Fact-finding Mission for a Programme on Postharvest Practices in Bangladesh

Prepared on behalf of the Swiss Agency for Development and Cooperation

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Executive summary

A two-week mission was undertaken in Bangladesh to identify potential interventions in the postharvest systems of fruit, vegetables and grains that would lead to a reduction in postharvest losses. These interventions were to be compatible with market-based approaches to benefiting poor people (M4P), for possible inclusion in a future SDC postharvest programme in Bangladesh.

The approach taken to the mission was to gather initial insights through a kick-off workshop with Bangladeshi postharvest scientists. There followed in-depth interviews with key informants starting with the scientific establishment. Then to test potential ideas for loss reduction suggested from researchers and gather new ones from those who work in the value chains we interviewed the market actors - farmers, traders and processors large and small,. Outside Dhaka, many of the interviewees were in the Mohasthan village wholesale market (*hat/bazar*) in Bogra and its surrounding countryside.

The available loss figures suggest that for cereal grains losses range from about 4-10% while fruit and vegetables range from 20-40%. Because of the very large scale of rice production, the financial value of rice losses far exceeds losses of other foods. The next greatest value of losses was from potatoes (Table 1).

Information gathered on grains (cereals and pulses) suggests that there is not much room for implementing loss reduction measures. For rice it is likely that losses at each link in the rice postharvest chain are not great, except in some particular circumstances, but add up to a sizeable total loss in some areas (perhaps as high as 13%, based on 2010 estimates). Although as percentages the losses at individual links in the chain may be low, the great scale of rice production in Bangladesh means that such losses represent large tonnages (financial values). There may therefore be much to be gained from loss reduction. However, current uncertainties about the economics of the introduction of driers and the economics and practicalities of mini combine-harvesters suggest that any attempt to support the rice sector should wait for more thorough analysis. In this regard, a proposed postharvest survey by IRRI will be of interest. Links with IRRI should be maintained as there is considerable potential synergy between Katalyst's business approaches and IRRI's technical expertise. Support for the adoption of mechanical threshers may still hold some value in freeing labour to address other postharvest activities but is unlikely to have much direct impact on the postharvest losses of rice.

Maize losses are considered to be about 4%, this seems to be due to short storage periods. Maize is grown as a cash crop for the animal feed industry but there is some human consumption, especially the Chittagong Hill Tracts (CHT). A recent study points to clear scope for much increased maize cultivation but support to help contain postharvest losses will have to wait until there is enough maize on the market that farmers wish to retain some. It was noticeable that farmers do not employ maize drying cribs of the type used in the humid parts of West Africa and this could be considered, perhaps as part of the on-going Katalyst maize strategy. The metal silos technology pioneered by SDC for maize grain storage in Central America would appear to have no immediate usage for mainstream maize farmers in Bangladesh but may find a role in due course when production increase reaches the localities where maize is an important crop for human consumption, since such places are foci of food insecurity and so would benefit from better storage methods.

Pulses are a very important part of the Bangladeshi diet, and are in effect 'the poor man's protein'. Storage losses are suggested as a major constraint to smallholders dealing in pulses but there is insufficient information available to decide whether an intervention to reduce losses would be appropriate. If better storage is worth addressing, then there may be a suitable technology that could be adopted. In West Africa, the Bill and Melinda Gates Foundation has a large programme promoting the 'triple bagging' technique for the storage of cowpea (in 50kg lots). This may be appropriate for Bangladesh but detailed investigation by a storage technologist would be required to confirm this. In particular it would be necessary to investigate the extent of losses and the benefits of achieving better quality produce and longer storage periods.

Review of the losses of four key fruits (mango, banana, pineapple and jackfruit) and four vegetables (potato, tomato, cauliflower and brinjal) emphasised that quality and weight losses start at farm level

and continue through the transport and handling chain. On farm and during transport to market bruising at harvest, inadequate application of postharvest treatments and damage due to poor packaging are important, in the assembly markets poor sorting and grading and inadequate postharvest treatments lead to further losses and inadequate packing and handling lead to even more losses as the crops are moved to their terminal markets. Furthermore, attention was drawn to the poor facilities at the village-level wholesale markets (*hat/bazaar*) which lack any stores, appropriate sorting, grading and washing spaces, trained staff for sorting and grading to pre-set standards or staff trained to load and unload trucks to minimise damage.

To benefit small farmers and poor people, the best target for loss reduction would appear to be fruit and vegetables as these can contribute proportionally more to livelihoods than rice and so the high losses in vegetables are a particular drain on potential income. Currently, the cost of losses tends to be borne directly by the producer, since the trader will demand the delivery of a greater than official weight to compensate for expected losses. For example, where the standard unit for tomatoes is 40kg (*mon*) the trader will expect to receive 44kg for the same price, in anticipation of a 10% loss. Whilst fruit and vegetables may be considered better targets than grains, this should not preclude interventions with grains, especially as improvements in cereal postharvest productivity and the timing of harvests can have a considerable influence on the opportunities producers have to devote the resources required, especially labour, to reduce loss in fruit and vegetables. Furthermore, around 80% of women in rural Bangladesh are involved in homestead vegetable production. This contributes to meeting the family's nutritional demands and increases access to cash income that women can save or spend. Women perform a major role in postharvest activities such as cleaning, washing and grading of the harvested goods and so stand to gain if this sector is more productive.

Recommendations are made for three postharvest interventions to reduce fruit and vegetable losses.

Intervention 1 - A package of measures to reduce losses at village wholesale and assembly markets

To reduce postharvest losses of fruit and vegetables to a minimum, ideally Bangladesh should have a quality conscious, local and export market for fruit and vegetables, with standardised sorting and grading, appropriate packaging, and be served by a cold chain of refrigerated stores at each level of the market linked by refrigerated trucks. This kind of supply chain would minimise postharvest losses but is unlikely to materialise for many years to come. However, the first steps in this direction can be taken by demonstrating the advantages that can be achieved by offering elements of this supply chain at the first assembly markets (*hat/bazaar*). It is recommended that in five hat/bazaar in 2 or 3 districts (Bogra, Rangpur, Rajshahi), market actors should be facilitated to invest in the development of essential market infrastructure as business opportunities, including short-term cooled storage (10°C-15°C), a clean and sheltered sorting/grading and washing space, and the creation of more loading ramps. Interventions linked to this would be the promotion of better packaging and the training of market staff in sorting and grading and in truck loading and unloading.

Intervention 2 - Promotion of effective postharvest treatments to extend shelf life
It is recommended that postharvest treatments should be promoted so that shelf-life and quality can be maximised. The options available need to be communicated in a very simple, well illustrated way. This work would be a collaboration between for Department of Agricultural Extension (DAE) and enterprises marketing postharvest treatments, ensuring the availability of advice on treatments and the availability of the treatments themselves.

Intervention 3 - Promoting contract farming for effective postharvest management
It is recommended that contract farming of fruits and vegetables should be promoted to bring a systemic change in the service market that will reduce losses. Large processors should be made aware of the benefits that they can obtain from contract farming (using approved contracting methods) and farmers similarly informed of the benefits to them. The better services could be achieved by facilitating service providers, the contractors (large food processors) and contract farmers to implement better postharvest treatments, better sorting and grading and better packaging arrangements.

Acknowledgements

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Acronyms and abbreviations

ADB	- Asian Development Bank
BARI	- Bangladesh Agricultural research Institute
BAU	- Bangladesh Agricultural University
BCSA	- Bangladesh Cold Storage Association
BFVAPEA	- Bangladesh Fruits, Vegetable and Allied Products Exporters Association
BRRI	- Bangladesh Rice Research Institute
CIRDAP	- Centre on Integrated Rural Development for Asia and the Pacific
DAE	- Department of Agricultural Extension
DAM	- Department for Agricultural Marketing
DFID	- Department for International Development (UK)
EPB	- Export Promotion Bureau
GoB	- Government of Bangladesh
IRRI	- International Rice Research Institute
M4P	- Making markets work for the poor
MT	- Metric tonne
SDC	- Swiss Agency for Development and Cooperation
WB	- World Bank

Contents

Annexes

1. Introduction

This mission was envisaged as a means of identifying potential interventions in the postharvest systems of fruit, vegetables and grains that would lead to a reduction in postharvest losses. The interventions sought were to be compatible with making markets work for the poor (M4P), for possible inclusion in a future SDC postharvest programme in Bangladesh.

Postharvest activities extend from the harvesting of the physiologically mature crop, through a number of steps involving processing, transport, handling and storage, until the food arrives at the consumer (farm to fork). Losses may be incurred at each of these steps. The physical losses may be a loss in weight, or complete loss of a certain portion of the crop, and/or a loss in crop quality. Both lead to reduce financial returns. There may also be a loss of opportunity, this is where failure to meet quality criteria confines produce to lower value markets. In the case of weight loss, loss reduction not only improves incomes and food security, but it conserves the resources that were devoted to crop production, i.e. labour, land, water and agricultural inputs (Hodges *et al.,* 2010; Parfitt *et al.,* 2010). For this reason loss reduction is often preferable to increases in crop production to achieve the same food supply. However, this approach is dependent on 1) the losses being reducible and 2) there being sufficient incentive for the value chain actors to adopted measures that reduce losses.

A justification for this mission was that, historically, the focus of government and development actors in Bangladesh has been on gains in crop production. Whereas to overcome rural poverty and achieve national food security it is believed that more attention needs to be given to postharvest practices since at the outset it was assumed that Bangladesh suffers about 15% postharvest losses in grains and up to 40% losses for fruits and vegetables. Nevertheless, relatively little has been done to improve postharvest practices and technologies, and the capacities of relevant GoB ministries in this regard appear weak. Furthermore, policy on this issue still lags behind that on crop production. The Bangladesh Food Security Investment Plan, has a big investment gap in the field of postharvest practices. Similarly, the National Strategy for Accelerated Poverty Reduction II gives highest priority to the development of the agricultural sector in addressing and rapidly reducing poverty and outlines medium-term policies to foster agriculture sector growth that include, for instance, promotion of agro-processing activities. But translation of the policy into practice is making slow progress. Some development partners, such as ADB and WB, and on a smaller scale several NGOs, have started to take up the issue of improving postharvest practices, but there still appears to be substantial untapped potential.

The key elements of the terms of reference for the mission are shown in Annex 1 and the itinerary followed in Annex 2.

Postharvest losses from agricultural production in Bangladesh, based on figures available in the literature for 2008, are presented in Table 1. Agricultural output is dominated by rice and although the actual proportion of rice lost is much lower than for fruit and vegetables, the actual financial value of those losses is much greater due to the large scale of this crop. The closest to rice in loss value is potato at less than half the loss value of rice. The proportion of losses of fruit and vegetables are about three times greater than for grains. This is not surprising as these are much more perishable crops.

Table 1: Estimated value of postharvest losses from grains, fruit and vegetables in Bangaldesh, 2008*

Crop	Production (million MT)	Producer price (BDT/kg)	Postharvest weight loss %	Postharvest loss (million MT)	Loss (million BDT)
Grains					
Rice	46.905	11.9	10.1	4.74	56,375
Maize	1.346	12.3	4.07	0.05	674
Wheat	0.844	18.9	3.62	0.03	577
Fruit					
Mango	0.767	45	27.4	0.21	9,457
Banana	1.005	12.1	24.6	0.25	2,991
Jack fruit	0.926	6.48	44	0.41	2,610
Pineapple	0.238	5.7	43	0.10	581
Vegetables					
Potato	6.648	15	19.32	1.28	19,266
Brinjal	0.222	19	29.4	0.07	1,240
Tomato	0.143	12.85	32.9	0.05	605
Cauliflower	0.156	9.3	34.3	0.05	499

*Production and producer prices – fruit and vegetables Bangladesh Bureau of Statistics 2008, grains – FAOSTAT 2008
Postharvest losses estimates for fruit and veg - Hassan et al. 2010, potato – Hossain and Miah 2009, grains Bala *et al.* 2010

Approach to the Mission

Initial insights to the subject area were gained through a kick-off workshop with Bangladeshi postharvest scientists. The workshop was attended by 14 people (Annex 3) (40% of original invitees were unable to attend) from several institutions concerned with research and consultancy on the postharvest handling of a range of crops, mostly fruit and vegetables, or in donor activities in the field. The agenda is shown in Annex 4. Following the meeting there were in-depth interviews with key informants starting with the scientific establishment, then moving on the market actors - farmers, traders, processors large and small to test potential ideas for loss reduction suggested from researchers and gather new ones from those who work in the value chains. Structured interview guides were devised for the various actors (Annex 5). Outside of the Dhaka area, many of the interviewees were in the Mohasthan village wholesale market (*hat*) in Bogra and the surrounding countryside. A listing of the interviewees can be seen in Annex 6. In support of the text, further information is given in a number of annexes - a listing of the large processors of agricultural products (Annex 7), A listing of the key actors and service providers in the fruit and vegetable market, including definitions of their various roles (Annex 8), organisations/projects involved in with postharvest agriculture (Annex 9) and postharvest treatments given to fruit and vegetables (Annex 10).

2. Kick-off workshop on postharvest loss reduction priorities in Bangladesh

Following an explanation of the purpose of the mission the approach for the meeting was to work through examples of specific crops to draw out the group's knowledge. This was done by presenting a matrix with the key postharvest questions on one axis and target crops on the other (Annex 11). The group was facilitated to provide answers to the questions in the matrix.

