IX. POST-HARVEST TECHNOLOGY FOR VARIOUS CROPS OF PAKISTAIN: CURRENT STATUS, EMPLOYMENT GENERATION AND PROSPECTS

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Abstract

The mainstay of Pakistan's economy is agriculture. It contributes about 32% to the Gross National Product, and accounts for 57% of the labor force and over 50% of foreign exchange earnings. About 70 % of the country's population depends directly or indirectly on agriculture for its livelihood.

The major agricultural crops are wheat, rice, sugarcane, and maize, whereas minor crops are oilseeds, and pulses. Flourmills are the major food processing industries in Pakistan. The total flourmill capacity is 7.5 million metric tons. About 40% of the total market of grain local manufacturers supplies processing equipment.

There are at present about 76 sugar mills, which are producing about 2.5 million metric tons of sugar. However, recently the demand has exceeded production by 0.3 to 0.5 million tons, which is being imported. Ninety percent demand for sugar processing equipment is met through local manufacturing, and remaining 10% is supplied by the Europe, Japan, and Singapore. Pakistan exports complete sugar mills to Bangladesh and Indonesia.

The oilseeds consumption was 2.0 million tons during 2001-2002, and local production was 0.582 million tons, which meets 29% of the domestic consumption. Basic storage, filling and packing machines of vegetables oil mills are fabricated in Pakistan. Solvent extraction and recovery plants, and refining machinery are imported from Europe, China, and the United States.

The agro-climatic conditions of Pakistan varied from tropical to temperate, allowing 40 different kinds of vegetables and 21 types of fruits to grow. Area under fruits and vegetables is 0.995 million ha with total production of 11 million tons. Most consumption is in fresh form. During the peak harvest season, a great proportion of fresh fruits and vegetables are lost due to unavailability of suitable post-harvest technologies.

Secondary processing industry (flour mills, sugar mills, oil mills etc) is fairly developed in the country. However, primary processing of agricultural produce

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(cleaning, grading, packaging, drying, pre-cooling, storage etc) is poorly developed in the country.

The higher cost of processed products, consumer habits of eating fresh commodities, season ability of fresh fruits and vegetables, and low quality of the processed products are the key constraints for the slow growth of food processing industry. These constraints must be removed to develop fruits and vegetables processing industry in the country on sound footing.

The key low-cost technologies, which have the potential to generate the employment opportunities in rural areas, are as follows:

- Seed / grain drying, aeration and storage technology
- Rice drying technology for obtaining higher head rice yield
- Efficient dal (pulses) processing technology
- Rice par-boiling technology
- Apricot and dates drying and processing technology
- Modified atmosphere technology for fruits and vegetables
- Pre-cooling technology for fruits and vegetables
- Cool stores for potatoes, citrus, and apples
- Fruits and vegetables cleaning, grading, and packing technology
- Small-scale fruit juice technology for the remote fruit growing areas

In addition, various techniques which have already been developed in the country has great potential and can be disseminated among end users. Efforts on sustainable basis are required to develop and disseminate low-cost post-harvest technologies in the country.

The Government policies are very encouraging for the development / adoption of post-harvest technologies. However, there is scarcity of trained manpower in the field of post-harvest engineering and management.

A. Introduction

One of the greatest challenges of the twenty-first century will be to feed world's population, because food resources are limited, and the world population is increasing at an alarming rate. About 10 to 30% of total world grain production is lost after harvest (Chelkowski,1991), because of inefficient handling, inadequately implemented post-harvest technologies. If these losses are eliminated by applying an integrated system approach, which combines engineering, economic and biological principles, the world food supply can be increased by 10 to 30% using very few additional basic resources (land, water, and capital) and energy consumption. To protect resources and ensure sufficient food supplies for the world population,

development in post-harvest technologies provide considerable opportunities for scientists and engineers.

