Main Postharvest Problems and Countermeasures for Agricultural Products in China

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Abstract

China is a large agricultural country. The main cereal crops cultivated in China include paddy rice, wheat, maize, millet, sorghum. The output of both paddy rice and wheat ranks first in the world. China also is one of the centers of fruit origin and more than 30 species of fruits are produced for economic purpose such as apple, citrus, pear, grape, peach, pineapple, litchi, longan, mango, banana, etc. At the present level of fruit production, China has become the second largest country in the world, and the production of both apple and pear ranks first and of citrus third in the world. However, the development of agriculture still faces great challenges such as the growing population, the continuous increase in the consumption level, the increasing demand for agricultural produce, the continuous decrease of farmland, the decrease of agricultural resources, the reduction of severe postharvest loss and improvement of postharvest technology.

The paper will deal with the postharvest problems encountered in agricultural products, especially cereals, fruits and vegetables such as postharvest handling, storage methods, postharvest loss, packaging, food distribution, shelf-life extension and some socio-customary problems. It will introduce various aspects relating to the background, present situation, countermeasures, development, future targets and international cooperation.

Introduction

In China, agricultural research so far has been mainly concentrated on the improvement of crop production itself to achieve self-sufficiency in food in order to support the growing population. It is clear that, in the near future, the food supply problems will be more complex as patterns of food consumption have improved in the region along with the increase of income and social development.

Postharvest technology should be more emphasized to prevent crop losses and for utilizing agricultural products efficiently to meet the changes in the food demand, especially the demand for processed foods. The development of postharvest technology could contribute to securing a stable supply of food products in addition to the increase of agricultural income and improvement of the diet in China.

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Cereal production and postharvest technology to improve the quality of grains

The main cereal crops cultivated in China include paddy rice, wheat, maize, millet, sorghum, etc. In 1994, the acreage of paddy rice reached 30,171,000 ha, with a production of 175, 930,000 tons, both ranking first in the world. Wheat is another major grain crop, second only to paddy rice and in 1994, the acreage sown to wheat reached 28,981,000 ha, with a production of 99,300,000 tons, ranking first in the world. The total output of grain was 4.6, 5.045 and 4.925 billion tons separately in 1995, 1996 and 1997. At present, the total losses of grain are about 5-10% because of poor postharvest facilities, technology and handling. The China Government has already realized that more attention should be paid to increase cereal production, as well as to promote postharvest technology, improve grain quality and reduce postharvest losses.

1 Drying

From 1970 to 1980 more than ten kinds of drying facilities were designed and during the last ten years drying facilities developed very quickly. For example, in Heilongjiang Province 88 grain-drying centers were constructed with a drying capacity of 40% of the total. By the Yangtze River there are more than 1,000 sets of drying facilities with a drying capacity of 10,000,000 tons. Drying of grain is still a major problem due to the lack of adequate drying facilities in China. Presently, sun-drying is still the main practice to dry large volumes of grain in the countryside. For example, the government purchases each year more than 15,000,000 tons of grain with a high moisture content but the drying capacity is about 1/4 of the total. Therefore, the grain is not dry enough for safe storage in a short period after harvest. During storage, mould becomes an obvious threat, which causes damage due to the high aflatoxin contents and decay.

2 Warehouses for grain storage are not large enough and the conditions are poor

In China presently, there are 60,000 storages for grain with a capacity of 1.6 billion tons. The silos built with concrete or metal account for about 6% of the total storage capacity and they are located in the big cities. The warehouses built with bricks and wood account for 78%. The caves, which are ordinary houses built with mud and plant materials account for 27%. They are mainly used by small landowners and less at the national level and they are scattered. The storages are located in different areas depending on the use. Some storages for collecting grain are located in production areas or small counties with a volume of 25,000,000 tons. Some of the storages for transportation have been set up through railways, some are located in marketing areas and at the ports. More than thousands of kilometers of special railways for grain transportation have been built but because the warehouses are scattered it is difficult to gather the grain.

In the near future modern storages will be designed to protect the grain from moisture and temperature changes and also from microorganisms, insects, mites and rodents. Effective methods of grain storage enable to prevent the deterioration of grain quality. It will also be necessary to develop systems of small silos for farmers to prevent grain from being damaged by insects and rodents. Systems of larger warehouses should be located near large grain mills

for grain storage in the provinces and systems of high-capacity silos should be available at ports for grain exports.