The matrix provoked a great deal of discussion to the point that it was difficult to make progress in its completion so that in the end only two crops were considered (tomato and mango). An illustrative example of tomato had already been included but the illustration itself was a provocation to question the data, especially postharvest loss figures. Our illustration had suggested that 20-30% of tomatoes were lost due to poor handling and transport. This was rejected as a baseless figure and that as losses were 1) so variable and 2) not accurately measured, it was misleading to quote them. This was an interesting point since in the last few years there has been a proliferation of reports on postharvest losses of food crops in Bangladesh (to which the participants of the workshop had contributed) all of which quote estimates that do not seem to be based on recent measurements, at best questionnaire surveys where anecdotes of high losses in certain situations may lead to perceptions of much higher average losses. Nevertheless, there was consensus in the group that postharvest losses of agricultural products are significant and worth reducing.

The group was asked for their opinion on which crops offered the most potential to benefit poor people through postharvest loss reduction. They rejected mango on the ground that mango farmers tend to be in the richer group and because there are already many projects aiming at improving postharvest practices for mangos. Among vegetables they selected potatoes with emphasis on better storage, handling and transport. For fruit banana and pineapple were selected where there are needs to improve quality and shelf-life with better ripening procedures and much wider support for transport and handling procedures. No particular interest was expressed in the area of cereal grains or pulses.

3. Data on specific crops

a. Grain products

i. Rice

Importance of crop

Rice is the main staple crop of Bangladesh and fundamental to its food security. It is grown in three seasons. The main crop *aman* is in the dry season (58%) of production the other two crops (*aus* and *boro*) are rainy season harvests. Individual fields would normally have two rice harvests annually and between these harvests the land would be used to cultivate other crops.

PH activities and associated losses

The most detailed study of rice postharvest weight losses is from the 1980s (Greeley 1982a&b) when the best estimate of rice losses by farmers (but excluding processing such a milling and parboiling) was about 7%. This was at a time when a move from traditional to mechanical threshing methods had started but adoption of mechanical threshing resulted in slightly higher losses, not loss reduction. Loss reduction was not the motivation for change in technique but higher productivity through savings in labour. Storage losses were reported to be low due to short storage periods. At the time, Bangladesh farmers were considered traditional but efficient in their postharvest operations and large wet season losses were avoided by careful farm management. However, large farms that were harvesting high yielding varieties in the wet season sometimes suffered high losses (and this could still be the case today).

A fuller loss assessment survey was reported by Haque *et al.* (1991) that included milling and parboiling (which may be considered largely unavoidable losses). It shows, for the non-processing

operations, remarkably similar figures to Greeley et al. 1982a&b, with relatively small weight losses as each stage of the postharvest process (Table 3).

More recent details of rice losses, which appear to have been collected by questionnaire survey rather than actual measurement, are presented by Bala *et al.* 2010. In this case rice producer losses (Table 4) appear similar to earlier studies except for rather higher storage losses. This is surprising as the storage periods are short (six months), half the paddy is probably consumed within three months and in any case paddy is not particularly susceptible to insect attack. This gives more credibility to earlier reports of small storage losses (unless in the meantime there has been some unmentioned change in practice). The two farmers we interviewed stored paddy for 5-6 months and reported little insect infestation. A feature of the reports by Haque *et al.* (1991) and Bala *et al.* (2010) is that the estimated losses from one season to the next appear not to be great, i.e. Greeley's observation that "...large wet season losses were only avoided by careful farm management" seems to hold true even today.

Table 3: Postharvest losses from rice in different seasons in Bangladesh (Haque *et al.* 1991)

Postharvest operation	**Aman**	**Boro**	**Aus**
Pre-harvest & harvest*	2.5	1.14	2.01
Field stacking	0.8	0.72	0.58
Field transport	0.57	0.52	0.52
Threshing scattering	0.11	0.05	0.06
Threshing separation	0.87	0.72	0.75
Winnowing/clearing	0.46	0.57	0.36
Drying	2.11	1.63	2.84
Storage	0.3	1.2	0.3
Sub total	**7.72**	**6.55**	**7.42**
Parboiling	2.04	1.93	2.75
Milling	3.28	4.54	3.55
Processing sub total	**5.32**	**6.47**	**6.3**
Grand total	**13.04**	**13.02**	**13.72**

Table 4: Regionwise postharvest losses of rice in Bangladesh (from Bala et al. 2010)

Season	Region	Producer							Processor	Wholesaler	Retailer	Grand Total loss, %
		Harvesting loss, %	Transporting loss, %	Threshing loss, %	Parboiling loss, %	Drying loss, %	Storage loss, %	Total loss, %	Total loss, %	Total loss, %	Total loss, %	
Aman	Mymensingh	2.45	1.59	1.80	0.03	2.87	4.64	**12.71**	0.79	0.33	0.42	**14.04**
	Khulna	1.54	0.69	0.62	0.03	2.69	5.70	**10.86**	2.13	0.16	0.36	**13.21**
	Dinajpur	1.51	0.62	1.11	0.03	2.30	3.57	**8.84**	1.95	0.15	0.24	**10.96**
	Comilla	1.07	0.63	0.73	0.02	1.40	2.49	**6.19**	0.13	0.07	0.11	**6.48**
Boro	Mymensingh	2.47	2.01	2.23	0.04	2.79	4.82	**13.58**	0.79	0.33	0.42	**14.90**
	Khulna	1.40	1.03	0.83	0.04	2.81	5.73	**11.37**	1.70	0.13	0.38	**13.31**
	Dinajpur	1.78	0.93	1.28	0.04	2.40	3.75	**9.80**	1.98	0.17	0.27	**11.96**
	Comilla	1.02	0.71	0.74	0.02	1.63	2.50	**6.46**	0.13	0.07	0.15	**6.79**
Aus	Mymensingh	3.00	1.64	2.96	0.04	2.87	4.30	**13.97**	0.81	0.33	0.42	**15.30**
	Khulna	0.21	0.25	1.50	0.00	2.73	5.00	**9.40**	2.29	0.20	0.36	**11.97**
	Dinajpur	2.06	0.84	0.45	0.00	2.81	4.75	**10.50**	1.45	0.17	0.26	**12.17**
	Comilla	0.89	0.50	0.71	0.00	1.83	2.58	**6.40**	0.13	0.07	0.15	**6.72**

We saw many threshers in operation and spoke to a threshing service provider, who was landless but owned and operated a machine-powered thresher on behalf of farmers. The rice thresher suggested that there were as many as 500 others who offered this service in his Upazila. A miller we spoke to indicated a preference for machine threshed grain since it allegedly contained less foreign matter and so would attract a price premium. It was noticeable that we passed many harvesting groups still

threshing by hand, we spoke to one farmer who was hand threshing and it would seem that as household labour was available and the relatively small size of his harvest (1.2 MT) he was not willing to pay for a threshing service despite its ready availability. The thresher we interview charged 2kg for every 40kg he threshed. However, there may still be market opportunities for small-scale threshing entrepreneurs. A machinery supplier informed us that about 50% of thresher sales went to wholesalers and 50% to farmers and about 5% of all farmers are owners of machine threshers while 25% have access to them. About 10% use pedal threshers. The spread of machinery, such as threshers, is happening quite quickly as there are many suppliers on the market (although in Bogra there is only one that actually manufactures there) offering pedal or machine operated threshers of different sizes. There is a government subsidy of machine threshers, so that a thresher and its power source costing BDT60,000 can be purchased for BDT45,000, such subsidies are no longer available for pedal threshers. Even during our mission we noted an advertisement for the release of a new design of thresher.

Other programmes

A postharvest survey on rice loss reduction is currently in the planning phase by IRRI who suggest they need a clearer picture of losses before designing a programme, they have a USAID funded project 'Expansion of Cereal Systems Initiative for South Asia' in support of this. They also pointed out that for Bangladesh there has been no value chain study for rice. They suggest that rice drying is a problem and that, unlike for threshing, no appropriate technology is available and consequently no service providers, since apparently even large millers rely on sun drying (which was the case for the miller we interviewed). They may attempt to introduce a low cost mechanical dryer depending on the outcome of their survey; they have done this in Indochina as a demonstration to encourage demand for drying facilities by farmers and to encourage adoption by potential service providers. Some lessons could be learnt from the Mechanical Dryer Project implemented by Rangpur-Dinajpur Rural Services with support of BRRI and completed in 2002. There is also a labour shortage for rice cutting and this could make mini combine harvesters cost-effective for larger farmers. Discussions at BRRI showed that there was considerable enthusiasm for the introduction of combines, which have been used on their own plots. But this may imply the need for land levelling and many fields may be too small to benefit from this approach unless there is land consolidation.

Linkages with other crops

The resulting freeing of labour due to the further adoption of threshing machines, and even combines, will give farmers more time to engage in other postharvest activities which in turn may eventually be an important contribution to the reduction of postharvest losses for other crops such as potatoes for which time is not available for proper sorting and curing. However, the further mechanisation of land preparation, rather than of postharvest activities, may have much more impact in this regard.

Opportunities

It is likely that losses at each link in the rice postharvest chain are not great, except in some particular circumstances, but add up to a sizeable total loss in some areas (perhaps as high at 13% going by 2010 estimates). Although as percentages the losses at individual links in the chain may be low, the great scale of rice production in Bangladesh means that such losses represent large tonnages (financial values). There may therefore be much to be gained from loss reduction. However, current uncertainties about the economics of the introduction of driers and the economics and practicalities of combines suggest that any attempt to support the rice sector should wait for more thorough analysis. In this regard, it is recommended that close links should be maintained with the IRRI on their proposed postharvest survey. There is considerable potential synergy between Katalyst's business approaches and IRRI's technical expertise. Further, support for the adoption of mechanical thresher may still hold some value in freeing labour to address other postharvest activities but is unlikely to have much direct impact on the postharvest losses of rice.

ii. Maize

Importance of the crop

Widespread production of maize started around the year 2000, intended as a cash crop for sale to feed mills that supply the poultry industry. There is only one harvest from April to the beginning of June, which in 2007/08 produced around 1.3m MT. The harvest time coincides with rainfall which, especially for the later portion of the crop, can impede drying. Local production only fulfils about half of Bangladesh needs with the deficit made up by imports, mostly from India. This year prices have risen quite steeply from around BDT18/kg to BDT28/kg. Other uses for the crop are being considered, and ACI is assessing the feasibility of a starch production plant using maize.

PH activities and associated losses

A group of farmers interviewed near Bogra had been growing maize for around 12 years and produced about 30 bags (2.4 MT) each. Little (1-2%) is held little back for household consumption although one farmers used 5% of this production to feed his own animals; almost all is sold from the house to collectors, who to put it in their own bags. The typical series of postharvest activities is for the farmers (equally male and female) to pluck the cobs and carry them to the house where they are dehusked and put out on a drying floor or on mats in the sun to dry. The cobs must then be shelled and about 90% of farmers avail themselves of the services of motorized shellers while the remainder shell by hand. If need be the shelled grain may be further dried. If the weather is dry then postharvest processing can be completed in 3-4 days but wet weather can delay this for 15-30 days. The losses identified by farmers are at the threshing stage where they say that 5% may be lost due to immature and wet grain and faulty threshers. They didn't identify other losses but were concerned about production issues especially good quality seed and the better use of inputs such as fertilizer and pesticide.

From the point of view of the thresher operator, the main source of loss results from having to work with damp grain. About 70% of the cobs are insufficiently dried which subsequently incur a loss of 2-3%, this also results in the job taking longer and a greater use of fuel. As might be expected the thresher suggests lower losses at threshing than the farmers.

Maize collectors visit houses on behalf of wholesalers with vans and place the maize in their own bags. In buying maize the collector is looking to see whether or not it is dry, has fungal infected grain and is of good red colour. If grain fails in these quality criteria then the price is discounted by 33%, good quality dry grain receiving BDT21/kg whereas wet grain receives BDT14/kg. The collector will then undertake some grading and sorting using handpicking and winnowing and some drying. This is undertaken by hired labour all of whom are male. At this stage the crop can lose 5-7% by weight of which around 3% of this is dust and other foreign matter (the remainder is assumed to be moisture change). There is thus a loss to the collector, which it is assumed he must have factored into the price, but little if any actual wastage.

Figures for maize losses, in the literature, suggest the process of harvesting through to drying results in a loss of only 1.6% but thereafter storage accounts for a loss of 2.5% (Bala *et al*., 2010), giving a total of about 4%. Farmers appear not to store for any length of time so in this case it must be assumed that the losses mentioned are incurred by wholesalers and processors (feed mills). The literature also points to human consumption of maize in the Hill Tracts Region, especially the Chittagong Hill Tracts (CHT). A recent study (Ali *et la.,* 2010) points to a clear scope for much increased maize cultivation but support to help contain postharvest losses should wait until there is enough maize on the market that farmers are obliged to store on-farm longer.

Other programmes
Katalyst has an ongoing comprehensive maize strategy aimed at helping marginal and small maize producers. It aims to enable better access to agricultural inputs such as fertilizer and seeds, to expand contract farming, help identify and promote low cost dryers that would at least be suitable for larger farmers and help identify markets other than the poultry industry.

Linkages with other crops
The main cause of postharvest loss for maize would appear to be damp maize at harvest. One approach being considered through Katalyst is to introduce early maturing rice for use by maize farmers so that maize can be planted earlier and hence harvested before the onset of rainy weather.

Opportunities
It was noticeable that farmers do not employ maize drying cribs of the type employed in the humid parts of West Africa and this could be considered, perhaps as part of the Katalyst maize strategy. The metal silos technology pioneered by SDC for maize grain storage in Central America would appear to have no immediate use for mainstream maize farmers in Bangladesh but may find a role in due course when production increase reaches the localities where maize is an important crop for human consumption since such places are foci of food insecurity and so would benefit from better storage methods.

iii. Wheat

Importance of the crop
In recent years wheat production has been in steady decline, from 1.84 million MT in 2000 to 0.84 million MT in 2008 (FAOSTAT). The area covered by our field visit was not wheat growing so the opportunity for data gathering on this crop was minimal.

