price varied from just about Taka 6 to 20 with a mean of Taka 9.5/kg. In about 30% cases, there were complaints of prices being charged above Taka 9/kg i.e., more than 50%. Only just about a third did get the urea at the stipulated price of Taka 6/kg.

TSP price varied from Taka 23 to 56 with a mean of Taka 39/kg. Two thirds of the farmers complained of paying between Taka 30 and 45 per kg. Just about a quarter paid more than Taka 45/kg. MoP prices varied from Taka 22 to 44 with a mean of Taka 31-32/kg. One third of the respondents paid up to Taka 30/kg while 58% paid between Taka 30 and 45/kg.

These field level urea prices were at a time when the price fixed by the government had not yet been changed. That means that farmers paid on an average 50% more for urea than the price fixed by the Government. And also that dealers did reap an economic rent of Taka 3.5 per kg of urea sold over and above what has been paid to them as subsidy to be passed on to the farmers. The total unearned profit to urea dealers was Taka 8.75 bn.

It is not definitively known who among the farmers benefited from the subsidy, if at all. But this much is known that there had been substantial anomalies in preparation of the list of farmers and their land under *boro*. It has been alleged that people have inflated their land under *boro* so that despite a rationing they can get enough for application on actual land. How widespread the practice was can not be definitively known. What is known, however, that farmers clamored for the fertiliser distribution to be deregulated and allowing the free market to operate. Secondly, they wanted the whole supply or rationed fertiliser at one go because according to them lining up several times at distant places for a small amount of fertiliser is costly and adds to their cost of production. While one understands their arguments, it is imperative that there must be a regulatory mechanism to ensure that there is a fair play in distribution. How to do that is not, however, clear.

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<sup>32</sup> The information is from an on-going study on diesel subsidy by the present author and the data refers to the *boro* period this year.

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### **Subsidy in diesel**

Last year for the first time the Government has distributed nearly Taka 2.50 bn as subsidy for diesel operated irrigated rice cultivation to farmers. The subsidy was supposed to be distributed to farmers who had no more than 2.5 acres of cultivable owned land and who did not cultivate more than 2.5 acres of *boro* rice land whether owned or rented or both under diesel operation. Thus from the beginning a kind of equity has been built in into the system.<sup>33</sup>

The problem was again in listing. Limited time was available to the Department of Extension personnel on the ground (Sub-Assistant Extension Officers or the erstwhile Block Supervisors) to prepare the list. Various anomalies have been reported. The end result according to research underway is that while 75-80 percent of eligible farmers did get some cash, just about one-half of the ineligible ones also did get it. Furthermore, about 15-16% of eligible farmers had not been listed at all.

The rate of subsidy was fixed at taka 5.45 per decimal of land cultivated with *boro* rice. The eligible ones did get about Taka 3.5 per decimals and the ineligible ones about Taka 2.5 per decimals. Yet, because the size of *boro* rice land was larger for the ineligible ones, they did get much more than the eligible ones.

Apparently, there had been several pathways for the subsidy to end up at inappropriate hands. There had been allegations of fees for listing names, changes were not given at the time of payment, ineligible ones did get a part of the money while eligible ones did get less than their due and finally pump owners some time did get a cut. The field impression was that anywhere between a quarter to a third of the money did not reach the ones for whom the subsidy was targeted. Also, the subsidy was given at the end of the season when these could not really be used for direct cultivation purposes. But some did say that they used part of it for paying hired labour.

Little is known regarding the benefit distribution of subsidy in electrified irrigation. But as these are directly paid to the REB, it is likely that even if there are informal payments to be made, these may not be much. And in any case, electrified irrigation cost has been found to be much lower than diesel operated irrigation. In that sense, the farmers under

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<sup>33</sup> Note, however, that a farmer may pass both the eligibility criteria, but may still have with rented in land irrigated *boro* land under electricity operated irrigation schemes and thus the total cultivated land above 2.5 acres during the *boro* season. What should be done in these cases, is not clear. The list should have had information on all land under cultivation whether irrigated or not and whether irrigated with electricity-operated or diesel-operated equipments.

