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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

A COMPILATION OF BASELINE STUDIES FOR THE DEVELOPMENT OF TECHNICAL ASSISTANCE PROJECTS ON THE REDUCTION OF POSTHARVEST LOSSES IN EXPORTING AND IMPORTING COUNTRIES

The Cases of Cambodia, Indonesia, Laos, Philippines, Thailand and Vietnam

United Nations Industrial Development Organization (UNIDO)
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1 Executive Summary

Food security is a major concern in the world. In view of an increasing global population, coupled with scarce and dwindling natural resources and climate change, the need to provide sufficient food – both in terms of quantity and quality – is an urgent matter. Several strategies have been devised to address this concern, among them, the reduction of postharvest losses (PHL) along the agro-value chain. This strategy has the potential to significantly increase food availability without having to intensify production, thereby avoiding further pressures on resources such as land and water.

The postharvest system consists of a set of operations, covering the chain from harvest, through primary and final processing, transport and storage, up to final consumption. An efficient postharvest system aims to minimize losses and maintain product quality until reaching the final consumer. But as urbanization and changes in incomes and diet continue, supplying food that meets increasingly sophisticated market demand is challenging.

Despite the regions' enormous capacity to produce food, Asia and the Pacific are home to 64 percent of the world's people living with food insecurity. A certain amount of loss along the agro-value chain is inevitable until the product reaches the consumer. But significantly, it has been observed that current PHL in developing countries in Asia range from 10 to 30 percent, compared to only 6 to 10 percent in developed countries, such as the USA, Japan and European countries. As the following country analyses will illustrate, losses along the postharvest chain of up to 65 percent have been recorded (see papaya production in the Philippines). Against the background of widespread food insecurity and poverty (especially among farm households), these high PHL waste valuable resources and contribute to humanitarian, socio-economic, developmental and political challenges.

Baseline studies were therefore conducted to assess the extent and nature of PHL, and to support the development of technical assistance projects on the reduction of PHL. Six countries in Asia, i.e. Cambodia, Indonesia, Laos, the Philippines, Thailand and Vietnam, were selected for an in-depth analysis of postharvest chains. The studies cover a range of agricultural products and value chains, i.e. rice and maize (in all six countries), cassava (in all countries but the Philippines), fishery (in Cambodia and the Philippines), coffee as well as a selection of fruits and vegetables (in the Philippines).Besides identifying the points and degree of losses along the chains, the analyses included assessing current harvesting, processing, storing and transporting technologies and the existing support framework in the individual countries and sectors.

The following report compiles the individual studies collected from the six countries and presents their findings and recommendations, which create the background for clearly focused follow-up projects that address the needs identified at the respective country levels and include intra-regional cooperation and exchange, thereby creating impact at the regional level. The findings and recommendations are thus expected to be beneficial for policymakers and stakeholders of the whole system of the commodity supply and value chain, especially farmers.

1.1 Study Objectives and Methodology

The baseline studies take a holistic and integrated value chain approach, which is of necessity as PHL may occur in various parts of the chain and may result from weaknesses in the enabling environment, including factors such as research and development, information services, public and private investments (policy, legislation, infrastructure, etc.), and training and capacity building. The studies therefore identify the political, economic and technological framework governing selected agricultural and agro-industry sectors.

The specific objectives for the baseline studies on PHL are as follows:

1. Identification of the points of losses and quantification of losses at the different stages
2. In-depth analysis of the value chain from farm to retail
3. Description of postharvest technologies currently in use, their advantages and drawbacks
4. Identification of support institutions assisting in technology transfer and adaptation, and description of their role and set up
5. Identification and description of the existing support framework for the different sectors, both government and private sectors
6. Development of recommendations derived from the assessment of the PHL studies

Study teams in the six countries came from the Faculty of Agro-Industry at the Royal University of Agriculture in Cambodia; the Faculty of Agricultural Engineering and Technology, Institut Pertanian Bogor in Indonesia; the National Agriculture and Forestry Research Institute of the Ministry of Agriculture and Forestry in Laos; the College of Agriculture at the University of the Philippines Los Banos; the National Food Institute in Thailand and the Institute of Agricultural Engineering and Postharvest Technology in Vietnam.

In each case, the study team conducted an initial desk study in 2011/2012, which included a review of previous studies on postharvest operations and revealed policy, economic and technical aspects of the postharvest systems. Subsequently, primary data was collected through surveys and field observation. For the survey, respondents, such as farmers/farmer groups, owners of agricultural machinery, transporters, collectors/traders and processors were selected by purposive sampling to cover the whole supply chain. They were interviewed by team members with the help of structured questionnaires to provide information on PHL. Furthermore, Focus Group Discussions (FGD) were organized by coordination with local agricultural authorities. And interviews were conducted with Ministries and Provincial Departments of Agriculture, financial institutions, the agricultural machinery industry and other institutions. In addition to survey and interviews, study teams made observations on postharvest chains and losses, technology and machinery currently used for handling and operations, technology transfer, sector support systems, current problems and development needs.

1.2 Findings and Recommendations

Studies of the postharvest system in Cambodia, Indonesia, Laos, Philippines, Thailand and Vietnam collected information on PHL for various durables and perishables in the individual countries. Based on the challenges identified in the six studies, the following tables summarize the findings and recommendations: first, the data on PHL is presented, as identified by the surveys conducted for the baseline studies. Second,country recommendations are detailed by product, i.e. (1) rice, (2) maize, (3) cassava, (4) fishery, (5) fruits and vegetables and (6) coffee.

As the analyses in Chapters 2 to 7 illustrate, postharvest value chains differ by product and country. While the typical rice farm in Thailand, for instance, uses a rice harvester, mechanically threshes and has shifted the drying process almost entirely to rice milling manufacturers, in other countries covered by the baseline studies farmers continue to manually harvest, thresh and sundry their rice production. Agro-value chains are found to differ even across regions within the same country: while in South Sulawesi (Indonesia) farmers use stripper harvesters and power threshers for rice harvesting, farmers in West Java (also Indonesia) continue to use manual harvesting and threshing practices, as most farmers do across Laos, for instance. Requirements for improving the postharvest system and reducing PHL within a single country can therefore be markedly different.

However, there are similarities in challenges faced too, based on shared climatic conditions, cultural or institutional traditions or levels of economic development. At times, all of the sectors studied in a country require similar improvements and investment to reduce PHL. For instance, it has been found that all sectors studied in the Philippines would benefit from a further development of service facilities and village level processing facilities, operated by farming organizations/cooperatives. In other cases, required improvements are product specific and cut across country boundaries, such as the provision of better drying facilities for grains or efficient cooling equipment in the fishery sector. Other recommended actions again would benefit the postharvest system of all studied countries, such as improved storage facilities or enhanced capacity building in operation, maintenance and repair of existing farm machinery and postharvest technologies for growers and/or farmer intermediaries.

Noticeable too, in some countries the selected products and their postharvest chains enjoy extensive institutional support in form of policies, strategic road maps, dedicated research and support groups/agencies and availability of investment finance (e.g. in Indonesia, Philippines and Thailand). In other countries such a support system has not yet been introduced or remains in the initial stages to date (see the maize and cassava sectors in Cambodia and Laos) – often due to financial constraints and lack of expertise. In addition, the creation of a supporting environment may be strongly encouraged by government policies, initiatives and targets (e.g. Vietnam), whereas in other countries (or individual regions or sectors), the private sector plays the main driving force for promoting a better postharvest handling system (e.g. in the surveyed areas for maize in Laos).

Table 1-1. PHL, as identified in the surveys of the baseline studies

	Cambodia	Indonesia	Laos	Philippines	Thailand	Vietnam
Rice	10-13% (dry/wet season)	4-13% (mechanical/ manual operation	20%	17%	5-10% (at harvest alone)	9-17% 12% (nationwide)
Maize	*No data**	13% max	5-15%	13%	5-10% (at harvest alone)	10-13% 18-19% (nationwide)
Cassava	16-73%	3-53%	15-30%	*NA*	5-10% (at harvest alone)	9-10% (in favorable weather)
Coffee	-**	-	-	15-20%	-	-
Pineapple	-	-	-	53%	-	-
Papaya	-	-	-	64%	-	-
Eggplant	-	-	-	53%	-	-
Tomato	-	-	-	39%	-	-
Bitter gourd	-	-	-	49%	-	-
Fishery	*No data*	-	-	40%	-	-

*no data provided in baseline study
** not covered by baseline study.

Table 1-2. Country study recommendations – Rice

Cambodia	Indonesia
Support good practice of seed selection Improve postharvest technology application by providing training in operation, repair and maintenance for e.g. farmers, millers and owners/users of power tillers, tractors, threshers, combine harvesters, drying ovens etc. Improve access and conditions of loans for traders and millers as financing is a serious constraint for business development, increasing milling capacity and improving storage and drying facilities Implement and strengthen existing policy, regulation and standards related to rice postharvest operation	Karawang, West Java: increase use of flatbed dryers to improve quality of dried paddy at farmer and small rice mill unit (RMU) level; shift from manual harvesting and threshing to use of reaper and power threshers Bone, South Sulawesi: construct temporary storages with appropriate design in market area Implement fully automatic rice milling machineries at large RMUs to compete with imported premium rice
Laos	**Philippines**
Shift from manual harvesting and threshing to appropriate mechanisation and use of technologies Establish a national postharvest team with key members from public and private sectors (e.g. as a Learning Alliance) Provide capacity building for farmer intermediaries (i.e. the Learning Alliance members) in the use of postharvest technologies Implement good drying operations; advocate for decision makers (awareness and support) to re-start dryer technology transfer and provide appropriate policy for promoting and engaging with more manufacturers Introduce safe storage and make hermetic storage systems locally available	Provide efficient equipment/machineries to producers: e.g. dryers and moisture meters; dryers are particularly important where harvesting coincides with rainy days Develop service facilities and village level processing facilities (e.g. operated by farming organizations/cooperatives), which can also perform product marketing functions Increase capability building of stakeholders in supply chain, specifically farmers, e.g. with trainings, seminars and tech-demos for proper methods/technologies in postharvest handling; strengthen extension services of lower government units Enhance postharvest research and development efforts to develop new affordable, sustainable and eco-friendly technologies and techniques to minimize PHL
Thailand	**Vietnam**
Introduce a high quality standard to encourage farmers to change farm management, including care for plantation and selection of harvest time Consolidate a national training course on postharvest practice, with practical use and easy access to training documents/materials for growers Encourage harvesting operators, who play increasingly major role in high harvesting yield Improve drying process, raise efforts by supporting units, government and non-governmental organizations to reduce sundry costs for growers	Select and adopt high quality varieties, e.g. with high yield and good resistance against pests, lodging, grain falling, etc. Conduct research and tests on agricultural machines, equipment and facilities, especially reapers/harvesters, dryers, stockpiles etc. Organise training courses on farm technologies, operation of farm machinery and equipment, especially rice reapers and combine harvesters for farm operators Transfer technologies and support investment in grain drying for intensive rice production areas Research and transfer removable storage facilities convenient for farm households in shortage of space;equip households with simple and low-cost facilities

Table 1-3. Country study recommendations – Maize

Cambodia	Indonesia
Harvesting only when maize fully matured and prepare clean containers for harvested maize Improve drying practices: dry on clean concrete floor, use solar dryers and/or electric dryers and control final moisture depending on intended storage time Greater attention to the threshing process Proper labeling and branding of the produce, and fixing of bag net weight Improving storage by e.g. using clean and dry warehouse, building elevated storehouses with roof, allocating space for ventilation and implementing proper pest control	Encourage use of power shellers and mechanical dryers among farmers, collecting traders and warehouses; facilitated by provision of guarantee credits for Gapoktan and UPJA by central and regional government Reinforced efforts by extension workers to inform farmers in Central Lampung on balancing cropping between maize and cassava
Laos	**Philippines**
Shift from manual harvesting and threshing to appropriate mechanisation and use of technologies Raise efforts by extension workers informing farmers on improvements in the cropping systems Encourage use of appropriate sheller and mechanical dryer among farmers, groups of farmers, collecting traders and warehouses Improve sanitary and phytosanitary measures to facilitate the export of maize Obtaincredit for investment in power shellers and mechanical dryers for farmer groups (e.g. from Agricultural Development Bank)	Provide efficient equipment/machineries to producers: e.g. dryers, moisture meters and dehullers; dryers are particularly important where harvesting coincides with rainy days Develop service facilities and village level processing facilities (e.g. operated by farming organizations/cooperatives), which can also perform product marketing functions Increase capability building of various stakeholders in the supply chain, specifically addressing farmers, e.g. with trainings, seminars and tech-demos for proper methods/technologies in postharvest handling; strengthen extension services of lower government units Enhance postharvest research and development efforts to develop new affordable, sustainable and eco-friendly technologies and techniques to minimize PHL
Thailand	**Vietnam**
Encourage growers' groups Reduce sundry costs for growers, support development of cooperative sundry floors Consolidate a national training course on postharvest practice, with practical use and easy access to training documents/materials for growers Training on good practice in maize storage at grower and further processing stages	Select and adopt high quality varieties, e.g. with high yield and good resistance against pests, lodging, grain falling, etc. Conduct research and tests on agricultural machines, equipment and facilities, especially reapers/harvesters, dryers, stockpiles etc. Organise training courses on farm technologies, operation of farm machinery and equipment Research and transfer removable storage facilities convenient for farm households in shortage of space; equip households with simple and low-cost facilities, e.g. wooden/tin containers

Table 1-4. Country study recommendations – Cassava

Cambodia	Indonesia
Introduce labor saving agricultural mechanization appropriate for cassava harvesting conditions Improve yields by providing better cassava varieties Encourage cassava processing, which is severely limited due to lack of techniques, market access and financial support Increase investment in postharvest activities, e.g. drying and storage facilities, by public and private actors Capacity building, product development and manufacturing of processing technologies and transfer to target beneficiaries and development of clusters to supply identified markets Implement government policies effectively to produce beneficial effects of agricultural research and technology improvements	Central Lampung: no recommendations where large scale tapioca industries purchase most of the fresh cassava roots Pacitan: encourage development of 100 ha pilot project for cassava production, establishment of small tapioca industries and their use of machinery
Laos	**Philippines**
Shift from manual harvesting to appropriate mechanisation and use of technologies Train farmers to have better understanding of how losses occur and how they can be prevented, e.g. educate on importance of swift postharvest transport Carry out research on soil improvement and sustainable production systems Further in-depth study of PHL in the cassava handling chain to improve the understanding of process value and technology More support from government policy to develop appropriate postharvest technology	*Not studied*
Thailand	**Vietnam**
Encourage use of certified cassava varieties Introduce a clean cassava standard, which would provide incentive for better postharvest practice by farmers Consolidate a national training course on postharvest practice, with practical use and easy access to training documents/materials for growers Introduce new, high yield harvesting machines that are easy to use, leave less roots in the ground and require fewer workers for operation Improve drying practices to reduce loss through wind and fermentation; reduce sundry costs for growers	Select and adopt high quality varieties, e.g. with high yield and starch content and good resistance against pests Conduct research and tests on agricultural machines, equipment and facilities, e.g. for drying operations Organise training courses on farm technologies, operation of farm machinery and equipment Research and transfer removable storage facilities convenient for farm households in shortage of space; equip households with simple and low-cost facilities, e.g. wooden/tin containers

Table 1-5. Country study recommendations – Fishery

Cambodia	Philippines
Upgrade the entire fish postharvest handling system, especially the practices of food processors, to improve sanitation conditions and quality of processed fish	Provide efficient icing or chilling equipment for fish after harvest until the product reaches consumers Increase capability building of various stakeholders in the supply chain, specifically addressing fisherfolks, e.g. with trainings, seminars and tech-demos for proper methods/technologies in production and postharvest handling; strengthen extension services of lower government units Develop service facilities and village level processing facilities (e.g. operated by farming organizations/cooperatives), which can also perform product marketing functions Continue to develop cold chain system and change attitude of consumers to accept chilled and/or frozen commodities Enhance postharvest research and development efforts to develop new affordable, sustainable and eco-friendly technologies and techniques to minimize PHL

Production and postharvest operations for fruits and vegetables (pineapple,papaya, eggplant,tomato and bitter gourd) were only analyzed in the Philippines case study.It was found that perishables, such as fruits and vegetables, tended to have higher losses than durables (rice, maize and coffee) as they have a high water content and are thus more susceptible to handling injuries, loss of moisture and spoilage.The largest share of PHL is borne by the farmer and retailer, occurring mainly during sorting at farm level and at the end of the supply chain at the retailer's.

Table 1-6. Country study recommendations – Fruits & vegetables

Philippines
Provide efficient equipment/machineries to producers, e.g. chillers and ice making machines, to reduce moisture loss and delay development of diseases during transport
Increase capability building of various stakeholders in the supply chain, e.g. trainings, seminars and tech-demos for proper methods/technologies in postharvest handling; strengthen extension services of lower government units
Develop service facilities and village level processing facilities(e.g. operated by farming organizations/cooperatives), which can also perform product marketing functions
Provide tramlines, especially in hilly/mountainous areas where vegetables are produced, to facilitate transport and reduce costs
Advocate changes in policy of shipping lines for agricultural produce, e.g. charging shipper by weight not container
Continue to develop cold chain system and change attitude of consumers to accept chilled and/or frozen commodities
Enhance postharvest research and development efforts to develop new affordable, sustainable and eco-friendly technologies and techniques to minimize PHL

Production and postharvest operation of coffee was again only analyzed in the Philippines study. As with other durables, critical factors are harvesting and drying operations. Especially the latter is an important activity, which greatly influences the recovery both in quantity and quality during the later stage of milling.

Table 1-7. Country study recommendation – Coffee

Philippines
Provide efficient equipment/machineries to producers, e.g. depulpers, dryers
Increase capability building of various stakeholders in the supply chain, especially growers, e.g. with trainings, seminars and tech-demos for proper methods/technologies in postharvest handling; strengthen extension services of lower government units
Develop service facilities and village level processing facilities (e.g. operated by farming organizations/cooperatives), which can also perform product marketing functions
Enhance postharvest research and development efforts to develop new affordable, sustainable and eco-friendly technologies and techniques to minimize PHL

2 Cambodia

In 2010, Cambodia produced 8.25 million tons of paddy. For about 80 percent of Cambodians rice production is the main source of income. However, poor postharvest practices lead to large losses along the chain from production to consumption.There is a pressing need therefore to map existing supply chains and document deficiencies in order to identify entry points for research and development. A supply chain approach has become critical to improving production and marketing efficiencies and increasing profitability and market competitiveness of local products. This is of particular importance in the face of trade liberalization and market globalization, which have a great impact on Cambodia.

In 2011 the Faculty of Agro-Industry at the Royal University of Agriculture in Phnom Penh conducted a study on the postharvest handling system and losses of rice and cassava in Cambodia. The source of data for this study was obtained from primary and secondary data. Various working papers, reports and journal articleson the selected crops were reviewed, and data collected through field observation and interviews. Battambang, Pursat and Takeo Provinces were selected for studying the rice postharvest chain, Pailin and Kampong Cham Provinces focused on cassava. Farmers, owners of harvesters/threshers, transporters, collectors/traders, millers and exporters, as well as key staff at the Provincial Department of Agriculture in Battambang and Pailin were interviewed. Further investigations took place in Kandal, Siem Reap, Kampong Thom and Kampong Speu Provinces to provide insights into the different practices and losses for the selected crops.Throughout, respondents were asked to estimate the losses. The averages at each point of the supply chain were calculated and will be presentedin the following.

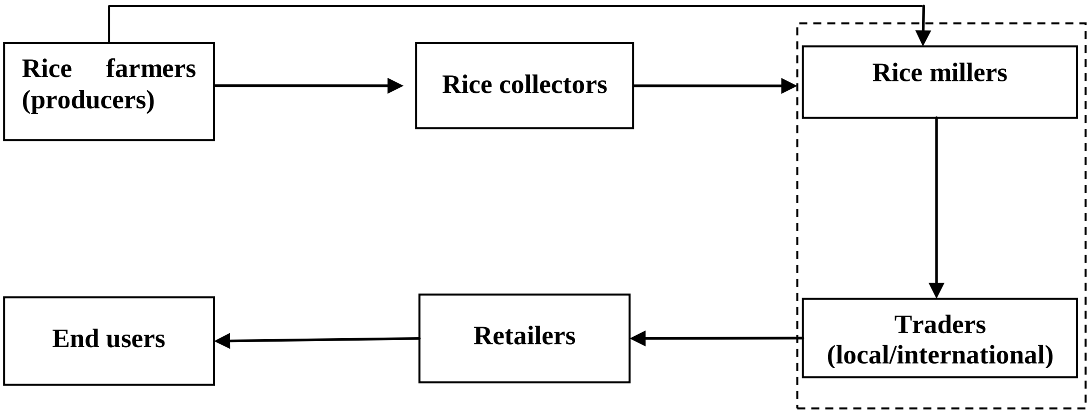
An earlier study on “Need Assessment for Technology Adaptation in Agro-Industrial Processing” (August 2010) analysed various postharvest chains in Cambodia, including pepper of memot, coffee bean, cashew nut, maize, fish products and silk. This study also collected primary and secondary data on the production of the selected crops. It will provide the information for the discussion of the maize and fishery sectors below.

2.1 Rice

For more than 80 percent of Cambodiansrice is the main staple food and rice productionthe main source of income. Rice plays an integral role in the economy of rural Cambodia. According to MAFF (2010), total cultivated area for rice production has considerably increased from 2.5 million ha in 2006 to 2.8 million ha in 2010 and production from 6.26 million tons in 2006 to about 8.25 million tons of paddy in 2010. However, the rice sector faces a number of notable constraints along the chain from production to consumer. Among them, inadequate and improper postharvest practices, which contributeto the poor quality perception of domestic products.

There are many actors along the rice chain (Figure 2-1), including rice producers, rice collectors, rice millers and traders (who are mostly one actor), retailers and end consumers.Generally, farmers in Cambodia grow rice only once a year, while some places with adequate irrigation systems or water sources can produce rice two times or more per year. There are two seasons of rice production, dry and wet or rainy season, of which the latter is the most common accounting for 86 percent of total rice production.

Figure 2-1. Overview of a simple rice supply chain in Cambodia



Conventional agriculture still dominates as the availability of technology is limited by the financial means of farmers. Farmers can harvest manually or by reaper, which is commonly practiced for wet rice season. A conventional toolfor harvesting is the sickle, but this method is labor intensive and time consuming. Using the reaper is better and faster, but it is not easily operated in lowland rice fields. A technology commonly used for dry season rice is the combined harvester, which harvests, threshes and cleans. Harvest takes thereby less time and, because threshing and cleaning is included in the operation, paddy rice harvested by combine harvester can be dried or sold directly through a collector/trader. In contrast, harvesting by reaper or by hand will require other operations, such as threshing and cleaning, before the paddy rice can be dried or sold. In case threshing is done manually, cleaning must be done with conventional tools as well (Picture 2-1).

Picture 2-1. Conventional tools for harvesting and cleaning

Picture 2-2. Modern tools for rice harvesting in Pursat Province

After harvest, the paddy rice is generally transported to the threshing area/machine or to the drying area, followed by storage activities before undergoing milling to produce milled rice for consumption. Transportation means include ox carts or power tillers. The majority of farmers sell their paddy rice immediately to rice collectors. Very few farmers store paddy rice until the peak price period. The collectors transport the paddy rice by small trucks to millers,who have a larger space to store paddy rice. Some paddy rice collectors act as collectors, millers, traders and even retailers at the same time. Due to limited financial resources, the collectors handling volume is generally small, but they are the direct link to producers.

Picture 2-3. Transportation practice in Pursat Province

Sun drying is the only drying method used by Cambodian farmers. Farmers lay rice on a mat on the ground. Rice millers also use the sun drying method, but the rice is put on concrete ground instead. The solar drying system is being introduced in Cambodia, but it is still very limited. Recently, a modern miller has established his own drying oven or warehouse in order to produce quality rice for export. Those drying practices are mostly seen in Battambang Province, where a large number of rice fields are located.

