

Draft (not to be quoted)

Managing Bangladesh Agriculture under Climate Change

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December 2008

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I. Preamble

Bangladesh is one of those developing countries which may have to bear the brunt of climate change due to global warming to which she has contributed very little. Very few sectors will remain untouched. One of the major sectors to be most adversely affected is agriculture. This is a major cause for concern because it is the single-most important source of livelihood of the people in the country as well as the supplier of much of the food including the staple that they consume. In short livelihood and food security both will be severely threatened severely compromising the capability of the sector to contribute to future economic growth. This short paper will try to delineate the range of policies that may need to be adopted and implemented to avoid or at least minimise such prospects. To put the issues in proper perspective, I begin with the importance of agriculture in the economy and society of Bangladesh.

II. Importance of Agriculture in Bangladesh

We first define agriculture in a broad manner. This includes crop cultivation including plantation and tree crops, livestock and poultry, fisheries and forestry. Agriculture as a whole has historically played a major role in the economy in terms of the GDP. But this has been falling over time, although the absolute size has been rising. Two decades back, agriculture contributed nearly 30% to GDP. It is now down to 20% or so. Manufacturing industries contribute another 15-16%. The rest is accounted for by services. Agriculture thus would seem to have not much significance in the economy. But such appearances are deceiving.

First and foremost, agriculture is absolutely critical for food security as it supplies 90% or more of the supplies of rice, the basic staple food in the country. Furthermore, apart from staples it provides the animal protein in the form of fish and meat (from livestock and poultry) which are essential for maintaining nutritional status of people as these are

hardly ever imported and domestic production and supply constitute almost the only source.

Secondly, agriculture supplies basic raw materials to industries such as rice milling, jute textiles, sugar, cigarettes, leather, tea, edible oil, paper including newsprint. Third, agriculture through forestry is a major source of biomass for fuels particularly in rural areas and small towns. In 2003, biomass as firewood, crop residues and tree residues contributed fully eighty percent to rural energy consumption in the country while electricity contributed hardly 1%. Without such biomass, most people in the country would have no other energy to cook their food.

Fourth, agriculture is still the largest employer in the economy. For the nation as a whole 45% of all labour above 15 years of age were employed in agriculture in 2005. In rural areas it was 55%.

Fifth, agriculture, at one time was the most important earner of foreign exchange. While the number one position is now occupied by ready-made garments and knitwear contributing 75% or more to goods exports earnings, agricultural and processed agricultural goods are the second largest group of exports items and contributed 12-13% of total export earnings in 2006/07. The largest single agricultural item among these commodities is frozen shrimp.

All such contributions of agriculture indicate that it is an extremely vital sector of the economy. This is also underlined by the fact that the national GDP historically moved in tandem with agriculture. If agricultural growth was good, so was that of GDP while low growth in agriculture coincided with low GDP growth. Any major disruption to agriculture caused by factors such as climate change on a long-term basis is therefore an issue of life and death for Bangladesh. To understand why, it is necessary to discuss, at least briefly, the characteristics of Bangladesh agriculture which we do in the next section.

III. Characteristics of Agriculture¹

3.1 Food crop farming

Predominance of rice: One characteristics of agriculture or rather the crop sub-sector is that it is dominated by the cultivation of rice. 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 mn acres. Rice alone accounted for 26.7, 25.6 and 26 mn acres of the total. That means rice contributed around 75% to the cropped acreage.

Much of rice that is now grown in the country is based on dry period (*boro*), irrigation-dependent and energy-intensive (direct energy in the form of diesel and electricity and indirect energy in the form of fertiliser) cultural practices. These are by and large high-yielding and hybrid varieties. The local indigenous varieties are hardly cultivated during this season now.

At present dry period *boro* cultivation accounts for nearly 52% of all domestic production. Practically the rest is accounted for by the wet-period (but some time dependent on supplementary irrigation) *aman* rice in which too the high-yielding varieties are prominent though less so compared to *boro*. *Aus* is the third and completely wet-period rice which has lost its earlier significance.

There are three important points to note here. First, the over-all rice acreage has more or less remained unchanged although there has been change in inter-seasonal distribution in favour of *boro* (see Fig. 1). At the same time, the local varieties have dwindled in significance and HYVs have gained very substantially (Fig. 2). And all these have resulted in the very substantial rise in domestic output and supply of rice leading to, and this is the third point, insignificance of imports (Fig. 3).