PH activities and associated losses
The literature suggests the losses associated with wheat are relatively low although vary somewhat from place to place. For example Mymensingh losses are estimated to be around 6% while Dinajpur and Sylhet were estimated to be only 3.25% and 1.42% respectively. National losses are considered to be only about 3.6%, and this is attributed the fact that storage periods are short (Bala *et al.* 2010).

iv. Pulses

Importance of the crop
The main pulses in Bangladesh are lentils, mung bean, grass pea and chickpea. They are considered neglected crops although they are a very important protein sources, referred to as the 'poor man's protein'. There has been a decline in production over the years so that in the 1990s about 700,000 hectares were devoted to pulses and currently only 320,000 hectares. The area has been lost to Boro rice, potato, maize and vegetables. The largest area is devoted to lentils although the greatest monetary value comes from the mung bean crop. About 25% of farmers cultivate pulses which provide for about 30% of Bangladesh needs, the rest being made up by imports, mostly from India, although in the case of chickpea from Australia. The typical selling price for pulses is 60-70 BDT/kg. Harvesting pulses is labour intensive since pods do not all ripen at the same time and harvesting is by hand.

PH activities and associated losses
Two important constraints were mentioned for pulses. Losses in storage tend to be relatively high (7-8%), especially due to bruchid beetle attack, so that farmers do not have much confidence in retaining stocks and sell quickly to avoid losses, also there is a problem in the small-scale preparation of pulse flour. Unlike with maize or rice, no small mills are available for dehusking and flour preparation this makes pulses a less attractive option to the consumer. The pulse market is supported by traders, millers and processors. In the case of processors there is some contract farming, especially for mung bean.

Other programmes
IDRC had a programme to reduce losses in pulses that was completed in 1985, in the period 1995 to 2000, the Crop Diversification Project promoted better storage of pulses using plastic drums or traditional stores with plastic liners and the Entomology Division of BARI completed a project on the management of stored grain insect pests of pulses in 2009.

Linkages with other crops
Recently, IRRI have appointed a co-ordinator for the promotion of rice /pulse intercropping in recognition of the importance of pulses for both soil fertility, as they fix nitrogen, and as an important source of dietary protein.

Opportunities
Currently, there is not enough information to show whether or not there is an opportunity for an intervention to limit postharvest losses of pulses. It would be important to obtain documentation on earlier projects and then survey the current storage requirements of pulse farmers and establish the potential benefits to farmers of being able to retain pulses for longer periods free of insect infestation. If there are benefits then low cost interventions such as triple bagging, being promoted in West Africa by the Bill and Melinda Gates Foundation project, could well be feasible. A further linkage, to make pulses a more readily used component of the diet, would be to promote small-scale pulse milling.

b. Fruits

i. Mango

Importance of the crop
Mango is a very important cash crop with a peak harvest in mid-April to mid-June. Production in 2008 was estimated at 767,000 MT. Once mature, mango typically has a shelf-life of 2-4 weeks. Mango is an export crop and sought after by local processors for the preparation of pulp and juice and processing into pickles and bars.

PH activities and associated losses
Most recent loss estimates suggest that 27% of mango are wasted (Hossian *et al.*, 2010), with a value of BDT9,457 million. Damage due to bruising occurs at harvest and during handling and transport. Transport providers suggest that about10% for fruit and vegetables are lost in handling and transport (Box 1 gives information on transport operators).

Box 1 - Transport operators (Mohasthan hat bazaar)

In the assembly market the transport operators rent trucks and provide these to traders wishing to move goods to distant markets, from 200 to 700 km away. At Mohasthan there are 26 operators with about 100 trucks at their disposal. It was considered that about 10% of fruit and vegetables were lost during transport/handling.

They pointed out that sometimes transport is lacking and crops are left piled in the market, where there are no specific storage facilities. They confirmed that market storage would be a useful development for traders that have missed the opportunity to market their goods. Typically they would need storage for about 2 days.

The transport operators have their own association for inter-district trucks.

Mango sorting is done on farm with larger better quality mangos going to the open markets while smaller and more blemished mangos going to processors, or purchased by the poor. As processors will make juice or pulp from mango they represent a less quality conscious market than that for fresh consumption. Trader when buying mango look for preferred varieties and pay less for mangos with black spots (a discount of BDT500/40kg), those with lacerations caused by bamboo baskets and less mature greener mangos which are typically used for transportation over longer distances. Adoption of plastic crates for mangos has resulted in higher prices since the proportion damaged in transport is reduced (one trader claiming down to 6%). In our survey area, 30% of farmers had access to plastic crates and they apparently received BDT300/40kg more for their crop (see Box 2). Shortage of crates was apparently the main reason that other farmers were not using them (the crates in use were second hand Indian ones that could be purchased for BDT120, but are in short supply). The other farmers used bamboo baskets or sacks. It was alleged that the use of sacks encourage earlier ripening. When immature mango are offered then prices are lower and a supplement of 4kg to the standard weight (40kg or '*mon*') is demanded to account for losses, since those mangos that are immature at harvest can become rotten very quickly, especially when they are treated with ripening chemicals. For mature mangos prices are higher and account for losses the standard unit is increased by only 2kg.

Box 2 - Advantages to farmers of adopting better packaging

The Katalyst packaging project has demonstrated the benefits that accrue to farmers from the use of improved packaging; both improved bamboo baskets and plastic crates. The use of plastic crates (PC) has benefited farmers in multiple ways. Typically, traders either send the PCs to the farm gate or they rent them out to farmers. In both the cases, the produce is of better quality and fresher, these results in a price premium of BDT10/kg, with total annual increases in income of BDT11,185 for vegetable farmers and BDT5,318 for mango farmers.

Mangos are subject to postharvest treatments, using fungicides or hot water treatment, to prevent fungal attack and may be ripened with approved chemicals, although the majority of mangoes are either matured traditionally (under straw) or sold as mature hard mangoes (Hassan *et al.,* 2010). Some further details of postharvest treatments are given in Annex 9.

Other programmes

Mangos have featured heavily as a development project target and would appear to the best supported fruit with strong interest from researchers and large-scale enterprises

ii. Banana

Importance of the crop

Banana is a significant cash crop, often produced by less wealthy farmers than those who cultivate mangos. There are harvesting peaks in December-February and September-October. Shelf-life is typically 2-4 weeks. Production in 2008 was estimated at just over 1 million MT. At times the market is over supplied and during gluts prices may fall by 75%. This suggests that at certain times there would be advantages from export if quality can be assured and particularly if there is better

control over ripening. Processing of banana is limited, at a small-scale banana chips and banana bars at a large-scale banana pulp which is used as an ingredient in mixed fruit juices and ice cream.

PH activities and associated losses
Most recent loss estimates suggest that 25% of banana are wasted (Hassan *et al.*, 2010), with a value of BDT2,991 million. Farmers reported few if any problems during harvesting since the crop is more accessible than say mangos, however research reports point to bruising and latex injuries as being significant (Hassan *et al*. 2010). Harvesting is done by men and about 70% of the crop is then taken to market for sale, the remainder is sold from the farm to commission agents. A small proportion of the crop may be ripened on the plant and is kept back for home consumption. Farmers suggested that they do nothing by way of postharvest treatments and sell as soon as possible. They considered their losses to be very low. The main quality characteristics were large size, number in the bunch and a spotless healthy appearance. Traders listed the same characteristics but included maturity. Trader claimed not always to receive the quality they need especially the prevalence of black spots.

Typically, commission agents sell and keep bananas on behalf of wholesalers, they may also arrange for the bananas to be ripened before their terminal market. This may be done using chemical ripening agents or heat. Hassan et al. 2010 found that all commission agents used either natural or artificial methods for ripening as did most wholesalers. It is claimed that artificially ripened bananas have a shorter shelf-life than naturally ripened. It appears that ripening practices are poorly understood by and traders and researchers claim that the right chemicals are frequently not available on the market.

It was suggested by traders that about 7% of their bananas were wasted, 5% due to handling and transport and 2% due to early ripening. However, it seems probable that loss may be considerably greater since we witnessed several truck loads of bananas where there crop had been just loaded on top of itself so they bunches at the bottom are likely to have suffered considerable damage and those at the top damaged due to exposure to sunlight (Box 3 gives more information on truck loading). The bunches may be loaded and unloaded several times and handled roughly. However, trials on transporting bunches of bananas in plastic crates showed minimal damage (Hossain, 2010).

Other programmes
Hortex, as part of the ADB Crop Diversification Project has been investigating the use of plastic crates for the transport of banana in Bogra, where they have a supply chain officer.

Box 3 – Truck loading (Mohasthan *hat/bazar*)

The workers are responsible for loading and unloading the trucks. They have two shifts of 60 men who work on alternate days.

Trucks are regularly overloaded and there is a financial incentive for this. The workers consider that about 1/2kg from every 40kg is lost during handling, mostly by fruit and vegetables falling out of the packaging. They sometimes load cucumber and bitter gourd onto trucks with no packing and this is usually the case with bananas.

From the transporters point of view, sacks are the preferred method of packaging as when packed in the truck there is no movement during transport and no 'lost space'. The tariffs for loading different containers are based on the time they take to load rather than their weight so a jute sack of 80/90kg is BDT5 while a plastic crate of 25-30kg is BDT4.

When loading bananas, a full truck load costs BDT1880. The breakdown of this cost is Labourers- BDT700, Market Leasee – BDT800, Market Association - BDT 300, Social cause – BDT80.

The transport workers have their own association.

Opportunities

Banana would appear to offer a particular opportunity for loss reduction as it widely cultivated by farmers of all scales, and appears to have received very limited attention. There are considerable gains to be made from better transportation and handling, optimising ripening practices and further development of processed products.

iii. Pineapple

Importance of the crop

Pineapple is an important cash crop. It is harvested in May/July and production in 2008 was estimated to be 238,000 MT. Pineapples are eaten fresh and there is only one large scale processor (Allied Food and Extract Industries), apparently, there is very little demand for pineapple juice or other products.

PH activities and associated losses

Most recent loss estimates suggest that 43% of pineapple is wasted (Hassan *et al.*, 2010), with a value of BDT583 million. The quality of pineapples in Bangladesh is considered to be poor. Growth promoters are used during production which leads to large but watery, tasteless fruit (one researcher suggested that the use of growth promoters for pineapples should be banned). They are harvested when not fully mature and treated with ripening chemicals so that their colour changes to make them appear ripe (although ripening chemical do not actually ripen the pineapple). Cuts and bruises are the main concern at harvest and there after bruising and vibration damage during transport and handling.

Other programmes

It would appear that there are no other programmes specifically targeting pineapple.

Opportunities

Improvement in quality can be achieved through better production practices and improvement in transport and handling.

iv. Jackfruit

Importance of the crop

Jackfruit is a significant cash crop grown all over Bangladesh (it is the national fruit). It is harvest is in April to mid-July and production in 2008 was estimated to be 926,000 MT.

PH activities and associated losses
Jackfruit losses have been estimated as 44% with a value to the producer of BDT 2,610 million. This high loss seems in part attributable to production problems (insect attack, soft rot) that make a quite high percentage of jack fruit unmarketable, possibly because the growers do not tend to use pesticides or fungicides. An important postharvest reason for higher loss in jackfruit is the excessive use ripening chemicals, these accelerate ripening and shorten shelf-life (Hassan *et al.,* 2010).

c. Vegetables

i. Potato

Importance of the crop
Potato production in Bangladesh is most intense in the north west of the country and production overall exceeds national demand. In 2008/09, a production of about 7 million MT exceeded demand for table potatoes to the extent that many farmers were unable to sell their crop, which went to waste. Yet there is a large export market for favoured table varieties and varieties suitable for processing that could absorb the excess.

PH activities and associated losses
Recently published postharvest loss figures (Hossian and Miah, 2010) indicate that average harvesting loss is 5.65% and home storage loss for three months storage 7.35%. The average loss in cold storage during nine months storage period was 3.82%. Two different types of potato marketing systems were identified for home stored and cold stored potatoes. The average losses at traders' level for home and cold stored potatoes were 11.95 and 9.61%, respectively. Household and restaurant levels losses were 3.24, and 4.52%, respectively. Total postharvest losses of home stored cold storage stored potatoes were 27.65% and 23.11%, respectively. It has been suggested that in order to reduce this postharvest loss, more cold storage needs to be established at farm level.

The farmer we interviewed were first and foremost rice producers with potatoes as their second crop in terms of value. After harvest the potatoes are piled on the land since there is limited space in the house there is also little time to sort the potatoes or for curing as the harvest coincides with preparations for the Boro rice harvest. Consequently there are losses of 2-5%. Enough potatoes are kept back for household consumption for about 5-6 months (5-10%), 10% are retained for seed and the remainder 80-85% are sold. Some but not all the farmers place their seed and table potatoes in cold storage. Women are engaged in harvesting, sorting and cleaning and both men and women in bagging. Losses in cold storage are 8-12% of which the farmers believe 1-2% is their fault for poor postharvest handling.

In the cold storage we investigated, 70% of deposits were seed potatoes that tend to be stored for 8 months while the remaining 30% are table potatoes. The majority of deposits were from farmers (70%), depositing typically around 20 bags, 25% were traders and 5% were from the owners of the cold store. The business faces difficulty with the high costs and unreliability of power supply and large variations in demand. It was claimed that losses in storage were about 3% and that this was due to the potatoes not being properly sorted or cured and some potatoes suffering heat damage prior to storage. The 3% loss is clearly at some variance from that claimed by the farmers.