Picture 2-4. Drying practice of rice: in village, along the roadand in modern drying oven/warehouse

In those cases where farmers store their paddy rice, it is usually inopen storage inside the barn (Picture 2-5). In a modern system, storage is combined with the drying houseat the rice miller and trader. This kind of system is costly, but temperature and relative humidity are controlled and it is thus very efficient to maintain rice quality and prolong the shelf life before milling.

Millers are usually the main actors along the postharvest chain, acting also as traders who sell the rice to retailers. Producers sometimes store their rice at the millers', having to sell the rice to them at any time or price. Small milling is generally found at village level for daily consumption of villagers. In a remote area hand milling is practiced, but this is rare. The operation of medium size millers has not changed over the past two decades, but recently some new modern mills have been installed, which aim at rice export, especially to Europe.

Apart from millers/traders, there are some traders, particularly international traders, who buy milled rice or paddy rice from millers for distribution without owning milling facilities. They work with local rice facilitators (rice commissioners). At other times, traders buy paddy rice from local collectors to sell to millers/traders in neighboring countries (Vietnam or Thailand), or international companies contact millers directly.

Picture 2-5. Storage practice in Battambang Province

Picture 2-6. Modern milling and storage in Battambang

Rice retailers in Cambodia are usually rice shops, which specialize in both wholesale procurement and sales of rice, and market stalls that sell limited varieties of rice in the market. There are also grocery stores and a few supermarkets that sell milled rice.

Losses occur at every stage of the chain from harvest to retail (see Table 2-1):Selected farmers estimate that their losses during harvest amount to approximately three percent. The main causes are rodents and poor operation management of harvesters (Picture 2-7). At transport, losses occur when the rice bundles are carried by oxcart or power tiller to the home and threshing area, and when it is transported from harvesting area/storage to selling store or trader (Picture 2-8). During threshing rice can spill over the mat used for threshing or the grains cannot be separated from the straw. Higher moisture content of rice results in a higher loss.Average losses ranged from 1.4 to 2 percent for dry and wet season rice, accordingly.

Picture 2-7. Loss at harvesting: Spillage from harvesting device in Pursat Province

Picture 2-8. Losses during transportation in Pursat Province

During drying, chickens are the most common cause for loss. In addition, there is weight loss due to drying. Losses are estimated at an average of 1.4 percent. At rice millers, it was slightly below, at around one and 1.5 percent for sun drying and oven drying, respectively. Losses at the milling stage can be intentional, where the miller steals milled rice from the paddy rice owner, or unintentional, caused by technological errors,spillage during milling, rice being attached to the roller and low quality of paddy rice. It was estimated by the millers that losses during milling are about 0.1 to 10 percent. Milling loss is heavily dependent on the quality and the capacity of the milling machine, the requirement of rice polishing level and miller skills. Generally, the recovery rate is at 64 percent of milled rice for domestic consumption and below that for export rice. The low recovery rate is mainly caused by the absence of a quality market and of a contract between millers and farmers.

Storage loss at farm level depends on the facility, but it is estimated to amount to 1.6 and 2.7 percent for dry and wet season rice, respectively.Loss in storage at the miller was estimated at 2 to 5 percent for paddy rice and 0.1 percent for milled rice. The main reasons for storage loss include damage by rodents, insects and fungus, as well as weight loss.

Picture 2-9. Loss at storage: punctured sacs and bird damage

Table 2-1. PHL estimates for dry and wet season rice

Postharvest operation stages	Percentage of Losses (%)					
	Dry season rice (N=21)			Wet season rice (N=31)		
	Min	Max	Average	Min	Max	Average
Harvesting	1	5	2.98	1	10	3.01
Bundle drying	0.5	2.5	1.29	0.3	3	1.55
Transportation	0.5	4	1.64	0.2	5	1.79
Threshing	0.3	3	1.35	0.2	6	2.01
Drying (sun drying)	0.1	2	1.40	0.1	4	1.42
Storage	0.5	3	1.57	0.5	8	2.69
Total	**6.5**	**14**	**10.08**	**3**	**28**	**12.47**

Source: Survey in Battambang, Pursat and Takeo Province, March-May 2011

In terms of institutional support, there are three technical organizations within MAFF that are relevant to Cambodia's postharvest system for rice and other products below. The Department of Rice has direct responsibility for the rice production system. The Department of Agro-Industry supports all activities related to postharvest technology in terms of service provision and quality and safety management of all agricultural products. The Department of Agricultural Engineering supports machinery technologies. Other organizations under MAFF, such as the Department of International Relations and the Department of Agricultural Extension also work in the field of the rice postharvest system, depending on availabilities of funds.

Furthermore, the general Department of Industry, MIME, plays an important role for overseeing the milling industry of Cambodia and promoting effective and efficient implementation related to food processing.Agricultural academic institutions share knowledge on postharvest issues and provide up to date information to all of the above institutions.

Another major contributor to rice technology and industry development in Cambodia is Cambodia Agricultural Research Development Institute (CARDI). CARDI continues to develop the rice sector by working on seed production and breeding varieties. Many varieties have been bred and improved to increase productivity without compromising grain quality and to meet domestic and export demand.

In addition to this, there is collaboration with different donors, who have been working to improve the postharvest system in Cambodia (MAFF, 2011), including:

- CAVAC, an Australian funded value chain program by MAFF and MoWRAM that operates in Takeo, Kampong Thom and Kampot Provinces and promotes rice based agriculture.
- Agricultural Diversification in Cambodia (PADAC), a program supported by AFD, which has conducted postharvest trials of cassava and other industrial crops in Battambang and Kompong Cham Provinces.
- The Food and Agricultural Organization (FAO), which developed a strategy plan related to postharvest technology of rice and cassava, e.g. agro-industry strategic development plan for 2010.
- USAID, which launched HARVEST, a program implemented by Fintrac, with a budget of USD 53 million. Commercial agriculture, including rice and cassava, is a main component of the program, which aims at reducing PHL and ensuring food safety through Good Agricultural Practices (GAP).
- The System of Rice Intensification (SRI), managed by the Department of Rice Cropand supported by national and sub-national government agencies and external development partners (e.g. PRASAC, OXFAM, GIZ and CEDAC).It supports diversification (e.g. organic rice for niche marketing).

With regards to the rice postharvest system, the rice export strategy of 2010 is relevant. It is a newly established strategy by RGC with the ambitious goal of exporting one million tons of rice per year from 2015. The strategy paves the way for a number of governmental institutions to take on roles for supporting rice export:

- The Committee on Economic and Financial Policiesshall be responsible for monitoring, evaluation and coordination at the policy level to ensure the consistency and efficiency of these policy measures with other economic policies.
- The Agricultural Produce Export Promotion Committee led by MAFF and MoC are in charge of overall coordination and serve as a secretariat to the Prime Minister in implementing the Policy on the Promotion of Paddy Rice Production and the Export of Milled Rice.
- MEF and NBC shall be responsible for addressing issues related to the establishment of financial institutions as well as issues related to financing, according to the spirit of this policy.

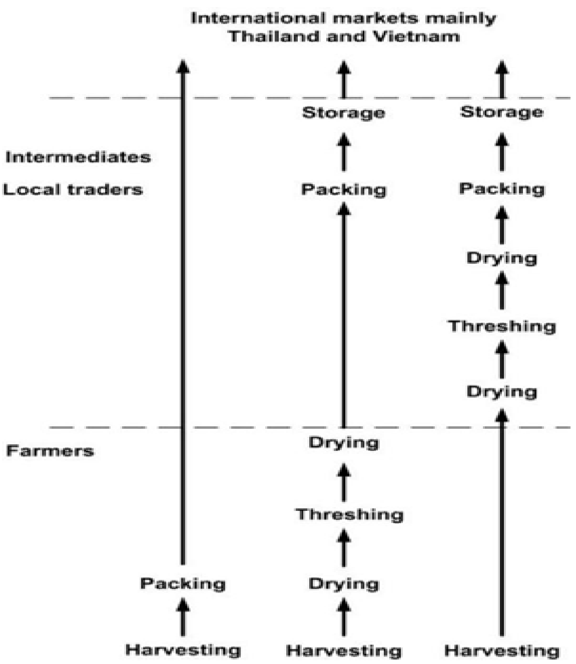
- Concerned ministries/institutions shall implement their functions in accordance with their assigned responsibility stipulated in the above policy measures and institutional arrangements, and shall report the progress and propose modified or additional measures to the Prime Minister for decision and guidance as required.

2.2 Maize

Maize is grown in every province in Cambodia. It is estimated that production reached about 600,000 tons in 2009. In 2008, Battambang Province had by far the biggest plantation area with 92,510 ha (62 percent of total production area). Including Pailin, Kampong Cham, Kandal and Banteay Meanchey with a harvested area of 12,876 ha (nine percent), 11,249 ha (eight percent), 11,151 ha (seven percent) and 7,613 ha (five percent), respectively,those were the top fiveprovinces in terms of plantation area (MAFF, 2009).

Red and white corns (maize) are the two types of maize that are being planted. Maize is grown two times per year in the provinces along the Thai border. In Battambang, maize is mainly grown in Kamrieng, Phnom Proek, Samlot and Ratanakmondul Districts. Red corns constitute about 90 percent of corn plantation nationwide. In the provinces bordering Thailand (Battambang and Pailin), red corn plantation constitutes over 99 percent of total plantation (MAFF, 2009). Red corns are mainly sold to Thailand and Vietnam for animal feed purposes right after the harvest season, while white corns are mainly for local human consumption. Proper implementation of the postharvest operation is still a major problem, however, which leads to postharvest and quality losses and subsequently low prices.

Figure 2-2. Postharvest handling chain of maize in Cambodia



Current postharvest practices consist of drying, threshing, drying of grains and storage. These steps are either done by farmers or traders (Figure 2-2). Farmers do not have much knowledge on good postharvest practices and their importance for grain quality. They harvest the maize manually when it is fully matured. Cobs are dehusked, then detached from the plants and placed in pile for transportation to the farm yard. Driven by higher prices, some farmers harvest their maize too early when it is not fully ripe. This practice is very common at the early stage of the harvest season, but it contributes to postharvest loss and rejection of the maize from prospective buyers.While waiting for the next step of the postharvest process or awaiting transportation, maize is usually left out in the open space directly on the soil with or without packaging. This practice is very common and it is a major risk for contamination and deterioration of the quality of the maize.

Picture 2-10. Maize harvesting and awaiting transportation

The next step, drying, is aimed at lowering the moisture content of maize. The final moisture content is very important for storage time and preserving the quality of the grains. In some cases, maize is preliminarily dried to reduce moisture before going into threshing. In other cases, maize is dried until its moisture content reaches 12 to 13 percent, which means there will be no further drying after threshing. Most of the time, maize is sun dried without any cover. This procedure presents a high risk in terms of preserving the quality of the produce. Notably, maize harvest is during the monsoon season, which means that the maize,which being dried, is often left soaked with rain water.

Picture 2-11. Drying of maize

Following drying, maize undergoes threshing to separate the grains and the cob. This step is usually done using a threshing machine. The grains are removed from its cob, then air-cleaned to remove the majority of impurities. The procedure does not constitute any risk to grain quality. But some farmers cannot afford the cost of acquiring imported threshing machines. Hence, they resort to manual means of threshing, which results in low efficiency, a high level of wastage and high labor use or additional costs to have the maize threshed by a private threshing machine. Most of the threshing is done at the collectors/traders warehouse.After threshing, where necessary, grains are dried either with the help of a drying machine or they are sun dried to reduce the moisture content to 12 to 13 percent. Again, losses can be significant when grains are sun dried without any cover. Final moisture control is uncertain; as there are no or very few moisture testers in use. Farmers use their instinct and experience to decide whether drying is completed.

Picture 2-12. Threshing by farmers and traders vs. threshing by a private company

Picture 2-13. Sun drying of maize in open space and biomass (corn cob) fired drying

Only few traders have proper packaging with label and exact weight. Many farmers and traders pack the grains in old second hand bags, which are sufficient for transportation, but not for longer storage times. Storage is, like drying, a critical step for preserving the quality of the grains and minimizing PHL, but storage conditions in Cambodia do not meet the standard for storage. Maize is usually stored under the house in the open air, directly placed on the soil or under a thin tent. There is no system to protect the grains from pests, and storage temperature and humidity are not controlled. There is hardly any storage of grains, as most are immediately sold to foreign traders.

Picture 2-14. Maize storehouses

Currently,there is no institution to provide any type of support to production and export of maize. There is an increasing number of traders who possess dryers with capacity of drying several tons of maize per day. Some collectors/traders lend seed and fertilizers to farmers.

But farmers will have to pay back after the harvest season by selling their produce to the lenders.

Kogid Cambodia Ltd, a branch of Kogid International of South Korea, has just begun their business operation in Cambodia. They have installed a maize dryer with a daily capacity of 500 tons. Kogid Cambodia Ltd buys red corns, threshes, dries and packages them with proper company label. They produce a very good quality of red corns accepted by international buyers, especially Korea, where red corns of Cambodia are high in demand due to their organic characteristics. Within Cambodia Kogid is considering the option of contract farming, including the provision of basic technical assistance to farmers,and the introduction of buying criteria. It is hoped that this will help farmers produce a better quality crop.

2.3 Cassava

According to MAFF data 2010, cassava was the most important crop after rice and maize in Cambodia. In recent years, cassava production increased strongly due to high demand in local consumption and in export as raw material for processing industries. Cambodia is the fastest growing cassava producer, ranking 15th worldwide (MoC, 2010). In 2010, the cultivated area was about 206,226 ha, with a production of around 4.25million tons.Cassava is easy to grow. However, at62 to 65 percent moisture content,it is a very perishable tuber crop with a storage life of less than 48 hours (Mumbi et al., 2011). Traditionally, research has focused on improving production output through better crop quality, harvest and storage. But in order to help boost profits of farmers and other supply chain actors, efforts should now be made to reduce PHL of cassava, which are estimated to range between 16 and 73 percent along the cassava supply chain (below). The following assessment is based on Pailin and Kampong Cham, which are important provinces for cassava production in Cambodia.

Farmers in Pailin and Kampong Cham grow cassava only once a year.They play a crucial role in the chain, supplying cassava to the collectors/traders or in some cases directly to exporters. Farmers are responsible for all inputs at the growing period up to harvesting. In some cases, farmers grow cassava with other crops, such as maize and soybeans, for home consumption and as a source of income. In Kampong Cham Province, particularly, cassava is grown within the rubber plantations. Generally, cassava farmers tend to have small or medium sized plots of land, typically 2 to 5.6 ha, although there are also large farms of 50 ha or more. Most cassava producers are self-employed, and some undertake contract farming for factories.

The best time to harvest is when the leaves turn yellow and their density decreases. Early harvest results in low yield, higher percentage of broken roots and lower starch content.Harvesting cassava is labor intensive and almost exclusively done by hand. On average, harvesting one ha of cassava requires 240 to 320 man-hoursand 168 to 248 man-hours for handling. The number of labor per ha varies depending on soil condition, cultural practice and the variety of cassava.

Picture 2-15. Cassava harvesting tools in Pailin Province

After harvest, the cassava roots are collected with common bamboo basketsand carried to the truck where they are piled up or sometimes put in 50kg sacks for transport. The roots are either sold directly totraders/exporters or processors, or sold through a network of collectors and middlemen to factories in Cambodia, Vietnam and Thailand.Normally, the roots are transported on the same day; later transport will result in weight loss and damage to the root.

According to farmer responses, PHL at farm level ranged between 0.5 and 9 percent in Pailin Province and between 0.2 and 5 percent in Kampong Cham Province. The difference in PHL may be explained by the on average smaller cassava cultivation area per household in Kampong Cham. Other factors include variety selection, soil preparation, soil profile and structure as well as harvesting method.

The main causes for PHL during harvesting are physical loss(roots damaged during harvesting, left in the ground or field due to oversight), followed by physiological and biological loss (insects, rodentsand diseases). In some provinces, e.g. in Kampong Thom, physical loss also occurs due to thievery, which is not included in the PHL figure above.Physiological loss due to the reduction of moisture of fresh roots accounts for a 10 percent loss within one day of storage, and a 50 percent loss within three to four days. The biological loss accounts for 0.5 to 4 percent according to farmer estimates. Biological loss can be very high too: e.g. in one particular case, 30 to 70 percent of production was destroyed by disease prior to harvesting.In addition, unfavorable weather can contribute to further PHL.

PHL during transportation from farms to collection centers is not negligible, accounting for 0.5 to 3 percent. The loss is caused mainly by spillage. Either there are gaps and holes in the walls of the transporting trucks or, where sacks are used, transporters are careless or sacks are punctured. The PHL during transportation from farm to collectors is still the farmers' responsibility.

Picture 2-16. Cassava transportation

To prepare for drying, the fresh roots are chopped into small pieces using a knife (farmers) or a chopping machine (traders). Farmers chop the roots on the field, using an old tarpaulin or PVC sac as drying surface or sometimes just laying the slices directly onto the ground. Drying takes place at the farm level only if a farmer cannot transport the fresh roots to the market on time, the farmer’s production volume is low or the market price is unfavorable. Otherwise, drying is done at the collection center or at trader level. At trader level, drying is done on the concrete yard at a capacity of 50 to 300 tons. Drying takes about three to four days, during which the fresh roots lose 50 percent of their moisture content. Traders with onlya small drying yardwill dry the roots only if they cannot be sold within two to four days.Small scale traders and farmers prefer to sell fresh roots because drying is time consuming and losses occur.

Picture 2-17. Chopping machine and drying yard in Pailin

At trader or collection center level, total PHL ranges from five to ten percent. Losses at the collection center occur during chopping, drying, storage and transport for processing or export: during the chopping process cassava flour is scattered from the drying yardor pieces of cassava and cassava flour are attached to the chopping device; during drying wind or rain lead to losses of about four to five percent; and during storage 0.5 to 2 percent are lost due to pests, spillage, spoilage and diseases. The condition of storage is an important factor for the extent of quantitative and qualitative PHL since dried chips are very sensitive to temperature and humidity. Further loss during transportation for processing or export is estimated at around 0.5 to 3 percent, depending on distance and type of truck. It is mainly caused by spillage and weight loss during transportation.

Table 2-2. Causes and extent of PHL along the cassava supply chain

Causes of losses	**Losses (in %)**
At farm level:	**11-63**
• Physical loss: left underground, damaged roots, spillage during transport to trader	0.5-9
• Physiological loss: moisture loss	10-50
• Biological loss: pests, disease	0.5-4
At trader level:	**5-10**
• Drying	4-5
• Storage	0.5-2
• Transport	0.5-3
Total	**16-73**

Source: Survey data from Pailin and Kampong Cham Provinces, March 2011

According to the Ministry of Commerce (2011), there are about a dozen cassava processors in Cambodia, located in Battambang, Kampong Cham, Kandal and Phnom Penh. Their products include cassava starch, animal feed or bio-ethanol. However, those companies are run as joint ventures with Thai, Vietnamese or Korean enterprises and specialise on unique cassava products.In Pailin, there is little further processing besides simple boiling of cassava and production of Num Bak Bin (dessert) for home consumption or for sale in small shopswithin the province.

In Kampong Cham Province there are some processing facilities in form of micro and small scale enterprises that produce Sago, Saray and dried and wet cassava flour for domestic supply. According to the agro-industry office of Kampong Cham Provincial Department of Agriculture, there were 262 such cassava processing enterprises in 2007, but by 2011 only five or six were remaining. According to the Royal University of Agriculture, this decline is due to processors facingproblems such as high production costs, low market pricesfor final products, insufficient labor and capital and lack of production area.

2.4 Fishery

Freshwater fishes are one of Cambodia's most important traded commodities. Fresh and processed fish are traded widely within Cambodia, with the majority of trade originating at the Tonle Sap Lake and Mekong River. It is estimated that about 400,000 tons of freshwater fish are caught every year (Chea and McKenny, 2003). Fishes are the main source of protein for the Cambodian population. Fishes are consumed fresh or as processed products, in particular dry fish and Prahok (fish paste).Fish processing involves a number of steps and challenges.

Despite being one of the biggest freshwater fish producers, Cambodia is still unable to directly export processed fish into lucrative markets such as the USA, Japan and Europe due to food processors'poor hygienepractices. Fresh fish is currently exported to Vietnam and Thailand, although it is largely informal. Fish products have been identified as a product with the potential for export in the DTIS Report (2007), a study conducted by the Ministry of Commerce and UNDP Cambodia. But in order to meet quality standardsof export markets, the fish postharvest handling system in Cambodia must be improved.

Picture 2-18. Fresh catfish and fish products on sale in Cambodia

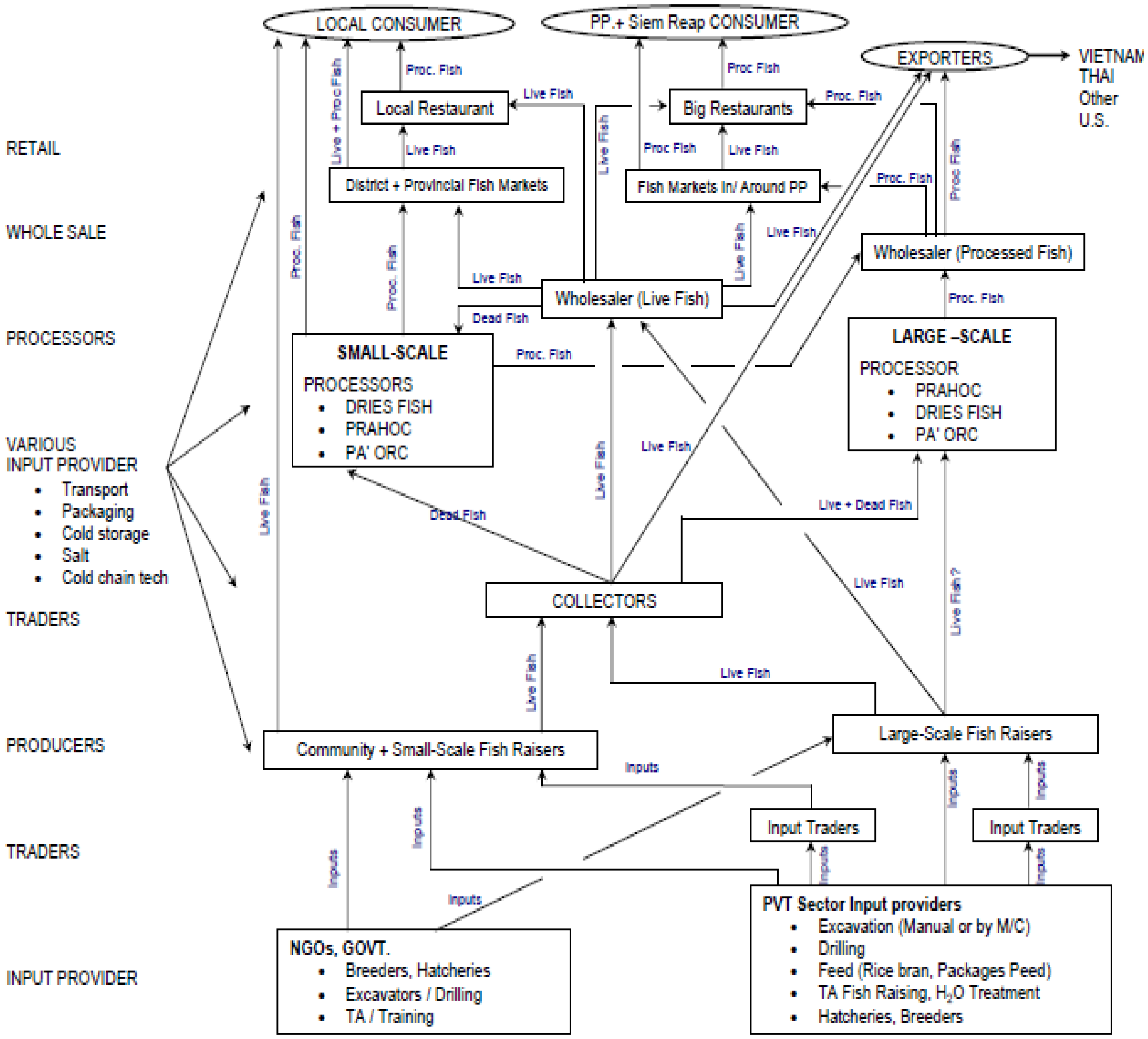
The two main dangers of processed fish products are microbiological and chemical dangers. Fish contains every nutrient that microorganisms (pathogen and non-pathogen) need for growing. Chemical risk of fish products is also serious as several small processors liberally and intentionally use chemical preservative additives. Sulfites, nitrate and nitrite compounds are known to be used in fish processing by some processors. Some others, unidentified and more toxic compounds, have been reported to be scarcely used. The effect of these chemical compounds on human health is less obvious than that of microbiological hazards. However, long term exposure and consumption of certain chemical compounds could cause cancer.Improving sanitation conditions and the quality of processed fish is urgently required to enable export and to protect the health of Cambodian consumers. In order to ensure good quality fish products, one has to examine all steps of processing (see Figure 2-3).