¹ Part of the discussion here draws upon a currently on-going larger study by the author on agricultural policy options.

Fig. 1: Inter-seasonal Distribution of Rice Land

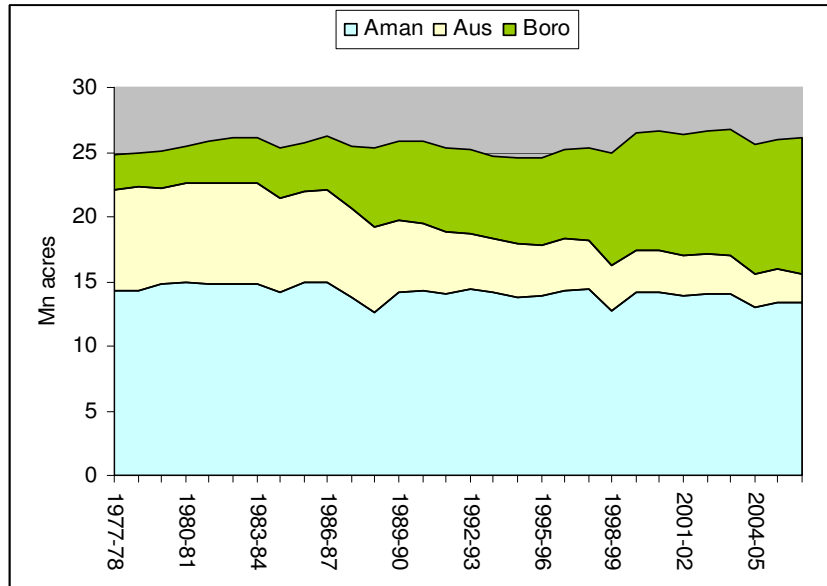


Fig. 2: Rice Output by Seasonal HYVs and Local Varieties

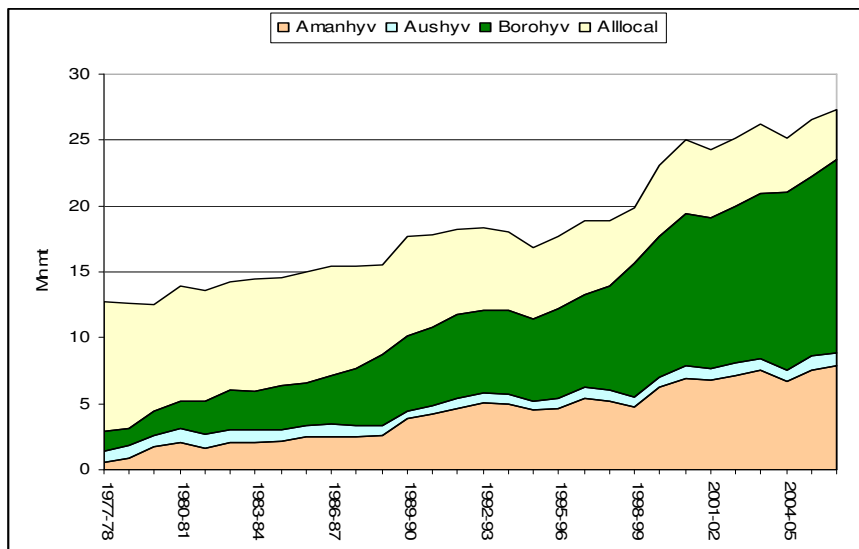
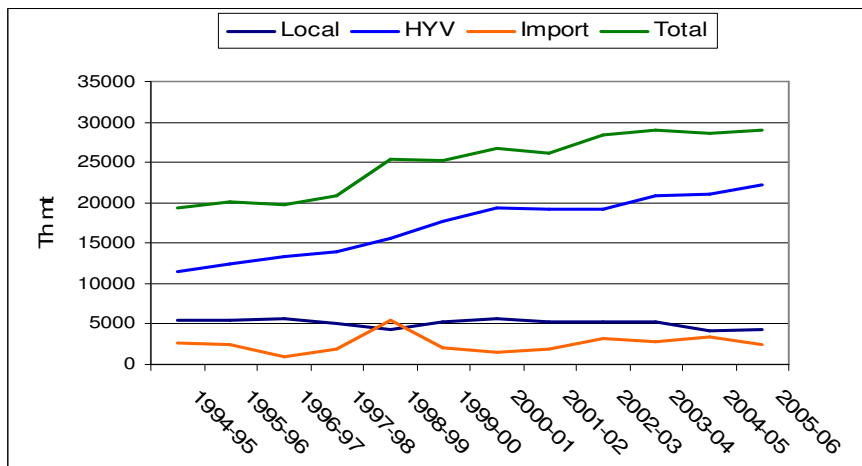
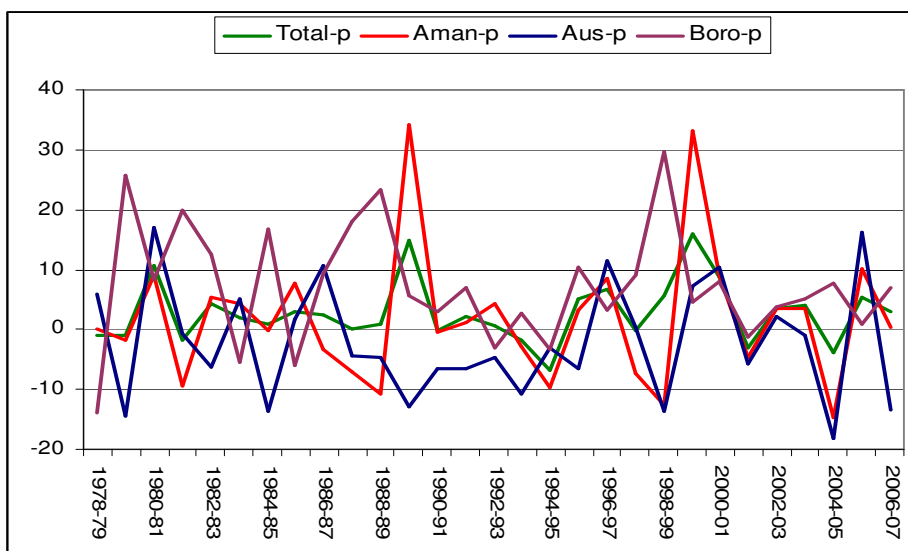


