II. POTATO PRODUCTION, POST-HARVEST UTILIZATION AND ITS IMPLICATIONS FOR EMPLOYMENT IN THE RURAL SECTORS OF ASIAN COUNTRIES

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Abstract

In the rice/wheat-based food systems of Asia, potato (*Solanum Tuberosum*) consumption per capita is still relatively small but growing rapidly; both fresh potatoes and processed potato products are becoming increasingly popular in the region. Per capita consumption of fresh potatoes grew at an average annual rate of 4.6 percent between 1971 and 2002. The increase in demand for processed products was especially rapid in China, Thailand, Indonesia and the Philippines. The long-term trend for per capita potato consumption in Vietnam, Malaysia and Singapore, has also been positive. Policy makers in the region have noted that the potential of the potato for diversifying the consumer diet of away from rice/wheat, and that the processed potato is not only bring added-value to potato production but also generate more employment opportunity in rural areas, despite the fact that at present potato's contribution to total caloric intake in Asia remains small. In China, the major distribution of potato is mainly in the western and mountainous areas, where poor farmers, mostly ethnic groups, live. The improvement on potato production is important both for the national program on poverty alleviation, rural economic development and for the rural employment improvement for the farmers on marginal land and in ethnic areas.

While the demand for fresh table potatoes has been largely met locally or regionally, the demand for processed potato products has so far been supplied mainly through imports in Asian countries. The popularity of American-style fast food restaurants in urban centers of Asia has resulted in a rapid increase in imports of frozen French fries, especially from North America. Strict quality criteria by multinational fast-food restaurant chains have kept locally grown potatoes from supplying much of the demand for processed potatoes. Hundred millions of US dollars per year has been spent on the import of the processed potato to Asia from developed countries, such as USA, Canada and Australia.

There are technical and socio-economical constraints for potato production and processing in developing countries, these constraints are also related to the constraints for local farmer on site employment and value add to their local potato production. In the land resource-poor countries in Asia, adding value to its agricultural products

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by processing is an important way out for the poor potato farmers in the rural areas. Potato processing can generate stable income, create more employment and contribute to rural development; this is especially true when the processing raw materials are from locally produced potatoes, as the production chain of potato takes many years and there are employment opportunities at each part of the chain if the chain is kept to the locality.

A. Introduction on potato production

Potato is the fourth most important food crop after the cereal wheat, rice and corn in global crop production. According to FAO statistics, world output in 2001 was 308 million tons harvested on 19 million hectares with an average productivity of 16 tons/ha. Statistical time series over the last 40 years show a decreasing trend of cultivated area of potatoes in developed countries while the trend is consistently upwards in the developing world (Crissmann, 2002; Hijimans, 2000). As a matter of fact, in the early sixties developed countries accounted for 89% of total world output but now their production has decreased to only 64% and it is expected to be only 50% by the year 2020 (Scott, 2000; Walker, 2001). That is today, developing countries produce one third of total output, but in twenty years half of the world potato production will take place there. A closer look at the disaggregated statistics over the same period shows that potato production in Asia has grown four fold, while in Africa and Latin America it has doubled (Daw Hla Hla Nyunt, Myanmar, 2002; Dao Huy Chien, Vietnam 2002; F Ezeta, Peru, 2002; Juanita B. Salvani, Phllippines, 2002; Kongpang Kangavong, Lao PDR, 2002; Lu, Wen-He, China 2002; Malinee Pituck, Thailand, 2002; Ri Ki Jae, DPRK, 2002; Rusli Nyak Hukum, Indonesia, 2002; Seng Vang, Cambodia, 2002). In China, for instance, production reached an annual growth rate of 6% over the last decade, higher than any other food crops and well above the population growth (Qu DY, 2002). Since the disintegration of the Soviet Union, China is currently the major potato producer in the world with a total annual output of 60 million tons on 4 million ha and productivity of 15 tons/ha. Increase in potato production in Asia resulted from combined gains in yield as well as in cultivated area (Qu DY, 2002). A comparison of growth rates among the four major food crops shows that potatoes have exceeded cereals over the last two decades indicating a potential for further growth and an increase in the relative importance of the potato in world food supplies (Cissman, 2002; CIP Lima, 2000).