Dry fish is very popular in Cambodia. The process to make dry fish includes the preparation of fish, salting, seasoning and drying. Each step is considered at risk of microbial contamination and development.The quality and freshness of the fish prior to processing is very important for final product quality. For economical reasons, dead fish are chosen to make dry fish. Fishermen useice to keep the fish fresh during transportation. But most of the time this step is not handled properly (e.g. by using poor quality ice) and the fish has already begun to spoil.

Preparation of the fish includes de-scaling, head cutting, opening the belly, and overall cleaning. This is the most unhygienic step of all operations, as can be seen in Picture 2-19. Waste from the fish taints the wooden or concrete floor. This makes the cleaning process very difficult and inefficient. The floor’s rough surface is a perfect place for development of microorganisms, constituting the biggest source of microbial contamination. Biofilm can be seen forming on the surface of these types of floors. The wooden chopping board is another source of similar contamination. The surrounding area, which is in general not clean, further adds to contamination. In addition, workers, who come into direct contact with the fish, have never had a medical checkup or taken leave when sick. Besides this, the preparation step involves using contaminated water for cleaning fish andcould take several hours, long enough for the development of microorganisms. For technical reasons, ice is put on top of prepared fish to get a better texture and color of dry products. This technique has been used lately to substitute the use of chemical compounds for brighter color of final product.

At the next step, salt is mixed with the prepared fish. Other ingredients such as sugar, seasoning, ginger and other spices are also added. Fishes are then soaked in the brine overnight as can be seen in the pictures below. Some processors use chemical compounds to help preserve the organoleptic quality of the dry fish. Other chemical compounds are used to prevent insects from coming into direct contact with the fish, particularly flies. The concentration of salt in the brine solution is high enough to prevent pathogen microorganisms from growing.

Figure 2-3. Fish value chain map in Cambodia



Source: Menning et al., 2006

Picture 2-19. Preparation of fish

Picture 2-20.Tools for fish processing


Picture 2-21. Salted fish soaking in brine


Picture 2-22. Drying of fish on grilles and near a dump site




After soaking in the brine overnight, the fishes are taken out to sundry (Picture 2-22). They are placed on a bamboo grille, which is used daily during the peak season, but has almost never been cleaned and is therefore another source of contamination. Drying takes between one to three days, depending on sunlight and client orders. One-day dry fish has still a high moisture content and cannot be preserved for a long time. Mold can easily grow on it if it is not stored in proper condition. However, customers prefer this type of dry fish, because of its softer texture and better taste. In general, dry fishes are sold unpacked and suspended in the air to prevent mold growing. Notably, dry fish is highly contaminated by microorganisms. However, these microorganisms do not grow or they grow at a very slow rate because of the salt concentration and low water activity.

Prahok, a popular ingredient in Cambodia, is a fermented product made from fish. There are mainly two types of Prahok: ordinary prahok and boneless prahok.The key steps of the Prahok making process include preparation of the fish, salting and fermenting. The freshness of fish is not important in the processing of prahok. In fact, fresh fish will be left to spoil in order to make good prahok. Generally, one species of fish is used to make a batch of prahok. Preparation of the fish involves cutting the head, de-scaling, opening the belly, overall cleaning and washing. In the case of boneless prahok, bones are removed at the preparation stage. It is very important to remove as much of the fat as possible, since it will have a great influence on the final quality of prahok as well as preservation time. Similar to preparation for processing dry fish, this step is also greatly exposed to the risk of contamination and development of microorganisms.

Next, the prepared fish is soaked in water for several hours until the fish is swollen due to the degradation of the fish protein. The fishes are then drained. The surrounding environment is dirty and could very well be a source of pathogen microorganisms. Mold growth and biofilm was spotted in the processing area, and communicative diseases carried by workers could easily be transferred to the products through direct contact.

Picture 2-23 Surrounding environment of a Prahok processing area

In the next step salts are added and mixed with the swollen (spoiled) fish. This is done with an objective to inhibit the alteration of microorganisms to avoid totally spoiling the fish. Salted fish are kept overnight. The amount of salt used at this stage is very important for if too much salt is used all microorganism activities might be inhibited and in that case the product would not become Prahok. The processed fish is then sun dried for about half a dayto ensure a good aroma (but some processors, especially the big ones, skip this step) before more salt is added.

For the final fermentation stage, the salted fishes are put in a container and more salt is added. The fish must always be covered by the brine solution to prevent oxidation of the fatty acid in the fish. Oxidation results in the development of a reddish color, which processors and buyers use as a quality indicator. Fermentation time varies between two to six weeks, and continues during transportation and storage.

Picture 2-24. Salted fish kept in wooden containers for fermentation


Fish products have enjoyed some institutional support over the past few years, especially from the Fishery Administration. For instance, the provincial office of the Fishery Administration in Siem Reap has held trainings on hygiene for several fish processors and fish traders in the region over the course of last year; several fishery communities have been set up especially in the provinces surrounding the Tonle Sap Lake; and the Cambodian Organization for Women Support (COWS) has supported several fishery communities by providing basic skillsof fish processing and hygiene and by helping to find a market for processed fishes.

2.5 Recommendations

Rice

- Support good practice of seed selection, which will reduce PHL of polished rice by about 10 percent(Chan Sarun, 2011).
- Improvepostharvest technology application by providing training in operation, repair and maintenance to the various actors along the postharvest chain, e.g. farmers, millers and owners/users ofpower tillers, tractors, threshers, combine harvesters, drying ovens etc.Since 2010, 40 training courses for 913 farmers have already been provided by the Department of Agricultural Engineering on (1) Operation, repair and maintenance of agricultural machines; (2) Rice postharvest losses; and (3) Land preparation and harvesting (MAFF 2011). The same department also conducted testing programs on agricultural machinery at a few selected sites.
- At trader level, apart from technical problems, financing isa serious constraint for business development. The survey found that local collectors who act as traders in the supply chain of rice could not increase their business due to financial limits. In addition, millers are lacking financial means to increase their milling capacity and to improve storage and particularly modern drying facilities, all of which is required for improving milled rice quality to meet international market standards. Some banks currently provide

credit for such needs, but according to interviewees, access to loans is difficult and interest rates are high.

- Existing policy, regulation and standards related to postharvest operation must be implemented and strengthened to boost the development of the rice supply chain.

Maize

- Harvesting should only take place when maize is fully matured; clean containers for harvested maize must be prepared.
- Dryingmaize should be done on a clean concrete floor; solar dryers and/or electric dryers should be used for homogenous drying and to protect from rain and undesired impurities; and final moisture should be controlled at 11 to 14 percent, depending on the intended storage time.
- The threshing process requires greater attention to minimize losses.
- Proper labeling and branding of the produce, and fixing of the net weight per bag.
- Improving storage by storing in a clean and dry warehouse to avoid reabsorption of moisture, building elevated storehouses with roof, allocating enough space to allow good ventilation and implementing a proper pest control plan.

Cassava

- Agricultural mechanization is the most critical challenge for cassava production in Cambodia. Production suffers from labor shortage and the cultivation area of individual farmers is usually large enough to make a mechanical cassava harvester application economical. Thus, a labor saving technology, appropriate for cassava harvesting conditions in Cambodia, is required.
- While the yield of cassava in Pailin seems to be equally good as in other countries, the yield in other Cambodian provinces is very low and varying.Therefore, yieldsshould be improved by providing a good variety of cassava, i.e. one tolerant to disease and weather, and with plenty of starch and a long shelf life.
- Cassava processing should be encouraged and promoted to improve postharvest profits. E.g. in Pailin, processing is severely limited due to a lack of techniques, of marketaccess for final products and financial support for processing businesses. This leaves farmers vulnerable to market and price fluctuations for fresh roots.
- Investment in postharvest activities, such as drying and storage facilities, is essential to maximize the productivity of cassava production. Involving private sector partners along the entire market chain, as well as working with a wide range of public and private sector service providers is also imperative.
- The development of the cassava sector will require initial activities in capacity building, product development, manufacturing of processing technologies and transfer to target beneficiaries and development of clusters to supply identified markets.
- The interaction between technology and policy cannot be overemphasized. Government policies need to be implemented effectively to produce the beneficial effects of agricultural research and technology improvements, especially for the cassava system.

Fish

- The fish postharvest handling system in Cambodia, especially the practices of food processors,suffers from poor sanitation conditions and poor quality of processed fishes. Upgrading those practices is urgently required to meet quality and hygiene standards set by lucrative export markets, such as the USA, Japan and the EU.

3 Indonesia

In Indonesia three commodities, i.e. rice, maize and cassava, were selected to be studied for postharvest losses in the agro-value chain from producer to consumer. In 2010, Indonesia produced 38 million tons of milled rice, 17.6 million tons of maize, and 22 million tons of cassava (BPS, 2011). PHL ranged from 10 to 20 percent, and varied depending on location, season and manual or mechanized operations.

The following study was conducted by a research team from The Department of Mechanical and Biosystem Engineering, Faculty of Agricultural Engineering and Technology, Institut Pertanian Bogor, and was submitted to UNIDO in 2012.Partner institutions for the study included the Ministry of Agriculture, BULOG (National Logistics Agency), the regional government of targeted areas and related private sector associations.

An initial desk study revealed policy, economic and technical aspects, and reviewed previous studies on postharvest operations of rice, maize and cassava. The following survey was conducted in four provinces: West Java and South Sulawesi for rice, and East Java and Lampung (in Sumatera) for both maize and cassava PHL. The provinces were selected according to their major production of the given commodities in Indonesia, and for their geographic location. As selected, each respective commodity was studied in one location in Java and one outside Java.

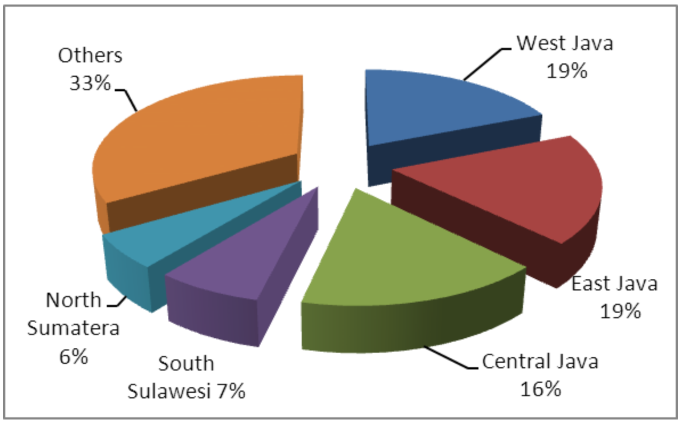
A total of 81 respondents were selected by purposive sampling to cover the whole supply chain of rice, maize and cassava. Respondents were interviewed by the team members based on a structured questionnaire developed for the purpose of this study. Interviews were also conducted with the partner institutions in Jakarta such the Ministry of Agriculture (Directorate General of Food Crops, Agency of Agricultural Machinery Development, Agency of Food Security) and BULOG (National Logistics Agency).In addition, Focus Group Discussions (FGD) were organized by coordination with the local agricultural authorities. Participants were farmers and farmer groups, collecting traders and wholesalers, the processing industry, feed meal industry, agricultural machinery industry and financial institutions.

Observations were made on PHL, the costs incurred and revenues gained along the supply chain, the technology and machinery applied for postharvest handling and operations, technology transfer, current support systems, problems and requirements for future development of the postharvest value chain.

3.1 Rice

Major rice production regions in Indonesia are West Java, followed by East Java, Central Java, South Sulawesi and North Sumatera (Figure 3-1). The two locations selected for the study of rice PHL were Karawang District (West Java) and Bone District (South Sulawesi).

Figure3-1. Paddy production centres in Indonesia



Source: Ministry of Agriculture, 2011

In Karawang District (West Java) rice farmers harvest the paddy twice a year. Productivity of rice in Karawang is seven to eight tons paddy GKP (18 to 20 percent moisture content wet basis) per ha, which is above the average of national rice productivity of four to five tons paddy GKP/ha. In the rainy season of February/March, paddy is generally harvested at a high moisture content of 26 to 28 percent. Farmers often harvest early, even though they are aware that this may have a negative impact on rice quality, for the following reasons: the price of paddy decreases as increasing volumes of produce enter at the peak harvest season;farmers have the impression that their income is higher by harvesting early since the weight of paddy reaches its maximum prior to optimum harvest time; employing farm workers for harvesting may not always be possible at the time of ideal level of paddy moisture content; and farmers fear for their production due to a harmful environment, such as a sudden breakout of pests and diseases, and adulteration by human beings.

Harvesting is done manually by sickle. This leads to 2.5 percent losses. Reapers aresometimes utilized by farmers who own large areas, thus reducing the harvest loss to 1.5 percent. But they are used for lessthan one percent of rice production. Manual threshing by beating the paddy to a wooden triangle on the paddy field contributes to five to six percent of losses. While mechanical threshing could reduce the losses to around onepercent, threshersare only used for 1.6 percent of total paddy production, way below the average 12 percentuse of threshers in West Java. This figure is also low compared to Thailand, for example, which has been practicing 100 percentmechanical threshing for the last two decades. Transportation of grain to the next postharvest players is done in plastic bags, carried by truck, thus not incurring any significant losses.

Drying of rice from GKP to GKG (14 percentmoisture content) is largely conducted by rice milling units (RMU), the rest by small-scale farmers for domestic consumption. While all the large RMUs dry rice using continuous dryers and automatic controlled dryers with a capacity of about 10 tons per hour, farmers still employ sun drying methods.Estimated sun drying losses may reach 2.5 percentdue to the delay of drying caused by weather uncertainty. On the other hand, mechanical drying losses are of no significance, amounting to less than 0.5 percent.Storage is generally practiced by large RMUs using well maintained warehouses for staples of rice bags or silos, thus, no significant losses occur in this handling system.

Picture 3-1.Manual harvesting, sun drying, flat bed drying and continuous column drying of paddy in Karawang

Picture 3-2.Small RMUs, large RMUs, rice packaging and 50kg rice packages in Karawang

Small RMUs usually do not have the capital to purchase stock so they keep only the rice in rice bag staples for a two to three day milling capacity. Small RMUs utilize rubber roll rice hullers and abrasive rice polishers with a capacity of 0.5 to 1.0 ton per hour. Milling losses are estimated to bea maximum of one percent at small RMUs, and range from 0.4 to 0.5 percentfor large RMUs and RPCs.The estimated total possible PHL by manual operation amounts thereby toa maximum of 12.5 percent, the estimated total possible PHL by mechanical operation is a maximum of 4.5 percent (Table 3-1).

Table 3-1. PHL of rice in Karawang, West Java

Postharvest Operation	Farmers	Small RMUs	Large RMUs
Manual harvesting	2.5		
Mechanical harvesting	1.5		
Manual threshing	5.0 – 6.0		
Mechanical threshing	1.0		
Sun drying	2.5		
Mechanical drying		0.5	0.5
Rice storage			Not significant
Rice milling		1.0	0.4 – 0.5

Source: Standard National Indonesia (SNI)

The rice supply chain is unique since it consists of two kinds of commodities: rice and paddy. What is more, Karawang absorbs paddy not only from farmers in the district, but also from the neighboring districts such as Subang, Indramayu, Demak and Banten. Paddy from outside Karawang starts to flow in when there is no harvest inside the district. Limited supply of paddy often causes small RMUs to operate only six to ten months a year. Large RMUs usually stock paddy for the whole year.

Figure 3-2 (below) illustrates the supply chain of rice that includes farmers, RMUs, grocers, retailers, supermarkets, restaurants and individual buyers. About 80 percentof milled rice produced in Karawang is sent to neighboring cities such as Jakarta, Bogor, Tangerang, and Bekasi and Bandung. Large RMU seven send the rice inter islands, e.g. to Sumatera and Kalimantan. The rice supply also involves grocers who sell the commodity to Jabotabek areas, retailers and big restaurants. Retailers in turn sell the rice to individual buyers and small restaurants.

Table 3-2 lists the costs incurred along the rice supply chain. Harvesting and threshing costsare commonly included in a profit sharing system with the farm workers who gain 20 percent of profit for services done that cover the operation from seed planting to threshing. Transportation cost is commonly charged to suppliers. Drying costs differ, between sun drying and mechanical drying at small and large RMUs. Milling costs tend to be lower at 300 IDR/kg milled rice at small RMUs, compared to large RMUs. Transportation of milled rice to the end consumers is shouldered by RMUs, varying depending on the distance. In the wholesale market of Johar, the milled rice sellers sometimes have to put the commodity in temporary storage at 15 to 20 IDR/kg until they find a good deal.

Figure 3-2. The rice supply chain in Karawang

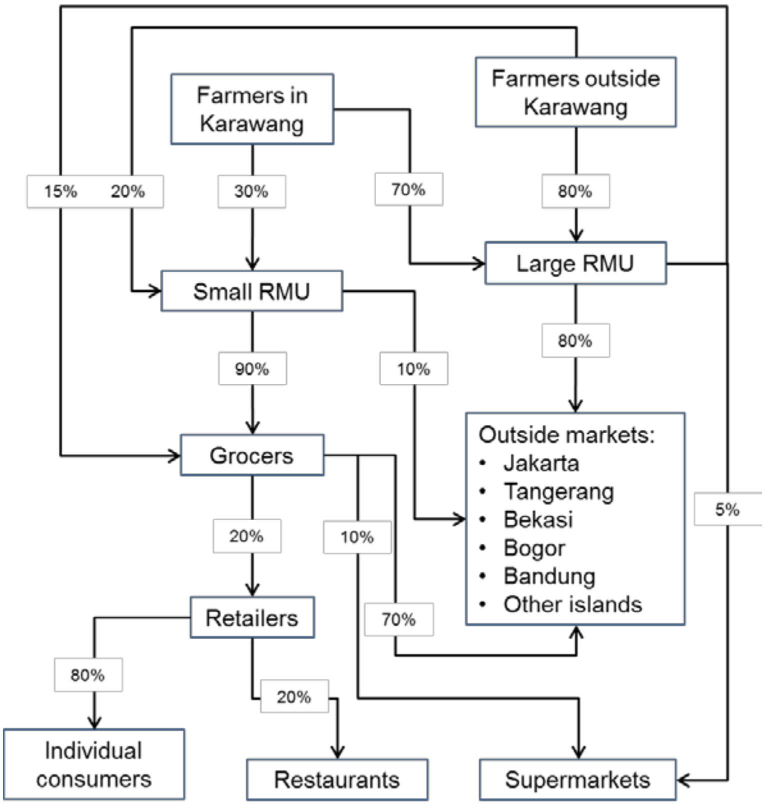


Table 3-2. Costs incurred along the rice supply chain in Karawang (in IDR/kg)

Postharvest Operation	Farmers	Small RMUs	Large RMUs and RPCs
Harvesting and threshing	20% of profit		
Transportation to RMUs	25 – 50		
Sun drying		30	30
Mechanical drying		200	150
Rice milling		300	300 – 450
Packaging		15	15
Transportation to end consumers		20 – 30 (close distance) 50 – 100 (long distance)	
Temporary storage at wholesale market		15 – 20	

Similar to farmers in Karawang District, farmers in Bone harvest the paddy twice a year. Rice yield amounts to five to six tons GKP/ha. In the rainy season of April to May, paddy is commonly harvested at a higher moisture content of 23 to 24 percent wet basis, while in the dry season moisture content is 18 to 19 percent. Harvesting is done by farmers renting stripper harvesters with a design that has been adapted from IRRI. Its capacity is one ha/day and it incurs an estimate loss of only 0.5 to 1 percent.

Threshing in general is done by power threshers with an estimated loss of one to two percent. However, in cases where the operators do not work properly, grains may be lost along with straw blown away from the power thresher. The amount of grains hiding in the blown straw is estimated to amount to four percent. Threshed grains are put into plastic bags and carried by collecting traders to the RMUs since farmers sell the paddy right on the field. Estimate losses during transportation are of no significance.

Drying from GKP to GKG at 14 percent moisture content is done by collecting traders or RMUs. Sun drying and flatbed drying (3 to 10 tons/batch) are common practices by collecting traders and small scale RMUs, while larger scale RMUs use mechanical drying, e.g. circulation drying with a capacity of 10 to 14 tons/batch. Sun drying losses may reach twopercent, while mechanical drying losses are less than one percent.

Picture 3-3. Sun drying, flat bed drying and circulation drying of rice in Bone

Grains are transformed to rice by rubber roll huskers and abrasive type polishers at small RMUs with 0.5 to 1 ton/hr capacity. The yield ranges from 57 to 59 percent, depending on rice quality. Large RMUs have a capacity of one to three tons/hr, operating with a series of milling equipment that covers cleaner, destoner, rubber roll husker, whitener, polisher and grader. The yield is better, ranging between 60 and 62 percent. Large RMUs have also silos to store the dried paddy and milled rice to facilitate operation during the off-season. RMUs in Bone provided no estimates of rice milling losses.

Picture 3-4. Small and large RMUs in Bone

It should be noted that the postharvest handling practice in Bone is unique in the way that no standard quality and milled rice are followed by the market. Consequently, dried paddy and milled rice may be temporarily stored for an unknown period in expectance of a better price. Unfortunately, temporary storage takes place in shops that have no special design for storing grains. Hence, serious losses may occur if the grains are stored for more than one month. The total estimated possible PHL along the chain amounts to a maximum of 6 percent (Table 3-3).

Table 3-3. PHL of rice in Bone

Postharvest Operation	Farmers	Collecting Traders	Small RMUs	Large RMUs
Mechanical harvesting	0.5 – 1.0			
Mechanical threshing	1.0 – 2.0			
Transportation to RMU		Not significant		
Sun drying	2.0	2.0	2.0	
Mechanical drying		1.0	1.0	0.5
Rice milling			Not available	Not available

The rice supply chain in Bone is illustrated in Figure 3-3.During the off-season paddy will be purchased from outside Bone District. Milled rice produced in Bone is also supplied to neighboring provinces such as South East Sulawesi, Maluku and East Nusa Tenggara. The costs that incur along the chain are shown in Table 3-4.