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electrified irrigation are getting higher benefits compared to those under diesel operated ones.

The diesel subsidy has been given for the first time last year. The government has again made an allocation in the budget for this year. But if a substantial sum gets lost due to inappropriate payments, question is should this be continued? This author believes that there may be three types of option. *First*, electricity subsidy may continue but the diesel subsidy may be discontinued. This will create dissension while creating inequity. Second, both electricity and diesel may be subsidized. On the ground of equity, there must be an equalization of cost of irrigation across fuel choice. Hence, if subsidy for electricity is continued, there must be subsidy for diesel for such equalization. Third, one may also argue that neither of the subsidies may be given. But possibly that will not be politically saleable. We believe that the second argument should hold but the system of listing and payments may be made much more foolproof for lowering waste and leakage (also see later).

### **Recent developments under the new Government**

The new Government has recently changed the system and fixed the prices of non-urea fertiliser at the dealer level almost to one half of the prevailing market price to compensate the importers who had imported earlier at high international prices and were unable to sell them at the prevailing rate of subsidy.

Under the present Government there has also been a change in the farmer level pricing at the local level. Previously the subsidy was paid at the importers level and the prices were also fixed at that level. But what the local price a dealer could charge (up to a limit) was determined by local conditions of transport and other factors as determined by the local administration. This discretion of the local administration has now been withdrawn. The dealer's margin has now been determined at the central level and added to the subsidy paid to the importer. It is now between the dealer and the importer as to how much margin he/she can get from the importer subject to the proviso that the prices to be charged to the farmer must be the one fixed by the Government.

### **Policy options for inputs pricing, subsidy and distribution**

*Is there a case for inputs subsidy alone*

Before one makes a case for inputs subsidy, particularly those for fertiliser and irrigation, it may be pointed out that subsidy is not the only instrument in the arsenal of the policy maker to support agricultural growth, its diversification and sustainability. Not only that such a subsidy has to be looked at from the over-all macroeconomic efficiency,

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but also even if we look at agriculture alone, there are several other ways to make it more productive and viable. Output price policy is one option which is a short term policy as subsidy. Technological change supported with an effective extension system is another option which is a medium term to long term option but probably with a more lasting effect on productivity and lowering of costs of production. Both these issues have been discussed and analysed earlier.

Then again, if the objective of subsidy is to lower the immediate cost of inputs to farmers, similar objectives may also be achieved through the provision of an appropriate and adequate credit facility or lowering import tariffs on several types of equipments such as power tillers and tractors, and irrigation equipments and other implements such as threshers or rice hullers. Lowering of import tariffs on equipments may have the added advantage that it helps in fostering the spread non-farm activities such as repairing services in the rural areas. Given such a variety of options to lower costs of production and related activities in agriculture, there is a case for understanding which one of these options or some of their combinations may be the right choice for Bangladesh. The policy makers need to know the opportunity costs of each of them before making up their mind. Given these caveats we now turn to the issues related to the subsidy option.

#### *Challenges for an inputs subsidy system*

The policy options for pricing, subsidy and distribution mechanisms for fertiliser and diesel-irrigation have to be examined against the backdrop of two types of challenges facing the government. The first type of challenge is to ensure food security by providing farmers including marginal and small cultivators who are in the majority to produce and innovate as well as keeping food prices within the means of the common consumer. The second is to keep the budgetary pressure on the government within a reasonable limit. The third is to avoid or minimise unintended negative effects such as degradation of land due to unbalanced use of fertiliser.

Note that for a very long time urea price has remained fixed which means that the relative price of urea compared to that of rice which has been rising had fallen over time providing farmers' incentives to use more of urea. This was not the case for TSP and MP in more recent years as their prices have been rising fast compared to that of rice. There is thus a case for providing enough subsidies for non-urea fertilisers to provide farmers incentives for using them as well as to help in balanced application of fertiliser as noted earlier. The recent move by the Government to increase the subsidy on non-urea fertiliser and thus lower their private costs to farmers is expected to limit such imbalances.