B. Constraints for potato production and post-harvest utilization

Post-harvest for potato is the critical sector for employment and potato farmers' basic interests in production countries. Globalization and free trade pose a challenge to the economies of the developing countries. The potatoes are one of the most sensitive agricultural commodity to open competition, especially on post-harvest process, because of its social and technical implications (Gitomer, 1996). The accelerated growth rates of consumption of processed potato products observed in the

1990s throughout the developing world reflect important changes in consumption patterns. Among the factors that have triggered this change there is the fast urbanization process, economic growth, the new dynamics of modern life and an aggressive expansion strategy of transnational corporations. It is likely that the patterns of expansion of the last decade will continue in the next few years and that without a competitive domestic industry most developing countries will become even more dependent on imports of frozen fries and other potato processed products to meet their growing demand, this will also cause both market and rural employment problems for the potato producing farmers. Therefore an analysis of competitive advantages of the potato production chains in developing countries is indispensable in order to formulate policies on potato production, utilization, industrialization, trading, and rural employment.

Competitive advantages of nations depend on the conditions of production and demand factors, development of related support industries, the strategy, structure and competition among producers. Adapting these concepts to the potato production and utilization chains we may say that competitive advantages for potato production and utilization depend on the production factors, markets, access to inputs and efficiency of the production unit. In addition to these endogenous factors there are a number of exogenous factors which influence the competitive capacity of a region, country or production unit. There is no doubt that international trade policies, domestic government policies and climatic risks are important factors of the equation that should not be ignored. An analysis of competitive advantages is therefore a complex exercise because of the large number of variables involved; some of which are beyond the control of farmers or national policy makers. Nevertheless despite the complexity of the analysis there are a number of technological and socio-economical factors that are major constraints to competitive production in developing countries, as discussed below.

1. Pests and diseases

Late Blight (*Phytophthora Infestans*) continues to be the most serious pathological threat to high productivity because of severe yield losses and increased production costs. The situation has become quite difficult in areas of intensive potato monoculture in cool and rainy subtropical areas where the fungus exhibits high infection pressures, and farmers have to spray fungicides every 3 or 4 days to protect their crops. Bacterial Wilt (*Ralstonia Solanacearum*) is the next serious threat worldwide. This disease is particularly harmful in the warm and humid tropics and subtropics. The strategy to control the Wilt rests on integrated management practices such as crop rotations and healthy seed. It is extremely important that seed flows are organized as to avoid contamination of non-infected areas of a country. Potato viruses and viroid (PVX, PVY, PVS, PVM, PVA, PSTVD) are the main factors for potato yield reduction in most planting areas, even new technology has been taken to reduce the damages, but the technology is not available especially in developing countries,

the virus agent causing yield decline is still the major constraint for total yield production of potatoes. Among insect pests of world importance there are two which cause severe damages to potato crops in developing countries: Potato Tuber Moth and Leaf Miner.

2. Seed quality

Seed production has experienced remarkable progress in the developing world since the early 1980s. Rapid multiplication and pathogen detection techniques have been the main scientific developments that supported important advances of the seed industry in developing countries. The technology has rapidly diffused among public and private sector institutions and business, facilitating the multiplication of good quality basic seed. Thanks to this technology many developing countries have reduced imports of basic seed and others have improved yields of their own varieties. In some countries some farmers have built basic seed units to supply their own commercial needs, and others have become specialized in seed production and marketing of in-vitro plants, mini-tubers and different generations of tuber seed. Through these production steps, hundreds or thousands of employment opportunities are generated for the local farmers and farmer technicians. Despite well-recognized technological development on seed production most developing countries face severe difficulties in providing their farmers with good quality seed. The problems are beyond the laboratories and greenhouses and very often they are not of technological nature. Although there are differences among developing countries as to the particular constraints for the efficient operation of a seed supply system, most of them are related to institutional weaknesses associated with organizing production, quality control and distribution.

3. Processing varieties

The recent expansion of the potato processing industry in most developing countries has created a demand for better varieties for chips, frozen fries and potato flour/starch/flakes. Quality requirements of potatoes for processing differ significantly from those of table potatoes. Starch content, specific gravity, low sugar level and shape (length and width) are important parameters that are closely looked at by processors in order to meet their quality standards. Until recently the breeding programs of most developing countries had paid little attention to quality parameters of their selections leading to relatively few varieties with processing quality. More recently, most breeders measure specific gravity and frying quality of their advanced selections before decisions are made to release new varieties.

4. Production costs

Intensive production of potatoes demands high levels of investment in agricultural inputs such as seed, chemical fertilizers and pesticides. In addition,

farmers of developing nations have high transaction and financial costs to buy inputs and services as well as to store and market their products. Moreover subsidies to agriculture, a common practice in developed countries, are rarely seen in the developing world. High production costs and low productivity per unit of surface area result in extremely high cost per unit of product which is the main reason of the low competitive capacity of farmers in developing countries. The large proportion of the potato areas in rain-fed agriculture and high level of political instability contribute to increased risk and uncertainty making potato agriculture a risky business. Small commercial farmers are particularly vulnerable to price risk and frequently are forced to minimize costs by reducing inputs which in turn leads to poor yields. Subsistence farmers are less vulnerable to price risk because their participation in the market is sporadic.