The trader we interviewed purchased potatoes from assembly points and uses cold storage to wait for price rises. This year he has cut his cold storage from ten thousand to two thousand bags since he expects prices to remain low due to a market glut. He particularly traded in the granula table variety. Typically about 80% of the crop he receives is of adequate quality the remainder is not a complete loss and can be sold to hotel, restaurants and for animal fodder, discounted from BDT300/kg to only BDT50/kg. His main concern was that farmers take insufficient care with the potatoes and need to sort and cure better. The cold stores are also a problem and suggested there were losses due to incorrect temperatures and there is germination in about 1% of cases. He considered the business would be improved with better capacity and capability of cold stores.

Other programmes
Katalyst has already developed a comprehensive potato strategy that considers agricultural inputs, promotion of industrial varieties, improving postharvest management by helping cold stores to provide better services and assisting the extension service to promote natural storage among farmers that do not use the services of cold stores.

ii. Tomato

Importance of the crop
Tomatoes are a significant cash crop grown all over Bangladesh. Production in 2008 was estimated to be 143,000 MT. Shelf-life is typically less than 2 weeks. There is a winter crop harvested December/January and recently a smaller, but more lucrative, summer time harvest (grown June to November). There is a single processor for the production of tomato pulp (PRAN).

PH activities and associated losses
Tomato losses for the winter harvest have been estimated as 33% with a value to the producer of BDT605 million. There is considerable pressure for farmers to sell their tomatoes as soon as possible to gain good prices and avoid the substantial price falls in the season. This leads many to harvest immature fruit which are then treated with ripening agents. This results in poor quality tomatoes that have a short shelf-life. It is considered that 10-20% of customers are prepared to pay higher prices for better quality tomatoes. The peak of the season is quite short and it is suggested that short-term storage facilities and better control of ripening could enable a much better return and lower losses. Summer tomatoes are produced under more sophisticated conditions in poly-tunnels and produced with the benefit of insecticides and growth regulators. The summer tomatoes are allowed to get to maturity before harvesting, are carefully graded to remove small-sized, disease infected and insect infested fruits and then marketed in plastic crates. Consequently, for the summer crop losses of farmers and commission agents amounted to about 7% compared with 17% for the winter crop (Hassan *et al,*. 2010).

iii. Cauliflower

Importance of the crop
Cauliflowers are an important cash crop grown all over Bangladesh. Production in 2008 was estimated to be 156,000 MT. They are harvested January/March and typically have a shelf-life of less than 2 weeks.

PH activities and associated losses
Annual cauliflower losses have been estimated as 34% with a value to the producer of BDT 498 million. For growers, cuts and over maturity of the 'flower' are the major problems. Subsequently, discolouration of the 'flower' is the most serious problem during transportation. Cauliflowers have been wrapped in paper to reduce transport damage, weight loss and discolouration. Discoloured 'flowers' are unsaleable by retailers.

Other programmes
BARI under its DANIDA project 'Value Addition to the horticultural crops through postharvest technologies', has tested wooden crates (larger than standard plastic crates) to reduce cauliflower losses and claim to have achieved good results. The project will be completed in November 2011 and its outputs, which relate to the adoption of postharvest loss reduction techniques, income generation and entrepreneurship, are currently being evaluated, and will be of interest to inform further project activities.

iv. Brinjal

Importance of the crop
Brinjal is a significant cash crop grown all over Bangladesh. Production in 2008 was estimated to be 222,000 MT. The harvest is October/April and the crop typically has a shelf-life of 2-4 weeks.

PH activities and associated losses

Brinjal losses have been estimated as 29% with a value to the producer of BDT1,240 million. It appears that brinjal growers mostly do not grade their produce. The commission agents collecting the brinjal generally use jute or plastic bags. The main postharvest loss in brinjal appears to be due to bruises and vibration damage caused during transport. However, by the time the brinjal has reached retailers an additional problem is that the stalk has separated from the main body of the brinjal.

4. Postharvest loss reduction opportunities with the biggest potential for pro-poor and pro-gender impacts

Setting target crops for loss reduction, based on best benefits for the smaller farmers and poor people, requires estimating the value of losses to farmers. This is problematic, but one approach is to consider the actual profitability of the individual crops. This is done in Table 5, where rice is compared with a range of vegetables. This suggests that vegetables can contribute proportionally more to livelihoods than rice and so the high losses in vegetables are a particular drain on potential income generation. Experiences of fruits suggest that these are comparable with vegetables in their profitability. Fruit and vegetable crops may therefore be particularly suitable targets to make loss reduction contribute to poverty reduction. Currently, the cost of losses tends to be borne directly by the producer, since the trader will demand the delivery of a greater than official weight to compensate for expected losses. For example, where the standard unit for tomatoes is 40kg (*mon*) the trader will expect to receive 44kg for the same price, in anticipation of a 10% loss. Whilst fruit and vegetables may be considered better targets than grains, this should not preclude interventions with grains, especially as improvements in cereal postharvest productivity and the timing of harvests can have a considerable influence on the opportunities producers have to devote the resources required (especially labour) to reduce loss in fruit and vegetables.

Table 5: Net profit from one season of one acre of a range of crops (from Katalyst Comprehensive Vegetables Strategy- figures compiled by GMark, 2008)

No.	Major Crops	Production Cost/Acre	Yield/ Acre (MT)	Total Sales (BDT)	Net Profit (BDT)
1	Ginger	40,000	4.8	1,20,000	80,000
2	Potato	45,000	10	1,00,000	55,000
3	Cauliflower	25,000	8	80,000	55,000
4	Tomato	35,000	12	90,000	55,000
5	Pointed gourd	23,000	6.4	70,000	47,000
6	Brinjal	18,000	8.2	60,000	42,000
7	Sweet gourd	18,000	7	60,000	42,000
8	Cabbage	20,000	11.2	60,000	40,000
9	Bitter gourd	24,000	4	60,000	36,000
10	Okra	10,000	3.6	40,000	30,000
11	Groundnut	15,000	1	40,000	25,000
12	Chili	20,000	3.6	45,000	25,000
13	Cucumber	20,000	3.2	45,000	25,000
14	Radish	10,000	12	30,000	20,000
15	Wheat	18,000	1.4	35,000	17,000
16	Boro rice	18,000	2.2	33,000	15,000
17	Maize	24,000	3.4	35,000	11,000

Improvements in the vegetable sector may help small and marginal farmers to sell more vegetables and raise their incomes. Around two thirds of small and marginal farmers (those with less than 2.5 acres of land) cultivate vegetables commercially and the others cultivate vegetables for domestic consumption. Improving market access and increasing productivity and profitability gives commercial vegetable farmers the chance to increase their current income from vegetables. Domestic vegetable farmers get the opportunity to begin production to open a new income stream. Furthermore, around 80% of women in rural Bangladesh are involved in homestead vegetable production (Rural Access, 2009). This contributes to meeting the family's nutritional demands and increases access to cash income that women can save or spend. Women perform a major role in postharvest activities such as cleaning, washing and grading of the harvested goods and so stand to gain if this sector is more productive.

The need to strengthen the capacity of rural women in Bangladesh in relation to postharvest activities with fruit and vegetable has been recognised and their training priorities for a range of produce have been identified by Rahman *et al.* (2009), these priorities for a selection of crops are shown in Table 5. Typically about 10 priorities are listed for each crop, increasing shelf-life appears in the top three for all the crops, processing and storage is a strong need whilst transport/handling and marketing is somewhat lower in the list, probably because this job is undertaken more by men.

Table 6: Top three training priorities for women engaged with fruit and vegetables postharvest activities (from Rahman et al., 2009)

Training priority	Mango	Banana	Pineapple	Potato	Tomato	Brinjal
Increasing shelf-life	2	1	2	2	1	3
Bottling and canning	-	2	-	-	-	-
Processing and storage	-	3	1	1	3	2
Storage	-	-	-	-	-	-
Transport/handling and marketing	-	-	-	3	-	-
Treatments for disease and pest control	3	-	3	-	2	1
Dumping and waxing	1	-	-	-	-	-

5. Recommendations for a postharvest programme compatible with making markets work for the poor (M4P)

In section 4, it was concluded that the greatest benefits for poor people are likely to accrue from initiatives that reduce losses of fruit and vegetables. The following list of recommendations includes three interventions that offer opportunities to reduce fruit and vegetable losses. There are also two suggestions for grains, which with further investigation might generate additional ideas for inclusion in a postharvest programme.

The survey of postharvest practices, revealed systematic weakness for fruit and vegetables value chain including poor performance in 1) the use of postharvest treatments, 2) sorting and grading, 3) packaging for transport, 4) handling during transport, and 5) market place infrastructure. Failure in all these has an effect on fruit and vegetable postharvest losses. A summary of the causes and underlying reasons of these losses is given in Table 7, 8 and 9.

Table 7: The losses and underlying cause of losses for grains

Crop	Location/stage	Cause	Underlying reason
Rice	**Farm ops (excluding processing)**	Scattering from field to threshing area	Late harvesting
	Aman Boro Aus	Drying inadequate	Lack of drying facilities
	Totals **7.7%** **6.6%** **7.4%**	Storage – insects and moulds	Lack of airtight storage
Maize	Threshing **5%**	Threshing of damp grain	Late harvesting of maize
Pulses Lentil & Mung	Storage **7-8%**	Insect infestation	Lack of airtight storage
Wheat	All stages **3.2%**	?	?

Table 8: The losses and underlying cause of losses for vegetables

Crop	Problem/ post harvest stage	Cause	Underlying reason
Tomato	Harvest	Ripening agent on immature tomatoes leads to quality loss	Early harvest gets better price
	Harvest	Gluts	Limited processing capacity for pulp
	Farm storage	Farmers pile tomatoes	Lack awareness and facilities
	Transport and handling **Total 20%**	Rough handling and inadequate packaging	Lack of awareness, lack of plastic crates
Cauliflower	Transport and handling		
	Traditional **25-35%**	Rough handling, inadequate packaging	Lack of awareness, lack of improved crates.
	Improved **10-15%**	Wooden crates better	
Potato	Harvest	Glut	Oversupply, limited cold storage and processing
	Field at harvest **2-5%**	No sorting, left in piles in sun	No time - Boro land preparation
	Home storage – **7.0%**	In adequate storage conditions for uncured potato	Lack of space and knowledge
	Cold storage **8-12%**	Poor sorting, wrong temperatures, poor ventilation	Farmers lack time, unreliable power, low financial return

Table 9: The losses and underlying cause of losses for fruit

Crop	Problem/ post harvest stage	Cause	Underlying reason
Mango	Harvest	Bruising	Lack of skill
	Decay during postharvest operations	Postharvest diseases (fungal attack)	Recommended treatments not on market
	Shortened shelf-life	Poor ripening procedures	Lack of knowledge
	Transportation and handling **Total 27%**	Failure to use good packaging, poor handling	Lack of awareness, lack of plastic crates
Banana	Decay during postharvest operations	Postharvest diseases (fungal attack)	Recommended treatments not on market
	Shortened shelf-life	Poor ripening procedures	Lack of knowledge
	Transportation and handling **Total 25%**	Failure to use good packaging, poor handling	Lack of awareness, lack of plastic crates
Pineapple	Postharvest quality and shelf-life poor	Growth regulators used in production	Get bigger fruit this way but tasteless
	Allowed to waste	No processing opportunities	Lack of popular demand
	Transportation and handling **Total 30%**	Failure to use good packaging, poor handling	Lack of awareness, lack of plastic crates

In view of the underlying causes of postharvest losses, the following interventions have been devised as market driven solutions. The solutions are targeted at better ways of overcoming the constraints that prevent markets working better for poor farmers, through postharvest losses reduction.

Intervention 1 - A package of measures to reduce losses at village wholesale and assembly markets

Ideally, in the future Bangladesh should have a quality conscious, local and export market for fruit and vegetables with standardised sorting and grade, appropriate packaging and served by a cold chain of refrigerated stores at each level of the market linked by refrigerated trucks. This kind of supply chain would minimise postharvest losses but is unlikely to materialise for many years to come. However, the first steps in this direction can be taken by demonstrating the advantages that can be achieved by offering elements of this supply chain at the first assembly markets, to create a demand for such facilities in non-project markets.

Five contrasting village assembly markets (*hat/bazar*) should be chosen for the purposes of the project and each offered the package of measures described below. The *hat* would be in northern Bangladesh in 2 or 3 districts that are important growing areas for fruit and vegetables (Bogra, Rangpur, Rajshahi), currently the priority area for SDC's development activities.

1. **Short-term storage** - Currently, assembly markets offer no storage facilities yet an ability by traders/farmers to store fruit and vegetables for short periods when they have not been able to sell or transport stock, would extend shelf-life and lower losses. The facility envisaged would be in village markets and would be cooled using low cost means (evaporative cooling – to 10ºC or 15ºC). An appropriate design for such a cooled store should be sought on a competitive basis from the agricultural research and extension organisations in Bangladesh; the winner would work in consultations with market actors.

2. **Sorting/grading and washing space** - Currently, assembly markets offer no appropriate sorting/grading and washing space. Such space should ideally be located close to the storage facility, must be sheltered from sun and rain, have a smooth easily cleaned surface from which water will

drain, and should provide access to water so that fruit and vegetables can be washed. An appropriate design for a sorting and grading space should be sought on a competitive basis from the agricultural research and extension organisations in Bangladesh; the winner would work in consultations with market stakeholders.