Figure 3-3. Rice supply chain in Bone District

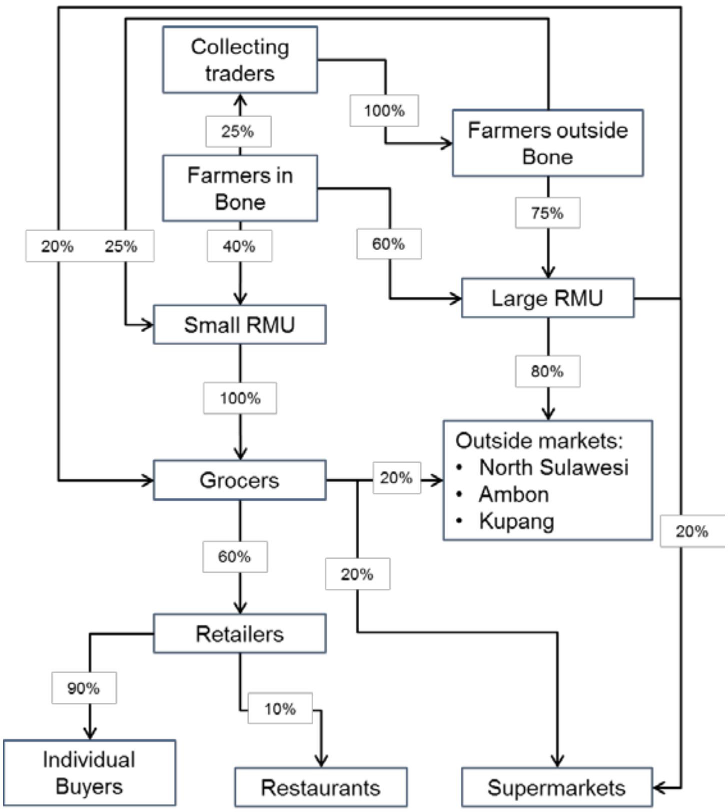


Table 3-4. Costs along the rice supply chain in Bone District(in IDR/kg)

Postharvest Operation	Farmers	Collecting Traders	Small RMUs	Large RMUs and RPCs
Mechanical harvesting	40			
Mechanical threshing	10% in kind			
Transportation of paddy to RMU		25 – 50		
Sun drying			30	30
Mechanical drying			250	150
Rice milling including packaging			250 – 300	350
Transportation of rice to end consumers			30 – 40 (close distance) 100 (long distance)	
Temporary storage at market area		15	15	

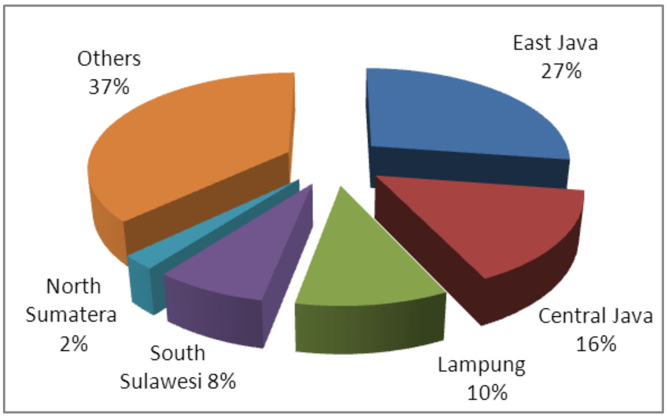
In terms of institutional support, the 2058 farmer groups in Karawang District are served by 232 regional government extension workers. Other governmental programs that support the rice farmers include provision of agricultural inputs for rice planting, technology consultancy and provision of specific credit schemes for agribusiness development. More specifically, the Ministry of Agriculture launched a program called "The Strategic Policy on Rice Postharvest Handling" under the Directorate General of Processing and Marketing of Agricultural Products (DGPMAP). The main objectives of the program are (DGPMAP, 2009b) are to reduce yield losses by three to four percent, and increase the milling rate by two to three percent; to develop a farmers group based postharvest institution in order to reposition farmers not only as producers but also as suppliers of industrial raw materials at the farm gate marketing system; and to facilitate the needs of farmers/farmer groups in obtaining and utilizing optimally postharvest machinery, access to credit institutions and market access through the partnership with Bulog(a state company, which purchases paddy and rice to stock for national food security) and the free market.

To achieve those objectives, the DGPMAP has implemented, for instance, the following: the development of a farmers group based postharvest institution; assistance of farmers with postharvest services in seven provinces; capacity improvement of farmers groups regarding technical and managerial aspects of postharvest handling; procurement and distribution of appropriate postharvest machinery by using both government and private sources of budget;establishment of a machinery rental service (called UPJA), especially for postharvest handling; quality improvement of the products through revitalization of small scale RMUs and dryers, and storage to ensure good quality rice; and technical and management guidance on the application of SOP and GHP on postharvest handling. Furthermore, the utilization of a credit scheme was facilitated and a business partnership between farmers groups and agro-industrial companiesestablished.

3.2 Maize

The main production region of maize in Indonesia is East Java Province. Outside Java it is Lampung Province (Figure 3-4). Tuban District (East Java) and Central Lampung were selected for the survey.

Figure 3-4. Major production centers of maize in Indonesia

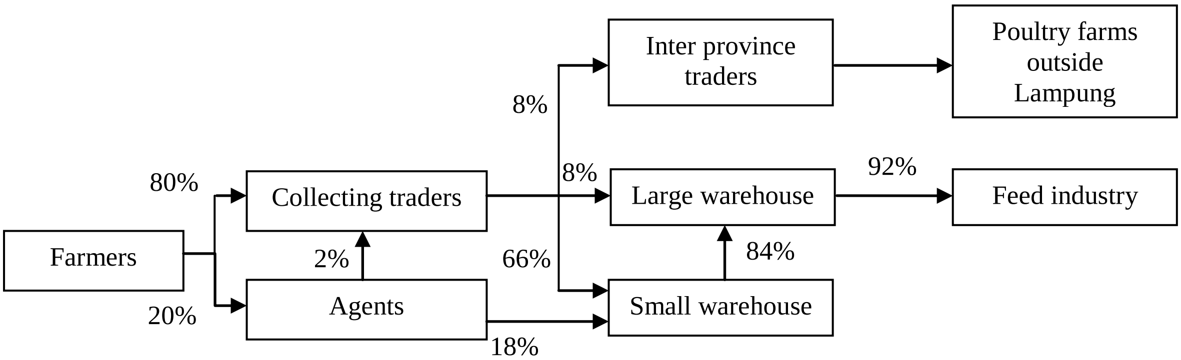


Source: Ministry of Agriculture, 2011

In central Lampung District maize is harvested either at high moisture (30 to 40 percent) or low moisture content (17 to 20percent). Harvesting at high moisture content usually takes place within the rainy season close to rice planting time. Harvesting is also carried out depending on the income needs of farmers. When harvesting at high moisture content, the quality of maize is reduced. This is reflected in a high value of rafraksi, i.e. a price reduction by buyers according to maize moisture content.

Farmers either sell their product to collecting traders directly or through an agent. Agents act as brokers between a collecting trader or a small warehouse and a farmer. Fees for the agent are the responsibility of the collecting trader or the small warehouse owner. These parties use agent services when maize production is low. Supplies to large warehouses are maintained continuously, according to work contract. Inter province collecting traders sell maize grains with a moisture content of 14 to 16 percent to poultry farms outside Lampung.

Figure 3-5. Maize supply chain in Central Lampung



Shelling is carried out mechanically with a 24 HP maize sheller by custom service units (UPJA) or collecting traders. The lowercapacity maize shellers operated by UPJAsproduce ash, which, mixed with the grains, reduces the grain selling value.Packaging of maize cobs and grains is carried out inside plastic bags having a capacity of 50 to 60 kg. Bags used by the farmers and the collecting traders are secondhand bags. The price of new bags, approximately IDR 1,500 per piece, is considered too expensive. Damaged second hand bags therefore may cause losses during transportation and loading.

Drying of grain is performed naturally under the sun by the farmers. The drying takes place on the sun drying floor, with a thickness of about three cm. The drying time will take three to five days. Farmer groups who received maize shellers from a government grant carry out shelling and drying themselves. The drying aims to reduce grain moisture content to 18 to 20percent. At this moisture content, the grains are sold to collecting traders or small warehouses. Small warehouses generally have a storage capacity of 2,500 tons. They will further dry the grains with a mechanical dryer to a moisture content of 14 to 15percent. This dryer has a capacity of 600 tons per day. Total possible losses along the postharvest chain amount to 10 percent (Table 3-5).

Picture 3-5. Harvested maize at low moisture content, grain left inside the husk, loading maize cobs, and 24 HP maize sheller

Table 3-5. PHL of maize in Central Lampung District

Postharvest operation	Losses, dry matter	Reasons
Harvesting	<0.1%	Cobs left on the field
Sun drying	2-5%	Delay of drying
Mechanical drying	<0.1%	Loading and unloading
Shelling at high moisture content	1-2%	Foreign matters mixed with grains
Shelling at low moisture content	<0.1%	Grains left on cobs and in working areas
Packaging	Not significant	
Transportation of cobs	Not significant	
Transportation of grains	0.5-1%	Spilling out if damaged second hand bags used
Storage in small warehouses and by famers	2%	When stored longer than two months

The distribution costs and prices of maize in 2011 are presented in Table 3-6. When the maize price decreases below IDR 1,600/kg, farmers will lose income and thus shift to cassava planting.

Table 3-6. Distribution costs and prices of maize in Central Lampung (in IDR/kg)

Postharvest operations	Supply chain actors			
	Farmer	Collecting trader	Small warehouse	Large warehouse
Harvesting	154			
Shelling	70	70		
Loading and unloading	40	40	40	40
Sun drying		35 – 40		
Mechanical drying		175	175	175
Storage for longer than 2 months		30	30	30
Procurement		1,400 – 1,900	2,200 – 2,700	2,700 – 3,400

Central Lampung has several supporting institutions: 311 Gapoktan (Organization of Farmer Groups), village workshops, 35 UPJAs (Unit of Agricultural Machinery Services) and one UPJA center. Agricultural machinery operated by UPJA includes hand tractors, transplanters, water pumps, maize shellers and rice milling unit. Agricultural machinery manufactured by the village workshops include maize shellers, winnowers and mechanical dryers. Table 3-7 lists the government programs to improve the postharvest handling system of maize.

Table 3-7. Government programs to improve postharvest handling system of maize

Programs	Activities	Target	Implementation year	Financial source
SLPTT	Training and supervision, at least 8 times each planting time, and seed aid. Facilitators: extension workers, BPTP, POPT.	Farmer groups	2008 - present	Central government IDR 3 millions for each farmer group with arable land of 15ha
BLBU	Providing maize seeds	Farmer groups	2007 - present	Central government
Agricultural Machinery Grant	Mechanical dryer and silo	Gapoktan	2007	Central government
Agricultural Machinery Grant	Mechanical maize sheller	Farmer groups	2007	Central and regional government
Equipment Grant	Tarpaulin	Farmer groups	2008	Central and regional government
Agricultural Machinery Grant	Sun drying floor	Farmer groups	2008	Central and regional government

BLBU: Direct Aid of Excellent Seeds
SLTP: Field Schoolof integrated crop management
POPT: ControllingPestPlantOrganisms
BPTP:AssessmentCenter ofAgriculturalTechnology

In Tuban District, East Java Province, there are two harvesting systems: harvesting done by farmers themselves, or maize plants on the field being sold to a collecting trader before harvest (*tebasan* system). In the latter case, farmers will estimate their production and negotiate the price, harvesting is then done by the collecting trader. Farmers use manual hand shellers, whilecollecting traders use mechanical power shellers.Problems are encountered during the wet season since shelling losses are high at high cob moisture content. The dried maize quality decreases. This will cause high *rafraksi* with a negative impact on farmers' income.

Drying is carried out either of maize cobs in the dry season, or grains after shelling in the wet season. The majority of maize is distributed in the form of grains at high moisture content (30 to 40 percent) in the rainy season or low moisture content (18 to 25 percent) in the dry season. Maize is transported at high moisture content from farm to collecting traders, and at low moisture content from collecting traders to agent, feed industry and other end consumers.

The potential losses at each step of the postharvest operation are similar to Central Lampung (Table 3-8). There is an additional possible loss due to careless operators running the power sheller when maize grains are mixed up with foreign materials from the ground cobs or earth. Total possible loss along the postharvest chain is 13 percent.

Figure 3-6. Maize supply chain in Tuban District

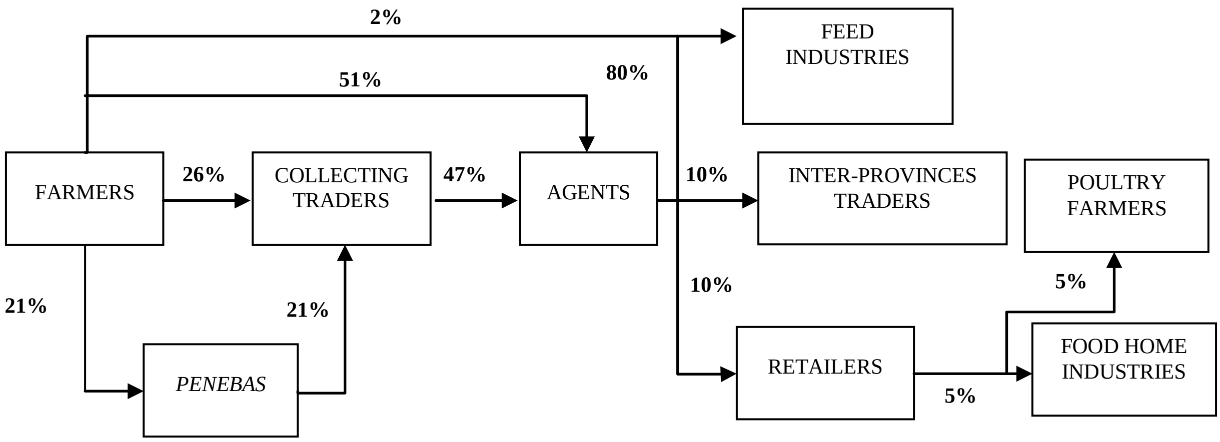


Table 3-8. Potential PHL in maize in Tuban District

Postharvest operations	Losses, dry matter	Reasons
Harvesting	<0.7% 3%	Cobs left on the field Foreign materials
Sun drying	3-5%	Delay of drying
Mechanical drying	<0.1%	Loading and unloading
Shelling at high moisture content	1-2%	Foreign matters mixed with grains
Shelling at low moisture content	<0.1%	Grains left on the cobs and in working areas
Packaging	Not significant	
Transportation of cobs	Not significant	
Transportation of grains	0.5-1%	Spilling out of damaged secondhand bags
Storage in small warehouses and at famers	2%	When stored longer than two months

The cost and price of maize in Tuban is presented in Table 3-9. The highest cost is paid by agents linking collecting traders (in villages) with retailers (in urban areas). Farmers pay the smallest transportation cost, usually from the farm to the road side, where the collecting traders are already waiting with their vehicles.

Table 3-9. Distribution costs and prices of maize in Tuban District (in IDR/kg)

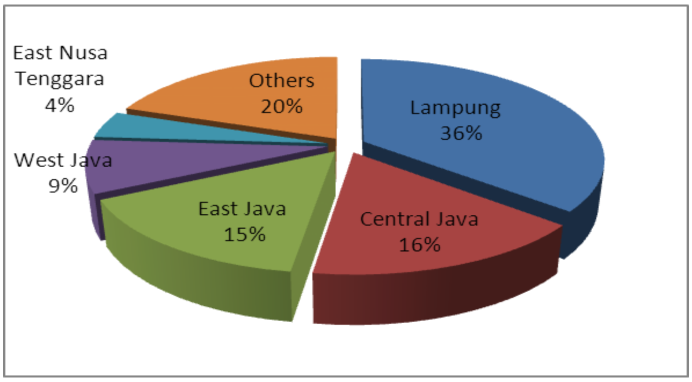
Postharvest Operations	Actors in supply chain			
	Farmer	**Collecting trader**	**Agent**	**Retailer**
Harvesting	7 – 12			
Shelling	40	30		
Sun drying		40		
Transportation	10 - 16	15 – 20	140 – 220	20 – 50
Storage for longer than 2 months		30	30	30
Procurement		2,000 – 2,350	3,000 – 3,100	3,300 – 3,500

Institutional support is provided by farmer groups, Gapoktanand farmer cooperatives. Tuban has an average five to eight Gapoktan in each sub-district.There is no UPJA for maize postharvest services, but there are a few individual private agricultural machinery services. Postharvest equipment that is used in the field are maize power shellers and winnowers. The maize sheller usually comes in the form of a multipurpose thresher that can be used to thresh rice, shell maize and thresh soy beans. Large scale collecting traders and agents also have their own maize sheller. Several large scale collecting traders also own mechanical dryers and good quality warehouses.

3.3 Cassava

Lampung, Central and East Javaare major production areas for cassava in Indonesia. Within those provinces, Central Lampung District (Lampung Province) and Pacitan District (East Java) were chosen for the survey. Cassava developed into a major crop in Central Lampung due to the growing tapioca industry. In Pacitan, it is regarded a secondary crop in multiple cropping.

Figure 3-7. The major production centres of cassava in Indonesia



Source: Ministry of Agriculture, 2011

In Central Lampung, cassava harvest is generally done manually by pulling out the cassava stem along with the roots. In the rainy season the soil is softer and manual harvest encounters no problems. However, in the dry season farmers are forced to use leverage to dig the soil around the plants. Harvesting is usually done by farm workers in a group of five to eight persons with the capacity of harvesting two tons per day.

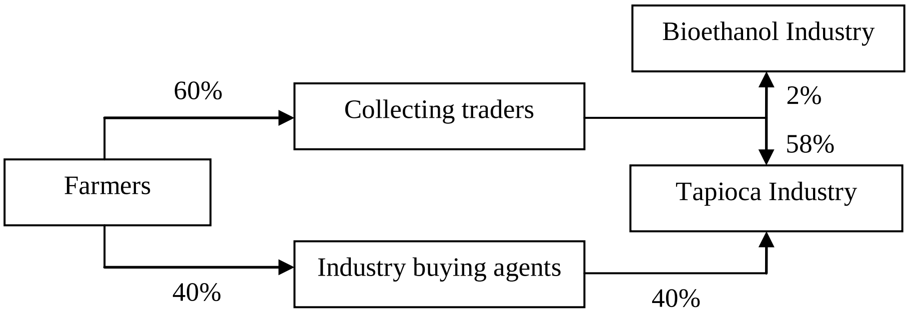
PHL is measured from the wet cassava mass weighed by farmers right after the cassava is uprooted. In this condition, farmers include soil and foreign matter in the yield. Cassava harvest losses are influenced by the season: the average cassava loss in the rainy season is 0.01 to 0.05 percent, while in the dry season it increases to one to three percentdue to broken roots being left uncovered in the earth during hand pulling. Losses in the temporary pool site refer to the vaporization of moisture content from fresh cassava roots. Even though thereis commonly onlya delay of one to two days, the weight difference may amount to 7 to 15 percent. Quality checks performed by the receiving industries deduct a significant percentage (8 to 35 percent) from the weight of cassava. Immaturity due to early harvest adds to the losses (Table 3-10).

About 60 percent of cassava production is sold to collecting traders, 40 percentdirectly to the tapioca industry through industry buying agents, who work as freelance matchmakers between farmers and industry. The collecting traders also sell the roots to the tapioca industry (58 percent) and bioethanol industry (2 percent).Pick-up vehicles with a capacity of six to seven tons are used by collecting traders totransport the cassava roots from the farms to a temporary pool site. The collecting traders will further carry the cassava in dump truckwith a capacity of 12 tons from the temporary pool site to either the tapioca or bioethanol industry. As shown in Figure 3-8,98 percent of cassava production is consumed by the tapioca industry.The costs incurred in the cassava supply and distribution chain are described in Table3-11.

Table 3-10. Postharvest losses of cassava in Central Lampung

Postharvest operation	Losses	Reasons
Harvesting	0.5-3%	Broken roots left in earth; uncovered roots during dry season
Transportation	0%	
Delay in the temporary pool site	7-15%	Delayed by 1-2 days, losses incurred mainly due to moisture content reduction
Quality checks by receiving industry	8-35%	Weight losses due to subtraction of soil and foreign matters, and/or cassava maturity

Figure 3-8. Cassava supply chain in Central Lampung



Picture 3-6. Cassava harvesting, cutting the roots from the stem, temporary pool site and dump truck carrying cassava to tapioca industry

Table 3-11. Costs and pricesalong the postharvest chain of cassava, Central Lampung (in IDR/kg)

Sources	Actors in Cassava Supply Chain				Remarks
	Farmer	**Collecting trader**	**Industry Buying Agent**	**Processing Industry**	
Harvesting	35 – 45	40			Harvesting and loading to vehicles
Pitching the farmers to industry			25		Paid by the tapioca industry
Transportation to temporary pool site	30	30			
Transportation to processing industry		30 – 85			Depends on distance from farm to industry. Industry pays the cost for contracted collecting traders
Procurement Price		600 – 700	600 – 700	800 – 900	

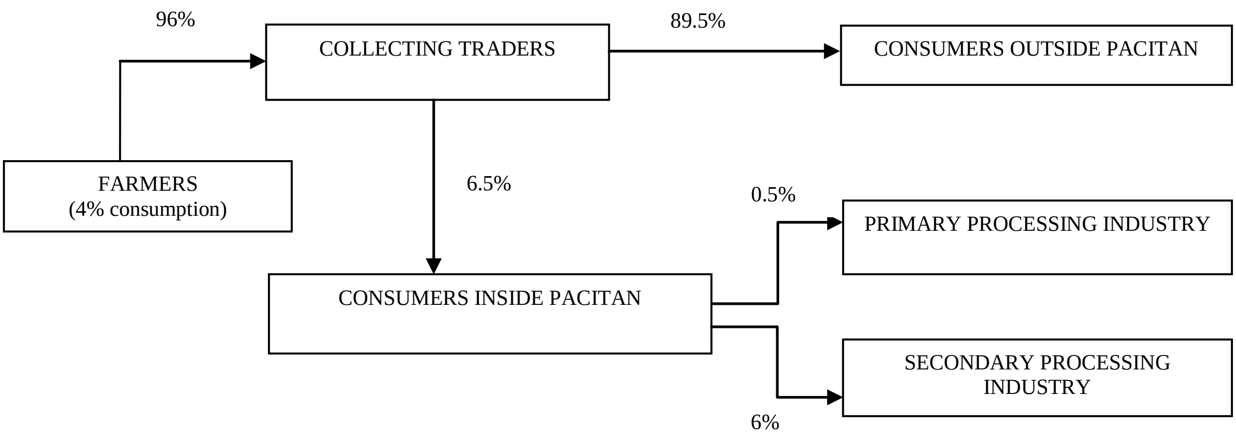
As fresh root production has been well adsorbed by the tapioca and ethanol industries, the government has no programsfor the cassava postharvest handling system. Competition to purchase fresh cassava roots is high with the large scale and modern tapioca and bioethanol industry outwitting the small scale tapioca industry. Most cassava farmers in Central Lampung sell the roots fresh, so there is no value added by them. Another cassava processing industry is a pellet feed plant, but it is forced to purchase fresh raw material from other provinces such as Central and East Java.

Similar to Central Lampung, cassava harvest in Pacitan District is done by hand with hoe and fork. Farmers bring the cassava from the farm to the road in bamboo baskets balancedon their shoulders. From this point, the collecting traders or processors transport the fresh roots using pick-up or truck, depending on purchase volume.

As illustrated in Figure 3-9, most of the cassava (96 percent) is sold as fresh roots directly from the farm to the users, within Pacitan District (6.5 percent) or to other districts or provinces (89.5 percent). The processing industries in Pacitan consist of primary processing industryfor dried cassava chips, gaplek (dried cassava cuts) and tapioca, and the secondary processing industry for snack foods.The remaining four percentof cassava production are consumed as staple food by the farmers, mainly in the tapioca home industry. In this pattern ofpostharvest chain, PHL is a maximum of three percent during harvesting and less than 0.2 percentduring transport.

Picture 3-7. Tapioca processing in the home industry: Peeled cassava, settling and sun drying the starch

Figure 3-9. Supply chain of cassava in Pacitan



The costs and pricesalong the postharvest handling chain of cassava in Pacitan are described in Table 3-12. Data shows that even though the price at the collecting trader level remains relatively stable, the price at the processor level fluctuates highly. It can therefore be assumed that collecting traders, not farmers, gain a potentially large margin. In the low season of cassava production, the collecting traders increase the selling price. If the farmersspread planting over the year, there would be no peak and low season of cassava.However, they have no incentive to do so as their income remains the same at low or peak season.

Table 3-12. Costs and pricesalong the postharvest cassava chain in Pacitan (in IDR/kg)

Sources	Actors in Cassava Supply Chain				
	Farmers	Collecting Trader	Primary Processor	Secondary Processor	Remarks
Harvesting	20				Includes carrying cassava to the road
Transportation		100	25	25	
Procurement		450 – 500	1,000 – 1,500	1,000 – 2,000	Primary and secondary processing industries

Yield and costs of producing primary processed cassava are shown in Table 3-13. Among them, cassava chips requirethe shortest manual processing time, while gaplek requires longer manual processing time. Tapioca production requires processing equipment and thus some investment.