Fig. 3: Domestic Output and Imports of Rice



One further concern regarding the output is the year to year variability (Fig. 4). 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. 4: Year to Year Fluctuation of Rice Output by Season



As local varieties have been substituted by HYVs, the over-all yield per acre has risen particularly in case of boro where the switch from low-yielding *aus* to high-yielding boro has been extensive. For aman the yield had been static. It appears, however, that the opportunities for further expansion of boro area by switching from *aus* have more or less come to an end. Any further rise in boro output therefore has to come through rising yield and exactly that is what has been observed in recent years. Aman, however appears to be a problematic case.

Aman land suffers from flood or storm damages (particularly in coastal areas) as well as from soil moisture stress during the critical flowering period necessitating facilities for supplementary irrigation.² As a result of all these, so far the yield of aman appears to be static. 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 except for boro, the yield rates of HYVs are largely static or even falling.

Spatial aspects of agriculture: Bangladesh is often thought to be a homogeneous country, yet there are substantial variations in agro-climatic situation and natural resources endowment with consequent potentials of growth and actual performance. It is not surprising to find that the experience of agricultural growth and productivity appeared to have synergy with the development of irrigation.

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 largely by availability of mechanised tillage. On the whole the upshot of these studies is that there are substantial spatial variations in growth performance. In so far as these regional differences in growth are influenced by agro-

² Historically failure of aman in the past has been the harbinger of famine in Bengal. See Chakrabarti, Malabika, *The Famine of 1896-1897 in Bengal: Availability or Entitlement Crisis*, Orient Longmans, 2004.

climatic factors, climate change is likely to have serious implications for future agricultural development in such areas.

3.2 Industrial crops and bio-fuels

There are several crops which are basically industrial crops although may be used either for processing as food or non-food purposes. Sugarcane is major industrial crop whereas the domestic production of sugar is not sufficient to meet demand. Maize has become more important compared to earlier years mainly due to its use as poultry feed but also as food in the most recent past when food prices sky-rocketed. The most important among the industrial crops is perhaps jute. None of these are used as bio-fuels except that the residues of these crops (bagasse, maize stalks and cobs and jute sticks) are used biomass fuels.