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## Subsidy and pricing options

### *Per farm or per unit of land*

Subsidies may be given either on a per farm or on a per unit of cultivated area basis (a schematic diagram of the policy options is provided in Fig. 15 along with the advantages and disadvantages of various options). As the cultivated area under a farm varies from season to season, a country-wide survey has to be undertaken at least twice (for *aman* and *boro* seasons) for determining the level of subsidy to be given to a farmer. This is costly and administratively very complex. Hence this is not a feasible and practical option.

### *Universal or targeted subsidy*

The other option of providing subsidy on a per farm household basis may be either universal or targeted to, say, marginal and small farmers (MSF) only. One may also think of targeting the subsidy only to regions which are lagging in terms of agricultural growth for one reason or another. At the moment as the price of fertiliser is fixed at the dealers' level and sold to whoever wishes to buy, theoretically this is a universal subsidy given to all farmers. There are arguments, however, both for and against universality.

One may argue that targeted subsidy in favour of the MSF will help those who can not bear the cost of fertiliser required for cultivating HYVs and hybrids. Larger farms can bear the cost and may not be given subsidy. There are two arguments against such targeting.

Much of the net marketed output comes from large farmers. If their costs of production are high, this will ultimately adversely affect the consumer through high market prices. On the other hand, a targeted subsidy will necessitate a listing of all farmers while a universal subsidy may need a far simpler listing based on say the National Identity Card or a certificate from the local government (Union Council) stating if somebody is a farmer cultivating land under own direct management.<sup>34</sup>

The diesel subsidy for irrigation, if the Government wishes to continue it, may be either universal or targeted to specific groups. Again in this case, the same arguments as before apply. But there is a third point in favour of subsidy for large farmers. All including large farmers who irrigate their land with diesel operated equipments spend more whether they are owners or not of pump machines than those who irrigate with electricity operated pumps as electricity for irrigation is universally subsidised.

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<sup>34</sup> A full listing with details of land may not be avoided even in case of universal subsidy if the available supply of input has to be rationed as happened last year in case of fertiliser.

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Hence, if the case for diesel subsidy is made on the premise of differential in private cost of irrigation due to universally subsidised electricity, there is no *a priori* argument against providing universal diesel subsidy.

Diesel subsidy may also be provided through lowering the price of diesel as in case of fertiliser. But lowering diesel prices may have its limits. One particular worry is the problem of smuggling out if the domestic prices become too low as prices across the border are comparatively higher.

If both fertiliser and diesel is to be subsidised universally, there may be a case for further simplifying the whole process. One may provide a combined cash farm subsidy to the farmer (identified through either NIC or a UC certificate) which the farmer may use as he/she sees fit, be it for purchasing water or fertiliser or seedling or paying for hired labour. In that case, the market prices may prevail. This money may be a fixed amount per farm which will be equitable in the sense that large farmers will get comparatively less per unit of land than the marginal and small farms. The government may not need to fix the price of fertiliser or diesel but may only ensure that enough of the inputs are available in the market. This is also likely to help in raising allocative efficiency in production.

Cash subsidy has one possible disadvantage which is that of arrangement for actual disbursement of large sums of money. The experience of cash diesel subsidy has shown that farmers do prefer to get the money through banks to avoid various hassles. However, payments through banks may also be a huge administrative task. Payments through non-government agencies may be an option. Obviously, subsidy through a pricing system has no such disadvantage of disbursement.

In case the government does not wish to provide universal subsidy for either fertiliser or diesel for irrigation, or wishes to distribute fertiliser and subsidy for diesel irrigation on a pro rata basis of land under cultivation, lists of farmers with land under cultivation would be necessary. Despite the pitfalls in preparing such a list, several points may be noted. First, it is better to prepare one combined list for fertiliser and diesel subsidy. Second, the lists may be prepared carefully with house to house listing and with provisions for revising the list if there are inaccuracies. For this to happen, the list must be well-publicised. It may also be possible to prepare a digitised data base of the farmers based on the list which may be updated easily later on and publicly available for inspection.