5. Processing technology

Expensive processing machines, long cold chain and supporting facilities for potato processing developed in the industrialized countries are far beyond the capacities of low-income in developing countries; the infrastructure environment is another constraint for the development processing industry in these countries. The strategy to realizing the benefits of post-harvest processing for the poor farmers has been the difficult challenge forced the developing countries in Asia.

Simple processing of potato by farmers including the starch-processing, noodles processing, dry-chips processing can generate good income if well organized in processing and marketing, as there is still a big market for the processed potato products. Surveys in Shandong, Sichuan and Inner Mongolia of China show that the whole village or township can become very specialized in potato processing, the whole village work on potato processing and make stable but higher income than other farmers without any post-harvest processing and more farmer labors, especially the young farmers, prefer to stay in their home village for the kind of self-employment to make more income by the product processing (Fuglie, 2003). The challenge for the small household or group household level processing is the pollution and poor quality of the products, the limited market capacity and seasonality.

6. Price volatility

Seasonality of production, perishability of the product, demand price inelasticity and scarcity of storage capacity are the main reasons of the high price volatility observed in developing nations. All of these added to the lack of reliable market information systems translate into high price risk for potato farmers. Potato production in developed countries of the northern hemisphere is very seasonal since about 90% of their production is harvested between September and November but their large storage capacity has been an efficient way of reducing price volatility.

Countries located in tropical and subtropical areas have greater variability of planting and harvesting seasons that reduces seasonality of supply but does not affect price volatility. Production contracts between farmers and industry have also helped price stabilization in developed nations but this has not been an efficient instrument to reduce price volatility in most developing countries. Reliable market information could help significantly to reduce the cycles of over or under supply but institutional weakness and scarcity of resources undermine the efforts. Moreover, a large number of small producers are difficult to reach with timely information and this asymmetric distribution of information tends to favor a few privileged farmers or middlemen. Definitely, price volatility has devastating effects on the small commercial producers with weak financial resources to weather periods of low market prices.

7. Market access

Processing and exports are market opportunities to expand potato production and stabilize prices. Nevertheless access of smallholders to the industrial production market has been quite limited because industry suppliers prefer to deal with a group number of large producers. In addition, most of frozen fries used by transnational fast-food corporations and franchises are imported from developed countries. The possibility of building local processing plants has been hampered by the low competitive advantage of local raw material that does not meet price expectations or quality standards. Exports of potatoes in-natura from developing countries to Europe or North America face severe phytosanitary barriers. Exclusion of smallholders from the specialized segments of the market may lead to a process of concentration of property that may force many farmers to go back to subsistence agriculture or look for alternative crops or, even worse, migrate to cities where employment opportunities are scarce.

8. Institutional weakness and public policies

Many of the technological and socio-economical limitations to potato production in developing countries have roots in inappropriate public policies and institutional weaknesses. In most developing countries, official policy gives little support to potato production and industry while cereals and export crops are often considered strategic for agricultural development and receive substantial support for research and development. Genetic and agronomic improvement of potatoes depend largely on public sector investments which have become scarce since the last decade. Meanwhile the local private sector has relied basically on imported varieties and foreign technology for production and industrialization. In many countries, however, the private sector has made heavy investments in basic seed production trying to compensate inefficiency at the public sector to supply them with quality stocks. It is expected that the opportunities emerging from the fast growth rate that the processing industry has shown in the last decade will foster specialization and private investment over the next decade. Strengthening mechanisms of supervision and control will be

required for the development of the local seed industry in most developing countries. Associations and vertical integration may be advantageous to reduce transaction costs and increase negotiating capacity of farmers.

9. Environmental hazards

Intensification of the potato crop and the increased international trade observed over the last decade as a result of specialization of potato agriculture and market globalization pose a considerable challenge to the agricultural sector of the developing world. Agrochemical-intensive agriculture may have deleterious effects on natural resources and overall environmental conditions. The utilization of high steep hillsides for seed production in the tropics and subtropics would lead to deforestation, soil erosion, siltation and chemical contamination of rivers and water streams and loss of water retention capacity of catchments. Insufficient rotation or monoculture in some areas have increased nematode population to levels that makes it impossible to produce without heavy applications of highly toxic chemical nematicides. The loss of potato biodiversity is linked to the narrowing of the genetic base resulting from breeding programs oriented to satisfy the demand of the largest and more profitable segments of the market. International trade of large volumes of ware and seed potatoes has facilitated dissemination of exotic pests and diseases to several production regions. Furthermore, the impact of the exclusion of smallholders from potato agriculture, by reducing income and employment opportunities of many rural families, could induce the vicious circle of poverty intimately associated to the degradation of national resources.