If we look into Pakistan's conditions, agriculture is the mainstay of its economy. It contributes about 32% to the Gross National Product and accounts for 57% of the labor force and over 50% of foreign exchange earnings. More than 70% of the country's population depends directly or indirectly on agriculture for its livelihood. Agro-climatic conditions of Pakistan ranging from tropical to temperate allowing to grow 40 different kinds of vegetables and 21 types of fruits. Major vegetables grown include potato, onion, chilies, melons, cucumber, tomato, turnip, okra and pea, whereas citrus, dates, mango, guavas, apples, banana, apricot, grapes, almonds, peach, plum, and pomegranate are the main fruit crops. The other major agricultural crops are wheat, rice, cotton, sugarcane, and maize. Secondary processing technologies for these crops have been fairly developed in the country; however, so far much emphasis has not been given for primary processing (cleaning, grading, handling, drying, pre-cooling and storage, etc.) of these agricultural commodities. Therefore, tremendous losses are associated with these crops after harvest.

Keeping this in view, this piece of work was undertaken with the following specific objectives:

- To investigate the present status of post-harvest processing technologies for various crops in Pakistan.
- To identify various post-harvest technologies that can be developed / adopted in Pakistan with particular reference to employment generation in rural areas.
- To present the Government policies and constraints related to the development / adoption of post-harvest technologies.
- To present the future prospects of post-harvest technologies in the country.

B. Present status of post-harvest processing

1. Post-harvest processing of crops

(a) Wheat

Wheat is the leading food grain of Pakistan, and being the staple diet of the people, it occupies a central position on agricultural policies. It contributes 12.5 percent to the value added in agriculture and 2.9 percent to GDP. Wheat is cultivated on an area of 8 million hectares and its annual production was about 18.47 million tons in 2001-2002. Flourmills are the one of the major food processing industries in Pakistan. The total flourmill capacity is 7.5 million metric tons. The local manufacturers supply Forty percent of the total grain processing equipments. Packing machines, fans, elevators, feeders and bag sewing machines for flour milling plants are manufactured locally. More than a dozen manufacturers in the private

sector produce complete flour milling and rice husking plants of small capacities.

At farm level, the storage consists of mud bins, metallic bins, concrete rooms, jute bags and wooden boxes. Whole sellers also practice open storage by putting bagged grain on plinth, which is covered with tarpaulin for protection. Storage owned by flour millers is for operational stock only (Baloch and Irshad, 1986). Due to poor drying and storage facilities the post-harvest losses are quite substantial. Chaudhary (1980) has estimated aggregate losses during various post-harvest operation of wheat in Pakistan to be about 15.3%. Therefore, efforts should be made to introduce in-bin drying and storage of wheat at farm level.

(b) Rice

Rice is the second largest staple food crop in Pakistan, and is major export item accounting for 6.1% of total export earnings over the last five years. Rice was cultivated on an area of 2.37 million hectares during 2000-01, and the production was 4.80 million tons. Due to unavailability of drying and storage facilities at the farm level, the head rice yield is about 30 to 40% (Tabassum et al., 1989). Whereas most of South-East Asian countries are achieving head rice yield up to 55%. To improve head rice yield, there is need to develop rice drying and storage facilities at farm level in Pakistan. So that millers may obtain dried rice of uniform moisture content for further processing. Koga (1977) also recommended introducing paddy-drying facilities in Pakistan in order to avoid the occurrence of sun checking of paddy during the sun drying process.

(c) Sugarcane

Sugarcane crop serves as a major raw material for production of white sugar and gur. Its shares in value added in agriculture and GDP are 6.3% and 1.5%, respectively. It was cultivated on an area of about 1.0 million hectares, and its annual production for year 2001-2002 was about 48.0 million tons. There are at present about 76 sugar mills, producing about 2.5 million metric tons of sugar. However, recently the demand has gone up than production by 0.3 to 0.5 million tons, which is being imported. Ninety percent demand of the sugar processing equipment is met through local manufacturing, and the remaining ten percent is supplied by Europe, Japan and Singapore. The U.S share is less than 1.0%. Pakistan exports complete sugar mills to Bangladesh and Indonesia. The major manufacturers in the public sector are Heary Mechanical Complex (HMC) and Karachi Shipyard and Engineering Works (KSEW). In the private sector, the leading manufacturers are Ittefaq Group of Industries, ABS Engineering Corporation (Pvt.) Ltd. and Star Mughal Industries.