Table 3-13. Yield and costs of primary processed cassava in Pacitan (in IDR/kg)

Cassava products	Yield (kg/100kg fresh cassava)	Cost of operation(IDR/kg product)	Sale Price (IDR/kg product)	Gross Margin (IDR/kg product)
Cassava chips	6	690	3000	2310
Gaplek	35	590	1000	410
Tapioca	10	1100	9000	7900

The regional government often provides extension to Pacitan farmers for growing cassava on margin land. In 2012, the regional government plans to open a 100ha pilot project for cassava plantation to supply the primary and secondary processing industries in and around Pacitan District. The start-up and growth of small scale industries for primary and secondary processing in Pacitan District is also encouraged by the regional government program. However, small scale industries commonly face problems in competing with middle and large industries to purchase fresh cassava roots during the low season. In light of this, the pilot project of the regional government in 2012 may provide a solution for the small scale industry.

3.4 Recommendations

Having analyzed the current postharvest chains of rice, maize and cassava in Indonesia, including the various players involved, losses, costs of production and institutional support, the following recommendations are made:

Rice

- In Karawang, West Java,future development should be directed at an increased use of flatbed dryers to improve the quality of dried paddy at farmer and small RMU level. A shift from manual harvesting and threshing to use of reaper and power threshers is urgently required, even though this may face resistance from contract farm workers.
- In Bone, temporary storages with appropriate design should be constructed in the market area to avoid possible losses if grains are stored for longer than one month.
- Large RMUs may consider the implementation of fully automatic rice milling machineries to compete with imported premium rice.

Maize

- The use of power shellers and mechanical dryers should be encouraged among farmers, collecting traders and warehouses to guarantee prime quality of maize and maximum income for the actors along the chain.
- The government, both central and regional, should provide guarantee credits for the Gapoktan and UPJA to facilitateinvestment in power shellers and mechanical dryers.
- It is suggested that extension workers reinforce efforts to inform farmers in Central Lampung on how to regulate the cropping between maize and cassava so that an optimum balance between the two commodities is created and price falls, which lead to lack of farm incomes, are avoided.

Cassava

- In Central Lampung, where the large scale tapioca industries purchase most of the fresh cassava roots, there isonly small room for postharvest handling recommendations.
- In Pacitan, if the development of the 100ha pilot project for cassava production is successful, the establishment of small tapioca industries with a capacity of 10 tons of fresh cassava per day and their use of machinery, e.g.for washing and peeling, grating or wet grinding the roots, water mixing, filtering, separating starch from water, dryingand dry grinding, should be encouraged.

4 Laos

Agricultural production in Lao PDR is predominantly based on traditional production systems. Most of the supply chains are inefficient multi-tier chains. Products change hands many times before finally reaching the end-users. Postharvest technology is poorly developed. Improper handling of agricultural produce after harvest often results in quality deterioration and significant economic loss. PHL in Laos have been reported to vary between 20 and 30 percent. In some instances, the figures can exceed 30 percent, depending on the handling and distribution chain which variesamong different regions. PHL can be attributed to several factors, however, improper handling and packaging, low-level technology, lack of basic equipment and facilities or packing houses and lack of trained personnel are large contributing factors.Hence, the postharvest handling chain of a commodity should be evaluated in a holistic manner in order to identify the causal factors in PHL and to provide appropriate control measures.

For the study of PHL in Lao PDR, three commodities were selected, i.e. rice, maize and cassava, of which Laos produced 3.1, 1 and 0.5 million tons, respectively, in 2010 (MAF, 2011). The study was conductedby the National Agriculture and Forestry Research Institute (NAFRIA) of the Ministry of Agriculture and Forestry in Laos. Initially, a desk reviewof previous studies in postharvest operations of rice, maize and cassava in Laoswas carried out, including policy, economic and technical aspects. For the field survey, a total of sixlocations were selectedaccording to their importance in the production of the given commodity: Thoulakom and Paksan Districts (Vientiane) for rice PHL; Hun District (Oudomsay Province) and Paklai District (Xayaburi Province) for maize; Vientiane Capital and Pakading District (Borikhamsay Province) for cassava (see Map 4-1).

Focus group discussions (FGD) were organized by coordination with the local agricultural authority. The participants of FGD were farmers/farmer groups, collecting traders/wholesalers and the processing industry. Respondents were selected by purposive sampling to cover the whole supply chain of rice, maize and cassava. Respondents were interviewed by the team members based on a structured questionnaire developed for the purpose of this study. Interviews were also conducted with the partner institutions in Vientiane such as the Department of Agriculture of the Ministry of Agriculture and Forestry and the National Statistics Centre. Observations were made on PHL, the technology and machinery applied for postharvest handling and operations, technology transfer, the support system, current problems and the requirements for future development.

Map 4-1. Project sites, Laos

4.1 Rice

In the wet season, the rain-fed (monsoon) rice crop is planted from late April/May, with the start of the rainy season, and harvested from October to early December. This represents over 80 percent of the annual paddy output. There are two rice production systems during the wet season: lowland and upland. About 75 percent of the annual area under paddy is lowland. While supplementary irrigation is widespread in the major paddy-producing provinces, there would appear to be still a lot of scope for expansion in this area with the use of appropriate structures such as diversion weirs and pumps.

Upland paddy crop is grown on slopes using shifting cultivation. The system is based on a low input, low output technology. Yields from upland paddy are highly variable, depending on soil quality in the uplands, but generally they are below 2t/ha. In recent years, provincial authorities have been trying to limit shifting cultivation in the interest of forestry conservation and reduced soil erosion, but results are mixed.

In the dry season,planting of the irrigated dry season paddy crop starts after the harvesting of the wet season in late November/December and the crop is harvested in April/May. Higher yielding varieties are used and yields are generally above 4.5t/ha. Although dry season irrigated paddy occupies only 12 percent of the country's total paddy area, it provides about 17 percent of the country's production. The Government has been encouraging increased dryseason irrigated paddy production for some time. However, the area under dry season irrigation remains small relative to its potential due to lack of capital investment in repairing and upgrading existing irrigation. Two provinces, Savannakhet and Vientiane Municipality, account for almost half of the country's dry-season irrigated production, Savannakhet producing more than 27 percent and Vientiane Municipality more than 20 percent.

The dry conditions at the beginning of the 2010 season led to some significant areas of planted land not being harvested. However, significant areas were also lost in 2009 as a result of flooding, so comparatively speaking, the 2010 national harvested paddy area is only marginally down from that of the last year. Significant changes (in terms of percentage though, not in absolute terms) were seen in wet-season upland paddy areas in Vientiane Municipality (survey areas) and in the south. In Vientiane Municipality upland production, which accounted for 5,540 ha in 2009, was reported to have been eliminated in 2010. On the other hand, the harvested upland area in the south increased this year by almost 50 percent from 7,600 to 11,240 ha.

Nationally, both lowland and upland wet-season rice yields were lower in 2010 than in 2009, with reductions of five and eight percent, respectively. The overall national average yield for both wet and dry seasons is expected to be 3.46 t/ha, down by four percent on the previous year's 3.61 t/ha. Yield reduction was greatest in upland rice in the south, with a 24 percent drop from 1.72 to 1.31 t/ha. Wet-season yields in the north did not change significantly from 2009, and indeed some provinces even registered a slight increase. Similarly, yields for the dry-season irrigated crop are expected to be virtually unchanged from 2009/10 in the north and centre, while in the south, because of low water levels in many streams following the poor and erratic rainfall this year, average yields are expected to be lower than those of last year.

National rice production, including the forecast for the dry season of 2010/11, is at 3.006 million tons, expected to be down by 6.2 percent on the 3.205 million tones achieved in 2009/10. Factors contributing to this reduction include: the reduced wet-season upland area in the centre; the reduced wet-season upland yields obtained in the south, and the anticipated reduction in yields in the south in the current dry season.

In Thoulakhom and Paksan Districts, the locations in the Vientiane Plain selected for the analysis of the rice postharvest handling system and PHL, rice farmers plant and harvest the paddy twice a year. The peak harvest season are usually the rainy months of October and Novemberand the second harvest is during the dry months of March and April. The distribution of irrigation water limits the planting to two times a year. Rice production follows traditional methods and productivity is low, around four to five tons paddy (19 to 20 percent moisture content wet basis) per ha. But this is above the national average of three to four tons paddy per ha, so that rice farmersin Thoulakhom and Paksan enjoy a higher income compared to areas producing lower yield.

PHL incur at all stages of the postharvest system. During harvest already, early or unexpected rains or a labor shortage can lead to spoilage. In the rainy season, paddy is generally harvested at a high moisture content of 22 to 27 percent, because farmers often practice early harvesting. Harvesting usually incurs two to three percent losses.During drying of cut paddy, which takes about two to three days, fungi develop due to rains or rodents and birds damage the production. Drying in the field incurs losses of approximately 10 percent during the milling process when poor paddy quality leads to breaking of grains.Where the drying was less good, this figure increases to about 14 percent. While there is a good rice milling design available from Thailand, the recovery rate is low at 55 percent. Furthermore, poor maintenance and hygiene in milling, as well as under-investment in milling facilities leads to losses at this postharvest stage.

When farmers practice manual threshing by beating the paddy to a wooden triangle on the paddy fields, this contributes to another four to five percent of losses. Mechanical threshing, used by most farmers, could reduce the losses to around one to two percent. But threshing suffers from a low efficiency of threshing machines.Transportation of grain to the next postharvest player is done in plastic bags carried by hand, tractors or trucks. Reported losses range between two and eight percent. As to storage, most farmers are found to keep rice in their own rice storage, which again leads to PHL: storage at high moisture content facilitates the development of fungi and leads to a low germination rate for seeds, and birds, rodents and insects further damage the seeds. Total grain loss is therefore estimated to amount to approximately 20 percent.

Picture 4-1. Manual rice harvest and threshing in Laos

In terms of institutional support, there are government programs which support the rice farmers by promoting agricultural inputs for rice planting, supporting production related technology transfer and providing agricultural credit schemes for farmers, groups of farmers and agribusiness development. A few years ago, NAFRI implemented a project to support the use of postharvest equipment by farmer groups in the provinces of Vientiane, Khammouane, Savannakhet and Champassack. Future NAFRI activities aim at improving and adapting the postharvest equipment and facilities to suit local farmer needs. Using more locally available materials is desirable to reduce costs. In addition, training is required for farmers, and opportunities for farmer exchanges and replication of success stories to other locations should be explored.

Picture 4-2. Rice harvest machineand introduction of a new grain dryer and a modern rice mill



4.2 Maize

From being a crop for household consumption, maize production has developed to become one of the most important cash crops in Laos over the last decade. According to the Department of Agriculture, the total of maize planting area had increased from more than 130,000 ha in 2007 to nearly 176,000 ha in 2009. Maize production in 2007 and 2009 was 620,000 and 848,700 tons, respectively. More than 90 percent of the maize production is exported to China, Vietnam and Thailand, and the rest is consumed within the country.Potential yield ranges from four to five t/ha. With 56,735 ha of plant area, Xayaburi Province has by far the largest maize plantation. It is followed by Oudomxay and Borkeo province in which planted areas reach 34,530 and 20,715 ha, respectively.

Paklai District (Xayaburi Province) and Hun District(Oudomxay Province) are two major maize production areas in the country. Paklai produces maize for export to Thailand, whereas Hun produces for export to China. Maize farmers in these areas plant two maize crops a year. The first maize production is in the rainy season from May to August, and the second crop in late September to January. The farmers harvest and thresh maizemanually. Qualitative loss occurs when the maize is harvested too early or late. At early harvest, there is a high moisture content, which increases problems for drying and storage. Late harvest, on the other hand, risks spoiling the crop due to kernel sprouting and pest damage (e.g. rats in farm fields). Another reason for yield loss was that not all maize cobs had been harvested from fields.The farmers interviewed showed that the loss of maize amounts to approximately 5 to 10 percent of the total maize production, which is equal to 30 to 55 percent of total losses.

Drying of grain is performed by farmersand takes place either on the cob in the field or on the sun drying floor where the grains are spread with a thickness of about two to three cm. The drying will take three to five days, during which time the maize is unprotected from e.g. birds, free range chickens and rats.Only in some areas there are drying machines available which belong to the private sector or traders. During the drying process recorded losses ranged from 12 to 22 percent.

Traditionally, shelling the grain is done by hand, which, however,is very labor intensive. In addition, it has a low productivity of approximately 5 to 20 kg/hour. Some farmers therefore invented a simple tool for shelling using a bicycle wheel. Also, there are electric or fuel operated shelling machines available for farmers to hire at an extra cost. Their productivity ranges from 300 to 2,000 kg/hour, depending on grain type and size of the equipment.

Cleaning the grains is very useful, because it increases purity, reduces mould and insect development and avoids the propagation of weed seeds in the grain. Conventionally, farmers drop grains from a certain height and use the natural wind to remove dust and weed seeds. The shelling and cleaning process could produce physical grain damages. Small maize kernels will also be blown out with dust and weed seeds, which provides for weight yield losses. In this process, it is estimated that maize loss varies from 3 to 10 percent of overall grain loss.

Shortly after harvest, farmers sell the seed with a high humidity of 22 to 28 percent to local traders. Farmers always receive low farm gate prices, particularly for the rainy season crop, due to the lack of appropriate storage and postharvest technology such as dryers, which has a negative impact on the quality of maize produced.

Maize grains are packaged in plastic bags having a capacity of 40 to 50kg. Bags used by farmers and collecting traders are secondhand bags either from manufactured feed bags or fertilizer bags. Damaged secondhand bags may cause losses during transportation and loading.

In large maize production areas silo storage for many hundred tons of maize is available. In some upland areas, farmers heap maize cobs on the barns or maize cobs in sheaths are stringed and hanged about a fire place, especially for seed production. Traditional storage methods lead, however, to pest and insect infestations and fungi introduced mycotoxins and aflatoxin. Depending on the period of storage and the quality of the storage facility, maize grain or cob losses range from 10 to 30 percent of total losses.

Picture 4-3. Harvesting maize by hand, shelling with a bicycle wheel and traditional storage

PHL therefore occurred in all of the stages of the maize postharvest chain. Total yield loss was estimated by farmers to range between 5 and 15 percent of the whole maize production. The highest loss of maize occurred during the harvest process, which accounted for more than 55 percent of total losses. This is followed by storage and shelling.

At present, the private sector promotes a better postharvest handling system in Paklai and Hun Districts, e.g. by using better dryers and storage. The role of the private sector is therefore very important in reducing PHL.Since 2006, the government recognizes the importance of the postharvest system and encourages the private sector to invest in postharvest technology, such as drying and storage facilities for maize.

4.3 Cassava

Since 2007, in many countries, including Laos, cassava has been changing from a subsistence crop to a commercial crop. Farmers are nowadays not only growing varieties that are good for direct human consumption, but also those varieties that are high-yielding and with a high starch content suitable for the starch industry as well as for animal feeding. So far, there is no ethanol industry in Laos. Cassava production in Laos has been increasing rapidly for the past five years due to the need of raw materials in neighboring countries. According to the Department of Agriculture, cassava plantation, production and productivity were increasing dynamically year by year, especially since 2007. By 2010 19,940ha were planted with cassava and production reached a total of 500,090tons.

Pak Ngum (Vientiane Capital) and Pakading District (Borikhamsay Province) are now major areas of cassava production. A number of cassava processing plants have been constructed and operated in these areas, but the postharvest handling system of cassava is not developed yet. In the survey locations, cassava farmers manually harvest by pulling the cassava stem along with the roots. Losses are higher during the dry season. When harvested by hand or machine, the roots break and remain in the soil. Observation showed that although harvesting by machine is faster, it is less efficient than manual methods. Moreover, roots remain not only under but also on the ground, as farmers did not collect all roots when loading the trucks. Harvesting losses are estimated to be around 15 to 30 percent of total production.

After harvest, farmers sell the raw roots to the processing plants at a good price (about 400,000 to 500,000 kip/ton). Some farmers chop the cassava roots and dry them for two to three days in the sun to reduce humidity and save on transportation costs by selling dry cassava chips. Drying can incur high losses of between 15 and 20 percent if there is not sufficient sunshine during the cold weather period, there is sudden unexpected rain orfarmers are inexperienced.

Losses in the temporary pool site are due to the vaporization of moisture content from the fresh cassava roots. Even though the delay amounts usually to just one to two days, the weight difference may reach 5 to 15 percent. Quality checks done by the receiving industries cut a significant percentage (10 to 20 percent) from the weight of cassava. Immaturity due to early harvest adds to the losses.

In the survey locations mostly Hyundai pick-ups were used to transport the cassava. Some farmers own the pick-up and transport to the processing plants. But in most cases collecting traders transport the cassava roots by pick-up vehicle with a capacity of five to six tons from the farms to a temporary pool site. Collecting traders will further carry the cassava in dump truck with a capacity of 10 to 12 tons from the temporary pool site to the tapioca industry to facilitate loading and unloading, and to reduce transportation costs.

There is very little research on the cassava production chain and cassava PHL in Laos. However, primary data suggests thatlosses along the cassava handling chain, including harvest, transportation, drying, storage and starch processing, amount to an estimated 15 to 30 percent of total cassava production.

Picture 4-4. Cassava harvesting by hand and roots remaining in the soil

Picture 4-5. Transportation of cassava rootsand starch factory in Vientiane Capital

4.4 Recommendations

The Government of Laos has formulated a policy for mechanization and modernization of the agricultural sector in the Seventh Five Year Social Economic Development Plan (2011 to 2015). This includes a policy for postharvest technology development. But due to limits in the government budget, there is a need for more support from ODA and FDI. A shift from manual harvesting and threshing to the use of appropriate mechanisation and technologies is urgently required for all of the studied sectors. The following recommendations are made to improve specifically the postharvestsystems of rice, maize and cassava,and thereby reduce currently high levels of PHL:

Rice

- A national postharvest team with key members from public and private sectors (e.g. as a Learning Alliance) is required.
- Capacity building for farmer intermediaries(i.e. the Learning Alliance members) in the use of postharvest technologies should be provided.
- The drying operation is considered critical during postharvest and it is complementary to storage. Resources and efforts must therefore be used to implement this technology;
- Advocacy for decision makers (awareness and support) to re-start dryer technology transfer and provide appropriate policy for promoting and engaging with more manufacturers.

- Work on safe storage and local availability of hermetic storage systems should be undertaken, and seeking funding and implementing key activities are recommended.

Maize

- The use of appropriate sheller and mechanical dryer should be encouraged among farmers, groups of farmers, collecting traders and warehouses to guarantee maize quality and raise the incomes of those involved.
- Since maize is an important export commodity, there is a need for the government to improve the sanitary and phytosanitary measures to facilitate the export of maize.
- It is recommended that the Agricultural Development Bankprovides credit for the investment of purchasing more power shellers and mechanical dryers for farmer groups.
- Extension workers are suggested to intensively inform farmers to improve the cropping systems so that farmers can engage in sustainable maize production.

Cassava

- Further in-depth study of PHL in the cassava handling chain is needed to extend the understanding of process value and technology for reducing cassava losses.
- Farmers should be trained accordingly to have a better understanding of how the losses occur and how they can be prevented. E.g., since root losses are less than 2 percent if the harvest is sent to a factory within 48 hours, whereas losses exceed 30 percent or harvest is rejected altogether if not within 48 hours,farmers should be educated to make sure that sufficient transport and labor is available for swift transport right after harvest.
- Researchers and extension workers are suggested to carry out appropriate research in soil improvement and sustainable production systems.
- And more support from government policy to develop appropriate postharvest technology and reduce losses is recommended.

5 Philippines

The Philippines is apredominantly agricultural economy. It has approximately 30 million ha of agricultural lands which represents 47 percent of the total land area in the country. In 2010, the gross value added in agriculture excluding forestry reached P257.214 million (at constant 1985 price). It employs 11.96 million persons which represents 33.1 percent of the total employment in the country (BAS, 2011). Landholding is generally small (1 to 1.5 ha) and involves family labor. The produce is sold to traders/middlemen that serve as consolidator and transporter, sellingon to wholesalers and/or retailers.

The country had experienced a declining trend in crop production starting in 2008 until 2010 due to natural calamities such as strong typhoons and floods that hit the country, eventhough the area planted/harvested had been increasing by an average of 0.5 to 1 percent on a yearly basis between 2006 and 2010.In the fishery sector, increasing production had been attained reaching an average of 3.4 percent on a yearly basis during that same time.

Postharvest handling of produce starts from the time of harvestinguntil the commodity reaches the consumers. It involves various practices such as washing, sorting, packaging, transporting, etc. for perishables, while primary processing is undertaken for durables (non-perishables) to include drying, sorting, milling, depulping/dehulling, packaging and transport. The primary purpose of these activities is to make the product suitable to the consumers/manufacturers.

On the trader/consolidator side, the produce can also be sold to other traders more than once such that the transfer of produce from one trader to another becomes circuitous. This is the case especially if the producing areas are far from the intended market.At each of the points along the supply chain, losses are incurred due to the nature of the produce (perishable vs. non-perishable), improper handling and poor transport facilities. In 2001, the Department of Agriculture reported that postharvest losses in grains (rice and corn), fruits and vegetables reached 15, 28 and 40 percent, respectively.

Recognizing the importance of reducing such losses to enhance food stability without adding pressure on dwindling natural resources, the Philippines through its Philippine Development Plan 2011-2016 targeted the reduction of postharvest losses of six crops (NEDA, 2011). Implementing agencies are the Department of Agriculture (DA) and the Philippine Center for Postharvest Development and Mechanization(PHILMech) or the Bureau of Fisheries and Aquatic Resources (BFAR) in the case of the fisheries sector.

Table 5-1. Targets for PHL reduction in 6 sectors in the Philippines

Commodity	Baseline		Target (%)
	Year	Value (%)	
Rice	2008	14.8	12.4
Corn	2009	7.2	6.6
Fisheries	2008	25.0	18.0
Banana	2009	16.0	13.0
Mango	2009	30.0	24.0
Eggplant	2002	39.0	31.0

There are a number of institutions and programs to support technology transfer and adaptation for improving postharvest operations. The Department of Agriculture (DA) and Department of the Science and Technology (DOST) are the two government institutions that are on the forefront of research and development, technology transfer/adaptation and policy setting in agriculture from production to post-production activities. Various state universities and colleges are also undertaking these activities and provide assistance to these two government agencies. Furthermore, local government units are also mandated to conduct technology transfer/adaptation and provide assistance to their respective constituents.Moreover, private organizations such as commodity groups, farming/fishery organizations and cooperatives, and other non-governmental organizations also lend a hand in this endeavor, primarily focusing on the small farmers/fisherfolks.

The Department of Agriculture provides the necessary interventions for the various stakeholders in agriculture in order to increase productivity, minimize postharvest losses and establish an efficient marketing system with the primary aim of food sufficiency. This is achieved through various commodity programs, i.e. the Rice Program; Corn Program for corn and other root crops (cassava, etc); High Value Commercial Crops Development Program for fruits, vegetables, industrial crops and other commodities; Livestock Program for livestock and poultry; and Fishery Program for the fishery sector.Each of the programs developed a strategic plan, implemented through the DA-Regional Field Units and other bureaus/attached agencies(crop and animal programs) or BFAR(fishery program).

However, there remains the need to determine the amount of losses incurred at each stage along the supply chainand the causal factors. This is to identify stages along the supply chain that contribute the largest shares of loss and to thus develop appropriate measures/strategies to minimize the said losses both in quantity and quality. Hence, this study was conducted between December 2011 and April 2012 to provide baseline information on the amount of losses incurred at each stage along the supply chain on the major/priority crops grown in the country. These include grains (rice/palay and corn), fruits (pineapple and papaya), vegetables (tomato, eggplant and amplaya/bitter gourd), coffee and fish.