C. Potato post-harvest utilization

The issues related to potato post-harvest utilization and trade are more complex and controversial than for production, area, and yield. The information on this also is lacking and reliable. General trend is growth in utilization and greater importance is attached to processing than fresh consumption (CIP Lima, 2000; NPPB, 2000).

Potato is consumed in most Asian countries as food, industrial raw materials and livestock feed; however, human consumption of potatoes as staple food most common. Feed and industrial uses are less important, but becoming more important in some countries with rapid economic development such as China. In most countries, tubers or residues unfit for human consumption are allocated to these uses. The accurate data on potato consumption in the Asian countries is hard to obtain on disaggregated basis at the regional, national or provincial level, shifting of cropping partners, planting area, yield and processing.

An analysis of global utilization trends shows important changes in consumption patterns over time. There are two basic principles that have determined these changes. On the one hand it is known that as per-capita income goes up there is a tendency to

reduce consumption of starch-rice food and to increase demand for protein-rich foods such as meat, milk, fruits and vegetables although there are some exceptions to this rule; but this pattern has been quite consistent over time and across regions. The second principle is that populations tend to diversify consumption by incorporating new food to their traditional diet. Indeed it has been observed that per capita consumption of potatoes in industrialized countries with high per-capita income has declined as income has risen. Conversely, it has gone up in developing countries as a result of diversification of their traditional diet based on wheat, rice or corn. In the Andes, the original area of the potato, a drastic reduction in per-capita consumption of potato observed over the last decade was brought about by public policies that favored local production and consumption of cereals.

During the last four decades, important changes in the world and regional trade of potatoes have taken place. World potato exports have gone up from less than 1% in the early 1960s to almost 4% in the late 1990s with a growing participation of developing countries. Among the most important potato exporters there are the North African countries when sell their off-season production to Europe. In Latin America the major importers of potatoes are Brazil, Venezuela, Mexico and Cuba, whereas and the major exporters are Argentina, Colombia and Guatemala. In East and South-East Asia annual exports of fresh potatoes amount to 70,000 tons exceeding imports by approximately 30,000 tons. From the 1960s to the late 1980s potatoes were mostly traded in-natura but today there is a variety of processed potato products that are traded, such as frozen fries, starch, flakes and de-hydro. In the 1990s there has been an impressive growth of international trade of frozen fries in parallel with the global expansion of the transnational fast-food chains. Since 1987 to present, McDonalds Corporation has increased the total number of restaurants in the world from 10 to 30,000, and most of this expansion has taken place in the developing world. Other transnational and domestic fast-food chains have also experienced substantial expansion boosting demand for frozen fries. In the developing world, most of the frozen fries are imported from North America or Europe. In the case in Asia, hundreds of millions of US dollars are spent on imports of processed potato products mostly from North America. Local farmers in the developing Asian countries are yet to benefit much from this potato-processing industry.

D. Potato post-harvest technology

Post-harvest is one of the efficient approaches in the improvement of potato farmers' livelihood. (Yang, 2000) The actual situations in the rural areas of Asian developing countries indicate that the needs for low-cost technology to produce, process and add-value while maintaining quality of its products. Research on both technology and improvement in infrastructure is critical in reaching this goal. (Skerritt, 2001) With respect to the role of post-harvest technology in the development of Asian economies, Tsubota (1999) noted that post-harvest technologies become more complex along with economic development. Technologies are generally more

agricultural production and product-oriented during the early stages of economic development. In this phase, technologies are not sophisticated and post-harvest enterprises are small-scale, and post-harvest chains are short and simple. Technologies and systems become more complex with development, and at present, many Asian countries are somewhere in the middle (Tsubota, 1999). A broad range of potato products are processed and marketed mostly by small-scale producers or traders using less sophisticated technologies, while a few large enterprises use more advanced technologies in processing plants or treatment facilities to process produce for upstream markets.