(d) Oil seeds

The major oilseeds crops include cottonseed, rapeseed, sunflower, soybean and safflower. During 2001-2002, the total consumption was about 2.0 million tons and the local production was bout 0.582 million tons to meet 29% of the domestic consumption. The edible oils are either imported directly or obtained by crushing the imported oilseeds in the country. The imported oilseeds are mainly canola and sunflower. Basic storage, filling and packing machines of vegetable oil mills are fabricated in Pakistan. Solvent extraction and recovery plants, and refining machinery are imported from Europe, China and the United States. The U.S has a 29% market share in this sub-sector. At present the oilseeds are, processed by the large solvent extraction plants located mainly in urban areas. There exists no low-cost, village-level technology in Pakistan, to decorticate and process these seeds effectively. Muhammad and Khan (1993) attempted to develop a village-level sunflower processing technology in Pakistan. However, such types of small-scale technologies are not yet adopted in Pakistan.

(e) Pulse crops

The pulse crops grown in Pakistan are Masoor, Mung and Mash. These are being sown on about 0.35 million hectares and their annual production is about 0.17 million metric tons. Dal (pulses) processing industry in the country is of poor quality, it is not being manufactured by the well-organized sector. Therefore, efforts are needed to introduce low-cost dal processing technology at the village level. Such type of industry may help in creation of jobs for rural youth.

2. Post-harvest processing of livestock and poultry products

Livestock is an important sector of agriculture in Pakistan. It accounts for nearly 37.5 % of agriculture value-added and about 9.4% of GDP. Its net foreign exchange earnings were to the tune of Rs. 53.0 billion in 2000-2001, which are almost 12.34% of the overall export earnings of the country. The annual production of meat (beef, mutton and poultry meat) and milk is about 2.1 million tons and 27.0 million tons, respectively. Meat processing and packaging is limited due to lack of freezing or chilling facilities in slaughterhouses or retail outlets. Local meat production equal consumption. Imports and exports are negligible. The market is expanding at five to six percent annually. The reasons for small milk production are low yield and inadequate processing and refrigeration facilities. Most of the milk is produced in rural areas and is consumed fresh due to the lack of preservation facilities. The market for milk is expanding at an annual rate of 5%. Pakistan imports powdered milk to meet the shortfall.

3. Post-harvest processing of fisheries

Fishery plays an important role in Pakistan's economy and is considered to be an important source of livelihood for the coastal inhabitants. Pakistan's seacoast yields a large variety of fish including shrimp, crab, lobster, sardines, salmon, sole and tuna. Total yield was about 654,500 metric tons during the year 2001-2002, of this, 47% is edible and 53% non-edible fish. The latter is primarily used for fishmeal. About 63,129 metric tons of fish and fishery products (worth of Rs. 5.9 billion) were exported to Japan, U.S.A., U.K, Germany, Middle East and other countries. Local consumption is low because of high prices and lack of marketing facilities. Efforts are needed to improve the post-harvest techniques, development of value-added products and uplifting of the socio-economic conditions of the fishermen's community.

4. Post-harvest processing of fruits and vegetables

Cultivated area for fruits and vegetables are 1.141 million ha with total production of 11.64 million tons (Anon., 2000-2001). Table 9.1 presents the area under cultivation and annual production of various fruits and vegetables. It is revealed from Table 1 that area under vegetables is 0.556 million ha with production of 6.643 million tons, whereas the area under fruit crops is 0.585 million ha with production of 4.997 million tons. Most consumption is in fresh form. Fruits and vegetables are processed to produce jams, jellies, ketchup and juices.

Banaras et al. (1992) reported that during the peak harvest season, a great proportion of fresh vegetables are lost. The processing industry is now coming forward. At present, only 1% of total fruits and vegetables produced moves into the processing channel, with mango and orange dominating. Among vegetables although, potato, tomato, peas and garlic have great processing potential, yet quantities processed at present are very meager as compared to their fresh consumption.

Table 9.1. Fruits and vegetables production in Pakistan.