5.1 Rice

Rice, or palay, is the most important crop grown in the Philippines. Around 80 percent of Filipinos consume rice as a staple food. It is grown throughout the country under rainfed and irrigated conditions. The majority of producers are small farmers whose landholding is more or less one ha. In 2010 15.8 million tons were produced, of which around 75 percent came from irrigated areas where farmers can plant more than once a year. In terms of area harvested, a total of 4,354,000 hectares was harvested, with the irrigated areas accounting for 69 percent.On a regional level, Central Luzon, Western Visayas, Cagayan Valley and Ilocos Region were the top four producing regions which account for around half of total production and total harvested area in the country. The average yield obtained in 2010 in the various regions ranged from 2.65mt/ha in Central Visayas to 4.34mt/ha in Central Luzon with a national average of 3.62mt/ha.

For the study on PHL, the five major rice producing provinces in the country, i.e. Isabela, Nueva Ecija, Iloilo, Bukidnon and South Cotabato, were chosen. A total of 170 respondents were randomly selected among the three highest producing municipalities in the province. Respondents included farmers, traders/millers, traders/wholesalers, wholesalers/retailers.

Among the farmer respondents, 40 percent belong to farmers' organizations/cooperatives while the remaining 60 percent had no affiliation.Manual harvesting was the most common method practiced by the farmer respondents. Across the sampled provinces, harvestgenerally took place twice a year (76 percent), while 12 percent of the farmer respondents harvested once or three times a year.After harvesting, the rice was hauled either manually or with the use of animal-drawn sled to form a pile.

Picture 5-1. Manual harvesting of paddy rice in the Philippines, using a scythe

Picture 5-2. Hauling harvested rice manually or by animal-drawn sled

Piling of harvested palay was being done to facilitate the threshing operation. Almost all of the farmer-respondents (88 percent) practice piling after harvest. Some farmers used net underlays in piling in the field while others made rectangular small piles in the field.Threshing was generally done by farmers using a mechanical thresher. Underlays were used for easy collection of scattered and spilled grains.Threshers are among the postharvest equipment that was owned or rented by the farmer respondents. The majority (65 percent) rented a thresher, while 32 percent used their own.

Picture 5-3. Net used as an underlay on pile and small piles of harvested palay in the field


Picture 5-4. Threshing of palay and underlay used to collect scattered and spilled grains


Few of the farmer-respondents possessed an air blower (four percent) or mechanical dryer (one percent), which are important postharvest equipment to ensure good quality harvest and better recovery during the milling operation.Instead, the most common method of drying was sun drying (92 percent). Drying of the palay was normally done by farmers before selling to reduce its moisture content for better storability. 84 percent of the farmer respondents dried their palay either for home consumption (24 percent) or selling to traders (60 percent). The remaining 16 percent sold their palay immediately after harvest.

Picture 5-5. Sun drying on mats in field or in cemented area


In terms of marketing, 69 percent of the farmer respondents had their produce picked-up by the buyers in their place, while the remaining 31 percent delivered their produce to the point of selling and/or storage. In the former way, the transport cost and other attendant loss in transport were shouldered by the trader. A marketing strategy by traders/millers was to allow the farmers to use their warehouses as temporary storage area provided that they will be the one to buy the palay once the farmer decided to sell it.

Picture 5-6. Sacks of palay stored inside a rice trader's warehouse

In terms of losses, farmers mentioned that quantity losses during harvesting were due to the shattering of grains from the panicle (78 percent of respondents) and unharvested or spilled panicles (25 percent). The underlying reasons were inherent characteristics of the variety (46 percent),unskilled labor (44 percent), or the unscrupulous practice of harvesters to intentionally leave panicles which they would gather later or labourers being in a hurry so they could still harvest on other farms, and late harvesting (4 percent). As with harvest, the major source of losses during piling (73 percent of respondents) was the shattering of grains during the operation due to the carelessness of the harvesters in handling the cut palay stalk. On the other hand, 20 percent reported no losses during this activity.

Losses in threshing can be traced to the inefficiency of the threshers and/or condition of the palay during threshing. More than half (59 percent) of the farmerrespondents mentioned that losses occurred either when good grains were blown away and mixed with the chaffs or when good grains were not threshed and went with the spent stalks (38 percent). Other than the inefficiency of machines, losses during threshing can also be attributed to the practice of threshing immediately even if grains had high moisture content to take advantage of the high price when supply was low in the market. As to drying, the sources of losses were spilled grains that could not be recovered(42 percent of respondents)and those eaten by animals (54 percent). Only a few farmer respondents (9 percent) experienced losses during marketing of their produce. This occurred only when sacks containing the palay had holes in it.

Quality losses were experienced during harvesting when panicles were submerged in water for a prolonged period lasting for several days. During piling, quality losses happened when there was prolonged inclement weather immediately after harvesting. Piling enhanced heating of the grains thereby hastening their deterioration. Furthermore, threshing with high moisture content of the grains resulted in a high mechanical damage which addsto loss in quality of product. Moreover, discoloration of palay had a corresponding quality loss.

The data on losses (Table 5-2) was estimated and/or identified by the farmer respondents. Their answers were based on the last two cropping seasons of 2011 (wet and dry seasons). The percentage losses estimated based on fresh weight were transformed into percentage losses on a basis of dry weight of harvest. The major postharvest operations for rice consisted of harvesting, piling, threshing, drying and marketing. Storage of palay was generally not practiced by the farmer respondents, only a small portion was retained and stored for home consumption. The mean total loss from harvesting to marketing was 12.5 percent of the total weight of dry harvest. Across the five provinces, losses were highest in harvesting (4.9 percent), threshing (4.1 percent) and piling (2.1 percent).

Table 5-2.Quantitative palay losses of farmers (in % of dry harvest)in surveyed provinces

	Nueva Ecija	**Isabela**	**Iloilo**	**Bukidnon**	**South Cotabato**	**Mean**	**Share of total**
Harvesting	6.60	4.79	3.53	2.28	7.06	**4.85**	39
Piling	4.17	2.27	1.21	1.41	1.21	**2.06**	16
Threshing	3.52	2.82	2.92	2.89	8.23	**4.07**	33
Drying	2.08	1.62	1.16	1.29	1.34	**1.5**	12
Marketing	0.09	0	0	0	0.09	**0.04**	trace
Total	**14.46**	**11.50**	**8.82**	**7.87**	**17.94**	**12.52**	100

These data deviated from previously reported loss figures since the estimates provided by the farmer respondents in almost all of the sampled provinces were influenced by the damages brought by the strong typhoons like “Pedring” and “Quiel” that hit the country in 2011 during the harvesting seasons. In addition to the inclement weather, there was a lack of labour during the harvesting period since neighbouring farmers were also busy on their own farms trying to save what was left after the calamity. The results showed the vulnerability to high losses due to high rainfall as shown by the relatively high farmer respondent estimates on losses at farm level involving harvesting, piling and threshing operations.

Compared to previous studies, a relatively lower loss estimate was given for the drying operation. This is explained by the growing practice of traders to buy wet palay, leaving only a small manageable portion (10 to 34 percent) of the total palay harvest with the farmers to dry primarily for home consumption.

The loss in quality was indicated in terms of reduction in price of palay. The data presented in Table 5-3 was also estimated by the farmer respondents based on their experiences.Buyers reduced the buying price of affected palay, depending on the degree of quality deterioration. Other buyers charged a “reseko” (less weight of 3 to 5 kg/sack) from the total weight. It was also observed that the traders’ basis on what penalty to apply (reduction in price or reduction in weight) depends on where they will get a higher income. The final buying price depended on the final quality of rice. For this reason most of the traders and millers had their individual method of testing the resulting quality of rice before any buying price was settled between farmers and buyers.

Table 5-3. Estimated price reduction of palay due to reduced quality

Operation	Price reduction (in %, at USD0.39/kg*)	Weight reduction ("Reseko", in % of 50kg sack)
Harvesting	19.27	8.73
Piling	16.73	5
Threshing	7.53	0
Drying	11.13	5.53

*USD1= PhP43.00

Traders were generally involved in hauling palay from the farm to their respective warehousesfor drying, storing and marketing, while millers/wholesalers were involved in milling, storage, distribution as well as drying.The majority are wholesaler/retailers who handled milled rice sourced from the farms within the municipality and the province to market it locally.

The fresh harvests purchased by the trader/miller respondents were sun dried using drying pavements or cemented roads/highways (80 percent of the respondents), on which the palay were spread two to three cm in thickness and left under the sun for four to six hours. Traders based on barangay (village equivalent) level directly purchased from farmers. Since the trader-respondents interviewed were classified as municipal- and provincial-based traders, most of them handled already dried paddy coming from the barangay-based traders.

Picture 5-7. Sun drying of palay on a multipurpose drying pavement

Table 5-4 shows the quantity of losses estimated by the trader/miller respondents. Among the postharvest operations, loss due to drying was the highest with 4.4 percent of the total volume traded by traders/millers. This represents 93.5 percent of the total loss experienced by the trader/miller respondents in their postharvest operations.

Palay storage duration ranged from half a month to three months in the warehouses of traders/millers, and losses were attributed to infestation of rodents, feeding of birds and other storage pest. As far as milling losses were concerned, traders/millers considered them minimal since spillage could be retrieved and reprocessed. For small millers, they used either a stationary or mobile single-pass rice mill, while the big millers use a multi-pass rice mill. The former rice mill resulted in a higher percentage of broken grains, whereas the latter mill produces better quality grains being whole and well-polished.

Table 5-4. Quantitative palay losses of traders/millers

Operation	Quantity Loss (in % of total weight traded)	Share of total loss (in %)
Hauling	0.28	6.0
Drying (sundrying)	4.33	93.5
Storage	0.02	0.4
Milling	Trace	Trace
Total	**4.63**	**100**
Stored milled rice	2.61*	

*Based on percent total weight of stored rice

Picture 5-8. Different types of rice mill: stationary single pass, mobile single pass and multi-pass rice mill

Table 5-5 shows the total estimated losses incurred along the supply chain, amounting to 16.8 percent. The highest loss occurred at the farmers' level accounting for 71 percent of the total loss.At trader/miller level, accountingfor 29 percent of total loss, most loss occurred at drying. In terms of value, losses after harvest amounted to 826 t/ha, valued at USD322.14.

Table 5-5. Summary of palay PHL

Stakeholder	Operation	Loss (in %)
Farmer		
	Harvesting	4.85
	Piling	2.06
	Threshing	4.07
	Drying	1.05
Trader/Miller		
	Hauling	0.28
	Drying	4.33
	Storage	0.20
Total		**16.84**

5.2 Corn

Corn is the second most important grain crop grown in the country. There are two general types of corn being grown in the country: yellow corn used for feeds in the livestock and poultry industry and white corn used as staple instead of rice in the Visayas and Mindanao areas. It is grown throughout the country mostly in rainfed areas. The majority of producers are small farmers whose landholding is around one ha. From 2005 to 2009 total production increased at an average 8.4 percent per year. However, a decline in production was observed in 2010 brought about by natural calamities and crop shifting to other crops such as cassava, sugarcane, pineapple, banana and pineapple. White corn contributed almost 66 percent to total production, yellow corn the remaining 34 percent in 2010. In terms of total area harvested, a similar trend was observed: the area harvested for yellow corn had an increasing trend from 2005 till 2008 due to high demand and market prices, but started to decline thereafter. For white corn, total harvested area declined from 1.49 million ha in 2005 to 1.34 million ha in 2010 (BAS, 2011). This was attributed to the shift of production areas to yellow corn and other crops.

On the regional level, Cagayan Valley, Northern Mindanao, SOCCSKSARGEN and ARMM were the top four corn-producing regions which accounted for 68 percent of total production and 58 percent of total harvested area. Average yield obtained in the various regions ranged 0.83 mt/ha in Central Visayas to 4.76mt/ha in Ilocos Region, with a national average of 2.55mt/ha. Survey work was undertaken in the same provinces as for rice, i.e. Isabela, Nueva Ecija, Iloilo, Bukidnon and South Cotabato. Except for Nueva Ecija, those provinces belong to the top corn producing areas in the country. A total of 85 respondents, consisting of 63 farmers/producers and 22 traders/wholesalers,were selected randomly in the three highest producing municipalities in each province.

In Nueva Ecija 75 percent of farmer respondents planted corn once a year. This was part of their cropping system in the rainfed lowland rice growing areas where rice was planted during the rainy season followed by another crop with a lesser water requirement than rice. For the rest of the provinces, corn was planted in upland rainfed areas. For Bukidnon and South Cotabato, farmers could plant three times in a year due to a favorable weather pattern in these areas which meant an even distribution of rainfall throughout the year. As for rice, the majority of the farmer respondents (62 percent) were not members of any farming organization/cooperatives.

Nearly all farmers practiced manual harvesting. Only three percent had been renting a corn combine to harvest and shell their corn. Harvesting was done by detaching ear corn, with or without husk, from the plant and placing it in a collection basket to be transferred by an animal drawn-cart for transport to the piling area.

Picture 5-9. Manual harvesting of corn ear and with help of bamboo basket for collection

Almost all of the farmer respondents (97 percent) practiced piling after harvesting and before shelling. This was done to facilitate mechanical shelling, which was practiced by all farmerssince corn kernel is the one being sold/traded in the market. The majority of farmers scheduled their shelling operation on the availability of dryer to be used. A quarter of farmers rented a dryer, 56 percent owned a dryer and a few farmer respondents used blower (6 percent) and mechanical dryer (11 percent). For those that rented shellers, corn cobs were piled in areas that would be readily accessible to the service provider of the mechanical sheller and/or near a drying pavement to facilitate immediate drying.

Picture 5-10. Hauling harvested corn ears and piling in a shelling area

Picture 5-11. Corn shelling with 2 kinds of shellers: hopper at the side and on top

Nearly 80 percent of farmer respondentsdried their corn kernels after shelling and before selling. The common practice of drying was by sun drying (73 percent), either using an underlay or roadsides and available pavement. Mechanical dryers were used by 6 percent. 21 percent did not conduct any drying as they sold the corn immediately after harvest.In terms of marketing, 65 percent had their produce picked up by the traders, the remaining 35 percent delivered their produce to the trader for sale.

Picture 5-12. Sun drying corn kernel on barangay road, major highway and concrete pavement

Quantity loss during harvesting was in the form of unharvested and/or spilled ear corn, which occurred for 73 percent of farmer respondents. The major causefor quantity loss – multiple responses were possible – was the kind of work delivered by hired labourers (59 percent of the farmer-respondents), the variety grown (8 percent) andlate harvesting (5 percent). Some labourers would intentionally leave the corn ear on the plant or on the ground to pick up later when hauling of harvest had been completed by the owner.During piling almost half of the farmer respondents (49 percent) reported no losses. Where losses occurred, these were attributed to the shattering of the kernel (42 percent of respondents) and consumption by animals (46 percent).

Three quarters of farmers, however, recognized that losses occurred during the shelling operation. These were attributed to unshelled grains coming out with the spent cobs (46 percent of respondents) and the mixing of good grains with the spent cobs (37 percent). The shelling loss could also be due to inefficient and/or depreciated machines and the moisture content of the kernel. In addition, nearly half of the farmers reported quality losses during shelling. Nearly all farmers reported loss in quantity of corn during drying. The sources were spillage (47 percent of respondents) and consumption by animals while grains were being dried (49 percent).Similarly, loss occurred during marketing due to spillage, especially when old sacks with holes were used.

Overall quality loss was reported by 62 percent of farmers, mainly due to too much rain during harvesting which showed in discolored kernels. This kind of quality loss resulted in a price reduction of USD0.08/kg or 27.5 percent. During piling only one third reported a quality loss, again due to inclement weather, resulting in the discoloration of the corn kernels brought about by fungal growth. As to shelling, 41 percent experienced a quality loss, attributed to a high moisture content, which made the kernels susceptible to mechanical damage and resulted in a high percentage of broken kernels. During drying, the one third of farmers that reported quality loss reported kernel discoloration, which was brought about by the extended drying period during rainy days. At the marketing stage, the pricing of corn was based on the moisture content and the visible quality in terms of colour and cleanliness of the grains.

Table 5-6 shows the summary of the quantity losses during the various operations done by the farmer-respondents. The mean total loss from harvesting to marketing was 8.59 percent of total yield obtained per ha in dry-weight basis. From farmers' estimation, harvesting, shelling and drying were the operations with the highest losses, representing 37, 29 and 23 percent, respectively, of the total loss incurred by the farmers.

Table 5-6. Quantitative corn losses of farmers (in %) in surveyed provinces

	Nueva Ecija	**Isabela**	**Iloilo**	**Bukidnon**	**South Cotabato**	**Mean**	**Share of total**
Harvesting	3.80	3.43	2.24	0.97	5.63	**3.21**	37
Piling	0.67	1.29	1.18	0.42	0.35	**0.78**	9
Shelling	3.83	1.76	2.43	0.55	3.80	**2.47**	29
Drying	2.10	1.46	0.92	3.80	1.50	**1.96**	23
Marketing	0	0.07	0.01	0.38	0.38	**0.17**	2
Total	**10.4**	**8.01**	**6.78**	**6.12**	**11.66**	**8.59**	100

Quality loss was expressed as percentage reduction in price. Farmer respondents estimated the highest reduction in quality of corn during piling. Prolonged piling would reduce quality which translated into a 19.2 percent reduction in price due to discoloration, at a base price of USD0.30/kg wet corn. This was followed by quality loss during harvesting which was estimated at nearly 17 percent. The two typhoons during the latter part of 2011 that coincided with the harvesting periods damaged the quality of corn by soaking and causing grain discoloration. The quality losses due to shelling and ineffective drying could reduce price by 14.2 and 11.5 percent, respectively. On average, the reduction in price due to quality loss was 15.4 percent.Loss in quality was also valued by discounting the total weight ("reseko" in local terms) of corn per 60kg sack.

Table 5-7. Corn price reduction due to quality loss

Operation	**Price reduction (in %, at USD0.3/kg*)**	**Weight reduction ("Reseko", in % of 60kg sack)**
Harvesting	16.92	10.15
Piling	19.15	0.69
Shelling	14.15	0
Drying	11.46	7.54

*USD 1.00= P 43.00

Corn traders were the link between farmers and the major consumers of yellow corn. Most of the trader respondents (93 percent) were wholesaler/assemblers supplying local and institutional markets. Trader respondents purchased different forms of corn from the farmers, i.e. corn on cob (COC) with husk, COC without husk, wet-shelled corn kernel and dry-shelled corn kernel. 35.75 percent of trader respondents purchased dry-shelled corn kernels averaging 81.84 percent of their total purchase in a single season. For traders buying wet shelled corn (17 percent), they also did the sun drying operation.

The major operations undertaken by the trader respondents under the system followed by most of the farmers in selling dry shelled corn were: transporting the produce from farms to their warehouses, storage and transport. A negligible amount of loss occurred during hauling and sun drying. Since the volume of procured wet corn was relatively small in relation to the dry corn procured, quantity loss in drying was also considered low. For traders, pests such as rodents and weevil were the main source of losses during storage (2.7 percent).

Table 5-8 shows the total loss incurred in corn along the supply chain, as estimated by the survey respondents. It amounted to 13.07 percent of total harvest. It was on the farmer side where the greatest loss occurred, contributing to nearly 80 percent of total loss. The trader/miller had much smaller losses.With a national average yield of 2.55tons/ha (dry kernel), which the farmers sell to the traders, it was computed that the potential yield of farmers before harvesting is 2.78 kg/ton. This translated into a total loss of 330kg/ha along the supply chain from production to user of the commodity. At a price of USD 0.30/kg, this loss amounted to USD 99.00/ha.

Table 5-8. Summary of cornPHL

Stakeholder	**Operation**	**Loss (in %)**
Farmer		
	Harvesting	3.21
	Piling	0.78
	Shelling	2.47
	Drying	1.96
	Marketing	1.96
Trader		
	Hauling	Trace
	Drying	Trace
	Storage	2.69
	Transport	Trace
Total		**13.07**

5.3 Pineapple

Pineapple is the second most important fruit species grown in the country after banana, in terms volume of production and export. There are three varieties grown in the country: Smooth Cayenne, Queen and Red Spanish. The first two varieties are utilized for food, both fresh and processed, while the latter variety is utilized for fiber for cloth known as piña cloth. In addition, Smooth Cayenne is the primary variety cultivated by multinationals (Del Monte and Dole) in large plantation-type production system primarily located in Mindanao. In addition, it is planted by small farmers catering to the local markets. In 2010, 2.17 million tons were produced on a planted area of 58,550 ha (BAS, 2011).

On a regional basis, SOCCSKSARGEN, Northern Mindanao, CALABARZON and Bicol Region were the four highest producing areas. The two multinationals had their area of operationin the first two regions. For CALABARZON, Cavite and Laguna are the two main producing provinces, which cater Smooth Cayenne to MetroManila markets due to their proximity. Camarines Norte is the main producing province in the Bicol Region producing the Queenvariety for MetroManila and other local markets. In terms of area planted in 2010, SOCCSKSARGEN and Northern Mindanao accounted for nearly 40 and 37 percent, respectively, totaling 44,816 ha. Again, this was due to the operation of the two multinationals that sell fresh fruits to Japan, South Korea, New Zealand, China, Hongkong and Singapore, and process and export pineapple worldwide.

Northern Mindanao, Bicol Region and SOCCSKSARGEN were the top three yielding areas with 49.55mt/ha, 36.44mt/ha and 34.95mt/ha, respectively. Yield levels ranged from 5.0mt/ha in Zamboanga Peninsula to 49.55mt/ha in Northern Mindanao, with a national average of 37.05mt/ha.

The baseline survey was conducted in three production areas of pineapple: Cavite and Laguna for Smooth Cayenne variety, and Camarines Norte for Queen pineapple. The survey involved 48 growers, 6 wholesalers and 33 retailers.

According to the farmer respondents in Laguna and Cavite, their technology in production was based on experience, while in Camarines Norte most farmers were associated with cooperatives so that their technology and knowledge in farming were acquired through seminars held by their respective cooperatives/associations, Department of Agriculture (DA), Office of the Provincial Agriculturists (OPAG) and/or from the office of the Municipal Agricultural Officer. Farming organizations present in Camarines Norte include San Jose Pineapple Growers Association, Basud Coconut and Pineapple Cooperative (BACOPECO), Basud Federation of Pineapple Growers and Labo Progressive Multi-Purpose Cooperative (LPMPC).

As to farm size, it ranged from 0.25ha to 7ha with 62 percent of farmer respondents having 0.5 to 1.9ha. According to farmers in Laguna and Cavite, one ha of land could accommodate an average of 25,000 to 30,000 plants for Smooth Cayenne,while for Queen it was 30,000 to 35,000 plants in Camarines Norte. Multiple cropping with banana, coffee, other fruit trees, coconut, vegetables and agronomical crops (rice and corn) was practiced by the majority. Monocropping was practiced by 35 percent of farmer respondents. Farmers did not generally irrigate (98 percent), but relied on rain as a source of water for their plants, and more than half of farmers did not own draft animals, irrigation pump or other farm equipment.

The source of labor during harvesting of pineapple greatly varied depending on growing area. Laguna and Cavite growers usually hired laborers to help with both harvesting and hauling of fruits. In Laguna, some farmers were the ones harvesting and they only hired haulers. For Camarines Norte growers, harvesters and haulers were generally provided by the buyer and only a small percentage was family and hired labor.

Harvesting was done manually and maturity was based on the fruit's shell color. All respondents harvested the fruits when 10 percent of the shell color turned yellow. Harvesting usually started early in the morning. For Laguna and Cavite farmers, harvesting was done once or twice a week, only a small percentage harvested three times a week. These farmer respondents supplied fruits to the nearby markets of Tagaytay City in Cavite and Calauan in Laguna. In the case of Camarines Norte, harvesting was generally done once a week.The duration of harvesting depended usually on the availability of labor and the number of fruits available.

Farmer respondents were all aware that losses were incurred during harvesting. Perceived losses generally ranged from 1 to 5 percent, with about 40 percent of farmers reporting this amount of loss. But about 19 percent reported a loss greater than 20 percent. Average loss in harvesting amounted to 8.28 percent.Common causes of loss were damage by rodents (40 percent of respondents) and birds (24 percent), undersized fruits called "butterball" in the case of Queen pineapple (9 percent), mechanical damage (7 percent),theft (4 percent), sunburn and decay (3 percent each).