In Asian developing countries, post-harvest processing of potato is the major practice for adding value to this crop either through traditional processing or modern technology. Potato processing varies greatly in scale and composition from country to country in Asia. Much of the processing is based on the expectations of increased demand driven by rise in the income level. Post-harvest technology is used for modern food and industrial products from potatoes, simple post-harvest technology is used for traditional consumption of potatoes in East and South-East Asian countries and China are fresh consumption and feed as mentioned. In the developing areas in China, the integration of traditional practice and modern technology also help both the farmers and the processing industries which tends to generate more jobs.

Processed potato products include noodles and vermicelli, flour, jams, preserved potatoes, which potato fries and chips can be processed using the traditional indigenous practices, varies from place to place. In the mountain areas, the traditional practice is the major way of keeping the potato as staple food for winter, women play key role in this work. This has been the way of life for the Indians in the Andes and the mountain people in South-West and North-West China for hundreds of years. The technologies used for the traditional practices are simple, in most case, are still by manual or facilitated by very simple machines.

Industrial processing with modern technology can be applied to potato starch processing, food processing, and manufacturing of alcohol, synthetic rubber, cellulose, rayon, perfume, glucose, amylose, and sugar syrup. New technology has developed to process potato into starch or modified starch for textile, foundry, iron-casting, electronic, paper-making, pharmaceutical, rubber and chemical industries.

There are direct and indirect benefits for potato farmers from new technology on potato processing. The direct benefits are linked to marketing their potato harvest to processors at relatively good price; indirect benefits would be updating the farming technology and potatoes themselves with good agronomic characteristics fit for the processing during the raw materials supply process. This will gradually help in improvements of the variety use, seed quality, field management, storage, among others. The case for Simplot in China is a good example. Simplot is one of the world's largest agri-business companies, supplying fresh potatoes for about half of the

company's US$3.5 billion annual revenues. As a major supplier of French fries sold by the world's two largest fast food chain stores - McDonald's and KFC. Simplot is the only foreign company to have localized potato growing in China. All the French fries provided to McDonald's restaurants in northern China are locally produced by 5,000 Chinese farmers in areas north of Beijing and processed by this joint venture company. These farmers are now working on 2,000 hectares of land, and the annual output reached 30,000 tons last year. The efforts of Simplot in China have helped local Chinese growers improve their infrastructure, farming techniques and steady increase in their income level. Under the contract between the growers and Simplot, the farmers should use designated potato seeds, chemical fertilizers, standardized irrigation facilities and adequate farming techniques to produce potatoes in line with the Company's requirement.

E. Potato post-harvest and rural employment

The development of an agro-processing of agricultural commodities can generate employment in several ways. First, there is employment in the processing industries themselves. Second, there is employment in wholesale and retail trade, bringing raw materials from farms to processors and finished products from processors to consumers. Third, agro-processing can generate more employment by increasing the demand for the agro-commodity. This stimulates more farm production than would have been the case without agro-processing, creating more farm work. Finally, expansion of agro-processing creates employment in related industries, such as suppliers of machinery and other inputs to the processing enterprises (Huang, 2003; Lin, 2003; Qin, 2002, Yang, 2000).

The amount of employment generated from agro-processing also depends on the size of enterprise. Large-scale enterprises typically use more mechanized, capital-intensive processing technology, which increases the amount of raw material processed per worker employed. Small-scale or household enterprises typically use more labor-intensive methods. For a given amount of raw material processed, the more labor-intensive enterprises will generate more employment, although each worker is less productive.

The accurate data in Asian countries on post-harvest and employment is fragmentary and hard to come by. From the data collected in China over the past years on agriculture business development and rural employment; the trend is positive between agro-business development and employment, this data on employment is not complete and it does not include the on-site employment (China Agriculture Yearbook, 1998, 1999, 2000, 2001, 2002).

The following case study by Keith Fuglie and his CIP colleagues in China may give you some ideas on the post-harvest sectors' employment in China. There are no officially published estimates of employment effects of potato and sweet potato

processing in China available. However, in 1999 and in 2002, CIP conducted formal and informal surveys of small, medium and large sweet potato processors in Shandong and Sichuan provinces, which included questions on employment and output. In Table 2.10 we have developed some rough estimates of employment effects of sweet potato starch and noodle processing drawing upon these surveys. These estimates suggest that the larger the scale of production the less the labor used per ton of sweet potato processed. However, the estimates of labor utilization of the large-scale enterprises are probably low, since they produce both starch and noodles as final products, where as the medium and small scale enterprises produced first starch and then made noodles from the starch. In general, noodle production is more labor-intensive. Of the 13.35 work days/ton of root processed by the medium-scale enterprises in Shandong, about 5 work days/ton was for starch processing and 8.35 work days for noodle processing from the starch. For the small-scale enterprises in Sichuan, about 8.6 work-days/ton was required to make starch, and about 12.6 work-days/ton was required to make the noodles from the starch, for a total employment of 21.2 work-days/ton of sweet potatoes transformed into noodles.

