Development and Constraints of Food Industries in Korea

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Abstract

Korea imports over 60% of food products, especially grains, from overseas. The industrial concern on postharvest technology is therefore not only for domestic products, but also for the exporting countries and the transportation and quarantine lines. Rice is the most important domestic product, 5 million tons/year, accounting for more than 80% of the total grain production in the country, while Chinese cabbage, radish and onion are important vegetables and apple and pear are important for postharvest storage.

Studies on postharvest rice processing technology were conducted in the 1970s and 1980s mainly at the Korea Institute of Science and Technology (KIST) and Korea Food Research Institute (KFRI), and the construction of Rice Processing Complexes (RPCs) was started from 1991 through the initiation of the seventh 5-year Economic Development Plan of the country. By 1997, over 250 RPCs were constructed throughout the country and additional 120 factories are under construction or in the stage of planning. The most important vegetable storage technology deals with "Kimchi"fermentation, which has been rapidly industrialized in recent years. Apple and pears are stored in the CA storage facilities, which were initially constructed through an IBRD loan in the late 1970s. As the importation of raw materials for the food industry is growing and the consumer demand for high quality food and better sanitation is increasing, the quality of the imported food is becoming an important social issue, and the public surveillance of postharvest handling of imported food is further emphasized. The need for the application of new technologies, such as food irradiation, for the effective control of insects and microorganisms, not only for domestic products but also for international trade, is emerging.

Introduction

Postharvest technology and the facilities for postharvest storage of foods in Korea have been improved remarkably during the last two decades, but the consumer demand for more fresh and wholesome foods is also growing fast. The rapid industrialization of the country in those years has changed the infrastructure of the agricultural sector dramatically. The farm population decreased from 45.9% of the total population in 1970 to 20.9% in 1985 and further to 11.5% in 1994 (ROK, 1995). The demand for liberalization of the food trade since the 1986 UR negotiation removed most of the protective barriers for domestic agricultural products. Korea imports from overseas almost all grains except for rice : 4.2 million M/T of wheat, 5.5 million M/T of maize and one million M/T of soybean annually. It produces 5 million M/T of rice

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annually, which meets the domestic demand, but it will be soon challenged by the low price of Californian rice. This situation motivates the farmers to shift their products from grains to vegetables and horticultural crops. Postharvest technology in Korea, therefore, can be divided into three categories, namely postharvest handling of rice, minimal processing of fruits and vegetables and quarantine control of imported products.

Food loss

It is important to determine the magnitude of food loss occurring in a country during and after postharvest handling of agricultural products. There are few reliable data for the estimation of the amount of food loss in a country. One of the approaches is the comparison of national food balance sheet with food consumption survey data, i.e. comparison of the amounts of food supply with those of food consumed. Fig.1 shows that under food shortage conditions in the 1960s, the amount of energy supplied to the people, as estimated from the national food balance sheet was lower than the amount of intake as measured by the national food consumption survey, while under food surplus conditions in the 1980s, the ratio showed an opposite trend (Lee, 1995). This fact indicates that under food shortage conditions, postharvest loss is not significant, because people are eager to gather more food materials and waste becomes minimal. However, under surplus conditions, people store the surplus foods for a longer period of time and become careless in terms of food consumption. In a society at an under-developed stage, since the majority of the people live in agricultural areas with a shortage of food, postharvest loss is minimal, and the increase in production is more important. When the society develops to a certain level so as to purchase needed foods from outside,

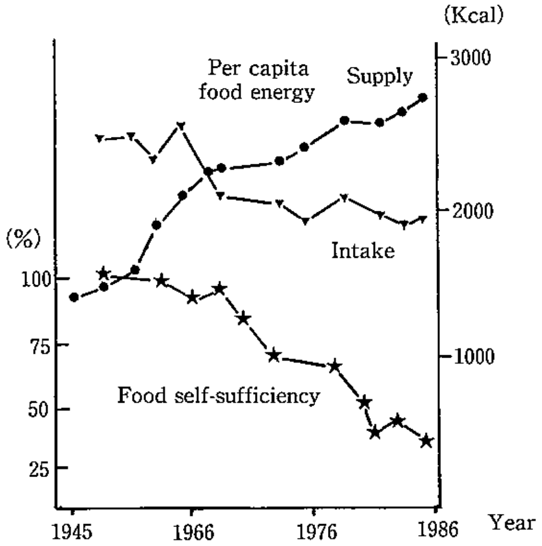

Fig.1 Changes in per capita supply of energy estimated from the National Food Balance Sheet and the intake energy estimated from National Food Consumption Survey, and changes in food self-sufficiency of Korea