3 Storage techniques and grain insect control

Several storage methods have been investigated and developed very quickly in China and some of them have been put into use. Mechanical ventilation storage technology is developing quickly and the technology has been spread to national storages in 29 provinces, cities and regions. The drawbacks are the lack of technicians and good management. CA storage technology with high carbon dioxide gave good results for the prevention of insects, mould and deterioration, especially for the grain stored in a high temperature and humidity environment. However, when the grain is out of CA storage, the quality deteriorates rapidly. Airtight storage or the use of tents for grain is the key point of CA storage. Low temperature storage including refrigerated and natural cold air storage gives good results. At temperatures of 15-20℃ rice with a 14-16% moisture content could be stored safely in summer in the southern part of China. Storage with ventilation of cool air outside is more suitable for storing grain in the northern part of China.

The amount of grain stored and the methods used presently are derived from customs, tradition, local needs, unique geographic and weather conditions, and natural resource availability. Regardless of the system of storage, controlling dust and spoilage and removing old grain residues are methods that help maintain the quality of grain. In considering whether to employ traditional methods for household or community grain storage using bags and baskets or to use bulk storage, it is necessary to evaluate several factors as follows: types of grain or other products being stored, duration of the period of storage, value of the product, climatic conditions, cost and availability of labor, cost and availability of bags, baskets, and other storage materials, capability of making storage materials, and incidence of rodents and destructive insects. Initially, grain is usually placed either in bags or stored loose in bulk storage. Generally, each method has its advantages and disadvantages.

Fumigation with PH_3 is one of the popular methods to control insects in China. Seventy percent of grain was fumigated with PH_3 and the efficiency can be improved under low temperature and low oxygen conditions. Research on plant-derived insecticides and grain-protective coating has been promoted for the last ten years. Insect control is a comprehensive project involving the control of the grain moisture content, storage conditions as well as chemical, physical and biological control.

The improvement of the grain storage facilities and equipment at household and village levels is a sound element on which to build a household grain security system. The Chinese Government is recognizing the difficulty in maintaining adequate food storages of high quality where only household and community storage systems are used. They are attempting to integrate local storage systems into a national system of food reserves. In such circumstances, storage of grain is maintained as needed at village, district, and national levels.

Fruit and vegetable production and postharvest technologies and problems

China is one of the centers of origin of fruit in the world and is recognized as the "cradle

of orchard". There are more than 300 species of fruit trees throughout the country and more than 30 species of fruits produced for economic purpose such as apple, citrus, pear, grape, peach, plum, apricot, hawthorn, kiwifruit, cherry, strawberry, banana, pineapple, litchi, longan, mango, red bayberry, coconut and papaya.

Since the founding of New China, the People's Government has paid great attention to fruit production and taken a series of effective measures so that fruit production has recorded a rapid development. Especially since the reform and opening-up policy and the lifting of restrictions on fruit markets, the enthusiasm of the farmers for fruit production has markedly increased. Fruit production has contributed to crop production and become one of the major sectors in the rural economy. By the end of 1994, China had devoted 7.264 million ha to fruit production, with an output of 35 million tons, increasing by 3.4 times and 4.3 times, respectively against the level of 1978. By the end of 1995 and 1996, fruit output was 42.15 and 46.53 million tons, respectively. At the present level of fruit production, China has become the second largest producing country in the world, with both apple and pear production ranking first in the world and citrus third. The output of apple, pear and citrus was 11.13, 4.04 and 6.81 million tons by the end of 1994, respectively. Fruit exports from China have also increased continuously, the amount of fruit exports being 431,000 and 490,000 tons in 1993 and 1994.

China is also one of the centers of origin of vegetables and it is the largest vegetable-producing country, with 9,600,000 ha devoted to vegetable production and with an output of 2.4 billion tons by the end of 1995. The most popular vegetables are Chinese cabbage, cucumber, tomato, cabbage, eggplant, celery, potato, peppers, peas, lettuce, melons, mushrooms, etc. More than 70 varieties can be supplied to the consumers and about 40 varieties can be marketed all the year round. The total amount of exported vegetables reaches 4~5 million tons.

1 Lack of storage facilities and postharvest investment

The postharvest losses are still serious with a percentage of more than 35% in China. Although the state financial support to agriculture has increased by 54 times and agricultural credit increased by nearly 26 times, the investment for postharvest technology is still inefficient compared to other sectors. The ratio of the state investment for postharvest technology to the preharvest value is only 0.38.