From the estimates in Table 2.10 and the estimates reported above of total sweet potato processed in China, it is possible to derive estimates of the aggregate effects of growth of starch and noodle processing on employment in processing enterprises in China. In Table 2.11 we have constructed some estimates of the aggregate employment in starch/noodle processing enterprises. We have assumed that all potato processing is done in large-scale enterprises, which have labor productivity equivalent to that of the large-scale sweet potato enterprise shown in Table 2.10. For sweet potatoes, we calculate the employment effects using the three levels of labor productivity for the three different sizes of enterprises. Since we have no data on market share of each scale of enterprise, the three estimates of employment effects are essentially upper-and lower-bound estimates of aggregate employment. The larger the share of total processing done by small-scale enterprises, the closer the employment effect will be to the upper bound estimate. If large-scale enterprises dominate processing, the employment effect would be closer to the lower-bound estimate.

The estimates in Table 2.11 suggest that sweet potato starch/noodle processing generated between 44.9 million work days and 143.16 million work days in 1997, depending on the scale of processing enterprises which accounted for the production. In terms of full-time employment equivalents, this amounts to between 150,000 and 480,000 full-time workers (at 300 work days per worker/year). For potatoes, assuming that all processing was done by large enterprises were created an employment estimate of 11.21 million work days or 37,000 full-time jobs in 1997.

These rough estimates of employment in potato and sweet potato processing enterprises in China do not include employment in wholesale and retail trade, input supply industries. Wholesale and retail trade and agricultural production tend to be

labor-intensive activities, so these effects are likely to be quite significant. (Keith Fuglie, 2003 draft)

F. Conclusions and recommendations

Potato is an important crop in feeding and improving the food security of many Asian countries in the future. Potato means many things to many people; in some cases, potato may mean the difference between subsistence and achieving better income; in others, potato may mean the difference between survival and starvation. In all instances, potato's potential to help improve food security and eradicate poverty will be important.

In Asia, faster economic growth would lead to less dependency on cereals and greater demand for potatoes in fresh and in processed forms. Potato can provide the basic needs: food, employment/income. Potato farmers in Asian countries can benefit from potato processing, but most of them are with small holdings, on marginal lands, and at the lower end of the economic scale. Hence technology and agricultural policy are important in providing assistance to the potato farmers to increase their benefits in income, employment and food security.

In China, higher income and increased urbanization have led to further increases in demand not only for meat, egg and milk, but also for processed potatoes. These will translate into greater use of potatoes as a source of starch for processed food, industrial materials, or as processing materials for fast food, which would generate higher income for potato farmers or processors at the farm and household level, and more employment in rural areas would also be improved.

The problems associated with technical weakness, inefficient marketing activities, lack of capital and poorly integrated production management are enormous which are difficult challenge faced by the developing countries in Asia. The data on post-harvest of potato and its relation with employment is fragmentary for Asian countries, but the general trend on agro-industry development and employment is clearly reflected in the data in the case of China. Another issue related to post-harvest in developing countries to generate more employment is to promote effective management in utilizing resources available rather than attempting to increase the level of sophisticated technology of the post-harvest industry. This will gradually prepare the developing countries to initiate enterprise development in the post-harvest sector.

Considering the actual situations in Asian countries and increasing demand for quality processed products of potatoes, the following recommendations are proposed:

- Improvement in research and technology development on potato processing variety, potato seed technology and seed system, potato ICM field

management, potato-harvest storage and adapted technology for post-harvest utilization of potatoes.

- Improvement in the technical support training for potato farmers and technicians to facilitate the technical elements in production to promote quality processing and continuous supply of raw materials. Training is critical component of the post-harvest technology extension which is also most appropriate means to improve the technical progress on potato processing. Training approach is complimentary to China's existing agriculture extension system.

- Improvement on market information accessibility for processing potato producers and for potato processors. The special requirements on both potato variety and the time schedule on processing raw materials supply are critical for efficient post-harvest utilization of potatoes, but in most cases in Asian countries, there is no efficient information channel for processing material supplier and potato post-harvest processors.

- Improvement on infrastructure to prepare for efficient post-harvest utilizations of potatoes. The main production areas of potatoes in Asian countries are in the high mountain areas, poor in infrastructure. Improvement in processing site on infrastructure and its accessibility to both potato production and to market areas will be beneficial for job security at seed supply units, produce units, storage units, transport units, processing units and marketing units.