Fruits	Area (million ha)	Production (million tons)
Citrus	0.199	1.898
Mango	0.097	0.989
Banana	0.030	0.139
Apple	0.058	0.439
Guava	0.063	0.526
Apricot	0.013	0.126
Peach	0.005	0.003

Pears	0.003	0.038
Plums	0.007	0.064
Grapes	0.013	0.051
Pomegranate	0.007	0.048
Dates	0.079	0.613
Almonds	0.011	0.033
Sub-total	0.585	4.997
Vegetables		
Onion	0.105	1.563
Garlic	0.008	0.064
Chilies	0.084	0.175
Coriander	0.005	0.003
Turmeric	0.004	0.042
Potato	0.101	1.666
Tomato	0.028	0.270
Misc. vegetables	0.221	2.860
Sub-total	0.556	6.643
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Total (Fruits + Vegetables)	1.141	11.64

The recent advances made in post-harvest technology and research at various institutions in Pakistan are summarized below:

- Freshly harvested tomato fruits of variety "nagina" when dipped in 4% $CaCl_2$ Solution and kept at 15°C maintained marketable quality up to 16 days.

- De-greening: Studies on de-greening of citrus and mango showed that citrus variety "salustiana" stored at 30°C and 85-90% RH (controlled atmosphere) developed uniform color after 24 hours. In case of mango "chaunsa" stored at 17°C and 80-85% RH after chilling resulted uniform color development and produced natural flesh taste.

- Wax coating: Wax-coating studies are being carried out to make the produce more attractive with better shelf life. Carnauba based surface wax increased shelf life of kinnow 3-4 weeks by delaying senescence.

- Potato storage: Autumn potato crop is the main crop grown in the plains of Punjab. The crop is harvested during the month of January. The produce is kept in the field until the end of February because of low temperature. Thereafter, potatoes are mostly stored in the field in ordinary storage structures, where weight loss, rotting and sprouting of tubers deteriorate the quality of produce. Low cost on-farm storage structures were developed, where the hot air is replaced by cool air during night, using electric fan and the inside temperature

was observed 3-4°C low and the stored potatoes retained marketable quality up to 90 days. However, further worked is required to develop low cost cooling systems using desiccant technology for potatoes preservation.

- In cold storage, when the potatoes are held at 4 to 5°C. At this temperature, starch is converted to sugar and therefore potatoes become sweet. However, quality of potato tubers when held at 5°C to 9°C and 90% RH was retained until 60 days as the weight loss, rotting, sprouting and sweetening were checked.

- Apricots when dipped at 3% solution of potassium meta-bisulphite for three hours and then dried proved to be successful.

- The Nuclear Institute for Food and Agriculture (NIFA), Peshawar demonstrated inhibitory effects on sprouting of onions and potatoes during storage, delay in ripening in banana, guavas, mangoes, pears, tomatoes and persimmon, rot control. In oranges and improvement in quality of mature green peaches by using safe level of Gamina radiations.

C. Constraints faced by post-harvest industry

Processed products are not generally liked by the consumer at large. It is only affluent urban consumers whose response to new products utilization is encouraging. It will take time to bring about measurable change in the old set habits of the general public, who only eat fresh commodities and have pleasure of enjoying the fresh tastes during the season.

The prices of processed products are high and beyond the reach of average income group of consumers. It is pretty difficult for them to afford the products even if they like to have and eat them. The expensiveness of the products is due to high cost of processing.

Most of the processing units work only during seasons of marketing / availability of fresh fruits and vegetables. The operating cost thus becomes higher than if they operate all the year round running at full capacity.

All the processing units have to depend for the supply of fresh fruits and vegetables in the open market, which are most often of inferior quality, culled and sometimes having blemishes and diseases. Further, well-suited varieties for processing are not grown in the country. Therefore, only the leftover and rejected stuff find its way into the processing units. The raw material quality adversely affects the quality of the end products.

In order to develop fruits and vegetables processing industry in the country on

sound footing, it seems imperative that various constraints (some of which are identified above) are removed and other conceptual, technological, operational defects are rectified. The post-harvest industry has ample potential and viability to develop, sustain and contribute towards the economic development of the country.

D. Government policies and strategies towards post-harvest processing

Ten-year perspective development plan 2001-2011 and three-year development programme 2001-2004 specifically presents the strategies to be under taken to develop post-harvest technologies for the agricultural produce. The key policies and strategies of the Government of Pakistan related to post-harvest technologies, presented in this plan are as follows:

- Agriculture will be diversified into high-value crops. Special emphasis will be laid on growing fruits, vegetables and flowers for the export market. The private sector will be encouraged to establish processing, grading, packaging, and refrigerative storage, etc., through provision of liberal credit.