If the government wishes to continue with the present system of fixing fertiliser prices, it may minimise its fiscal burden of subsidy by opting for several actions. First, the price may be kept as high as possible with an eye on affordability by the farmer which may be ensured to certain extent

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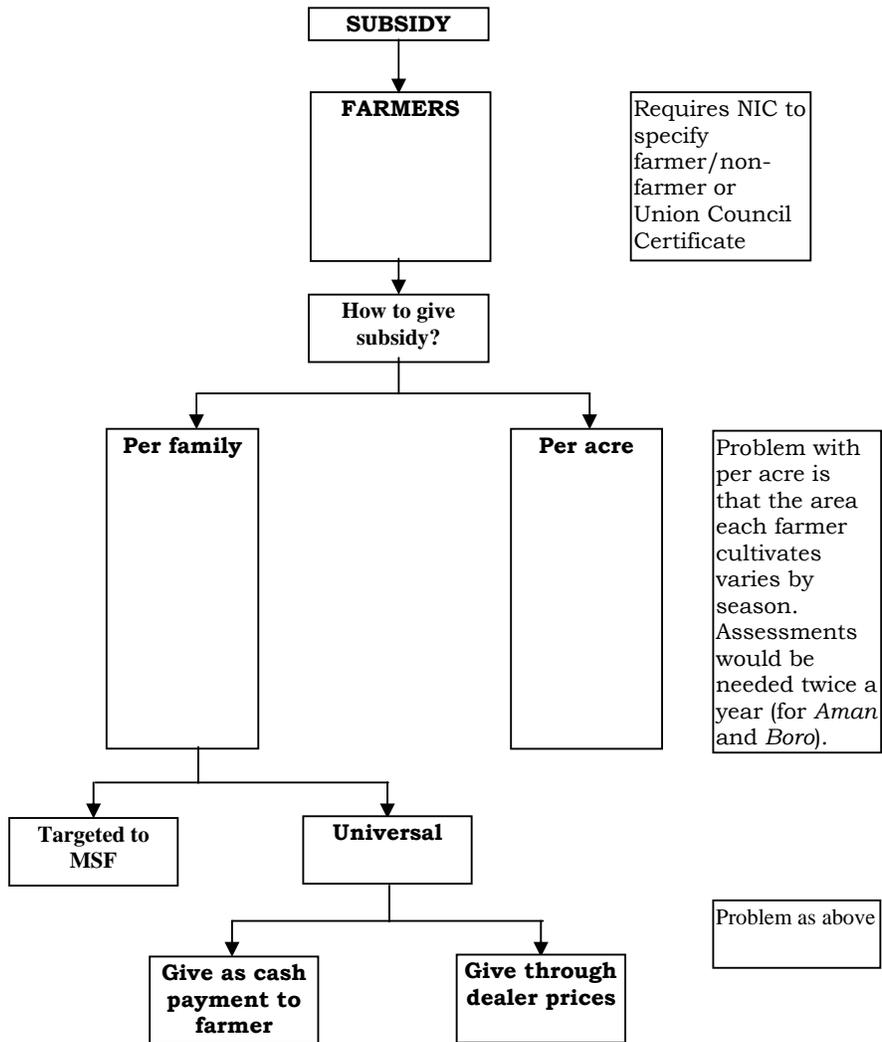
by providing cheaper and easily available credit facilities. Secondly, it may be remembered that part of the subsidy goes to domestic fertiliser manufacturers whose unit cost of production is much higher than the government fixed price. It is known for that matter that the urea factories have highly variable efficiency in use of the natural gas which is the main feed stock and supplied to them at a subsidised rate. They must be told to put their house in order, to eliminate waste and increase efficiency.

*Availability and the Distribution System*

Finally, the issue of availability needs to be looked at closely through the improvement of the distribution system. One option is to increase the number of licensed dealers and sub-dealers so that the fertiliser distribution is geographically equitable and competition is ensured for equitable access of farmers to inputs. Licensed dealers may be allowed to sell to any farmer if he/she comes from the general area served by the dealer or the sub-dealer. The other option in distribution of inputs is that anybody may be a retailer who may buy the input in bulk from a dealer or an importer. But this may not always ensure the quality of fertiliser.