- Development of favorable strategy at government policy level for potato post-harvest, taking full consideration of the balance among technology-sophistication, resource-efficiency and local employment.

In the long chain of potato post-harvest utilization, improvement in each part of the chain means improved efficiency, more income, and more employment.

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Appendix

Table 2.1. Major potato producers in the world, 2001

Country	Production / mt	Area / kha	Yield/ t/ha	Yield rank
China	64.1	4,202	15.2	7
Russia	34.5	3,335	10.3	9
India	25.0	1,341	18.6	5
Poland	20.4	1,194	20.4	4
USA	20.2	502	40.1	2
Ukraine	13.5	1,596	8.5	10
Germany	10.9	279	38.9	3
Belarus	8.7	725	12.0	8
The Netherlands	7.7	169	45.5	1
World	308.2	19,301	16.0	6

Source: FAO, 2002.

Table 2. 2. Potato production, growth rate in major potato producing countries in Asia, 2001

Country	Production / mt	Area / kha	Yield / t/ha	Production GR	Area GR	Yield GR
China	64.01	4,202	15.2	4.3	2.9	1.1
Indonesia	1.00	62.8	15.9	7.1	4.8	2.3
Japan	2.90	97.0	29.9	1.8-	2.0-	1.4
DPRK	1.90	18.8	10.0	3.8	4.2	0.4-
ROK	0.73	24.7	29.6	0.7	1.4-	2.7
Laos	0.035	5.3	6.6	2.5	2.1	0.4
Myanmar	0.319	29.3	0.9	4.1	0.7	3.3
Philippines	0.066	5.4	12.2	4.3	2.1	2.2
Thailand	0.0075	1.0	7.5	8.3	8.0	0.2
Viet Nam	0.316	28.0	11.3	5.1	5.7	0.7-

Source: FAO, 2002. Annual rate: 1961-1963 to 1999-2001. GR: growth rate, %.

Table 2.3. Potato production and growth rate in 1993 and its projection to 2020

Country/Region	Production in 1993 / mt	Production in 2020 / mt	1993-2020 (GR %)
China	42.5	87.8	2.72
India	16.3	43.3	3.67
Latin America	12.6	20.2	1.76
Developing world	94.3	194.0	2.71
Developed world	191.0	209.5	0.34
World	285.3	403.5	1.29

Source: IFPRI / CIP, 2000; GR%: growth rate, %.

Table 2.4. Potato consumption, growth rate in 1993 and its projection to 2020

Country/Region	Kg/per capita (1993)	Kg/per capita (2020)	Growth rate, %
China	14	20	42
India	13	21	61
Africa, Sub Sahara	3	3	-
Latin America	22	24	9
Developing world	13	16	23
Developed world	75	77	3
World	27	27	-

Source: CIP/IFPRI, 2000

Table 2.5. Imports of frozen potato fries into ESCAP countries, 2000

Country	K metric ton
Brunei	0.5
China	98.1
Indonesia	10.4
Japan	273.0
ROK	40.4
Malaysia	21.4
Philippines	34.6
Singapore	15.5
Thailand	9.5

Source: FAO data, 2002.

Table 2.6. Usage and consumption of worldwide potatoes, 1994-1996

Country/Area	Usage (%)					Consume Kg/person /year
	food	feed	potato	produce	others	
Asia (n=37)	53	18	7	13	9	14-15
China	36	31	6	22	5	14
India	73	0	10	0	17	14
Turkey	81	0	9	0	10	60
Iran	85	0	5	0	10	39
Bangladesh	81	0	9	0	10	10
Africa (n=33)	77	1	11	0	11	8
Egypt	74	0	12	0	14	21
South Africa	75	10	5	6	5	26
Algeria	82	0	8	1	10	33
Morocco	76	2	11	0	11	29
Uganda	68	0	12	0	20	13

Latin America	77	3	9	1	11	24
Peru	68	0	11	1	20	63
Colombia	71	10	6	0	12	56
Brazil	79	0	12	1	8	14
Bolivia	60	7	26	0	8	54
Argentina	85	0	4	1	10	52
Europe (n=38)	45	25	15	7	7	86
Russia	48	23	20	5	4	121
Ukraine	39	29	22	2	8	129
Poland	21	48	13	4	14	136
Holland	29	14	8	47	3	87
German	59	9	7	14	11	79
North America (n=2)	75	5	7	6	7	63
U.S.A.	32	1	7	60	0	61
World (n=148)	54	19	12	8	8	28
Development country	51	21	14	7	7	74
Developing country	58	15	8	10	9	14

CIP Potato Fact: A compendium of key figures and analysis for 32 important potato producing countries; n stands for the number of countries included in the statistic.