3.3 Livestock and Fisheries

In Bangladesh the livestock and fisheries sub-sectors are rather small when compared with crops. Again, however, this does not indicate their lack of importance. As already indicated these are major sources of animal protein while fisheries sub-sector provide the largest single product for export among agricultural commodities. The livestock sector faces two types of problems, one is that of feed which have to be imported or have to be produced domestically by setting aside land for food production. Secondly, the present stock is not much productive. The situation has not been helped by the recent major outbreak of avian influenza in the country.

In case of fisheries the main threat is that of loss of wetland due to their large scale conversion into crop land and also for non-agricultural purposes. The only saving grace is that small scale pond-fisheries in recent years have come up rather strongly.

3.4 Forestry

The proportion of area under formal forests in Bangladesh is small although she has the largest single patch of mangroves in the world. The mangrove is the largest forest land of the country. Mangroves and other forests provide the fuel for energy consumption, timber

for industrial processing and also provide a reserve of bio-diversity. It should be noted here, however, that in Bangladesh, the village forestry including homestead based forestry as well as roadside and canal side plantations provide the bulk of the firewood for consumption as biomass.

IV. Challenges to and Vulnerabilities of Agriculture due to Climate Change

4.1 Challenges

The preceding section may be used to understand the challenges before the agriculture 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, and ensuring adequate nutrition. And this must be done in a situation where the population continues to grow, albeit at a low rate and per capita demand may rise due to income growth. The combined effect is estimated to be a rise of 3% or so for cereals alone. The demand for non-crop food is likely to rise much faster.
- c. Agriculture also has to perform in an increasingly unfavourable condition of access to natural resources, particularly land. Between 1987/88 and 2006/07, for example, 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 staggering 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 vast scales are contemplated.

4.2 Climate change and resultant vulnerabilities

All the above challenges become much more daunting in the face of global warming and climate change. While this is not the place to analyse in detail the types and nature vulnerabilities that will arise due to the climate change, briefly these may be stated as follows:

- a. The physical impacts may be of several types mostly related to abundance or scarcity of water or its spatial spread and quality. The dry winter season may

- become warmer and drier. The rainy season may experience more precipitation. The sea level rise may inundate vast tracts of land over time unless defensive actions along the coast are undertaken or previous such infrastructures are kept in repair with redesigning wherever necessary.
- b. Floods, cyclones and drought all are thus likely to be experienced more frequently and/or in more severe degree.
 - c. The vulnerabilities faced by agriculture will thus be nothing new in a sense as such disasters are routinely faced by Bangladesh. But the present level of damages due to flood, drought and storm surges are likely to exacerbate probably several fold and this may happen in a quite non-linear fashion and no body knows when the natural system may break down and may not gain its old equilibrium.
 - d. All sub-sectors of agriculture will be affected adversely. Crops will be affected due to changes in seasonality of precipitation and other weather events such as foggy weather during summer hitherto unheard of. The mangrove may simply vanish if the sea level change takes place as some researchers have predicted. Livestock will be more heavily infested with parasites lowering their productivity. Also salinity increase along the coast will also impair their health. But where would the feed come from. If food production becomes uncertain, feed production is bound to lose out. Fisheries may benefit as wet land may increase but this may probably be at the cost of the small scale pond-based fishery due to rising temperature and drought. More importantly the area for fresh water fishery may actually dwindle if sea level changes take place as has been predicted. Then again warmer
 - e. The economic and social consequences will be mind-boggling. It is not only that the economic growth may be stalled and the hopes of Bangladesh to become a middle income country in decade's time may be dashed, but also the hunger and penury that will result will be beyond any rational speculation. Of course much will depend how the natural system shall behave. Already there are signs of the changes in many parts of Bangladesh and farmers state that their forefather's knowledge of farming is no longer applicable in the present situation.

- f. And who would suffer and what staying power do they have? In crop agriculture, farms up to 2.5 acres were 87% of all farms in 2005 and they farmed only 59% of total land. Their capacity to withstand large scale crop failure due to climate change induced events will be well-nigh non-existent.

V. Adaptation and Mitigation in Agriculture

5.1 Introduction

Given the vulnerabilities that Bangladesh faces and their nature and extent, adaptation is the prime need. Agriculture, however, is one of those few sectors where mitigation may also be important. While Bangladesh emits only a very tiny percentage of world total emissions, nevertheless, she is committed to do whatever she can by way of mitigation. Her attempts and thinking on mitigation in agriculture is part of that commitment. We shall discuss these issues in the sub-section after the next.