3. **Loading ramps** - Currently, transporters in assembly markets have very limited access to loading ramps, consequently produce is loaded onto the backs of trucks using ladders or just thrown into trucks. This does not result in good loading of relatively delicate products. The construction of more loading ramps would reduce the time taken for loading, reduce damage to goods and limit the stress on labourers. The ramps should be sited to optimise truck parking.

4. **Better packaging** - Currently, plastic crates are used for the marketing of some tomatoes and mangos. However, there is potential for a greater scale of use and on a wider range of fruit and vegetables such as bananas, cucumbers, chilli, yard long bean, pointed gourd spiny gourd and bitter gourd to be better packaged.

5. **Training transport loaders** - Currently, there is no training of transport loading/unloading staff to optimise handling and loading. Simple procedure should be adopted to minimise workload, injury to people and damage to food.

6. **Training sorter and graders** - Currently, there is no training of sorting, grading and packing staff to standardise procedures according to commonly needed qualities. This needs to be implemented and backed up by simple illustrated extension materials.

Project entry points

In association with the *hat/bazar* committees (Annex 12), the trader/transporter/labour organisations of project markets would be brought together and proposals presented for investment in the development of cooled storage space, development of a suitable sorting/grading and washing space, and construction of more loading ramps. Ideally all these developments would be located close to each other and would run as businesses with fees chargeable or whatever modality the market accepts. Further interventions will be required to identify the best entry points. The difficulties of working with the *hat/bazaar* committees and Upazila committees should not be underestimated, when reviewed seven years ago they were considered to be working rather poorly (Ashraf, 2004). It is likely that for initiatives to succeed, the actors involved would have to able to influence the system themselves to make changes rather than rely on the support of the committees. The absence of effective committees may indeed prevent beneficial change. If working as planned then the funds collected by the committees, through leases to the market actors, could contribute to infrastructural development and training in the market place but it would be unwise to count on this source of funds.

Appropriate designs of packages for a wider range of fruit and vegetables should be considered with existing and potential packing manufacturers (Bengal Plastic, PRAN etc) and informed by the existing Katalyst packaging project and by others concerned with promoting packaging (BARI, Hortex). The five project market places should be used for the test promotion of packages designed for specific crops. These should be introduced as a business opportunity for the operatives of the sorting/grading and washing space.

The DAE should be approached to develop and implement two simple training courses for supervisors and the workforce on 1) the loading and unloading of fruit and vegetables from trucks and 2) on the sorting and grading of fruit and vegetables for supervisors and workforce. These should both be developed in association with stakeholders such as the association of labourers and of the traders. The courses should be supported by simple illustrative materials that can be kept/displayed as an aide-memoire.

Intervention 2 - Promotion of effective postharvest treatments to extend shelf-life

Promote postharvest treatments so that shelf-life and quality can be maximised. The options available need to be communicated in a very simple, well illustrated way. These should include the recommended methods for growth promotion, prevention of postharvest fungal attack, including fungicides and hot water treatment, and the effective use of ripening agents (physical and chemical). To do so two measures can be taken:

1. Promotion of appropriate technology for postharvest treatment to extend shelf-life, and
2. Making postharvest treatment inputs available in the market.

Project entry points - This should be approached as a collaboration between those importing/marketing the products for postharvest treatment and the DAE. Existing guidance material such as 'A Postharvest Guide for Fruits and Vegetables' (a BAU publication currently being printed) should be assembled and the best practices collated into a simple and effective guide for each relevant crop.

Intervention 3 – Promoting contract farming for effective postharvest management

Promoting contract farming in fruits and vegetables will bring a systemic change in the service market and a postharvest chain with reduced losses. Large processors need to be aware of the benefits that they can obtain from contract farming (using approved contracting methods) and farmers need to be similarly informed of the benefits to them. Better services could be achieved by facilitating service providers, the contractors (large food processors) and contract farmers to implement the better sorting and grading and packaging recommendations developed in Intervention 1and the postharvest treatments developed in Intervention 2. These would all reduce wastage and improve quality standards.

Project entry points – Organisations with successful contract farming operations together with the DAE should be used to promote contract farming (of an approved type) with those large processors who either do not do it or have limited exposure. A list of processors who could be potential partners is given in Annex 7. Simultaneously, existing contract farming operations should be facilitated to adopt better postharvest practices by demonstrations and engagement with service providers.

Recommendations for investigations that could lead to ideas for further interventions

a. Postharvest technology for rice loss reduction

The results of IRRI's postharvest survey, to be undertaken in the next few months, will demonstrate whether or not it is feasible to introduce mini rice combine-harvesters and dryers into Bangladesh. Although it might appear that the introduction of this equipment is to the benefit of rich farmers, it may in the long-term benefit Bangladesh at large as the resulting increase in productivity will effectively lower rice prices/increase supply of the most important staple product. Yet there are even now labour shortages for rice harvesting. A move to reduce the labour requirement for rice can free up resources to make better postharvest arrangements for fruit and vegetables and so better livelihoods for poor farmers. The introduction of mini-combines and dryers could benefit from the business approaches applied by the SDC programmes and would be synergistic with the technical capabilities of IRRI.

b. Postharvest protection of pulses

Pulses area very important part of the Bangladeshi diet, and are in effect 'the poor man's protein'. Storage losses, caused by bruchid beetles, are suggested as a major constraint to smallholders dealing in pulses but there is insufficient information available to decide whether an intervention to reduce losses would be appropriate, although in the past there have apparently been projects to improve pulses storage in the past. If better storage is worth addressing, then there may be a suitable technology that could be adopted. In West Africa, the Bill and Melinda gates Foundation have a large programme promoting the 'triple bagging' technique for the storage of cowpea (in 50kg lots). This

may be appropriate for Bangladesh but detailed investigation by a storage technologist would be required to confirm this, in particular it would be necessary to investigate the extent of losses and the benefits of achieving better quality produce and longer storage periods.

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Annex 1 - Key elements of the mission Terms of Reference

Fact Finding Mission for a Programme on Post-harvest Practices in Bangladesh

Objectives of the consultancy

The principal objective of this mission is to assess the current post-harvest situation in Bangladesh and make recommendations with regards to potential intervention lines and modalities for an M4P compatible SDC post-harvest program. In particular it shall shed light onto the following issues:

a) What is the extent of the problem of post-harvest losses in different agricultural sectors (grains, fruits, vegetables) of Bangladesh, where do these losses occur (harvesting, handling, packaging, processing, storage, etc.) and what are underlying causes for them to occur?

b) Who are the main market actors and service providers in terms of post-harvest practices in different agricultural sectors?

c) How does the enabling environment (formal rules and regulations, less formal rules) for post-harvest issues look like?

d) What are others (GoB, private sector, donors and NGOs) doing and how to best encourage donor coordination, harmonisation and leveraging of resources?

e) Where are the biggest potentials in terms of pro-poor and pro-gender impacts?

f) Where does SDC have comparative advantages/added value to make use of untapped potentials and what are general recommendations in terms of program design (geographic focus, thematic focus, approach, financial volume, partners, potential implementing organisations, timeline, etc.)?

Methodology

The team shall employ a range of research and analytical methodologies suitable for the purpose of the mission, such as reviews, interviews, focus group discussions, small surveys, field visits, etc. A detailed work plan indicating methodologies shall be discussed with SDC at the outset of the mission.

The following activities are recommended, as part of the methodology for the review, whereas this list is not exhaustive:

- A review of secondary data on post-harvest practices from various sources in Bangladesh, as well as international best practice related to the topic
- A review of SDC experiences on post-harvest practices, globally and in Bangladesh (e.g. Katalyst)
- A mapping of activities of other actors (GoB, private sector, donors, bigger NGOs) in the field of post-harvest practices
- Interviews with key informants in GoB, donor agencies, private sector and NGOs
- Report writing
- Presentation of key findings to SDC

Deliverables

- A detailed work plan for the mission within 2 days of starting the consultancy outlining the methodology
- A kick-off workshop with key stakeholders to brainstorm on problems and potentials and to identify areas worth further exploring
- A final report of no more than 20 pages including an executive summary, but excluding annexes, with recommendations for an SDC program design (including proposal for a roadmap)
- A presentation of findings to SDC at the end of the mission

Annex 2 - Mission itinerary

Wed 4th May	Initial team meeting to plan kick off workshop
Thurs 5th May	Kick off meeting, Dhaka
Fri 6th May	Work plan development, report structure and questionnaire preparation
Sat 7th May	Visit to Bangladesh Agricultural University, Mymensingh
Sun 8th May	Visit to Hortex Foundation and the to the International Rice Research Institute (IRRI)
Mon 9th May	Visit to Bangladesh Agricultural Research Institute, Bangladesh Rice Research Institute
Tues 10th May	Travel to Bogra PM Interview Bangladesh Agricultural Development Corporation on seeds and a pulse miller and trader
Wed 11th May	Bogra AM Interviews with vegetable market, producers, traders and service suppliers PM Interviews with rice miller and threshing service suppliers
Thurs 12th May	Bogra AM Interviews with potato growers, wholesalers, cold storage operators. PM Interviews with processors of potato crisps, rice snacks and manufacturers of agricultural machinery
Fri 13th May	Bogra AM Interviews with fruit market producers, traders and service suppliers (banana and papya) PM Interviews with maize producers, traders and service suppliers
Sat 14th May	Bogra AM Interviews with mango producers, traders and service suppliers PM Return to Dhaka
Sun 15th May	Private sector Dhaka
Mon 16th May	Private sector Dhaka and preparation for debriefing
Tues 17th May	Debriefing Dhaka

Annex 3 - List of participants for the kick-off workshop

05 May, 2011
Venue: Hotel De Castle, Banani, Dhaka

Name	Organization	Contact Number, Email
Dr. Md. Kamrul Hassan, Professor, Dept. of Horticulture	BAU, Mymensingh	Cell;01714238614 mk_hassan2003@yahoo.com
Prof. Dr. Mohammad Rahim, Professor, Dept.of Horticulture	BAU, Mymensingh	Cell: marahim1956@yahoo.com
Dr.Md.Saleh Ahmed Post Harvest Handling &Quality Assurance Expert, National Agril. Technology Project	Hortex Foundation	Cell:01712740107 saleh@hortex.org saleh4s@yahoo.com
Dr.Md.Abul Kalam, Chief Scientific Officer	BARC	Cell:01727210995 drakazad61@yahoo.com
Dr.Miaruddin Head, Post Harvest Technology Division,	BARI, Joydebpur	Cell: 01199825632 pso.pht@bari.gov.bd
Dr.Md.Shahjahan, Former Head, Post Harvest Technology Division	BARI, Joydebpur	Cell:01716174288 shah_phd@yahoo.com
Dr.Sreekanta Sheel, Transportation & Storage Expert, National Agril.Technology Project	Hortex Foundation	Cell:01714083764 drsksheel@yahoo.com
Mr. Arun Kumar Saha Head, Agriculture and Rural Development Bangladesh Resident Mission	Asian Development B Plot E-31, Sher-e-Bangla Nagar, 1207 Dhaka	Phone: +88 028156000 (to 6016) Mail: asaha@adb.org
Mr. Ousmane Seck	World Bank	Oseck@worldbank.org
Mr Mushfiqur Rahman	Katalyst	Mushfiqur.rahman@swisscontact-bd.org
Stefan Gamper Assistant Coordinator Employment & Income	Swiss Agency for Development and Cooperation (SDC), Embassy of Switzerland	Phone: +8802 881 23 92-94
Dr Rick Hodges Consultant	Natural Resources Institue	Phone: +44 1632 883813 R.J.Hodges@gre.ac.uk
Md. Saifuddin Khaled CEO	GMark Consulting Limited	Phone: +88 (02) 8836775 khaled@gmarkbd.com
Abu Darda Market co-ordinator	GMark Consulting Limited	Phone: +88 (02) 8836775 darda@gmarkbd.com

Annex 4 - Agenda for the kick-off workshop

'Postharvest practices and opportunities for loss reduction'

14.00 – 14.15	Welcome and introduction to the mission objectives (Stefan Gamper, SDC Co-operation Office, Dhaka)
14.15 – 14.20	Introduction to the mission team
	Rick Hodges - Natural Resources Institute, UK Md Saiffuddin Khaled - GMark Consulting Ltd, Bangladesh
14.20 – 14.30	Brief roundtable introduction of participants indicating personal experience/interest in postharvest issues
14.30 -14.35	Introduction to how the workshop will identify priorities for postharvest loss reduction (Md. Saifuddin Khaled)
14.35 – 16.00	Identification of postharvest loss reduction priorities by participants (Rick Hodges)
16.00 – 16.30	Discussion on the mission work plan

- Targets for visits, e.g. enterprises that add value to food crops?
- Additional experts we should meet

Tea break

Annex 5 - Structured interviews with key informants

Postharvest specialist interview

Name of the Respondent: …….

Contact Details: …….

Institution: …….

Position: …….