Table 2.7. Trading of worldwide potatoes, 1999

Country /Area	Export of potatoes		Import of potatoes		Export-- Import	
	Sum (ton)	Price (KUSD)	Sume (ton)	Price (KUSD)	Sume (ton)	Price (KUSD)
Occident	5,386,382	1,272,523	5,019,858	1,247,099	366,524	25,424
Asia	801,466	179,654	723,112	198,753	78,354	-19,099
Africa	390,254	85,871	378,530	164,666	11,724	-78,795
East Europe	213,565	17,114	160,464	35,121	53,101	-18,007
South America	49,025	9,289	1,363,812	115,141	-1,314,787	-150,852
Holland	1,203,674	383,266	1,386,838	194,083	-183,164	189,183
Canada	525,890	115,287	219,102	59,411	306,788	55,876
U.S.A.	294,085	92,411	418,862	98,251	-124,777	-5,840
Pakistan	121,279	18,565	17,215	1,074	104,064	17,491
China	74,964	11,652	20,345	7,482	54,619	4,170
Turkey	64,607	14,510	24,298	11,381	40,309	3,129
India	38,000	4,900	61	4	37,939	4,896
Indonesia	32,403	5,892	11,038	5,797	21,365	95
Poland	30,781	18,903	24,542	5,410	6,239	13,493
Russia	9,284	1,606	204,285	25,160	-195,001	-23,554
Kazakhstan	3,539	652	22,495	2,104	-18,956	-1,452
Japan	261	473	8	3	253	470

Source: FAO database.

Table 2．8. Trading of worldwide frozen potatoes, 1999

Country /Area	Export of frozen potatoes		Import of frozen potatoes		Export-Import	
	Sum (ton)	Price (KUSD)	Sum (ton)	Price (KUSD)	Sum (ton)	Price (KSD)
Occident	1,530,129	1,168,522	1,517,979	1,230,107	12,150	-61,585
East Europe	34,933	21,275	67,016	34,867	-32,083	-13,592
Asia	27,810	21,990	490,402	435,088	-462,592	-413,098
Africa	14,754	6,541	10,999	7,471	3,755	-930
South America	4,599	2,803	57,325	51,619	-52,726	-48,816
Holland	897,203	683,980	73,510	52,370	823,693	631,610
Canada	576,416	383,097	20,179	16,415	556,237	366,682
U.S.A.	491,369	361,059	472,368	316,296	19,001	44,763
Poland	30,781	18,903	4,599	2,803	26,182	16,100
China	19,917	15,715	81,088	60,873	-61,091	-45,158
India	1,003	314	359	333	644	-19
Turkey	791	613	2,170	1,526	-1,379	-913
Malaysia	307	508	20,358	15,316	-20,051	-14,808
Indonesia	117	285	6,480	4,205	-6,363	-3,920
Japan	86	296	281,191	273,620	-281,105	-273,324
Russia	4	9	91,509	22,015	-91,505	-22,006

Source: FAO database.

Table 2．9. Agro-enterprise, its employment and production value, 1998-2002

Year	Number of Factories	Number of Jobs	Renminbi (10,000)
1998	9,074,974	91,582,810	899,005,978
1999	20,039,353	125,365,458	966,936,561
2000	20,708,863	127,040,877	1,084,260,687
2001	20,846,637	128,195,720	1,161,502,745
2002	21,155,389	130,855,754	1,260,468,793

China Agriculture Year Book, 1998-2002.

Table 2.10. Employment effects of sweet potato starch and noodle processing in China by scale of enterprise

Scale of production	Employment	Operations
Large – Shandong 72,000 ton/year	6.65 work days/ton sp root	300 days/year 1,600 workers
Medium – Shandong 240 ton/year	13.35 work days/ton sp root	40 days/year 80 workers
Small – Sichuan 0.4 ton/year	21.20 work days/ton sp root	7 days/year 5-10 workers

Note: Sweet potato (sp) root measured in dry weight basis (fresh weight divided by 5). Scale of production is tons of starch/noodles produced per year.

Table 2.11. Aggregate employment in sweet potato and potato starch / noodle processing enterprises in China, 1997

Scale of enterprise	Sweet potato Total processed = 6.753 million tons	Potato Total processed = 1.685 million tons
Large	44.9 million work days	11.21 million work days
Medium	90.15 million work days	-
Small	143.16 million work days	-