5.2 Adaptation

How should Bangladesh cope with the vulnerabilities discussed in the preceding section? Of course climate change will have ramifications for many sectors and some of these will reinforce the others while adaptation in one sector may yield benefits for others. Keeping these in mind, and also acknowledging that so far there has been little research on probable impact of climate change on non-crop agriculture, we may delineate the following areas for adaptation in agriculture. Drawing upon the National Climate Change Strategy and Action Plan (NACCSAP), these may be enumerated as follows:

- a. Development of climate resilient cultivars. This means research to develop varieties which are flood tolerant, resilient to warmer climate, resistant to drought, of shorter maturity so that they may be harvested before the deepening of drought or the full onslaught of floods. Note that the needs of the two main rice seasons are quite different as may be understood from their characteristics as discussed earlier. Both have to be equally emphasised although for somewhat different reasons as we shall point out shortly.

- b. Not simply new cultivars, the research system shall also have to develop new cropping systems which are climate resilient in the sense that if crops fail fully or partially, planting may be done with other varieties or crops which are more suitable for that period and for that area.
- c. Research must be carried out to find the resilience of fish and livestock to various climate related stresses and manage them accordingly.
- d. The agricultural extension systems also needs to be geared up to take upon the challenge.
- e. Risk management through various means against crop and output failure in non-crop sub-sectors becomes a major issue in adaptation. As insurance issues raise the problems of moral hazard and adverse selection, these need to be critically looked at for proper application in case of climate induced risks. Crop diversification is one way to minimise risks and needs to be encouraged although the experiences in this country in this regard is not very positive.
- f. Early warning becomes a major issue. So is long-range forecasting. If farmers know beforehand that rain is not falling during the next two weeks, their behaviour may be different than if they know that it will almost certainly fall. And that save the country from spending huge amount of money for importing food. Such forecasting has to be regionally made with smaller grids than at present and be available in real time to all countries and farmers.
- g. Finally, one has to also have an early warning system for food production and remain ready to import food as the situation demands.

5.3 Mitigation

There are several potential areas of emission of green house gases in agriculture and consequent potentials for mitigation. Earlier discussion indicates that energy consumption in agriculture has increased due to HYVs, mechanised irrigation and tillage practices. In case of boro rice cultivation, use of diesel and electricity is almost universal for cultivation. At the same time there are views that water management is rather inefficient meaning that proper water management may lead to lower irrigation needs and

consequently lower demand for energy. Tillage management may similarly probably lower energy consumption.

Proper water management may also help in reducing or eliminating any potential emission of methane from irrigated rice fields. Similarly methane emission may also be reduced if appropriate feed management and manure management is adopted in case of livestock.

In general if cultural practices may be improved, this may lower the demand for fertiliser and thus also help indirectly in conserving energy, particularly natural gas which is the main feedstock for production of urea, the major nitrogenous fertiliser used by farmers in the country.

Deforestation and degradation of forest land is often argued to be a major source of emission while afforestation is accepted as a major sink activity. In general therefore, forestry may play a major role in emission reduction. In this regard, the issues related to soil carbon management in forest, choice of species for popularisation, LULUCF and REDD issues are important. None of these, so far, however, have been studied in the country. Mitigation in forestry therefore has to consider these issues for future research.

VI. Investment, Finance and Associated Institutional Issues

6.1 Key issues in assessing the needs

Lack of analysis of the problems of adaptation and mitigation and consequently required information constitute the major bottleneck in assessing the needs of investment, their nature and the required financial needs not to speak of the institutional mechanisms for management of such flows. Note that in the preceding section, we have already indicated the needs for research for understanding the problems. In some such case such as development of crop cultivars, the National Agricultural Research System (NARS) probably has relevant information related to research costs. But almost certainly these information are strewn over many agencies, are unpublished and not easily understandable due to accounting formats used. In other cases, there has been no research

at all in the relevant areas and for any Climate Change Response Manager it would be a nightmarish experience to assess such needs.

A second difficulty arises because not only that sub-sectors differ in their basic characteristics and thus their amenability as well as response to any given methodology for such assessment. Assessing investment needs for planting rice and planting a given forest species certainly are not going to be assessed similarly. One way to circumvent this is to treat the sub-sectors separately.