For the subsidy and pricing system to be effectively run, one also needs other actions at the higher level of decision-making. The issue of keeping strategic reserves of fertiliser or staggering imports in a manner commensurate with the seasonality of demand needs to be closely monitored and remedial measures taken. If the private importers appear lukewarm in importing the requisite amounts, the government must be prepared to import fertiliser on its own. The issue of strategic reserves of raw materials such as rock phosphate also needs to be considered.

**Figure 15. Policy Choices in Operating Fertiliser Subsidies**



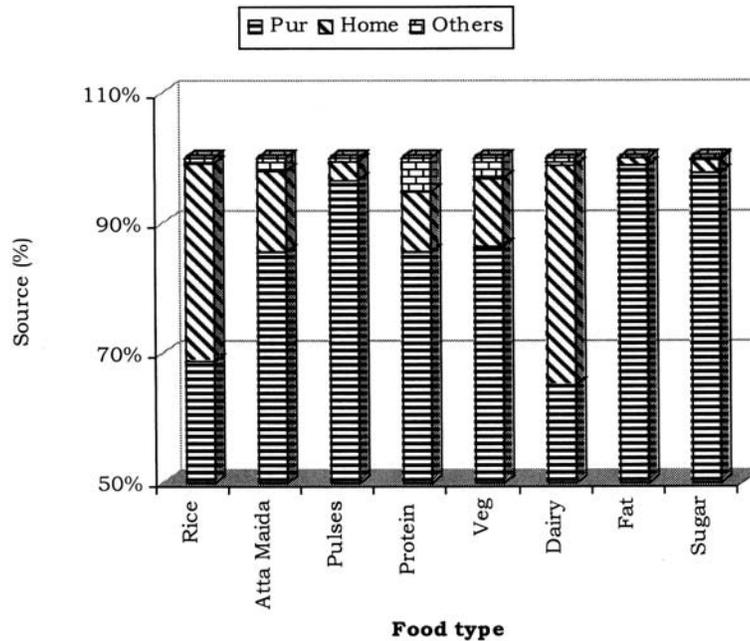
**Universal subsidies: alternative ways of delivery**

<b>Subsidy paid</b>	
As cash payment to farmers	Through administered dealer prices
<b>Advantages</b>	
<p>Progressive – MSF get higher subsidy per acre cultivated</p> <p>Flexibility – farmers can use for any input (increases allocative efficiency)</p> <p>Could be provided as combined payment for diesel and fertiliser</p>	Easy to administer
<b>Disadvantages</b>	
<p>Provides large farmers, who produce most of the marketed surplus, less incentive to increase production.</p> <p>Possible diversion to non-agricultural uses by family</p> <p>Requires registration system (NIC or Union Council Certificate)</p>	<p>Possible diversion by dealers to non-agricultural sectors (e.g., industries).</p> <p>Need to closely monitor dealers to check charging correct prices to farmers.</p> <p>Requires adjustment of subsidies each season to ensure allocative efficiency</p> <p>MSF access may be relatively restricted.</p>

**Issue of marketing**

We have earlier indicated the importance of marketing. Unfortunately, this is one of the most undeveloped part of the Bangladesh agricultural system. Yet this is true that much of the food reach the consumers through the market. The information in the HIES 2005 indicate that for practically all types of food including rice, market is the main source procurement (Fig. 16).

**Figure 16. Source of procurement of food**



Source: Based on unit records of HIES, 2005

At present there is the following number of formal markets in the country according to the information of the Department of Agricultural Marketing.

Primary/retail markets	9377
Wholesale cum retail markets	2893
Assembly/wholesale markets	828
<i>All markets</i>	<i>13098</i>

It is quite probable that the number of primary and small markets may be many more than indicated here. And this does not take into account the sales by farmers at their homes.<sup>35</sup>

The major problems farmers and marketing agents do talk about mainly revolve around the issue of transport problems and rural infrastructure. They may now know of prices in various markets because of the mobile telephony but taking full advantage of that depends on the hard infrastructure and its quality (Asaduzzaman: 2002; Baulch *et al*: 1998)

<sup>35</sup> For a detailed though somewhat dated analysis of rice market see, Baulch *et al* (1998).