postharvest loss becomes important for both importers and exporters. In Korea, the gap between supplied energy and intake energy exceeds 30% of the total supply. This amount of loss is not considered completely as postharvest loss, if the postharvest loss is defined as the loss occurring during the period from agricultural production to the acquisition by consumers. However, the food waste occurring at the consumer level can be reduced by proper postharvest treatments like minimal processing of vegetables.

Postharvest handling of rice

The conventional postharvest technology of rice, involving threshing, sun-drying on mat, storage in sacks in farm, requires heavy labor and is associated with grain loss, which is not sustainable in taking account of the current situation of agriculture in Korea. The cost proportion of such process was estimated to be 18% of the governmental purchase price of rice in Korea, and this proportion was 4 times higher than in USA (Park and Kim, 1993). Studies on the rice processing complex (RPC) started in the early 1980s, and the first RPC was constructed in 1991 in Dangjin and Eusung, Korea. By 1996, a total of 220 RPCs were constructed in the farm area throughout the country, and 33 new RPCs were under construction. It is anticipated that more than 400 units will be completed by the year 2004 (KRRI, 1997). The recommended minimum size of a RPC is 1,800 M/T rice/day of drying capacity, 1,200 M/T of

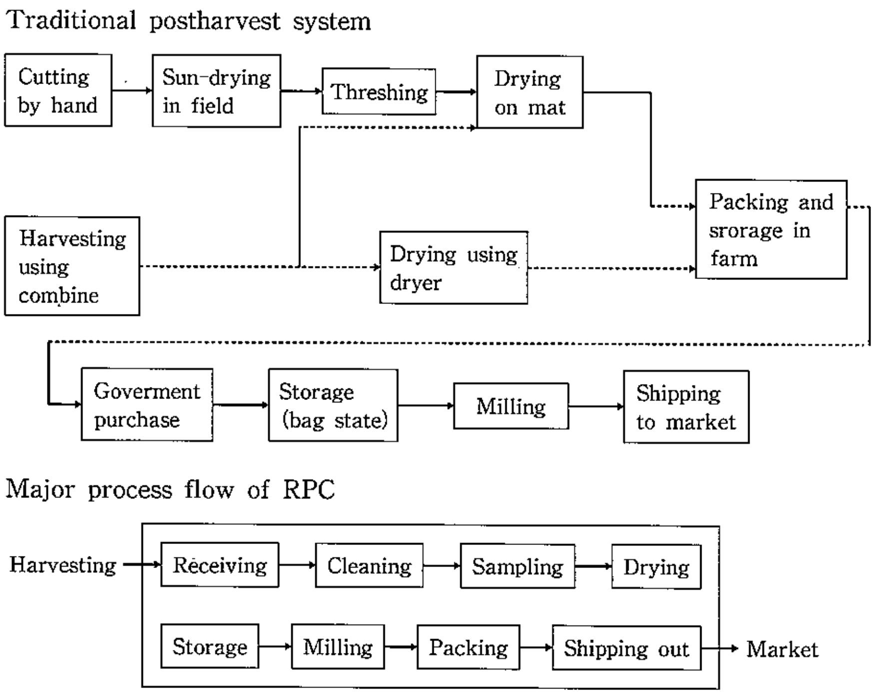

Fig.2 Comparison of traditional postharvest system of rice with major process flow of Rice Process Complex (RPC) in Korea

rice storage capacity and 20 tons/day of milling capacity. Fig.2 shows the major process flow of RPC in Korea. The function of RPCs in Korea is slightly different from that in Japan and USA. In Korea, drying, storage and milling processes are performed within a plant while drying and storage units are separated from the milling plant in USA. In Japan, the country elevator acts as long-term storage facility supplementing the rice center storage capacity. For this reason, the storage capacity of RPCs in Korea is very limited, and the construction of rice storage huts at the farm level, equipped with an air-blown drying system, is promoted. Presently over 80,000 improved storage huts are available and used for the storage of rice at the farm level throughout the country.