The third difficulty arises due to the uncertainties involved in assessment of the immediate physical and second round human system impacts. In the second case, there may already be relevant interventions (coastal dykes in Bangladesh, for example). This is an added complexity. But the general situation that exactly what impacts one will have to guard against is basically unknown. The uncertainty arises not only because of the limitations of data but also because there is no parallel case of the interaction between the natural system and the human system on such a vast and global scale and the associated possible non-linearity of response of the natural system. Models may help, but only up to a limit as models are always a simplification of the reality. In fact, it is not so much the assessment of the need but the type of need for adaptation that is crucial. It is always better therefore to base the actions on nationally best practices.

One such example is the development of several new cultivars by the NARS. These include shorter maturity variety which allows farmers to escape in a sense drought and avoid supplementary irrigation during the aman period. The other is the development of a salinity resistant variety which is now gaining popularity in coastal areas.

Finally, there is a need for integrated assessment of the impacts, not only across sectors, but probably more importantly across disciplines. The trade-offs between various measures in terms of their costs and benefits need to be understood for making better policy recommendation.

6.2 Way forward

Institutional arrangements: One may have to move in several directions all supportive of each other for adaptation and mitigation in agriculture. There will have to be adequate institutional arrangements for conducting various necessary research for assessing future adaptation and mitigation needs. The NARS has to be an integral part of this. But this also needs to be adequately supported through international collaborative arrangements. However, this will necessitate a thorough review of the NARS, its capabilities, strengths and weaknesses. The synergy between adaptation and mitigation has to be borne in mind while the researches are finally conceptualized and carried out.

Resource mobilization: Resources have to be mobilized. And Bangladesh here has already progressed somewhat along the road. The Government has set up an Endowment Fund (US\$ 45 mn) for adaptive agricultural research through a competitive grants programme. The NARS will, of course continue to conduct the cutting edge research. But as things are developing even under the Competitive Grants Programme, innovative research is likely to be given priority.

More importantly, the Government has already set up another Climate Change Response Fund (US\$ 45 mn) which may be replenished on demand. This money is expected to be coordinated for grants across sectoral ministries by the Ministry of Environment and Forest. One of the ideas is to use the money among others for setting up Climate Change Cells as focal points in ministries for mainstreaming climate change issues in development plans, programmes and actions. And one of the first such cells is that under the Ministry of Agriculture which is expected to soon chalk out a tentative programme of its own.

Yet another fund has been created through grants from the UK Government (initial grant of US\$ 75 mn). This is soon going to be operationalised. The money is by and large for adaptation. Naturally, only a part of the fund will be earmarked for agriculture. There is yet a fourth comparatively small grant coming from the Asian Development Bank

(US\$ 200 thousand) to be used mainly for capacity building for managing climate change. The core ideas are not clearly known.

A fifth large scale funding opportunity has arisen although how far Bangladesh may be able to grasp the opportunity is not yet clear. This is going to be JBIC programme, probably partly grant, partly loan, but mainly for mitigation purposes. This is still in the planning stage. It may be noted here, although this is not in agriculture, that one CDM project on waste to compost has been just put in operation.

On top of all these there are various funding ideas that are being mooted in the climate change negotiations. As and when some of these reach the stage of actual disbursement, there may be options for grants from the LDC fund, the Adaptation Fund, funding for REDD etc.

Coordination: Naturally, there are many things that need to be done. The response to climate change has to be well-coordinated not simply across sectors, but also within sectors. Particularly as funding is available for various related purposes, one has to plan well and appoint appropriate institutions or devise appropriate institutional mechanism for their implementation. For this to be done in the agricultural sector, several necessary actions must be undertaken immediately. These are:

- a. Revisit existing agric policies including revamping extension system
- b. Scrutinise the present major interventions and expenditure programmes of the government in agriculture as to their climate change sensitivity
- c. Develop guidelines for revision of existing programmes and develop new programmes in a climate sensitive manner

While the agriculture ministry may take the lead in all of these, it must not be forgotten that agriculture means various other sub-sectors beyond crops and that the actions in agriculture follow or have ramifications for other sectors. Thus, one would like to have close collaboration among the ministries of agriculture, fisheries and livestock,

environment and forest, food and disaster management, finance, local government and women and children welfare.

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VII. Summary and Concluding Remarks

References