- Sustaining and strengthening the process of agricultural transformation and modernization by increasing productivity through vertical expansion, diversifying agriculture into high-value crops, and improving the pricing, marketing, grading and distribution systems to improve farmers' income.

- Fruits and vegetables processing and preservation plants and export companies will be established in growing areas of these commodities.

- Post-harvest handling and preservation of fish catch will be improved by providing chilling/refrigeration system in the traditional boats through the financial assistance of Small and Medium Enterprises Development Authority (SMEDA).

E. Post-harvest technology and employment generation

- Parboiling is an age-old process in parts of Asia, Africa and to a limited extent today, in some European countries and America. It is done to improve the milling recovery of paddy, and to meet the demands for certain consumer preferences. It involves three important steps: (1) soaking; (2) heat-treating wet paddy (steaming); and (3) drying paddy to safe moisture level for milling. Traditional method of parboiling is very crude; hence there is need to introduce a low cost and efficient rice parboiling technology in Pakistan. This will not only improve the quality of par-boiled rice, but also generates employment in rural areas.

- To improve the head rice yield, there is need to develop and introduce rice drying and storage facilities at farm level. So that the millers may obtain the dried rice of uniform moisture content for further processing. This technology will enhance the farm level activities in rural areas and consequently more people can generate their business in such activities.

- There is need to identify and introduce a low cost Dal (pulses) processing technology in the rural pulses growing areas of Pakistan. This technology will help to create small business in remote areas of the country.

- Wheat and rice are the major staple food grains of Pakistan. Their annual seed requirement is 737,000 tons and 43,000 tons, respectively. Due to lack of seed processing and storage facilities, seed produced by the farmers and supplied by merchants and local dealers is of low and poor quality. Therefore, the seed cleaning, grading and storage technology at farm level should be introduced. This will help the rural youth for setting up small seed companies. Consequently, the employment opportunities will be increased in rural areas.

- Pakistan is the fifth largest dates producing country and it has a share of about 11% in the global production, which stood at 0.613 million tons in 2001. About two-thirds of the dates produced in Pakistan come from Balochistan. But due to lack of infrastructure, dates about the worth of a quarter billion US dollars produced in that area cannot reach the domestic or the international market. Bajoi (1996) reported that 50% of the dates produced in Balochistan goes waste annually. The major reason for this wastage is sun drying in open yards, where insects and wild animals move around and contaminate dates. At night due accumulates on the surface of the fruit and causes mould growth. Therefore, there is need to develop a low-cost dates drying technology, this will not only help to reduce tremendous losses occurred during post-harvest processing, but also generates opportunities for the self employment of the rural youth.

- Pakistan is producing 126,000 tons of apricot annually. The key producing areas are Balochistan and Baltistan. In these remote areas, farmers are not able to sell their fresh produce because of limited infrastructure facilities. Therefore, individual farmers after de-stoning, spread the apricot on rocks, stones and roofs. The sun drying of apricot being practiced in this area is crude drying, a method that is without any consideration for sanitation, correct stage of maturity and pre treatments. Consequently, the quality of dried apricot so obtained is poor (Rahman, 1986). Hence, there is need to develop and disseminate a small scale efficient apricot drying technology that can be used by the local people to generate the additional income.

- Feng (2001) stated that the Modified Atmosphere (MA) technology developed in China is now being widely used. This includes individual film wrapping of

citrus fruit, cauliflower, broccoli, and other fruits and vegetables; storage of garlic stalks in large plastic bags; and tent storage of apples and other fruits. Using the MA technique, garlic stalks can be kept at a temperature of 0-1°C for 9 months with losses of about 5%. The firmness of apples stored by this technique in caves could be maintained in excess of 5.5 kg and the losses were less than 4% after 6 months of storage. The MA packing storage provides a method that requires minimum capital and energy, and is not expensive to operate. There is need to introduce such type of technology in Pakistan in order to reduce post-harvest losses and to generate employment for rural men and women.