Date: / /

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1. Introduction to the mission

2. Overall, what is the extent of postharvest loss for this crop?

a. Weight loss -

b. Quality loss -

3. What links in the postharvest chain give the greatest losses?

4. What are the reasons for these losses?

5. Do these losses vary much between regions of Bangladesh? If yes, then which are most affected?

6. How could these losses be reduced (are there existing solutions including value adding opportunities)?

7. If there are no existing solutions what research is needed?

8. Are there any current initiatives (public/private sector) to reduce these losses?

9. If there are no initiatives then why not?

10. What bodies (private/public) have a current interest in this crop?

11. What actors and service providers are associated with postharvest activities for this crop? List the actual services provided (e.g. credit, inputs, technical advice, extension services, subsidies)

a. Service provider 1 -

b. Service provider 2 -

c. Service provider 3 -

12. Are there any rules and regulations (official or unofficial) that govern the quality and standards of this crop

13. Does loss reduction in the crop offer potential to improve the livelihoods of poor people. If so how?

14. Would loss reduction have any benefits from a gender perspective?

15. Would loss reduction have any disadvantages from a gender perspective?

16. Is there an obvious approach that could be taken to bringing together the various service providers to achieve loss reduction?

Thanks for your cooperation.

Enterprise interview

Name of the Respondent: …….

Contact Details: …….

Organization: …….

Designation and Responsible Department: …….

Date: / /

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1. Introduction about the visit and the mission.

2. What are the products that you process/produce/market?

a. Fruits: 1…….…….....2……..….3……

b. Vegetables: 1…….……...2……..….3……

c. Grains and Pulses: 1…….2……..….3……

3. From where do you source raw products? Do you have contract arrangements for sourcing raw products?

4. Do you receive the desired quality of raw products? If not please explain why

5. Do you get raw products (fresh produce/semi processed) at desired quantity at the desired time?

6. Are there better ways that the suppliers/farmers or your organization could operate that would increase the quantity and quality of food you receive, in a way that is mutually beneficial?

7. What improvements could be made in terms of adding value to the products?

8. Are there any opportunities to increase the market size? How that can be achieved?

Thanks for your cooperation.

Trader interview

Name of the Respondent: …….

Contact Details: …….

Business Location:

Date: / /

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1. Introduction about the visit and the mission.

2. What are the products that you trade/market?

a. Fruits: 1…….…….....2……..….3……

b. Vegetables: 1……..……...2……..….3……

c. Grains and Pulses: 1…….2……..….3……

3. From where do you source raw products? Do you have contract arrangements for sourcing raw products?

4. For the crops that you trade what are most important quality attributes?

5. Do you receive the desired quality of raw products? If not please explain why

6. Do you get raw products (fresh produce/semi processed) at desired quantity at the desired time?

7. Are there better ways that the suppliers/farmers could operate that would increase the quantity and quality of crop you receive, in a way that is mutually beneficial?

8. Do you process or modify the crop? Are there improvements that could be made in terms of adding value to the products by you or by the producers?

9. Is there any wastage or other quality changes during your activities?

10. Who are your customers?

11. How do you maintain the quality of the crops from buying to the time that you supply to your customer?

12. What are the services you receive from outside? Who provides them and at what cost? Are you satisfied with the service you receive? Are there any that you need but do not get?

13. Are there any forums/NGOs/Government bodies with which you are associated /assist your trade?

14. What skills are needed by your workers? Do they have these skills? Do they need better skills to do their job? Who could provide these skills?

15. If improvements can be made in the quality/quantity of produce you handle then who could help make these improvements?

16. Are there any opportunities to increase the market size? How that can be achieved?

Thanks for your cooperation

Service Providers interview

Name of the Respondent: …….

Contact Details: …….

Business Location:

Date: / /

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1. Introduction about the visit and the mission.

2. What are the services that you provide? At what cost? Are there any products/goods associated with your services?

3. Who are your customers?

4. How do you deliver your service?

5. Are there enough, too many or too few of these service providers in the market?

6. Is there any wastage or other quality changes during your activities?

7. Do you process or modify the crop? Are there improvements that could be made in terms of adding value to the products by you or by the producers?

8. Are there better ways that the suppliers/farmers could operate that would increase the quantity and quality of crop?

9. How do you maintain the quality of the crops during the delivery of the services?

10. What are the services you receive from outside? Who provides them and at what cost? Are you satisfied with the service you receive? Are there any that you need but do not get?

11. Are there any forums/NGOs/Government bodies with which you are associated /assist your trade?

12. If improvements can be made in the quality/quantity of service that you provide then who could help make these improvements?

13. What skills are needed by your workers? Do they have these skills? Do they need better skills to deliver these services? Who could provide these skills?

14. Are there any opportunities to increase the market size for your services? How that can be achieved?

Thanks for your cooperation

Farmer interview

Name of the Respondent: …….

Location of farm: …….

Size of farmed area: hectare

Main crops: 1..... 2..... 3..... 4.....

Date: / /

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1. Introduction about the visit and the mission.

2. What problems do you face in harvesting your crops?

3. How much of your crops do you sell and how much do you keep for household consumption?

4. What postharvest activities/treatments do you give your crops? And who does them? What do women do in the process?

5. Do you treat the crop for sale differently from the crop for your own consumption?

6. How much of your crop do you lose at harvest time and how much between the field and homestead?

7. Do you know ways that could reduce the amount of crop that you lose before it is sold?

8. To whom do you sell your crops? Where?

9. For the crops that you trade what are most important quality attributes?

10. Does anyone provide you with advice on how to produce better quality crops and to reduce losses, have there been awareness campaigns?

11. Are there additional skills needed to do better postharvest activities? Who could provide these skills?

12. What kind of services do you receive? Who provides them and at what cost? Are you satisfied with them? Would you be willing to pay for services that benefit you?

13. Are there any farmers associations or groups that do business or activities together? If yes, are you a member of them? Why or why not?

Thanks for your cooperation

Annex 6 - Persons interviewed

Name	Institution	Contact details/location	Date
Dr M. Burhan Uddin	Dept. of Food Technology and Rural Industries, Bangladesh Agricultural University	Burhan992003@yahoo.com	7/05/11
Prof. Md. Kamrul Hassan	Dept. of Food Technology and Rural Industries, Bangladesh Agricultural University	Mk_hassan2003@yahoo.com	7/05/11
Dr S.M. Monowar Hossain	Managing Director, Hortex Foundation	hortex@hortex.org	8/05/11
Dr Md. Saleh Ahmed	Post Harvest Handling & Quality Assurance Expert, Hortex Foundation	Saleh@hortext.org	8/05/11
Dr Sreekanta Sheel	Logistics (Transportation and Storage) Expert, Hortex Foundation	drsksheel@yahoo.com	8/05/11
Dr Md. Zainul Abedin	Representative for Bangladesh, International Rice Research Institute	m.z.abedin@irri.org	8/05/11
Dr Debashish Chanda	Post-harvest specialist and business model developer, International Rice Research Institute	d.chanda@irri.org	8/05/11
Dr M. Matiur Rahman	Co-ordinator, Rice Pulse Project, International Rice Research Institute	m.m.rahman@irri.org	8/05/11
Dr Miaruddin	Head, Post Harvest Technology Division, Bangladesh Agricultural Research Institute	pso.pht@bari.gov.bd	9/05/11
Dr Md. Shahjahan	Previous Head, Post Harvest Technology Division, Bangladesh Agricultural Research Institute	shah_phd@yahoo.com	9/05/11
Dr Md. Syedul Islam	Director (Administration & CS), Bangladesh Rice Research Institute	msibrri@yahoo.co.in	9/05/11
Bidhan Chandra Nath	Farm Machinery and Postharvest Technology Division, Bangladesh Rice Research Institute	Bidhan_brri@yahoo.com	9/05/11
Abdul Homar	Farm Machinery and Postharvest Technology Division, Bangladesh Rice Research Institute		9/05/11

Md. Nazim Uddin Srukh	Deputy Director, Bangladesh Agricultural Development Corporation	01712003782, Bogra	10/05/11
Pulse Miller	Private business	Bogra	10/05/11
Md. Saifil Islam	Retailer of new and second hand sacks for agricultural produce	Bogra	11/05/11
Mr Badshah Mia	Retailer of bamboo baskets for agricultural produce	Bogra	11/05/11
Md. Alam	Trader in vegetables, supplying wholesalers in other districts	Bogra	11/05/11
Transport workers	Workers responsible for loading vehicles with agricultural produce	Bogra	11/05/11
Md. Badsha	Transport operator, renting trucks and providing service to traders	Bogra	11/05/11
Rice/potato farmers	Small farmer growing rice only for home consumption, sells potatoes and earns cash as hired labour	Bogra	11/05/11
Abdulla Huq	Rice parboiler and miller	Bogra	11/05/11
Rice thresher	Landless person, with machine operated thresher	Bogra	11/05/11
Bamboo basket supplier	Agent for supply of a range of traditional and improved bamboo baskets that are used to transport agricultural produce	Bogra	11/05/11
Md. Abdul Aziz	Potato cold storage operator	Bogra	12/05/11
Potato farmers	A group of farmers with first crop rice and second potatoes	Bogra	12/05/11
Md. Bilal Hossain	Potato trader operating two trucks to distant markets supplying wholesalers and to export	Bogra	12/05/11
Md. Ashraful Isalm	Small scale processor of potato crisps	Chadma Hat, Sadap, Bogra, 01746171630	12/05/11
Rice snack processors	Small scale processors of snacks prepared from rice		12/05/11
Machinery	Producer of machine threshers for maize, rice, wheat lentils and	Bogra	12/05/11

manufacturer	mustard seed		
Group of Traders	Large wholesalers who supply smaller wholesalers	Pirganj, Rangpur District, Bogra	13/05/11
Group of Farmers	Small to medium banana farmers	Pirganj, Rangpur District, Bogra	13/05/11
Group of banana market labourers	Labourers responsible for loading and unloading trucks	Pirganj, Rangpur District, Bogra	13/05/11
Small-scale banana trader	Supplying retail market and paying a larger wholesaler for the ripening of bananas	Pirganj, Rangpur District, Bogra	13/05/11
Group of maize farmers	Small to medium farmers growing maize as a cash crop	Pirganj, Rangpur District, Bogra	13/05/11
Mr Raja	Maize threshing service provider	Pirganj, Rangpur District, Bogra	13/05/11
Mr Lal Miah	Maize collector for a wholesaler	Pirganj, Rangpur District, Bogra	13/05/11
Md. Shahidul Islam	Market trader in fruit and vegetables	Bogra Food Bazar	13/05/11
Shirajul Islam	Commission trader, market trader in mango and plastic crate supplier	Tomaltola, Natore	14/05/11
Md. Mahatab Uddin	Senior Manager, PRAN Agrobusiness Ltd – factory site	Hat Singherdha, Natore	14/05/11
Abdur Razzak Chowdhury	Head of Business, ACI Cropex – purchase of fruit, veg and grains mostly for wholesale.	Dhaka, razzak@aci-bd.com	15/05/11
Md. Eleash Mridha	Director, PRAN Food Division	Dhaka, edp@prangroup.com	16/05/11

Annex 7 - Companies processing fruit and vegetables

Company name	Area of specialization
Abul Khair Group	Involved in the production of beverage like fruit juice, flavoured milk etc.
ACI Foods Ltd.	Products manufacturing and exporting, spices (chili, turmeric, coriander, cumin), mixed spices (curry powder), mustard oil, snacks, sugar confectionery, puffed rice, aromatic rice, mango bar
Advanced Chemical Industries (ACI) Limited	Manufacturer, distributor/wholesaler of agricultural and agro-based products
Aftab Food Products Ltd.	Manufacturer, processor and traders
Akij Food And Beverage Ltd	Manufacturer & distributor of fruit & vegetable juices; fruit & vegetable nectars etc. and 'Cheeky Monkey' banana chips
Allied Food and Extract Industries	Manufacturer and exporter of canned pineapple, pineapple slices, Tidbit, Chunk in tin can, also process pineapple natural juice, pineapple jelly, jam preserve in glass/plastic jar.
Ankur Food Products	Various type / quality of Chanachur and related items
BD Foods Limited	Manufacturer & Distributor of agricultural food products
Bd Thai Food & Beverage Ltd.	Agriculture & food processing Industry
Bikrampur Potato Flakes Industries	Potato Flakes
Bombay Sweets & Co. Ltd	Making frozen French fries, chips and other snacks items using potato as a raw material
City Group of Industries	Manufacturer of ata, maida, suji etc.
Danish Food Products (Partex Group)	Manufacturer, processor and traders
Ejab Foods Ltd	Involving in the fields of jute based products, rice mill and potato cold storages, frozen French fries, potato rings
Euresia Food Proc. (BD)	Eurasia Food Processing (bd) Ltd is an overseas supplier
Exotica Inc.	Exporter of fruits, vegetables etc.
Fu Wang Group	Sell bakery products and mango juice
Golden Harvest Agro Industries Ltd	Manufacturer & Trader of frozen processed vegetable, Frozen processed Fish, Frozen processed Snacks
Green Connection International	Involved in importing fruits & vegetables from all parts of the world
Hassanco Bd. Ltd.	Potato chips
Hazi Amin Food Products	Chanachur, dal, jelly, potato chips,
Ifad Group	Manufacture of ata, maida,suji
Ispahani Foods Ltd	Manufactures flavoured potato snacks, chanachur, chana dal, fried dal, fried green peas
Kashem Food Products Ltd.	Manufacturer and distributor
Naicol French Fry(EjabGr)	Processed potato products
OKM Food Products Ltd	Manufacturer, processor and traders of agricultural products
Patwary Potato Flakes	It is a 100% export oriented industry and the first of its kind in the country.