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In any case, given such importance of marketing, of late the Government had been trying to develop the system somewhat through investments. One example is the development of wholesale markets under an ADB project. The success so far has been somewhat limited but even within that it has had some positive results in that market arrivals, particularly of perishable high value crops has increased substantially.

*Export marketing*

We have earlier indicated that if a factor-neutral technological change takes place at a pace of 1-1.5% per annum (i.e., the resource cost of production falls at that rate), Bangladesh may face a problem of domestic absorption. Exports of agricultural and agro-processed commodities have to gear up to make up for the possible future slack in domestic demand. Export marketing, particularly in agricultural and agro-processed commodities, is a different kind of business, however, compared to domestic marketing. It is not simply that global economic forces are important including macroeconomic policies related to exchange rates and support (subsidies, price support, credit policies) provided to agriculture under WTO rules, but also due to the problems of adhering to the stringent food quality standards under the WTO and other importing country (notably EU) rules (Asaduzzaman: 2004; Ahmed and Asaduzzaman: 2008).

In essence, there are major problems here in terms of a properly functioning regulatory mechanism for avoiding fraud and cheatings as well as awareness-raising and also managing costs of investments. It has been found, however, that necessary technological change for adhering to standards would substantially increase exports. This will thus improve Bangladesh welfare and lead to higher labour absorption helping in poverty alleviation while increasing profit for private business. But the technological change has to be financed and managed through proper guidance and assistance. This is an issue which needs to be taken up in all urgency which has been lacking so far. The reader is referred to Ahmed and Asaduzzaman (2008) regarding recommendations in this area of programme for support to agriculture.

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## SUMMARY AND RECOMMENDATIONS

### Summary

The ideas in this paper may be briefly summarised as follows:

Bangladesh agriculture has over the last thirty years been basically a rice-dominated crop agriculture. The output growth has been very substantial and helped by

- a. increasing dependence on the dry period irrigated *boro* HYV and of late hybrid rice;
- b. the changeover to *boro* HYVs has been largely through conversion of the land from the overlapping *aus* season the prospects for which now is rather limited and thus any further increase in *boro* output has to be largely through a rise in yield;
- c. the output from wet period, *aman*, rice has fallen in share but its absolute acreage has remained by and large static; the *aman* yield has increased but output has been variable due to various climatic and ecological factors;
- d. several challenges are now facing agriculture; not only it will have to ensure food security, help in poverty reduction, stabilize the incomes of the farmers, satisfy consumer preferences and also to contribute to over-all growth of the economy but this will have to be achieved under several severely constraining factors including those related to various climate and weather-induced, and ecological and public health, ever falling size of farms and land-man ratio, global competition and also high and volatile prices of essential inputs such as fertiliser and oil as well as high (falling now, though) international and domestic foodgrain prices;

### Broad recommendations

To meet these challenges simultaneously is going to be tough but not impossible. After all Bangladesh, once dubbed a basket-case, is no longer so and she has shown how technological change can help in getting out of the straightjacket of food insecurity and poverty. This time too, technology has to be the main weapon, but a technological change whose nature will have to be somewhat different than before as detailed discussion in earlier sections, particularly V and VI has shown. One necessary ingredient of such technology generation is that it has to be participatory with farmers in different ecological settings and demand driven. The technological change has to consider not simply varietal,

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improvements but also evolving more efficient farming system and crop diversification for raising and stabilising income.

But for the technology to be adopted by the farmers would necessitate several revisions, refinements and addition to policies regarding inputs subsidy (particularly for fertiliser and irrigation) and output price support. In essence subsidy has to continue, though not necessarily in the present form or at the present level. Particularly if both subsidy for fuel and fertiliser are allowed, the system have to be combined for greater efficiency and lowering wastage and fraud.

Apart from fostering technological change, intervention will be needed for totally revamping, revising or completely recasting the agricultural extension system with space for private agents. Earlier attempts to build some dynamism into the system have apparently failed. A thorough investigation is needed into the system before any reform is contemplated. In the mean time, there may be attempts at developing public-private partnership which may be useful for later incorporation into a new agricultural extension policy and system

Marketing remains the Achilles heel of the Bangladesh agriculture. This also needs to be developed and with immediate attention because if this system develops, farmers on their own are likely to move to crop and agricultural diversification without much further public stimulus. Here the public-private partnership is even more essential than elsewhere and can be introduced much more easily because of the divisibility of many of the operations and scopes for involvement of people on an individual basis.