People need more varieties of fruits and vegetables with a better quality along with the increase of the living standards. However, presently, most of the fruits and vegetables are still stored in conventional warehouses, underground storehouses and cavehouses depending upon the national conditions. The shelf-life is usually very limited and the quality cannot be guaranteed. There was no refrigerated storage for fruits and vegetables in the 1950s. The first refrigerated storage for fruits was built in 1968 and CA storage was built in 1979 with a total storage capacity of less than 100,000 tons at that time. In the beginning of the 1980s, refrigerated storage of fruits and vegetables increased rapidly, especially, after the lifting of the restrictions in the fruit market. The total storage capacity reached more than 6 million tons by the end of 1994 and the refrigerated storage and CA storage capacity reached 2.72 million tons. However, not all of CA storage is operational because of technical problems, including lack of fuel for some of the atmosphere-generating systems. Therefore, most of the fruits and vegetables for the market deteriorate very quickly after harvest. For example, there was only

1/4 output of apples to be stored in different ways.

2 Situation and problems of postharvest techniques, handling and transportation

There has been a remarkable development of storage technology and facilities for the last ten years. Presently, different types of CA equipment have been designed and manufactured in China with good and reliable performance. Apple and garlic stalks stored in CA for 10 months fulfilled the quality requirements in the international and domestic markets and were sold at a good price.

Widely used MA technology in China has been developed including individual film wrapping of citrus fruits, cauliflower, broccoli and other fruits, storage of garlic stalks in large plastic bags, and tent storage of apples, garlic stalks and other fruits. Using this MA technique, garlic stalks can be kept at temperatures of 0 to 1℃ for 9 months with losses of about 5%. The firmness of apples stored by this technique in caves could be maintained at a value above 12lbs and the losses were less than 4% after 6 months of storage. MA packing storage provides a method that requires minimum capital, energy and is not expensive to operate.

Although the output of fruits and vegetables is large, the quality of most them cannot be as good as the original one after harvest, because of poor postharvest handling. Usually treatments such as cleaning and washing, trimming, grading, sorting, precooling, waxing, disease control and suitable packing are not implemented before transportation, marketing and storage. Most of the fruits are transported to the market as raw products directly even without package. Presently, people are paying an increasing attention to postharvest handling. Thirty-four and 9 sets of automatic washing, grading, waxing, and packing lines for citrus and apple were already imported in the 1990s in several large production areas of fruits and vegetables and commercial storage.

China is such a large country. Most of the fruits and vegetables are transported by car without refrigeration. To lower the temperature of fruits and vegetables, some ice cubes are put between the products in the car during the long distance transportation. The number of refrigerated cars is very limited for transportation between provinces in China. There are about 4,200 refrigerated cars and more than 7,000 refrigerated and insulated vans, most of them being used for the transportation of agricultural products such as meat, poultry, fish and eggs.

Due to the poor transportation system, the total losses during transportation can amount to more than 15～35%.

Recommended quality and packaging standards for several kinds of fruits and vegetables have been enacted but enforcement of the regulations is limited except for the export products. Presently, most of the packages used for fruits and vegetables are made of plant materials, for example, bamboo baskets which are not suitable for soft products and stacking. Mechanical injury of fruits and vegetables is serious with the packages. Now cartons, wooden boxes and plastic boxes are used more commonly in storage and transportation in big cities.

Problems of agricultural development and future targets

The development of China's agriculture faces great challenges such as the growing population, the continuous increase of the consumption level, the increasing demand for

agricultural produce, the continuous shrinkage of farmland and the decrease in agricultural resources. By the middle of the next century, the population of China will reach 1.5-1.6 billion. In China, the availability of most of the resources as a whole is fairly high, but the availability per capita is comparatively inadequate. For example, the per capita availability of cultivated land is only one-third of the world average level. Facing the challenges afore-mentioned, the Chinese Government has fully realized that China cannot import large quantities of agricultural products. Therefore, China must adopt the strategy of self-reliance and integrated development, adhere to the national policy of family planning, expand the rural reform and opening-up policy, strengthen international cooperation, develop and utilize land and other agricultural resources in a scientific and rational way, and preserve the agricultural ecological environment. China must also maximize the use of science, technology and modern industry to set up a system of modern technology for agricultural production, and increase by a large margin the land use efficiency, labor productivity and the commodity proportion of agricultural products and reduce the postharvest losses. With the development of agricultural science and technology and agricultural education, increase of inputs of agricultural capital, technology, materials (especially in the case of postharvest technology) and improvement of the performance of the market mechanism, the potential agriculture resources will be further tapped.

The main target for agricultural development in the year 2000 is to improve the rural economy comprehensively in order to increase steadily the production of the major agricultural products, and satisfy the need of the people for a comfortable life and the need for promoting the development of the national economy in terms of quantity, variety and quality. The grain output will reach 500 million tons and the postharvest losses will be less than 5%. The fruit output will reach 54 million tons and the postharvest losses will be less than 15%. Cash crops such as cotton, oil and sugar crops will record a sustainable development. The problems of insufficient food and clothing will be solved and the farmers' life will improve.