The RPC in Korea played an important role in reducing the heavy labor demand of rice farms, thus increasing the farm size. A recent survey indicated that the average rice production per farm increased from 4.8 M/T in 1991 to 11.5 M/T in 1997 (KRRI, 1997). Most of the farmers dried their products by themselves and only 10.3% of the products were dried in RPCs. Among the methods applied for farm level drying, hot air-drying was the most widely used, handling 63% of the product, while sun-drying accounted for 32.6% and storage hut-drying for only 4.4. In 1989, sun-drying was the most important rice drying method accounting for 70.8% of the products, as shown in Table 1. The use of storage hut air-blown-drying depends largely upon the weather conditions during the harvesting season. The average temperature and relative humidity in October, which corresponds to the rice harvest season in Korea, are 13-16℃ and 65-75%, respectively, which are generally considered to be suitable for air-blown-drying of rice. The changes in the drying method improved the quality of rice significantly. A recent study on the effect of drying methods on the broken rice ratio showed that farm level sun-drying resulted in 7-16% broken rice ratio, while hot air-drying resulted in 3% and air-blown-drying in only 1%.

Table 1 Use of rice drying methods in Korea (1997)

Unit : %

	Total	Farm size		Farm district		1992	1989
		Small	Large	Center	South	total	total
Sun-drying	32.6	62.6	21.9	18.2	50.0	50.7	70.8
Hot air-drying	63.0	32.5	73.8	75.3	48.2	39.1	25.8
Storage hut air-drying	4.4	4.9	4.3	6.5	1.8	10.2	3.4

The use of rice processing complexes in Korea will expand and will contribute significantly to enhancing the competitiveness of Korean rice farming. The major advantages of these facilities are as follows : (1) reduction of the labor peak during the rice harvest season, (2) reduction of heavy labor of farmers, (3) decrease of the postharvest production cost by reducing grain losses, energy and labor requirements and by maximizing the processing efficiency, and (4) improvement of the quality of rice (Park and Kim, 1993).

Minimal processing of fruits and vegetables

Production and consumption of fruits and vegetables markedly increased during the last two decades in Korea partly due to the improved standard of living and also partly due to the changes in the world trade conditions of agricultural products as mentioned above. As shown in Table 2, the production of fruits and vegetables increased 5.4 times and 4.0 times, respectively, during the last two decades, while the grain production decreased. The increase in the production of house-grown vegetables by 17.3 times reflects the demand of consumers for horticultural products with a better quality. The major vegetables are Korean cabbage and radish which are used mainly for "Kimchi" fermentation, and the production of each amounts to ca. 2 million tons per year. Currently, around 190 different types of "Kimchi" are produced in households in Korea. The per capita daily consumption of "Kimchi" in Korea has been estimated to be 100 g for the last 20 years. The amount of exported "Kimchi" has increased steeply, with an average annual increase of 13.3% for the last 10 years, and the major export market is Japan. In 1993, the total production of "Kimchi" in Korea was estimated at 1.5 million M/T, and 10% was produced in factories. By the year 2000, it is predicted that the factory supply of "Kimchi" will increase to 20% of total production (Lee, C.H., 1997).