- Temperature is the most important factor in maintaining product quality and Maximizing the shelf life of fruits and vegetables through the marketing chain. The higher a product's respiratory heat, the more critical it is to rapidly remove field heat and hold the product at its optimal storage temperature. Mclauchlan and Bagshah (2001) presented a few pre-cooling methods being practiced in Australia. They stated that one of the simplest cooling methods is hydro cooling. Bulk bins may be hydro-cooled before packing, either by immersion in cold water or by showering cold water over them. Refrigerated room cooling is the most common form of cooling for fruits and vegetables. Forced air systems considerably improve the rate of cooling and make more efficient use of refrigeration. Vacuum cooling is another, but less common, cooling method suitable for leafy vegetables such as lettuce. Applying the vacuum to the produce causes evaporation of water and associated cooling. Every 6°C cooling is accompanied by a 1 % moisture loss, which can be reduced by spraying produce with water before or during the cooling process. These pre-cooling technologies should be introduced in Pakistan, in order to increase shelf life of fruits and vegetables, and to generate on-farm employment opportunities.

- Fruit sugar preserve technology (jams, jellies, marmalade, fruit paste) can be introduced in remote apricot growing areas of Pakistan, where the rural women can be trained to preserve fresh apricot using this technology. It will help the rural women to start small business in their areas.

- Fruit juice technologies: Fruit juices are products of direct consumption and are obtained by the extraction of cellular juice from fruit, this operation can be done by pressing or by diffusion (Dauthy, 1995). There is need to develop/adopt a low-lost, small-scale fruit juice technology for the remote fruit growing areas of Pakistan. This technology will help to reduce the post-harvest losses substantially, and create employment opportunities in the rural areas.

F. Future prospects

A reasonable work has been done in Pakistan on secondary processing of agricultural produce, however, the area of primary processing of agriculture produce is not yet developed, therefore, tremendous potential exists in this area.

The key low-cost technologies needed are as follows:

- Seed / grain drying, aeration and storage technology;
- Rice drying technology for obtaining higher head rice yield;
- Efficient dal (pulses) processing technology;
- Rice par-boiling technology;
- Apricot and dates drying and processing technology;
- Modified atmosphere technology for fruits and vegetables;
- Pre-cooling technology for fruits and vegetables;
- Cool stores for potatoes, citrus, and apples;
- Fruits and vegetables cleaning, grading, and packing technology; and
- Small-scale fruit juice technology for the remote fruit growing areas.

In addition, various techniques, which have already been developed in the country has great potential and can be disseminated among the end users. Efforts on sustainable basis are required to develop and disseminate low-cost post-harvest technologies in the country. Therefore, it is proposed that APCAEM should assist the Government of Pakistan in establishing a Post-harvest Engineering Institute at the national level.

G. Conclusions and recommendations

- Secondary processing industry (flour mills, sugar mills, oil mills, etc) is fairly developed in the country. However, primary processing of agricultural produce (cleaning, grading, packaging, drying, pre-cooling, storage, etc) is poorly developed in the country. The key technologies identifies in this paper needs to be developed / adopted to reduce the substantial post-harvest losses associated with grains, fruit, and vegetables. The adoption/dissemination of these technologies will help to generate the employment opportunities for the rural masses. However, to achieve this, there is need to establish a post-harvest engineering institute at the national level. The key responsibility of this institute will be to develop / adopt post-harvest technologies suitable to local conditions of Pakistan.

- The Government policies are very encouraging for the development/adoption of post-harvest technologies. However, there is scarcity of trained manpower in the Field of post-harvest engineering and management.

- The higher cost of processed products, consumer habits of eating fresh commodities, season ability of fresh fruits and vegetables, and low quality of the

processed products are the key constraints for the slow growth of food processing industry. These constraints must be removed to develop fruits and vegetables processing industry in the country on sound footing.

- Great potential exists for technologies involved in the primary processing of grains, fruits and vegetables. However, great efforts are required to develop/ adopt suitable technologies. These newly developed/adopted technologies should be technically, economically, and socially acceptable to rural community of Pakistan. The adoption of such types of technologies at large will help to generate employment opportunities for rural masses.

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