Sorting and grading were done by farmer respondents. For Laguna and Calauan, they usually had three to four classifications based on fruit size (large, medium, small and extra small). In Camarines Norte the buyers classified fruits according to size, either in five or eight categories. Some fruits were rejected during sortingdue to mechanical damage incurred during hauling of fruits from farm to collection center, but this only amounted to less than one percent.

Pineapple fruits were generally transported in bulk (by 92 percent of respondents). Others used bamboo baskets and sacks as container during transport. Generally losses were not incurred during transport. The road system was perceived by growers as good to very good (73 percent of farmers). This was probably the reason why losses were not incurred during transport.

For marketing, farmer respondents in Cavite sold their produce at their local market (Tagaytay), MetroManila (Nepa Q-Mart) and in nearby provinces (Batangas and Quezon). For Laguna respondents, buyers from the area, MetroManila (Divisoria, Pasig) and Bulacan were coming to them to purchase their fruits generally once a week. Camarines Norte farmers usually sold their produce in some nearby provinces in the Bicol Region (Albay, and Camarines Norte). Furthermore, they also sold their fruits to local traders, who sold the fruits in MetroManila markets (Balintawak, Divisoria, and Pasig). Aside from selling to traders and local markets, two of the farmers interviewed sold their produce directly to their cooperatives. The mode of pricing depended on fruit size. As mentioned earlier, there were four categories for Smooth Cayenne with a price difference of USD0.12 (P43.00=USD1) between sizes. In the case of Queen, pricing depended either on size alone or a combination of size and quality. For sizes 1 to 7, the buying price was the same which usually ranges from USD0.05 to 0.14 per fruit, while the undersize or butterball was bought at USD0.02 per fruit.

The farmer respondents experienced a number of problems in their farming system. 70 percent of respondents indicated that their problems were production-related. These included worm damage, rodent damage, weeds, death of plant and fruit cracking. Extra-technical constraints that affected their production system included high input costs, particularly for pesticides and fertilizers, and lack of financing. A small percentage of the farmer respondents indicated postharvest and marketing problems. Postharvest related problems include the incidence of mechanical damage due to rough handling and poor roads in the farms. Marketing-related problems cited by farmer respondents included the instability of market demand for pineapple and the low buying price.

The seven interviewed traders/wholesalers engaged in pineapple trading were also trading other fruits such as banana, papaya and mango. In the case of Cavite and Laguna-grown pineapples, trader/wholesaler respondents bought fruits directly from the farm and they paid the growers in cash upon purchase of fruits. Fruits were bought by piece and were priced based on size. In some instances when fruits were delivered by the growers, they were paid upon delivery of fruits. The volume of fruits bought varies between 1,200 fruits from Laguna and Cavite trader/wholesaler respondents, and 12,000 to 18,000 fruits on a weekly basis for those getting fruits from Camarines Norte. Fruits were loaded in bulk, without packaging, in jeepneys or pick-up type vehicles in the case of Laguna- and Cavite-grown fruits. In the case of Camarines Norte, trucks were the usual transport vehicle.

For trader/wholesaler respondents directly buying fruits at the farm, losses were incurred during transport, although the perceived loss was very low (less than one percent) due mainly to mechanical damage such as compression or bruising, attributed to rough handling during loading and unloading of fruits. Rodent damage was identified as a form of rejection or loss.

During wholesaling, loss was generally low. Trader/wholesalers indicated a range of 0.5 to 1 percent loss since the fruits were sold immediately upon arrival in the market. For those instances where fruits that were not sold stayed in the stalls for up to three days, losses were reported by wholesaler respondents to reach up to eight percent. The common causes of losses were the same as that encountered during transport, when mechanical damage in form of bruising and compression occurred. These damages became more prominent at the wholesale level. Overripening became a problem too when fruits were not sold immediately. And decay in the form of yeasty rot occurred due to mechanical damages incurred on the fruits.

Trader/wholesaler respondents identified various problems in pineapple trading and most of them were extra-technical in nature like delayed payment, polevaulting of growers (wholesaler advanced the cost of inputs) and transport problems like the long distance from farm to distribution centers.

Most retailer respondents procured pineapple one or three times a week. Their volume handled varied depending on market size and location. Only 6 out of 33 retailer respondents interviewed were solely selling pineapple. The rest were selling assorted fruits and vegetables. They usually purchased fruits directly from the farm in the case of the Cavite and Laguna-grown fruits. Others were buying them in the wholesale markets or trading posts particularly for Queen pineapple. Their selection criterion was based on size. They commonly transported the fruit by land using a tricycle (for nearby markets), which can load about 150 to 300 fruits of Smooth Cayenne and 300 to 400 fruits of Queen. Those buying in large quantities used jeep or vans in transporting the fruits. According to the retailer respondents, the fruits stayed on the shelf for two to five days, depending on the availability of other fruits in the market.

90 percent of retailer respondents reported that losses were incurred during retailing. They ranged from less than one percent to 20 percent, but most were between one and five percent. Losses were due to decay, overipening and mechanical damage in the form of bruising and compression. Overipening became a problem especially during the months when there were other fruits available in the market, like mango and melons. In some cases, retailer respondents who obtained fruits from Calauan experienced a problem called “kalamacho”, in which case the buyers returned the fruits demanding a replacement of the fruit. Fruits exhibiting “kalamacho” were hard when opened and the pulp was discolored (light to dark brown) with no extrnal manifestations. It could be determined by tapping the fruits, but required experience by farmers or retailers. Problems reported by retailer respondents were generally extra-technical in nature, the most common of which was low demand when other fruits became available.

An actual loss assessment was conducted in collaboration with a farmer in Camarines Norte and a trader supplying Queen pineapple fruits to a wholesaler in Balintawak market. Pineapple fruits were harvested manually and hauled to a collection area along the road using a carabao-drawn cart. Sorting of fruits based on size was done at the collection areas at the roadside. Fruits classified as marketable were then loaded in trucks and transported to

Balintawak market. Upon arrival in Balintawak, fruits were unloaded and piled for wholesaling. Sample fruits were then bought and delivered to two retailers for assessment of losses during the five-day selling period in wet markets in Laguna.

There were 18,000 standing pineapple plants in the collaborator's farm, but only 7,400 fruits, i.e. 41 percent, were considered marketable. The remaining 10,600 plants were not harvested and considered as field loss: 7,400 fruits due to decay, 3,000 fruits were undersized and 200 fruits were eaten by rodents and acted as bird nest. According to the farmer collaborator, this high incidence of field rejection was an isolated case since the farm was not properly managed due to limited resources during that particular season. Moreover, the unusually long rainy season during the growing period resulted in high disease incidence.

During sorting and sizing at the roadside collection area, there were fruits that were rejected, amounting to only 0.47 percent for being supersmall ("Buraot") in size. The truck arrived in Balintawak market ataround 9pm.After sorting and selling of fruits losses incurred were low, amounting to only 1.13 percent, due to compression and some fruits rodent damage. Losses at the wholesale level were expected to be low since fruits were immediately sold out.

Loss assessment at the retail level was done in Los Baňos, Laguna, in collaboration with the retailers in the wet market. Thirty sample fruits were left in the retailers' stall and the losses or unmarketable fruits were determined for five days. A big difference in the extent of loss was obtained between the two retailers. Retailer A encountered only about 24 percent of losses, while Retailer B's loss amounted to 56 percent, both due to decay.

The total postharvest loss incurred during the actual loss assessment amounted to 41.1 percent, based on computed losses at the wholesale and retail level. Higher losses were incurred at the retail than wholesale level since the fruits generally remained at the retail stall for five days when deteriorative changes occurred such as decay. Comparing the perceived loss at the wholesale and retail levels with losses during the actual assessment shows that actual losses at retail were higher than indicated. At the wholesale level, they were lower.

Table 5-9. PHL in pineapple, based on survey and actual assessment

Method of assessment	Average losses (in %)		Total loss (in %)
	Wholesaler	Retailer	
Survey	4.2	10.5	14.7
Actual assessment	1.1	40.0	41.1
Average	2.7	25.3	28.0

Table 5-10 shows the estimated quantitative loss incurred along the supply chain in pineapple. Farmers' harvesting of fruits and selling by retailers were the points where high losses occurred, amounting to 24.6 and 25.3 percent, respectively. Total losses exceeded 50 percent.With a national average yield of 37.05 tons/ha of fresh fruit, the postharvest losses along the supply chain, after harvesting, up to the final user of the commodity reached 27.9 percent, or an equivalent of 10.34 tons/ha. At a price of USD 0.12/kg, this loss amounted to USD 1,240.80/ha.

Table 5-10. Summary of pineapple PHL

Stakeholder	Operation	Loss (in %)
Farmer		
	Harvesting	24.60
	Piling	Trace
	Sorting	Trace
Trader/Wholesaler		
	Transport	2.65
Retailer		
	Transport	Trace
	Selling	25.25
Total		**52.50**

Picture 5-13. Activities flow from Queen pineapple harvest through wholesale market to retail

Harvesting of fruits

Haulingfrom the farm

Piling and sorting

Loading of fruits in a truck

Fruits in retail store

Pile of fruits in wholesale market

Unloading from the truck

Bulk loading of fruits

5.4 Papaya

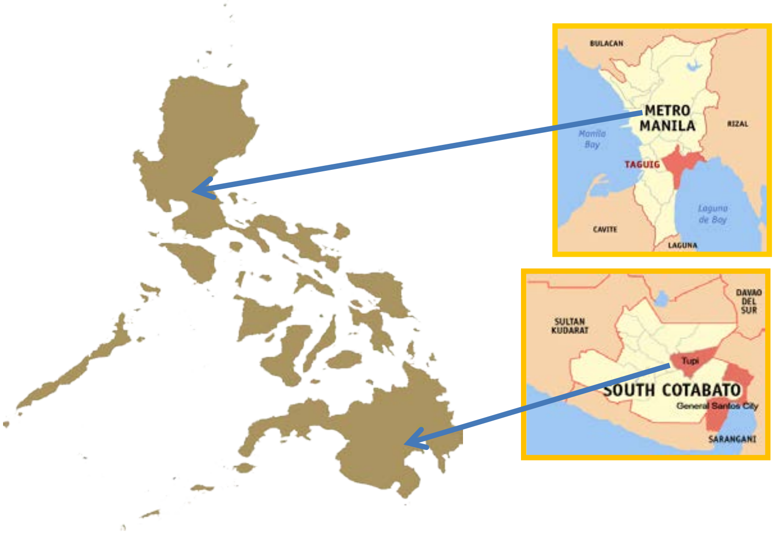
Papaya is another fruit species that is grown in the country both for domestic and export markets. Several varieties are grown in the country. For the domestic market, these are generally medium to large fruits (>1kg) such as ‘Cavite Special’, ‘Sinta’ or ‘Red Lady’. For the export market, predominately varieties belonging to the ‘Solo’ group (‘Sunrise’, ‘Kapoho’, ‘PPY’, ‘Red Solo’ and ‘Red Bonito’), which are small in size (<800gm), are grown. Both markets accept yellow and red flesh papaya. Papaya ranks fifth in term of volume of production among the fruit species grown in the country. In 2010, total production was 165,981 tons on an area of 8,751 ha(BAS, 2011).

In terms of regions, SOCCKSARGEN, Northern Mindanao and Davao Region were the top three producers in the country. This was attributed to the presence of multinational companies engaged in exporting both fresh and processed products. CALABARZON and Bicol Region also produced a considerable volume of papaya to cater for the major population centers in the Luzon area, especially MetroManila. Similarly, the three top producing regions also had the largest area planted to this crop and the highest average yield ranging from 23.24 mt/ha to 45.31 mt/ha. This was due to the system of cultivation followed by the multinationals engaged inhighly intensive production for the export market. In the other regions, less intensive cultivation was being practiced by small farmers.

In terms of consumption, papaya is also one of the most heavily consumed fruits in the Philippines along with banana and mango (Cucio and Siano, undated). The country’s per capita consumption showed an increasing trend from 1.59kg in 2000 to 1.78kg in 2009 (BAS, 2011).

For the baseline study important chain players (farmer/producers, wholesalers and retailers) were interviewed. The supply chain followed was specific for the ‘Solo’ papaya. Farmers in Tupi, South Cotabato, were interviewed, then wholesalers/retailers mostly from Divisoria and some from Balintawak, as well as retailers from Laguna and Metro Manila. An actual loss assessment from one farmer and two wholesalers and retailers each was also conducted. The fruits were sourced from Tupi, South Cotabato, a major production area and supplier of fruits both for the domestic and export markets. Losses from harvesting, field sorting, market sorting and marketing on wholesale and retail level were measured.

Map 5-1. Source of papaya fruits and major distribution areas from Tupi (South Cotabato) to MetroManila



The majority (74 percent) of papaya growers were not affiliated with any farming organization. Papaya growing areas were largely found in Tupi, South Cotabato, but there were a few in the nearby town of Polomolok. Farmer respondents growing only papaya were 67 percent, while 25 percent utilized crop rotation (e.g. with corn). The typical farm size ranged from 2.0 to 3.5 ha, while 23 percent of respondents had farm sizes of 0.5 to 1.9 ha and 25 percent had more than a 5ha farm. Farmer respondents were mostly dependent on rain water as their source of irrigation water, but some farmer respondents had deep wells and springs, collected water manually in huge plastic drums or used water pumps, e.g. electric, flexible and submersible pumps.They usually rented draft animals like carabao and a 4-wheel tractor during land preparation. In each growing area, a simple packinghouse was available wherein fruits were collected and placed in newly-assembled wooden crates. Trucks were the common logistical support, while some farmers had tricycles, elf (small truck) and multicab (minivan) to transport their harvested fruits.

Picture 5-14. Simple packinghouse found on papaya farms in Tupi, South Cotabato

Fruits were harvested at color break stage, that is, when yellow streaks were prominent at the basal part of the fruit. Fruits destined for MetroManila were harvested at the green stage to prevent premature ripening during transport. For the Bacolod and Iloilo markets, fruits were harvested at advanced color stage,with the peel having 30 percent yellow color. The harvesting index therefore depended on the grower and/or on the market requirement. The farmers usually hired laborers (77 percent of respondents) to do the harvesting, sorting, wrapping and packing of fruits in crates.

During harvesting two persons were assigned per tree: one to harvest the fruit using a harvesting tool called "selector" and a catcher who essentially caught the fruit and piled them in between the rows of plants with a layer of papaya leaves serving as liner.

Picture 5-15. Harvesting of papaya and harvesting tool used in Tupi

Farmer respondents generally harvested fruits only once a week per tree (61 percent), while about 21 percent of the farmer respondents harvested papayas twice a week. Although shipment of fruits from General Santos port to MetroManila was twice a week, farmer respondents had several farms wherein they could harvest fruits to be supplied to the buyers or shippers. On average, farmer respondents harvested 2,880kg of fruits/ha/week. The average marketable yield was 138,221 kg/ha/year with a range of 28,800 kg/ha/yr to 336,000 kg/ha/year.

Sorting of fruits and wrapping them with used newspaper was immediately done after harvesting. Thiswas done by a separate laborer, who also packed the wrapped fruits in wooden crates with a gross weight of 60 to 65kg/crate.For the local market, sorting was normally based on peel appearance, that is, fruit should be free from blemishes or defect like insect and disease damage. Size was not generally considered as a basis for sorting in the field.

Picture 5-16. Wrapping of papaya fruits and wooden crates lined with cardboard

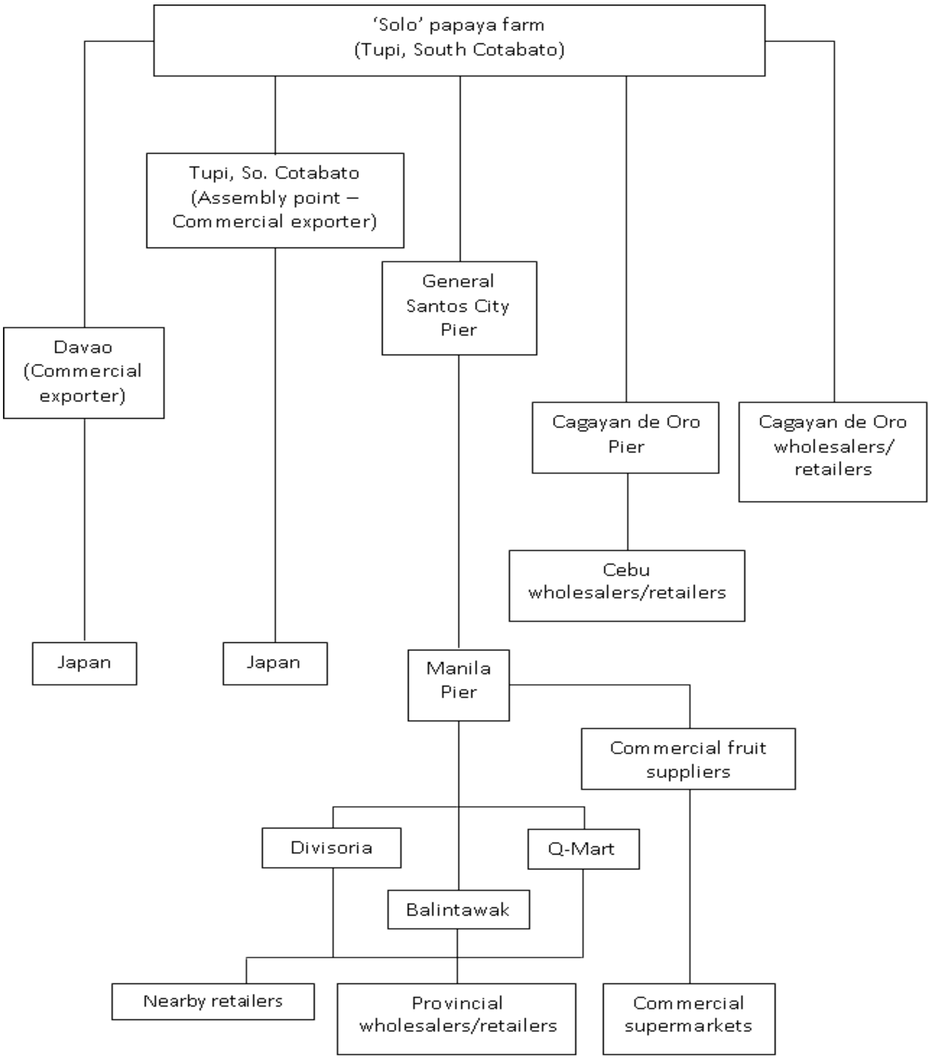
Seventy percent of farmer respondents indicated that sorting was a common postharvest practice. Other postharvest practices done were trimming of the pedicel, wiping or washing the fruits with water and alum, particularly when there was a heavy infestation of white flies and aphids. Apparently, farmer respondents were aware that postharvest disease like stem end rot was a problem during retailing of the fruit, thus about 11 percent of them reported that they wiped the stem end portion of the fruit with benomyl (a systemic fungicide) before wrapping with newspaper and packing in wooden crates. Farmers contracted by companies to produce fruits for export to Japanreported that companies did hot water treatment (HWT).

Wooden crates (59 percent of respondents) with a gross weight of 60 to 65kg were the usual containers used for of papaya, whether they were intended for Metro Manila, Bacolod or Iloilo markets. Farmerswho were contract growersused plastic crates as containersduring harvesting, which were provided by the company.

The two common marketing practices were: (1) growers harvested their fruits, which were picked up by buyers or shippers (60.7 percent) and (2) the buyer-shipper harvested and transported the fruits (39.3 percent), generally just once a week. Harvested papaya fruits were destined for MetroManila (three to four days sea-shipment), Cagayan de Oro (405 km), Cebu (405km+1 night sea-shipment) and Iloilo markets (one to two day sea-shipment). The flow of 'Solo' papaya fruits from Tupi, South Cotabato is shown in Figure 5-1. The road infrastructure was apparently good. Commonly used vehicle for transporting the fruits were trucks.

For the local market, method of pricing was "all-in", that is, there was only one price set per kg regardless of size and quality. Farm price of papayas for the domestic market was generally at USD 0.07 to 0.09/kg. The buyers were the ones setting the price.

Figure 5-1. Flow of papaya fruits from Tupi to various markets



All farmer respondents reported that losses were incurred during harvesting. During field sorting of harvested papayas, 32 percent of farmer respondents indicated that losses or rejection could exceed 20 percent, followed by those who reported losses of only one to five percent (27 percent).The most common reasons for rejection of fruits after harvest were the presence of "choco" spots (20 percent), deformed/misshapen (16 percent) and over maturity (15 percent). Choco spots developed due to the attack of a fungus (not yet identified), while fruit deformation, also known as "cat faced", was due to the phenomenon of sex reversal which occurs in papaya as a response to unfavorable conditions such as moisture or stress.

Farmers were also aware that there were losses during transport since the buyers gave them feedback as to the losses when fruits reached the market. Accordingly, about 3 to 5 percent or more of losses were incurred. The common causes of losses were overripening and mechanical damage in the form of compression, which in turn could be attributed to the amount of fruits packed in a crate.

When asked about their problems, farmers reported a variety of problems from production to marketing. In production, the main problem reported was the high cost of inputs followed by insect and disease damages. For postharvest, their concern was the rejection due to "choco" spots, and for marketing, it was the delayed payment. In some of the problems, respondents gave possible solutions. For example, for the high cost of inputs, they suggested that the government should provide assistance like subsidies for fertilizers of pesticides. With regardsto the proliferation of contract growers, they suggested that new markets should be explored and that the government should assist them in accessing new markets.

Picture 5-17. Deformed/misshapen, choco spots and insect damage

Eight wholesaler respondents from Laguna, Divisoria and Balintawak were interviewed. Most of them were also retailers, who display the more ripe fruits for retail. The wholesaler respondents in MetroManila handled around 7,200-18,000kg (150-300 crates) of fruits per week. The wholesaler respondents from Laguna (Biñan), who obtained papaya from Divisoria handled 2,100 kg per week.

Wholesaler respondents from Manila purchased their fruits directly from the farmers from South Cotabato (87 percent) to which they were closely related. They had no specific criteria for the fruits. Their main concern for the delivered fruits was the quality (external appearance) and peel color. Most of these wholesaler respondents accepted whatever was delivered as long as the fruits had no serious defects. Fruits were purchased either by weight (three quarters) or by container (one quarter) on a cash basis.

The wholesaler respondents in Divisoria transported the fruits from MetroManila portto the market using either a truck, "*kuliglig*" (motorized bicycle with sidecar) or a pedicab. For the Balintawak market, transport time was 1 to 1.5hr using a truck. Fruits coming from the pier were all packed in wooden crates lined with cardboard. For the Laguna wholesaler, it took one to two hours to transport fruits in carton boxes using a jeepney from Divisoria to Laguna. Packaging material used for selling were polyethylene bags, which contained around 10kg of fruits. Carton boxes (recycled banana cartons or any carton used for imported fruits) or wooden crates were also used depending on the amount of fruits being purchased.

The delivery was usually disposed in two to three days, but during lean buying times it could take up to five days. Wholesaler respondents did not have any method to preserve or extend the marketable shelf life of the fruits. All wholesaler-respondents encountered losses, which, according to wholesaler respondents from Laguna, reached 33 percent. Causes of losses were: too soft, over-ripeness of the fruits,diseases, fruits that failed to ripen and mechanical damages, mainly due to compression.The main problem of wholesaler respondents was the high initial rejection upon arrival in Manila (40 percent of respondents). These problems were very much felt when the market demand for papaya was low resulting in the fruits staying in their warehouses for more than three days. A suggested solution was to provide feedback observations to the farmer-producers to deliver only good quality fruits.

A total of eight retailer respondents were interviewed from Laguna, Caloocan, Pampanga, and Pangasinan. Their retail markets are located in public markets in Calamba City, San Pedro, Biñan, Laguna and in Farmers Plaza of Quezon City. The average volume they handled on a weekly basis was 81.25kg (ranging from 30 to 140kg/week). According to them, they were concerned about the color and peel quality when purchasing the fruits. They purchased the fruits in the wholesale market by weight either on cash (87 percent of retailer respondents) or consignment (13 percent) basis, and then transported them to their respective retail markets. Their common transport was a tricycle for short distance travel and jeep/jeepney or private vehicle for longer distances. Purchased fruits were packed in plastic bags, carton boxes or wooden crates.