Table 2 Amount and cultivated area of agricultural products in Korea

Units: 1,000ha, 1,000M/T

	Food grains		Vegetables		House vegetables		Fruits	
	Area	Amount	Area	Amount	Area	Amount	Area	Amount
1970	2,950	6,524	258	2,653	4	140	60	423
1980	1,982	5,324	377	7,676	18	412	99	833
1985	1,669	6,990	366	7,763	29	680	109	1,464
1990	1,346	5,476	317	8,677	40	1,017	133	1,766
1995	1,346	5,476	408	10,586	82	2,423	174	2,300
'95/'70	0.45	0.84	1.58	3.99	20.5	17.3	2.90	5.44

The major vegetables that are exported are onion, carrots, cucumber, strawberry, cabbage and melon. The total amount of exported fresh vegetables in 1995 was 38,733 tons, of which 95% was exported to Japan. Apple and pear are the major stored fruits, using MA storage, while peaches, grape, plums, oranges are seasonal products which are mostly consumed in the fresh state. The construction of refrigerated warehouses at agricultural production sites, especially fruit (apple and pear) and spice (onion and garlic) production sites, was the major emphasis of Korean agricultural policy in the early 1970s, and the government supported the construction by using an IBRD loan. By 1996, Korea operated a total of 922,478m^2 cold warehouses at production sites.

Minimal processing of fruits and vegetables is a major issue of postharvest technology in Korea today. This technology is promoted for the following reasons : (1) the cost for cargo transportation and handling is too high, (2) waste treatment in the restaurants and households causes problems and is costly, and (3) the consumer demand for fresh and ready-to-eat convenient foods is increasing. The cargo cost accounts for 17% of the GNP of Korea, which is exceptionally high compared to the 11% level in the advanced countries. In the agricultural sector, the cargo cost can be reduced to 40% of the present level by the standardization of cargo system. The volume of vegetables for transportation can be reduced significantly by simple trimming and proper produce packaging at the production sites. It will also reduce the kitchen waste in the cities. Vegetables contribute to 53% of the total food waste in Korea (Kim and Yoo, 1996).

Minimal processing of fruits and vegetables requires a cold chain system comprising precooling and cold storage at the production sites, cold storage in the processing and distribution lines and refrigeration at the household level. Presently, most of the Korean families own a refrigerator and supermarkets store their refrigerated goods in a cold room and refrigerated show cases. According to the 1995 statistics, the number of refrigerated trucks in Korea was 28,298, and the refrigerated showcase production capacity was 181,239 cases per year. However most of the refrigerated trucks and showcases are used for the storage and transportation of fishery products, meat and dairy products, beverages and ice cream, and frozen food products (Lee, S.Y., 1997).

The weakest points in the postharvest technology of fruits and vegetables in Korea are precooling at the production sites and low temperature transportation system (Kim, 1997). Proper precooling enhances refrigeration efficiency of harvested vegetables and thus enhances the product quality and shelf-life. The benefits of precooling were advocated by the researchers in the early 1990s and the government provided funds to build pressure cooling facilities at the production sites. By 1996, 120 precooling houses with a total area of 19,268m^2 were built. However, the purpose has not been well introduced to the producers, and the cost-benefit of precooling is not well understood by the buyers, who have to pay for it. Both producers and buyers consider that precooling facilities are ordinary cold storage houses.

Quarantine control of imported products

The present plant quarantine system in Korea was established when "The Plant Protection Act" was promulgated on December 30, 1961, and "The Enforcement Regulation of Plant Quarantine", "Exporting Plant Quarantine Regulation" and "Importing Plant Quarantine Regulation" were enacted in 1963. The Plant Quarantine Service is affiliated to the Ministry of Agriculture and Forestry. It consists of the headquarters, 5 branch offices, 18 sub-branch offices and 1 post-entry quarantine station. The officers are inspecting 2,350 commodities including cereals, fruits and vegetables, industrial crops and timber. All harmful organisms are subjected to plant quarantine management, and are classified into 3 levels of quarantine pests based on the results of pest risk assessment (Hong, 1993).

(1) Prohibited pests and diseases amount to 22 such as medfly (diseases 8, insects 14) and it is prohibited to import the products from the countries or areas where they occur. If products reach Korea, the whole cargo should be destroyed or returned.

(2) Restricted pests and diseases amount to 73 (diseases 38, insects 35) such as oak wilt disease and palm thrips. The products in the countries where they are distributed can be imported.

However if the pests and diseases are detected at the time of importation, the cargo should be destroyed or returned.

(3) Manageable pests amount to 129 (diseases 53, insects 76), and if they are detected at the time of importation, the cargo should be disinfected fully or partially. Unlisted pests and diseases which are detected for the first time, should be evaluated based on pest risk assessment to determine the methods of treatment.