One final point on credit. As indicated earlier we have little new knowledge regarding credit. It appears that dependence on informal sources have substantially fallen but not completely eradicated. What implications does this have for purchase and use of inputs and capitalization of agriculture? We know very little about this. Hence a proper subsidy policy to be framed will have to consider this aspect of flow of funds in the farm families.

A policy maker is likely to simply sigh at this moment and ask so what is new that you are suggesting. In fact, in principle, there is nothing new. What is new is the urgency of the matter and the priorities that need to be refixed within the framework of a competitive world which is now in a tail spin due to the recession. Bangladesh economy, or for that matter, its agriculture, is only partly subsistence-oriented and is aspiring to be a middle-income country in two decade's time. Now is the most difficult period as in the middle game of chess. Unless the development policy moves are made well and taking into consideration of various trades-off, in future, the options will be even more limited.

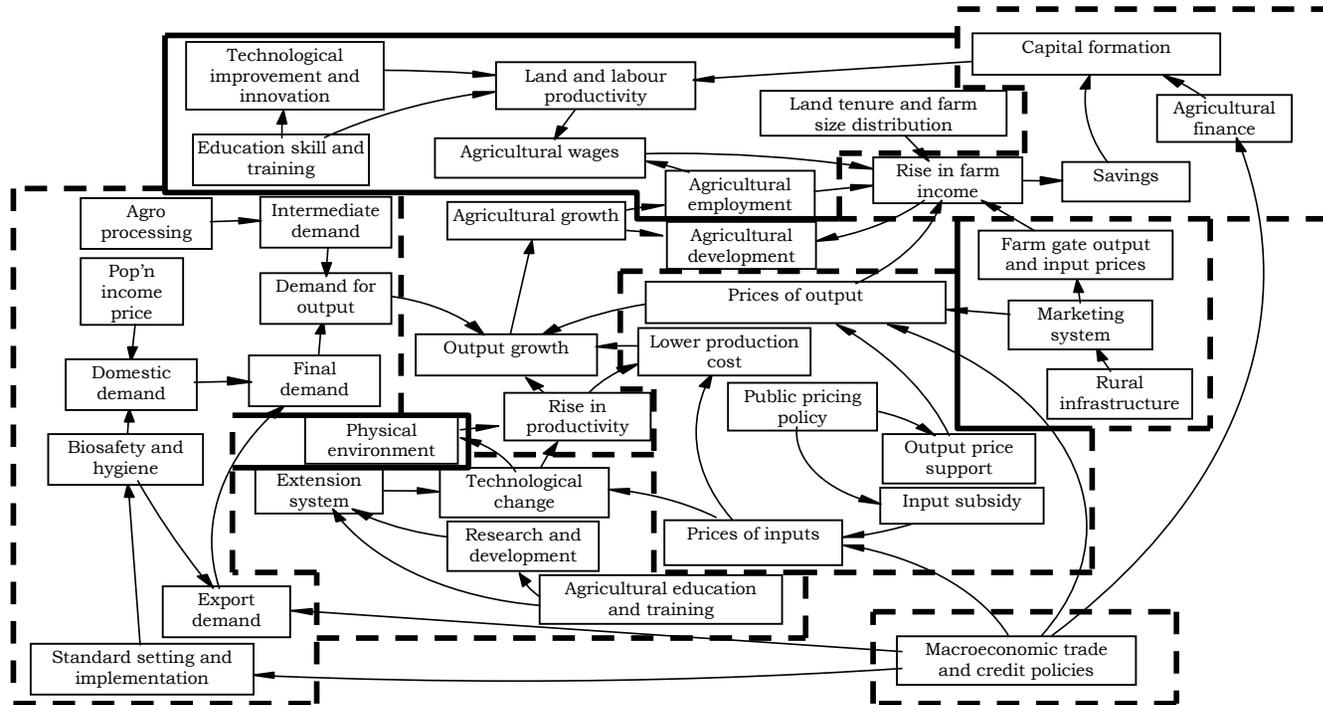
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**Annex 1. Factors behind and Pathways of Agricultural Development (Schematic diagram)**