Potato Flakes (BD) Ltd	Potato flakes
Pran	Fruit juice, fruit bars,tomato paste, pickles, chutney etc
S T D International	Agriculture product stocks, animal fodders etc.
Shaheen Food Supplier	Mango pudding, tomato ketchup
Square Consumer Products ltd	One of the biggest producers of consumer good, radhuni, ruchi chips, ruchi fried dal, ruchi chanachur
Stark Trading Corporation	Indenter and agent of local fruit and vegetable products
The ACME Agrovet & Beverages Ltd.	Manufacturer of juice, tea, spices stc.
Trimac Group	Involved in export & import of fruit and vegetable items and others
Tuan Group	Involved in packaging of fruit and vegetable, fried rice, nut, potatoes

Annex 8 - List of actors, service providers and a definition of their various roles

Actors	Service providers
1. Input supplier (seed, fertilizer, micronutrients, pesticide, machineries etc.) i.e. input producers, dealers, wholesalers, retailers 2. Contractor 3. Producers/Farmers/Contract growers 4. Traders i.e. wholesalers, retailers, Supper/Chain Shop 5. Collection agent/Commission agent 6. Exporters 7. Processing Companies/Entities	1. Store house 2. Cold store 3. Husking and drying yard (for grain) 4. Packaging 5. Government Organizations e.g. BCSA, BRRI, DAE, DAM, BAU 6. International Organizations i.e. IRRI (rice), CIP (potatoes) 7. NGOs 8. Bangladesh Fruits, Vegetable and Allied Products Exporters Association (BFVAPEA) 9. Transporters 10. Financial services

Definitions of actors and service providers in vegetables, grains and fruits sector

Name	Actors
Input producers	Input producers make and sell necessary farm inputs. These include seed, pesticides, fertilizers, growth promoters, ripening chemicals etc.
Contractor	Contractor is an entity who contracts farmers/traders to produce certain crops in pre-described way and at a particular time.
Farmer	Farmers cultivate crops on their own decision and their risk, producing and selling their own.
Farmers (size of)	Defined by landholding Large >750 decimal, Medium 151-750 decimals, Small 126-125 decimals, Landless 0-50 decimals
Cold Storage	Provides storage facilities to the grower and trader for seed and vegetables, fish, potato etc.
Contract Growers	Farmers who cultivate their land to produce a crop under contract, often a particular variety and in specific way for a predetermined price. They receive various services from contractors such as seed, pesticide, fertilizer, cash incentive etc.
Traders	The main activity of traders is to procure crops and then sell them to other customers for profit. Sometimes, they add value to crops by sorting, grading, cleaning, packaging, storing and transportation. Traders vary from one another in some particular ways and are known as wholesalers, faria / bepari / commission agent, retailers and collection agents. • **Faria, Bepari, Commission/Collection agents:** Traders who purchase products from farmers for specific party/parties and receive commission for their activities. • **Wholesalers:** Sell products in bulk for profit. They sell at market price and carries risk of loss. • **Retailers:** Collect products from wholesalers in small amounts and sell to the consumer for profit. • **Chain Shop:** Retail outlets that share a brand and central management, and usually have standardized business methods. • **Super Shop:** A physically large retail establishment, usually part of a chain. The term sometimes also refers, by extension, to the company that operates the store. Examples include large department stores such as Wal-Mart.
Exporter	Exports fresh and/or processed products. Crops are procured from contract growers or market agents and then placed on the international market. Exporters may grade, sort, process, package, and freight the crop or processed food etc.

Processor	Processors are those actors who process products, i.e. vegetables, potato, grains etc. to convert into other value added products. These include pickles, jam, jelly, starch, French fries etc. Processors collect products from either their contract growers or collection/commission agents. Some processors are now producing/cultivating large farm for their own uses. The processors then produce value added products and sell those to either domestic market or export them to international market or both.
Support Service Providers	
Service providers	A service provider is an entity that provides services to other entities. Usually this refers to a business that provides service.
Arotdar	Arotdars rent space for trade of agro-produce for commission. They facilitate trade of different agro-produce in the whole region.
Package Producers/suppliers:	Package producers are very important stakeholder in agricultural market and produce/supply jute sacks, mash bags, corrugated cartons, polypropylene sacks, boxes, crate etc.
Cold storage	Cold storage is one the most important stakeholders in agriculture sector. It ensures year round storage and supply of fast perishable products.
Store house	Store house provides storing facilities in exchange for service charge.
Husking and drying yard	Provide husking/threshing machines and drying yards in exchange for a rent to rice, maize and wheat farmers.
Transporter (domestic)	Transporters are mainly truck owners. They transport agro-produce from the field to the buyer's destination, i.e. cold storage, markets, etc.
Transporter (cross border)	Mainly ship owners are transporter in the case of exports.
Financial	Organizations providing financial services to different agricultural actors i.e. Banks, None banking financial institutes, micro-finance
Government Institutions	DAE: The Department of Agricultural Extension - provides technical support to farmers, growers and phytosanitary certificates to exporters. DAM: The Department of Agricultural Marketing of the Ministry of Agriculture, provides support to the marketing of agricultural product. EPB: Export Promotion Board - provides policy advice and information to exporters. BARI: Bangladesh Agricultural Research Institute is the largest multi-crop research institute conducting research on many crops. Research includes variety development and non-crop subjects such as soil and crop management, disease and insect management, irrigation and water management, development of farm machinery, improvement of cropping and farming system management, post-harvest handling etc. BRRI: Bangladesh Rice Research Institute researches and develops rice production. Its major area of involvement is increasing the quantity and quality of rice at lower cost through genetic improvement, disease and insect pest management, fertilizer, water and land use. BAU: Bangladesh Agricultural University conducts research, new crop variety development etc.
International Organizations	IRRI (International Rice Research Institute) is a nonprofit independent research and training organization. IRRI develops new rice varieties and rice crop management techniques for environmentally sustainable improvements in yield and quality.
Non-Governmental Organisations (NGOs)	NGOs are not for profit organizations that work for the development of different sector and/or actors. The Forum for Regenerative Agriculture Movement (FORAM) is an umbrella organisation of over 200 NGOs and other stakeholder groups in Bangladesh. It aims to improve livelihoods through introducing a regenerative/ sustainable agricultural system.
BFVAPEA	Bangladesh Fruits, Vegetable and Allied Products Exporters Association deals with the promotion of vegetable, potato and fruits exports, exporters working through BFVAPEA receive government incentives (10-20% for potato and 20% for vegetable and fruits).

Annex 9 - Organisations involved in postharvest development

Organization	Activity Name	Objective(s)	Completion date
ADB (Asian Development Bank)	Project: "Northwest Crop Diversification Project"	The project scope will include (i) farmer training and extension, (ii) farmer mobilization and credit, (iii) adaptive research, (iv) marketing support, (v) a pilot credit line for postharvest agribusiness support, and (vi) support for project management.	2008
ADB (implemented through DAE)	Project: "Second Crop Diversification Project (SCDP)"	The specific objective is to increase marginal, small, and medium farmers' incomes through improved efficiency and value addition of high value crop (HVC) production, improve rural income opportunities for the poor including women, empower rural women in commercial agriculture activities, enhance food security, safety, and nutrition through reduction of post harvest loss and strengthen institutional capacity in the agricultural sector through training and demonstration	2009
Bangladesh Cold Storage Association (BCSA)	This association deals with the potato cold storages	BCSA provides necessary technical, managerial and liaison services to its member organizations that store both seed and table potatoes.	
Bangladesh Fruits, Vegetable and Allied Products Exporters Association (BFVAPEA)	Deals with the promotion of vegetable, potato and fruits exports from Bangladesh	BFVAPEA is a mother organization for the fresh fruits and vegetable exporters. BFVAPEA have 11 members' elected executive committee and 5 permanent office staff including Advisor and Secretary. BFVAPEA deals with the promotion of vegetable, potato and fruits exports from Bangladesh to different countries. Without their concern, vegetable and fruits exporters can't get the benefit of government incentive (10-20% for potato and 20% for vegetable and fruits).	

BARI	Project: “Orange Development Project”	Motivate farmers to grow orange in favorable orageing areas, reduction of orange impost by increasing orange production, to identify and selection of orange mother plants, to introduce technology grafting, seedlings, and harvesting system, to control soil erosion and development of environment.	
BARI (Entomology Division)	Research: “Stored Grain Pest Management”	To know Management of stored grain insect pests of pulses.	2009
BARI (Postharvest Technology Division)	Research: “Processing and preservation of fruits and vegetables”	To know preservation of jackfruit and mango by osmotic dehydration method, optimization of processing method for guava pulp preservation, optimization of processing parameters for preservation of onion paste	2009
BARI (Postharvest Technology Division)	Research: “Handling, storage, transportation and packaging of cereals and horticultural crops”	To know effect of different packaging materials on the quality and shelf life of leafy/fruit vegetables, shelf life and quality of major fruits (mango, pineapple, banana and papaya) during modified atmospheric storage condition, packaging requirements for osmo-dehydrated products of pineapple, banana and papaya, standardization of packages for transporting fruits and vegetables	2009
BARI (Postharvest Technology Division)	Research: “Analysis and food quality control”	To know the effect of various ripening chemicals on the quality of fruits and vegetables	2009
BARI (Postharvest Technology Division)	Training: “Technology transfer”	Three days training program for dissemination of postharvest handling, processing and preservation technologies of crops	2009

BARI (Seed Technology Division)	Research: "Seed Preservation"	To know effect of storage methods on seed quality of Groundnut and French bean under ambient condition, evaluation of seed quality and seed storage potential in onion, studies on pre-storage seed treatment on the quality of cucurbit seeds, effect of harvesting stage, drying and storage methods on quality of chili seeds, seasonal variation and storage condition effects on quality seed of mung bean varieties.	2009
BARI (Seed Technology Division)	Research: "Seed Heath Status"	Study on seed health status of tomato, brinjal, watermelon and cucumber collected from different sources	2009
BRRI	Deals with research and development in relation to rice production	BRRI is a major component of the National Agricultural Research System (NARS) of Bangladesh, dealing with research and development in relation to rice production. Their major area of involvement includes producing more and quality rice at lower cost through genetic improvement, sustain biodiversity, quality and managing disease, insect, fertilizer, water and land for current and future generations, improving institutional capacity for advance research and to develop new innovations for the reduction of poverty and hunger in the country.	
Centre on Integrated Rural development for Asia and the Pacific (CIRDAP)	Training courses and Workshop: "Reduction of post harvest losses by improving storage methods and techniques"	Gives an overview with details about the necessary elements in the pre-harvest, production, and post-harvest processes, as well as analyze the economic implications of post harvest food losses	2010
UK Department for International Development (DFID)	Project: "Forestry research program"	To improve livelihoods through the development of small-scale fruit processing enterprises in Asia	2004

EU (implemented by UNIDO and International Trade Center (ITC)	Project: 'Strengthening the International Competitiveness of Enterprises within the Horticulture Sector in Bangladesh' (Bangladesh Quality Support Program (BQSP))	Improve conformity of horticulture products with requirements of selected priority markets covering supply chain, quality, packaging, market development.	2006 - 2009
Govt. of Bangladesh (GoB)	Project: 'Production, storage and distribution of quality seeds at farm level'	To help fulfil HYV rice and wheat seeds needs for producing 25 million MT of food grain.	
Govt. of Bangladesh, USAID, EU and FAO	Research: 'Capacity Strengthening of Rural Women in Bangladesh'	The main endeavor of the research project was to assess the need for capacity strengthening of rural women in conducting postharvest activities (PHAs) of vegetables and fruits.	2009
Hortex Foundation (World Bank)	Hortex has developed quality packaging cartons of international standard using virgin and kraft paper manufactured locally	Hortex-promoted crops are exported using paper cartons which have already received buyer's appreciation abroad and are helping develop a brand name image in the world horticultural markets. Hortex logo thus represents quality and standardization of exportable fresh produces from Bangladesh	
Hortex Foundation (World Bank)	Hortex has developed transport facilities for the vegetable exporters	Hortex has a fleet of 3 reefer trucks and 1 reefer container which are made available to the partner organizations at a promotional rate of rent. This is done to help maintain the cool chain effect from the pack house in the field to the point of shipment. Advisory services and training are also provided on the effective management of cool chain system.	

Islamic Development Bank and GoB	Project: "Marginal and small farm development"	To increase and secure income of small and marginal farmers through: strengthening of the extension services to the marginal and small farmers, introduction of on-farm and off-farm income generation activities.	
International Development Research Center (IDRC)	Project: "Legumes postharvest technology in Bangladesh: Phase – 1"	To reduces losses following harvest by developing improved on-farm drying, storage, and management systems for five legumes (Lentil, Chickpea, Black Gram, Pigeon Pea and Vetch) and by developing suitable training methods to demonstrate and encourage adoption of improved post production systems.	1985
IRRI (USAID funded project)	Project: "Expansion of Cereal Systems Initiative for South Asia (CSISA) in Bangladesh"	The objective of the project is refining, testing, and delivering postharvest related technologies through adaptive research trials and for developing appropriate business models for scaling out adoption and assist with upgraded business models for other recommended varieties and management practices/technologies in Bangladesh.	
Katalyst	Project: "Potato Sector Development Project"	Improve appropriate postharvest management and facilities for potatoes.	2010
Katalyst	Project: "Packaging Service Market Development"	To improve the existing packaging system focusing on bamboo and to introduce new plastic crates for packaging fruits, vegetables and fish.	2010
Katalyst	Project: "Maize Sector Development"	Introducing technological innovation since growing maize during the summer season is problematic and the harvest period usually coincides with the rainy season. Katalyst intends to identify low-cost dryer models that would be feasible for traders and lead farmers to adopt, and to which neighboring farmers would have access.	