Table 3 shows the activities of plant quarantine in 1992 (Hong, 1993). Cereals and industrial crops have recorded very high rejection rates, 48% and 33%, respectively, while fruits and vegetables relatively low rejection rates, 3-4%. The rejected cereals and vegetables contained mostly manageable pests and were treated by disinfection, whereas the fruits hosted mainly restricted pests and were destroyed. The importation of agro-products from China has increased annually since the amity treaty between the two countries was concluded in 1990. In 1992, 39% of imported cereals and 31% of imported vegetables originated from China while 70% of imported maize and 95% of imported sorghum among the forage grains originated from China. Also above 90% of imported dried radish, green onion and fernbrake originated from China.

Table 3 Activities of plant quarantine in Korea in 1992

Product	Unit	Number of products inspected	Number of products rejected		Rejection
			Disinfection	Destruction	Ratio
Seed	M/T	6,181	187	–	3.0
Bulbs	Thousand	76,660	7,709	4,336	15.7
Seedlings	Thousand	15,064	223	1,509	11.5
Cereals	1,000M/T	13,032	6,035	–	48.0
Fruits	M/T	211,824	740	6,348	3.3
Vegetables	M/T	56,688	1,840	277	4.0
Industrial crops	M/T	414,887	136,817	300	33.0
Timber	1,000m^3	8,735	8,186	5	93.7
Others	1,000M/T	1,686	1,158	89	73.4

Methyl bromide is the most widely used fumigant for food and agricultural products against pests such as insects and nematodes, and it is frequently used for the quarantine treatments. However, it was listed under the Montreal Protocol, an international treaty for the regulation of ozone-depleting substances worldwide under the auspices of the United Nations Environmental Programme, as one of the substances which cause a depletion of the ozone layer. The original phase-out schedule of methyl bromide was set for the year 2000. However, the last meeting of the Parties to the Montreal Protocol held in Montreal, Canada in September 1997 had revised the phase-out schedule of methyl bromide as follows:

Advanced countries: 25% reduction by the year 1999
50% reduction by the year 2001
70% reduction by the year 2003

Phase-out by the year 2005
(with exemption for critical uses)
Developing countries: 20% reduction by the year 2005
Phase-out by the year 2015

Although the use of methyl bromide for quarantine purposes and for preshipment fumigation was exempted from the phase-out schedule under the Montreal protocol, it is obvious that methyl bromide is on the way out and that it will not be available for controlling pests in food and agricultural products in the near future (Loaharanu, 1998).

Low dose irradiation is being recommended as an alternative to methyl bromide, ethylene dibromide and ethylene oxide fumigation of fresh agricultural products to overcome quarantine barriers in trade. A minimum dose of 0.15 kGy is effective for quarantine treatment of fresh fruits and vegetables against the fruit fly (Tephritidae family) and a minimum dose of 0.3 kGy is effective against other insect species. Unlike other competing techniques, irradiation is a broad spectrum quarantine treatment, not specific to insect species or host commodities. Its application for quarantine treatment of fresh horticultural produce is endorsed by regional plant protection organizations operating within the framework of the International Plant Protection Organization, i.e. North American Plant Protection Organization (NAPPO), European and Mediterranean Plant Protection Organization (EPPO), Asian and the Pacific Plant Protection Commission (APPPC), etc. The USDA issued a Notice of Policy on 15 May 1996 which authorizes irradiation for quarantine treatment of fresh fruits and vegetables against fruit flies regardless of host commodities (USDA, 1996).

A Joint FAO/IAEA/ICGFI Regional (RCA) Workshop on Harmonized Procedures and Regulations on Irradiated Food was held on 27-29 April this year in Seoul with 30 delegates representing food control authority and food irradiation experts from 15 countries in the Asia-Pacific region. During this workshop food regulations related to irradiation procedures, safety control rules, labelling requirements, quarantine procedures and marketing regulations of each country were reviewed and the expansion of the trade of irradiated foods was recommended in order to facilitate the trade of agricultural products of this region in the world market.

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