The basic target for agricultural development in the year 2010 is to ensure that the primary, secondary and tertiary industries in rural areas record a coordinated growth, and the major agricultural products and processed products satisfy both the need of the people in the transition from a comfortable life to a fairly affluent life, and the need for a steady and comprehensive growth of the national economy. The grain production capacity will reach 560 million tons and the total postharvest losses will decrease to 3%. The output of fruits will reach 65 million tons and the total losses will be less than 10-15%. The production of meat and aquatic products will enjoy a sustainable development and the production capacity of cash crops such as cotton, oil and sugar crops, will be at the same level as that of the consumption. Agricultural production and the ecological environment will be harmonized, and a foundation will be laid for sustainable development of China's agriculture.

The Chinese Government attaches a great importance to agriculture and rural work. It has formulated and is carrying out a series of policies and measures to support, protect and promote agriculture so as to fullfil the above target and task for agriculture and rural economic development. Although China's agriculture is facing a very arduous task, the reform and opening-up policy to the outside world have created extremely favorable conditions for its development. With the enhancement of the reform and opening-up policy, China's agriculture and rural economy will be even more prosperous. The Chinese Government and people have

the confidence and ability to rely on their own strength in solving the problem of food and clothing. China's agriculture will also make due contribution to the world agricultural development.

Agricultural research, education, extension and cooperation

Along with the establishment and development of the market economy system in China, the existing agricultural science and research systems are no longer suited to the present situation. The Chinese Government is making efforts to promote the reform of agricultural science and technology. Up to now, an agricultural science and research system administered both at the central and local levels had been basically set up, and the various agricultural universities and colleges have also built a relatively strong science and research force. According to the 1993 data, in the agricultural sector nationwide, there are 1,142 state-run independent research institutions. From 1978 until now, they have won many prizes and some of them are leading in the world. However, only some of the achievements have been put into use. There are 67 agricultural universities and 210 agricultural schools, which have trained many agricultural specialists in China. The Chinese Government attaches a great importance to technical and literacy education. By the end of 1994, continued education had been provided to 2.78 million farmers and adults.

China's agricultural extension system was first set up in the 1950s. At present, China has 213,000 agricultural extension units at the township level and above. Among them, there are 59,500 extension units for crop farming, but only a few extension units for postharvest technology of crops.

Up-to now the Bilateral Agricultural Joint Committees or Joint Working Groups have been set up with more than 20 countries. Meanwhile, ties with major international agricultural organizations and more than 140 countries have been established for the exchange of agricultural science and technology and cooperation.

Summary and priorities for postharvest technologies in China

As stated above, it is obvious that the low quality of the agro-products is due to poor postharvest facilities, technologies and processing practices. China should focus on the following problems of postharvest technologies:

1 Speed up the construction of grain storages and silos, and enlarge the storage capacity, especially at the national level where supplies of grain will be built up, to enable the government to control and maintain an equilibrium between the grain market and its price.
2 Improve the equipment used in grain storages, such as modern loading machinery, transport belt and system, cleaners, dryers, and elevators and automatic measuring units.
3 Improve the drying of grains to reduce the postharvest losses and damage caused by mould and insects.
4 Grain transfer storages should be built through the railways and equipped with modern loading and unloading systems of bulk grains, packing and breaking or opening grain package systems, and automatic measuring, cleaning and drying facilities.

5 Apply integrated control against fungi and insects to reduce postharvest injury of agro-products during storage.
6 Increase the capacity of refrigerated storage and CA storage for fruits and vegetables and improve the equipment.
7 Improve the postharvest handling facilities and methods to achieve standardization, commercialization, mechanization and industrialization of the fruits and vegetables.
8 Improve the methods of transport and develop a cold chain distribution system from producing areas to marketing places for fruits and vegetables.
9 Computerize the management of storages of grain or fruits and vegetables by monitoring the situation of the products and keeping their distribution smoothly.
10 Promote advanced research on postharvest physiology and technology of fruits and vegetables, especially for valuable fruits, such as mangoes, litchi, ya pear, etc.
11 Put new techniques of postharvest handling and storage methods of fruits and vegetables into use and reduce the postharvest losses.
12 Set up postharvest technology training courses and a pilot center for postharvest handling treatment for farmers and studies.
13 Formulate adequate policies in conjunction with technical measures.

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