Pilot Projects Division (PPD) and Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP)	Workshop: "Reduction of Post-Harvest Agricultural Crops Losses"	This workshop is organized with a hope to continue further national and regional collaboration on post harvest involving relevant institutions, policy makers and other stakeholders, when there are frequent natural calamities, rising population as well as the declining trend in agricultural investment has put food security in the Asia-Pacific countries under threat.	2009
PRICE (Poverty Reduction by Increasing the Competitiveness of Enterprises) (USAID funding)	Activity: "Linking banks with agro-enterprises"	PRICE has been supporting thousands of small horticulture farmers, the majority of whom own less than half an acre of land. PRICE has helped these farmers to improve their skills and knowledge of increasing productivity, improve postharvest handling, and mitigate other constraints such as access to inputs and finance through several agro-enterprises and associations. Access to formal sources is still difficult for the small agro enterprises and small holder horticultural farmers.	2011
Practical action	Article: "Cold Storage of Fruit and Vegetables"	To inform about preparation of crops for cold storage, harvesting and cleaning, ppe-cooling, construction and operation of a cold store, packing systems, temperature of storage, humidity of storage, atmospheres in cold stores and equipment.	
Research and Extension on Farm Power Issue (REFPI)	Project: "Mechanical dryer project"	Rangpur – Dinajpur Rural Services (RDRS) initiated a mechanical dryer project with the financial assistance from REFPI project and technical assistance from Bangladesh Agricultural University, Mymensingh, Bangladesh Rice Research Institute (BRRI) and the University of Agriculture and Forestry, Vietnam (UAFV). The main purpose of the project was to familiarize farmers with dryers, to examine the performance of different types of dryer and find out the most appropriate technology for Bangladesh.	2002

Collaborative research Support Programme (USAID)	Program: "Horticulture Collaborative Research Support Program – A Regional Approach to Food Safety for Fruits and Vegetables in Bangladesh"	Postharvest losses in Bangladesh are 38%, and it accounts for significant potential income loss mostly to small farmers which are largely women. This project establishes the South Asia Consortium on Food Safety that will be a collaboration of Bangladesh, Indian and U.S. institutions that will be robust and flexible enough to include other South Asian nations later. The consortium will work towards solving researchable questions, improving technical skills, Good Agricultural Practices, and capacity building in Bangladesh with the help of scientific expertise available within US institutions and local expertise available in India. India's involvement as a strategic partner will assist Bangladesh with both research and training.	2010

Annex 10 - Postharvest treatments, rules and regulations

Application of Plant Growth Regulators (source Hassan *et al.* 2010)
Although not strictly a postharvest treatment, plant growth regulators (PGRs) have a strong effect on postharvest quality. They are used to increase the size of most of the fruits and vegetables. In Bangladesh the commonly-used PGRs are Okozim, Planofix, Agron and Voxal Super, Biogeem, Ferti and Yield.

Table A: Use of plant growth regulators in selected Upzillas (Hassan *et al.* 2010)

Crop	Use of plant growth regulator
Mango	Widely used, 60-90% growers
Banana	Widely used, 60-90% growers
Litchi	Widely used, 60-90% growers
Pineapple	Widely used, 80-100% growers
Jackfruit	Sporadic, 0-70%
Papaya	Occasional, 8-40%
Brinjal	Universal, 100%
Cucumber	Occasional, 24-48%
Okra	Widely used, 60-80%
Cauliflower	Not used

Application of fungicides *(Source: http://www.ba.ars.usda.gov/hb66/022pathology.pdf*
Fungicides are very important elements for agriculture production but may present a hazard when misused. Postharvest chemical treatments that are presently used are thiabendazole, dichloran, and imazalil. However, resistance to thiabendazole and imazalil is widespread and their use as effective materials is declining. Preservatives or antimicrobial food additives are not generally thought of as postharvest treatments but they do control decay, and in some cases are the only means of control. These products include sodium benzoate, the parabens, sorbic acid, propionic acid, SO_2, acetic acid, nitrites and nitrates, and antibiotics such as nisin.

Temperature and RH for post harvest decay control
Proper management of temperature is critical to postharvest disease control that all other treatments can be considered as supplements to refrigeration. Fruit rot fungi generally grow optimally at 20 to 25ºC and can be conveniently divided into those with a growth minimum of 5 to 10 ºC, or -6 to 0ºC. Fungi with a minimum growth temperature below -2ºC cannot be completely stopped by refrigeration without freezing fruit. However, temperatures as low as possible are desirable because they significantly slow growth and thus reduce decay. High temperature may be used to control postharvest decay on crops that are injured by low temperatures such as mango, papaya, pepper, and tomato. Although hot water generally is more effective, hot air has been used to control decay in crops that are injured by hot water. Heat treatment eliminates incipient infections and improves coverage by fungicides. The primary obstacle to the widespread use of heat to control postharvest fruit diseases or insect infestation is the sensitivity of many fruit to the temperatures required for effective treatment. Both low and high RH has been related to postharvest decay control. Perforated polyethylene bags for fruit and vegetable storage create an RH about 5 to 10% above that in storage rooms. Although shrivel and weight loss are reduced, decay may be increased. Crops such as apples and pears with well-developed cuticle and epidermis, tolerate lower RH levels that help prevent storage decay. Often fungal spore germination is inhibited at low RH, and small differences in RH can have significant effects in relation to the degree of postharvest decay.

Integrated Control of Postharvest Diseases
Effective and consistent control of storage diseases is dependent upon integration of the following practices:

- Select disease resistant cultivars where possible.

- Maintain correct crop nutrition by use of leaf and soil analysis.
- Irrigate based on crop requirements and avoid overhead irrigation.
- Apply pre-harvest treatments to control insects and diseases.
- Harvest the crop at the correct maturity for storage.
- Apply postharvest treatments to disinfest and control diseases and disorders on produce.
- Maintain good sanitation in packing areas and keep dump water free of contamination.
- Store produce under conditions least conducive to growth of pathogens.

Fruit ripening (source Hassan *et al.,* 2010)
Bangladesh is facing a typical problem of using synthetic chemicals in accelerating ripening of climacteric fruits like mango, banana, papaya, tomato and jackfruit. Some non-climacteric fruit like pineapple are also being exposed to ripening chemical. Actually, for commercial agriculture accelerated fruit ripening is recommended all over the world for uniform ripening, taste and quality. In the developed country ethylene gas is used to accelerate ripening of climacteric fruits. This is healthy, and it does not pose any threat to human health. By contrast, in Bangladesh, different types of liquid plant growth regulators containing ethephon as active ingredient are sprayed on the fruits or the fruits are dipped into the solution of ripening chemicals. Although there are opinions in favour of using the chemicals, vast majority of the people of the country oppose to the use of ripening chemicals. Accordingly, the Government of Bangladesh have imposed ban on using calcium carbide to accelerate fruit ripening. The law enforcing agencies of Bangladesh are also vigilant to fine the peoples who use calcium carbide. At the same time they are destroying hundreds of thousands of fruits that were subjected to chemical spray.

Observations on the methods used to ripen fruits ain Bangladesh are shown in the Table B below.

Table B: Use of conventional and chemical methods on fruit from selected Upalizas (Hassan *et al.*, 2010)

Treatment/crop	Banana	Mango	Jackfruit	Pineapple
Conventional				
Heat	+	-	-	-
Piling fruit and covering with polythene	+	-	+	-
Covering in straw	-	+	-	-
Piercing the floral stalk with an iron rod	-	-	+	-
Chemical				
Calcium carbide	-	+	-	
Ethephon	-	+	-	
Ethrel	+	+	-	+
Harvest	+	-	-	+
Profit	+	-	-	
Promote	-	-	-	+
Ripen 15	+	+	+	+
Tomtom	+	-	-	+

The use of ripening agent is essential for the marketing of horticultural produce for commercial purposes. Uniformity in fruit colour, taste, flavour is prerequisite to the assurance of produce quality. However, misuse the technology must be avoided. So far, the government of Bangladesh has not given specific registration to any chemicals fruit ripening purposes. Some of the chemicals, for example ethephon, might have been given registration for early flowering or other purposes.

Annex 11 - Matrix used in the kick-off workshop

			Identification of priorities for postharvest loss reduction						
Crops	**Stages in postharvest system where there are significant loss (%?)**	**Why do these losses happen?**	**Are some parts of the country affected more than others?? (and why?)**	**What existing solutions are there that could reduce these losses, and by how much?**	**Are there any current initiatives in B'desh that are promoting this solution? If not then who could (public/private)?**		**How will this loss reduction benefit poor people?**	**How would other market actors gain from loss reduction?**	**Approach to facilitating change?**
					Public sector	**Private sector**			
Vegetables									
Tomato	Transport - Storage- Packaging/Handling-	Poor packaging , No Specialized Transport (Cool chain), Road Bumping, (Cost of transport and Packaging is a concern), Lack of Awareness , Lack of knowledge of transport handlers	All over Bangladesh	Better packaging - (Plastic Crates- This is not collapsible/Stackable, returning the crates to the destination is a problem), Better Transportation, Railway Transportation at night, Special goods train, Road Construction (Infrastructural Development), Cold Storage, Processing and Value Addition, Ground Level Processing Plant, Good Governance,	Hortex Foundation (NATP),	Packaging Industry, (Bengal Plastic), cold storage by Private Initiatives, Multi Chambered Cold Storage- Badamtoli Hazi Selim, Farmers market in Gabtoli, refirigerated transport Facilities, grocery Chain/Superstores like Rahim Afrooz, PRAN trhoug contract farming.	Better prices for farmers - selling heavier/matured tomatos, and premium for quality	Better supply of higher quality gives better income	Bringing more private sector players into the packaging market and creating awareness
Potato									

Fruit									
Mango	1. Harvesting, 2. Transportation and Packaging 3. Storage 20-30% in total	1. packaging is not so good, Immature harvesting, Post Harvest Diseases, Inappropriate usage of ripening chemicals, Pre-harvest factors, Indiscreminate usage of pesticides	1. Diseases and pest are more prelevant in Humid Areas (Chittagong, HT), For others norhern area	1. Other than the north east motivate on post harvest issue, Good Governance, Post Harvest treatment of fruits (fungicide)	Research- BAU, BARI- for hot water treatment not in commercial basis, Hortex Foundation-NATP project assisted by world Bank	Kansat mango Groweres Association (Northern Part-Chapai), ADB assisted government project NCDP developed a training part of Kansat under DAE, Fruit processing PRAN, AKIJ, Abdul Monem Ltd, Super Markets	Higher price for better quality	Getting increased sales, the profit will trickle down, Dedicated Brand Name (sourcing)-Square, Rahim Afrooz (for many of them), The superstore quality is getting better	
Example 2									
Oilseed									
Example 1									
Pulses									
Example 1									
Cereals									
Example 1									
Example 2									

Annex 12 - Hat/Bazar management committees

The Government has decided to form Union Hat/Bazar Management Committees at the each hat-bazar to ensure daily routine administration, collection of tolls, and the maintenance and development of all markets within the hat-bazar. The Government has also decided to form Upazila level hat/bazar Management Committees to supervise, direct and advise about the activities performed by each hat-bazar committee. The hat-bazar committees will be formed by the Deputy Commissioners and the Upazila committees will be formed by the Upazila Nirbahi Officer.

Hat-bazar based Management Committee

(i) Composition

The individual hat-bazar Management Committee is formed as follows:

One person elected from permanent and temporary shop owners…….	President
One representative elected from permanent shop owners……..	Member
UP member from the ward……..	Member
Reserved UP Female member…….	Member
One representative from female shop owners (if applicable)……..	Member
Community Organizer of Upazila Engineer's Office…….	Member
One representative elected/selected from temporary small traders running business for at least six months……..	Member
One representative elected/selected from local van and rickshaw pullers……...	Member
One representative selected from bus/truck owners (if applicable)…….	Member
One representative elected from permanent shop owners……	Member-Secretary

It is to mention that leaseholder will not be the part of any hat-bazar based Management Committee.

(ii) Functions

Preparation of development and maintenance plans through reserved money from lease value (15-25%) for the respective hat/bazar and submission to concerned authority for implementation.

Supervision of collection of tolls by the leasees and all activities regarding toll collection. Stop collection of tolls above approved rates and tolls from the buyers/sellers for the items exempted from toll collection.

Protection of the buyers/sellers from harassment for collection of tolls.

Cleaning of hat/bazars and take care of the hygiene matters.

The committee will meet at least once in a month and will discuss and make recommendations of all issues regarding development maintenance and collection of tolls etc. in the market and send the same to the Upazila hat-bazar Management Committee.

Upazila Hat-bazar Management Committee

(i) Composition

The Upazila hat-bazar Management Committee is formed with the Upazila Nirbahi Officer as the President, Upazila Engineer LGED, all Union Parishad Chairmen of the upazila, two representatives from all hat-bazar management committee presidents selected by UNO from the concerned upazila,

one respectable person from Upazila (selected by DC), one government officer from the concerned Upazila (selected by DC). Assistant Commissioner (Land) is the member-secretary.

(ii) Functions

The committee will meet at least once in a month.

Close monitoring to the management and maintenance of all the hat-bazars within the Upazila.

Review of activities and take appropriate measures of the management and development of all hat-bazars within the Upazila.

Ensure monthly meetings of the hat-bazar Management Committees'.

Ensure that the responsibilities assigned to the hat-bazar Management Committee are being performed properly.

Keep the Deputy Commissioners informed regarding the recommendations of the committees at the hat-bazar and Upazila levels and take steps as per his suggestions.

Ensure collection of tolls at the approved rate.

Maintain peace in the hat-bazars.

Protection from unauthorized possession of any land in the market by anybody and unauthorized construction (buildings in that space).

In a similar fashion, municipalities have their respective Management Committees and responsibilities positioned above Upazila hat-bazaar Management Committee.