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## Annex 2

### Trend line equations for output of rice

$$\ln amanq = 1.9559 + 0.0145 T^{***} ; \quad \text{Adj. } R^2 = 0.707 \\ (0.0017)$$

$$\ln boroq = 0.7627 + 0.0677 T^{***} ; \quad \text{Adj. } R^2 = 0.972 \\ (9.0021)$$

$$\ln ausq = 1.2582 - 0.0285 T^{***} ; \quad \text{Adj. } R^2 = 0.854 \\ (0.0022)$$

$$\ln totalq = 2.4699 + 0.0271 T^{***} ; \quad \text{Adj. } R^2 = 0.945 \\ (0.0012)$$

$\ln amanq$  = logarithm of *aman* rice output in mn mt

$\ln boroq$  = logarithm of *boro* rice output in mn mt

$\ln ausq$  = logarithm of *aus* rice output in mn mt

$\ln totalq$  = logarithm of total rice output in mn mt

Figures in parentheses are standard errors of the trend variable, T (time)

\*\*\* indicates statistical significance at 1% or less.

Equations are based on data for 30 years from 1977/78 – 2006/07.

### Annex 3

**Table A3.1. Average annual growth rates of gross output under different growth and technology scenarios**

Sector	Business as usual			Scenario 1			Scenario 1		
	No Tech	Tech 1	Tech 2	No Tech	Tech 1	Tech 2	No Tech	Tech 1	Tech 2
Agriculture	0.0365	0.0282	0.0246	0.0489	0.0406	0.037	0.0509	0.0425	0.0389
Crop	0.0274	0.0199	0.0167	0.0368	0.0294	0.0262	0.0378	0.0304	0.0272
Livestock	0.028	0.0193	0.0156	0.0428	0.0341	0.0304	0.0453	0.0367	0.0329
Forestry	0.0417	0.0303	0.0256	0.0524	0.041	0.0363	0.056	0.0447	0.0399
Fishery	0.0575	0.0478	0.0437	0.0748	0.0651	0.061	0.0776	0.0678	0.0637
Non-agriculture	0.0516	0.0429	0.0391	0.0736	0.0648	0.0612	0.0788	0.0702	0.0664
National output	0.0484	0.0398	0.0361	0.0686	0.0599	0.0563	0.0733	0.0646	0.0609

Source: Reproduced from BIDS (2004)

Note: Under the no technological progress situation the rates of growth of value added and the gross output are the same.

Scenario 1: Terminal year (2014/15) rate of growth of GDP is 8% pa

Scenario 2: Terminal year (2014/15) rate of growth of GDP is 9% pa

Tech 1: 1% rise in productivity per annum

Tech 2: 1.5% rise in productivity per annum

**Table A3.2. Changes in welfare and other indicators due to factor-neutral technological change in an open economy Bangladesh**

Changes in	Natio- nal	Rice	Other grains	Oil seed	vege- tables, fruits	Fibres	Milk	Fish	Forestry	Sugar
GDP (%)	17	-	-	-	-	-	-	-	-	-
Welfare (US\$ mn)	9302	-	-	-	-	-	-	-	-	-
Export (%)	-	296	157	232	91	150	175	88	42	48
Import (%)	-	- 46	- 18	- 22	- 26	- 30	- 22	- 23	4	- 4
Price (%)	-	-27	- 20	- 24	- 21	- 21	- 21	- 14	- 6	- 9
Us labour wage (%)	- 6	-	-	-	-	-	-	-	-	-
Land rent	- 23	-	-	-	-	-	-	-	-	-
Employment	-									
Land	-	-8	13	25	5	9	16	4	13	0.6*
Us labour	-	-19	11	27	2	6	12	0.4	11	- 4*

Source: See earlier table.

Note: The simulation is based on GTAP, a popular global general equilibrium trade model. The welfare is measured in terms of equivalent variation. \* refers to sugarcane. Us labour is unskilled labour