The normal shelf life of their papaya fruits was one to three days. Retailer respondents reported losses from 5 percent to as high as 60 percent. 38 percent of respondents experienced losses between 15 and 20 percent, but one quarter of respondents had losses of over 20 percent. These losses were attributed to decay, over-ripening and mechanical damages. Furthermore, retailer respondents did not know any method to preserve or extend the shelf life of papaya fruits. The most common problem encountered by the retailer respondents was the slow rate of selling papaya fruits resulting in over-ripening of fruits leading to greater losses. Another problem was the complaints of customers saying that papaya fruits were not sweet enough and had off-flavor.

In addition to the survey, an actual loss assessment was conducted. Harvesting in a farm (Farm A) in Tupi, South Cotabato, was observed and rejected fruits at the farm were classified and counted. The area (0.75 ha) was planted with approximately 1800 plants. Fruits were harvested in the morning using a "selector", assembled along the rows of papaya plants and then sorted out. A total of 3,138kg of papaya fruits were harvested and after field sorting, 56.6 percentwere classified as marketable. The main cause of rejection during this harvest was the presence of choco spots and insect damage.An effective insect and disease management program on the farm would be beneficial therefore. The farmer had estimated a far lower loss during the baseline survey, i.e. 18.5 percent.

From the acceptable harvested fruit from Farm A, three crates were tagged as the sample to be shipped to Metro Manila for evaluation on the wholesale level. Another set of samples from another farm (Farm B) were also tagged. The tagged samples were shipped by the respective farmer-shippers to their contact wholesalers together with their own shipment of papaya fruits for delivery to MetroManila. After three days, the fruits arrived in Manila, where they were picked up by the wholesalers.

The contact wholesalers were both from Divisoria, but their stalls were located at different areas. At the wholesale level, their usual practice upon arrival of the new shipment was just to store the papayas in their stalls. Fruits were then sorted according to their peel color. Fruits that were still green or at color break stage were treated with calcium carbide to hasten ripening.Typically, fruits were divided into three peel color stages.

It was observed that there was a big difference in the quality of fruits from the two wholesalers. Fruits of Wholesaler A were observed to have higher disease incidence and severity resulting in greater rejection. The estimated loss for this wholesaler reached 30.5 percent.On the other hand, very minimal or slight incidence of decay was observed in Wholesaler B. During the initial sorting (Day 1), only one fruit was considered as an unmarketable reject which showed severe symptom of soft rot. By the time all fruits were sold out, losses reached 2.5 percent.The rate of selling the fruits was quite fast, probably due to a more desirable fruit appearance, better market location and lower selling prices.

At the retail level, two fruit stands were asked to sell ‘Solo’ fruits coming from the two wholesalers. Similar results were observed, wherein higher losses were obtained in fruits coming from Wholesaler A. The observed loss was 26.3 percent (6.7kg) valued at USD4.69 (USD 0.7/kg). Rejection of fruits from Retailer A was due to noticeable decay (anthracnose and stem-end rot). Retailer B sold fruits coming from Wholesaler B and experienced only 4.1 percent loss due to the presence of anthracnose

Table 5-11 shows the estimated losses incurred by the major players in the supply chain and those obtained during actual loss assessment. As illustrated, there were discrepancies in values reported and those actually measured. But if the rejection at the farm was not included in the calculation of total loss, then interview and actual assessment based PHL from the point of transfer of fruit from the farm to the retail markets would be close and an average of 32.4 percent.In terms of value, total loss was computed to reach USD1,110.08 from the farm to the final buyer of the commodity(the price of papaya fruit was pegged at USD 0.12/kg farm gate price). Excluding the farm level, PHL amounted to USD469.72 which represents 42.4 percent of the total value of losses along the supply chain.

Table 5-11. Summary of papaya PHL (in %)

	Based on interview	Based on actual assessment	Average
Farmer	18.5	45.3	31.9
Wholesaler	10.0	16.5	13.3
Retailer*	23.0	15.2	19.1
Total	**51.5**	**77.0**	**64.4**

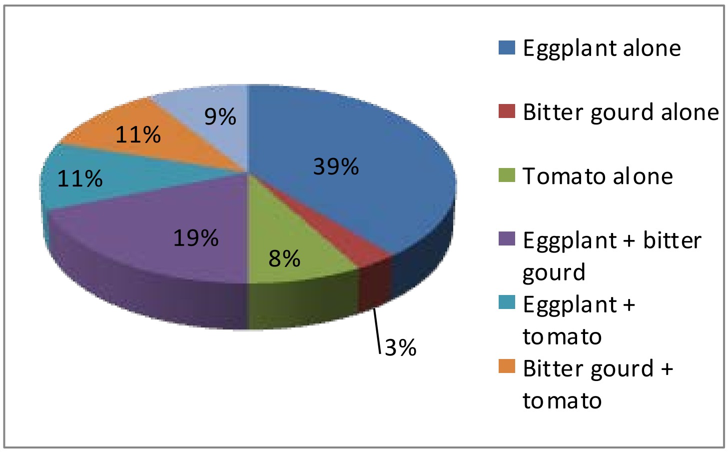
*3-4 days selling period

5.5 Eggplant

Eggplant is the most important vegetable species grown in the country. It is generally grown in the lowland either as part of the cropping system of farmers (after rice and/or intercrops with perennials) or as a solo crop. In 2010, the country produced a total of 208,242 tons on a harvested area of 21,423 ha. Ilocos Region, CALABARZON, Central Luzon and Cagayan Valley were the top fourproducing regions and the primary sources of eggplant for the MetroManila market. In the Visayas area, Western and Central Visayas were the primary producers of this commodity, while in Mindanao, it was Davao Region and SOCSCSKSARGEN.CALABARZON had the highest yield amounting to 21.17 mt/ha.

A total of 112 farmers, 27 traders and 36 wholesalers/retailerswere interviewedon the eggplant, tomato and ampalaya (bitter gourd) value chain (results below). The survey was undertaken inBatangas, Cagayan de Oro, Laguna,Metromanila, Nueva Ecija,Pangasinan and Quezon. Farmers grew eggplant, bitter gourd and tomato, either singly or in combination.In terms of farm size, the average landholding of the farmer respondents was 0.88 ha. Bigger areas for cultivation were found in Claveria, Misamis Oriental, while areas of less than one ha were found in the various provinces in Luzon, which accounted for slightly more than half of total farmer respondents.

Figure 5-2. Eggplant cropping system



Fruits ready for harvesting were determined either by size (around 30cm), by counting the number of days/months from planting (two to three months) or demand for the commodity (price). Harvesting was done manually on a weekly or twice weekly basis, depending on demand. The fruits were placed in containers such as bamboo baskets, plastic sacks or plastic crates and hauled using either an animal-drawn cart or horse with baskets on the side or hand tractor (2-wheel) to a makeshift packing shed or just under the shade of a tree. The fruits were then sorted by size and quality. Farmer respondents estimated that 5 to 40 percent losses were incurred due to insect damage (62 percent), mechanical damage (8 percent),deformity and rotting (4 percent each) and disease infection (2 percent). Washing the fruits with water was commonly practiced in Laguna, Batangas and Quezon areas, while water plus shampoo was used in Cagayan de Oro area. This was done to make the fruits shiny and attractive to buyers. Fruits were then packed into polyethylene bags (PEB) weighing 10kg/bag. In Cagayan de Oro, 50 to 60kg packs were prepared since these were to be transported to other provinces and even to MetroManila. This had resulted in some damage of the fruit due to compression, as well as development of diseases if it remains for three to four days before selling.

Most farmer respondents encountered the following problems: not being paid on time or not at all (consignment basis), high costs of input, lack of irrigation facilites and changing climate patterns.

The majority of traders handled various vegetables and other crops. They generally purchased eggplant from the farmers, who delivered the commodity to them. Upon receipt, they checked and did resorting and repacking of the fruits in PEB (10kg/bag). Again, losses were incurred due to insect damage, deformity, mechanical damage (compression), rotting and pilferage.The damaged fruits whose major portion was still marketable were packed vertically in PEB and sold at a much lower price to the retailers. Fruits classified as good were repacked horizontally. Fruits classified as semi-good were minimally processed to salvage the good portions of damaged fruits. These fresh cuts needed to be sold on the same day.

Picture 5-18. Causes of loss in eggplants: Compression, insect damage, deformities and disease infection

Picture 5-19. Horizontally and vertically packed eggplants

Upon receipt of the fruits by the wholesaler/retailer respondents, resorting was done to check the quality of the vegetables delivered and classify according to size and quality for better prices. Furthermore, it enabled them to check if rejected fruits were packed along with the good ones, especially in the middle or lower portions of the container. During this operation, rotting fruits were discarded. Then, another repacking was done which was considered additional work and expense.

On the retailer's side, the practice of minimally processing damaged and rejected fruits was done to minimize postharvest wastage. It allowed the retailers to have a break-even on their investment. It also provided convenience to customers who have little time to cut vegetables for cooking. However, the fresh cuts should be sold on the same day as the product will easily deteriorate, especially if temperatures are high.

Total average loss along the postharvest supply chain of eggplant from the farm up to the final buyer amounted to 52.5 percent. The highest loss occurred at the wholesaler/retailer level. Eggplant has a shelf life of only four days. Based on the national average of 9,720 kg/ha and a unit price of USD 0.23/kg, total postharvest loss along the supply chain reached 3,522kg valued at USD 810.00.

Table 5-12. Summary ofeggplant PHL (in %)

Area	Farmer	Trader	Wholesaler/ retailer	Total
Batangas	5	10	10	25
Laguna	10	*NE*	50	60
Quezon	30	10	50	90
Nueva Ecija	10	30	20	60
Pangasinan	15	*NE*	10	25
Cagayan de Oro	40	15	*NE*	55
Average	**18.2**			**52.5**

NE: No estimate

5.6 Tomato

Tomato is the second most important vegetable species being grown in the country after eggplant. It is grown for fresh and processed consumption. By 2010, a total of 204,272 tons of tomato were produced on 17,663 ha in the Philippines (BAS, 2011).In 2010, the four highest producing regions in the country were Ilocos Region, Northern Mindanao, Central Luzon and CALABARZON, in decreasing order. In the Ilocos Region, tomato was generally planted after rice. This coincided with the months during which rainfall was insufficient to support another rice cropping. In addition, a tomato processing plant producing tomato paste is present in one of the provinces (Ilocos Sur) in Ilocos Region. Northern Mindanao, where the climate is favorable for tomato production all year round, is the primary source of tomato for the markets of MetroManila and its neighboring provinces during off-season production in Luzon (June-October). Fruits in wooden crates were generally transported by boat and in some cases by plane when there was high demand/price in MetroManila. Furthermore, Northern Mindanao also supplied other provinces in Mindanao as well as the Visayas area. Central Luzon and CALABARZON production primarily caters MetroManila markets, where a small percentage was being produced under greenhouses to cater to the demand of institutional clienteles such as restaurants, hotels and supermarkets.

In terms of yield, Northern Mindanao had the highest average yield with 18.72mt/ha followed by Ilocos Region (18.45mt/ha), CALABARZON (12.92mt/ha) and Cagayan Valley (11.87mt/ha). The national average yield was 11.57mt/ha (BAS, 2011).For the survey the same producers/farmers, traders, wholesalers and retailers were interviewed as for eggplant and ampalaya (bitter gourd).

Harvesting of tomato was done when the fruits had the appropriate size, color break and/or drying of the leaves. In addition, farmers waited for two months after planting to start harvesting. However, immature fruits were harvested as long as they reached a marketable size when demand or price were high. Harvesting was done twice a week or every other week, depending on the demand of the commodity.

After picking, the fruits were placed in harvesting containers such as bamboo baskets, plastic crates, wooden crates or plastic sacks. These were then hauled using animal-driven carts or hand tractors (2-wheel) to a simple packing shed or just under a tree. Afterwards, sorting was done according to size and quality. Farmers reported that they experienced losses ranging from 3 to 25 percent. These were due to insect damage, disease infection, fingernail punctures during harvesting, over-ripening, compression and small size. In Cagayan de Oro, wiping or washing of fruits with water and shampoo was practiced to remove dirt as well as to make the fruits shiny and so more attractive to consumers.

The fruits were then packed in polethylene bags (PEB) weighing 10kg/bag, except in Cagayan de Oro, where the fruits were placed in wooden crates weighing 25 to 40kg/crate. Furthermore, it was common practiceto overfill the crates with fruits and forcefully close it to increase weight, since transport cost (either by truck or ship) was based on the number of crates instead of weight. The packed tomatoes were stacked up awaiting transport to the market either by the farmer respondents themselves or by traders.

The majority of farmers encountered the following problems: not being paid on time or not at all (consignment basis), high input cost, lack of irrigation facilites and changing climate patterns. For the trader and wholesaler, common problems were: the inclusion of rejects in the middle of the container ("bomba"), not being paid on time or not at all (consignment basis) and seasonal supply fluctuation.

Traders generally purchased from the farmers, who delivered the commodity to them. Upon receipt of the product, they checked and did resorting and repacking it in PEB (10kg/bag). In Sariaya, Quezon, fruits were placed in push carts and wiped with rags before repacking. Again losses were incurred due to insect damage, mechanical damage (compression and bruising), rotting and pilferage. Rejected fruits that were considered marketable were sold at a much lower price. Trader respondents in Balintawak market preferred Ilocos-grown tomatoes compared to those coming from Batangas and Pangasinan. They claimed that tomatoes from Ilocos were more firm and had a longer shelf life of up to seven days.

Wholesalers conducted resorting of the fruits again to check on the quality delivered. The main advantage was the ability for them to sort the fruits according to size and quality for better prices. Furthermore, it enabled them to check if reject fruits were packed along with the good ones. During this operation, rotting fruits were discarded. Then, another repacking was done or the fruits were placed on display for selling to retailer/consumers.

Picture 5-20. Tomato fruits on display in a wholesaler's stall in Balintawak market

Retailers purchased the fruits from the wholesaler and transported them either by tricycle or jeepney, depending on travel distance. Other vegetables from the same wholesale market were included. One retailer in Farmer's Plaza, Quezon City, wiped the fruits with rags dipped in kerosene to make them shiny and attractive to consumers. All retailers, once they reached their stall, displayed the fruits together with other commodities.

Picture 5-21. Retailer's transport of vegetables by tricycle and tomatoes on sale at retailer's stall

Table 5-13 shows the estimated loss based on the responses of the various stakeholders along the supply chain. Total average loss amounted to 39.3 percent. From the data available, it seems that wholesalers/retailers had the least amount of losses. Based on a national average yield of 11,570 kg/ha and a unit price of USD 0.12/kg (farm gate), total losses amounted to 4,547 kg/ha, valued at USD 545.65/ha.

Table 5-13. Summary of tomatoPHL (in %)

Area	Farmer	Trader	Wholesaler/Retailer	Total
Batangas	7.5	25	25	57.5
Laguna	9	*NE*	10	19.0
Quezon	20	*NE*	2.5	22.5
Nueva Ecija	10	3	10	23.0
Pangasinan	3	*NE*	8.5	11.5
Cagayan de Oro	35	*NE*	*NE*	35.0
Average	**14.1**			**39.3**

NE: No estimate

5.7 Bitter gourd

Ampalaya, also known by its English name as bitter gourd, is another common vegetable consumed by Filipinos. The fruit is cylindrical and has a distinct warty appearance. It has a bitter taste due to the presence of momordicin. It is also a good source of vitamins and minerals. The leaves are utilized in salad and in dried form, sold as natural supplement in various drugstores. Ampalaya is one of the least known vegetable in the ASEAN region. The plant is a vine and has a life span of six to eight months, with initial harvesting being done three to four months after planting.

In 2010 88,437 tons of ampalayawere produced on 11,129ha (BAS, 2011). Central Luzon (25,750t), CALABARZON (24,004t), Ilocos Region (9,995t) and Cagayan Valley (6,450t) were the four major production regions in the country. They primarily catered to MetroManila markets and other population centers in the Luzon area. Cultivation is year round in Central Luzon and CALABARZON, but highly seasonal in the Ilocos Region and Cagayan Valley where it is part of the cropping system of rice farmers. For the rest of the regions, production was quite small catering to local markets. In terms of production efficiency, Central Luzon ranked first with a yield of 12.86t/ha. This was followed by CALABARZON (10.16t/ha) and Ilocos Region (8.64t/ha). The rest of the regions had yields ranging from 2.18 to 7.21t/ha. The national average yield was 6.09t/ha in 2010 (BAS, 2011).

Together with the eggplant and tomato surveys, 112 farmers, 27 traders and 36 wholesalers/retailers were interviewed for the ampalaya survey. Harvesting of ampalaya fruits started 3.5 to 4 months after planting and lasted for the next 2.5 to 4 months. Fruits were ready for harvesting when they reached approximately 30cm in length, the ridges had already developed and spaces between the ridges began to widen. Furthermore, a light green color of the fruit served also as an indication of readiness to harvest. However, immature fruits were harvested if demand or market price were high. Fruits were handpicked and placed in a container such as bamboo baskets, plastic crates or plastic sacks. Afterwards, these were sorted in terms of size and quality in a simple packing shed. The sorted fruits were then placed in PEB bags with or without lining of old newspaper or banana leaf at the bottom of the bag.Each bag weighs 10 to 15kg. The packed fruits were then stacked up to three layers awaiting purchases and transport to the market by traders.

Picture 5-22. Sorting and packingof ampalaya fruits in a roadside packing shed

The farmer respondents estimated that losses ranged from 5 to 50 percent due to cracking, broken fruits/bruising during harvesting, deformation, insect damage (fruit fly), over-maturity and yellowing.The majority of farmers encountered the following problems: not being paid on time or not at all (consignment basis), high input costs, lack of irrigation facilitesand changing climate patterns. For traders and whosalers, problems encountered were: inclusion of rejects in the middle of the container (“bomba”), not being paid on time or not at all (consignment basis) and seasonal supply fluctuation.

The traders generally purchased from the farmers, who delivered the commodity to them. Upon receipt of the product, they checked and did resorting and repacking in PEB (10 to /bag). Again losses were incurred due to insect damage, mechanical damage (compression and bruising), rotting and pilferage. Rejected fruits that were considered marketable were sold at a much lower price.

Wholesalers did resorting of the fruits according to size and quality for better prices. Furthermore, it enabled them to check if reject fruits were packed along with the good ones.

During this operation, rotting fruits were discarded. Then, another repacking was done or the fruits were placed on display for selling to retailers/consumers. Retailers purchased the fruits from wholesalers and transported them either by tricycle or jeepney, depending on the distance of travel.

Picture 5-23. Causes of ampalaya fruit rejection after harvest: Bruising and cracking, deformities and premature ripening

At wholesaler and retailer level, fruits that were classified as semi-good were minimally processed to salvage the good portion of the damaged fruit to be sold the same day. This kind of processing consisted of cutting the fruits into thin slices and selling them either by themselves or in combination with other vegetables. The marketable shelf-life of ampalaya fruits was two to four days.

Picture 5-24. Slices of ampalaya fruit sold by wholesalers/retailers

Table 5-14 shows the estimated loss, based on the responses of the various stakeholders along the ampalaya supply chain. Total loss amounted to 49.4 percent. Losses incurrred by farmers and traders were much lower, ranging from 9 to 10.4 percent, compared to wholesaler/retailer losses that reached up to 50 percent in two areas. Based on the national average yield of 9,090 kg/ha and a unit price of USD 0.23/kg (farm gate), total loss reached 4,490 kg/ha, valued at USD 1,032.70/ha.

Table 5-14. Summary of ampalaya PHL (in %)

Area	Farmer	Trader	Wholesaler/Retailer	Total loss
Batangas	7.5	5	10	22.5
Laguna	5	5	50	60
Quezon	10	10	50	70
Nueva Ecija	15	10	*NE*	25
Pangasinan	12.5	*NE*	10	22.5
Cagayan de Oro	12.5	15	*NE*	27.5
Average	**10.4**	**9**	**30**	**49.4**

NE: No estimate

5.8 Coffee

Coffee is a popular drink among Filipinos. During the past few years, its popularity has increased due to the proliferation of specialty coffee shops such as Starbucks, Boston Café and Figaro, which are popular among young people. This has led to increasing demand for the commodity not only in the country, but also worldwide. Furthermore, a price increase at farm gate madeit more profitable for farmers. Recently, this generated new interest in growing coffee in the country, resulting in an increase of plantings.

There are four species of coffee being planted in the country:Robusta, Arabica, Liberica andExcelsa. Robusta, Liberica and Excelsa are generally grown in lowland areas, while Arabica is cultivated in the highlands. Robusta and Arabica are the most popular species being cultivated by farmers due to the demand by various processors such as Nestle (Philippines) Inc. (NPI), Universal Robina Corp. (URC), Commonwealth Foods Inc. (CFC), and various specialty shops. Liberica and Excelsa are popular in Batangas/Cavite provinces and known locally as “Barako” in the market.

In 2010, 94,536 tons of dried berry (the form that is generally traded by farmers) were produced, on an area of 121,399ha. In terms of coffee species, Robusta production predominates in the country with 72 percent of total production and 75 percent of total area planted. This was followed by Arabica, Excelsa and Liberica (BAS, 2011). Robustadominates in all regions except in Western Visayas, where Arabica accounted for 65 percent of total production. The preference for Robusta by farmers was driven by the high demand/price of NPI, which is the major buyer of coffee beans in the country (80 to 85 percent of the market), and the availability of bigger areas for cultivation in the lowland areas. Regionally, SOCCCSKSARGEN had the highest production reaching 27,761tons, followed by the Davao Region (22,681t), ARMM (10,803t) and CALABARZON (8,764t).

Eastern Visayas had the highest average yield per ha reaching 1.65 tons, while Central Visayas had the least amounting to 0.28t/ha. The major production areas in Mindanao (SOCCSKSARGEN, Davao Region and ARMM) had an average yield ranging from1.02 to 1.33t/ha. Central Luzon had an average yield of 1.59t/ha, the second highest in the country. Its primary production areas are in Bulacan (Dona Remedios Trinidad) and Bataan (Orani and Samal). The national average for 2010 was 1.07t/ha.

The survey was conducted in the major growing areas of coffee, i.e.in Luzon Mt. Province (Tadian, Bauko), Cavite (Alfonso, Indang and Amadeo), Bulacan (Dona Remedios Trinidad), Bataan (Orani and Samal), in Western Visayas Iloilo (Janiuay, Dingle, Calinog), Iloilo City; and in Mindanao Misamis Occidental (Ginoog City), Misamis Oriental (Balatnog), Bukidnon (Malaybalay), Davao Oriental (Mati) and Davao City. A total of 95 farmers, traders/wholesalers and buyers were interviewed and selected at random.

Farmers generally practiced multiple cropping systems (63 percent) with fruit trees (rambutan, durian, etc) as the major companion crop (50 percent). The majority of them did not belong to any farming organization (73 percent). Farm size ranged from less than 1ha to greater than 20ha, with an average of 2.3 ha. However, farm sizes of less than 1to 2ha predominate among the farmers (74 percent). 97 percent of farms operated without irrigation system.

The harvesting of coffee was highly seasonal and labor intensive. Two methods of harvesting followed were priming, whereby only ripe (red in color) berries were harvested, and stripping, whereby all berries on a branch are harvested when 25 to 50 percent of berries were ripe. Most of the farmer respondents (86 percent) did priming for up to six times, while the rest did stripping on the first harvest already. Additional labor was generally hired to do the harvesting work together with the farmer and family members at one to two week intervals.

The majority of farmers (81.4 percent) did not realize that losses occurred during the harvesting operation. For those farmer-respondents giving a positive reply on loss during harvesting, losses were due to dropping of the ripe berries on the ground, carelessness of the harvesters who aimed at finishing the operation at the earliest possible time, unharvested berries and pest infestation (berry borer). Loss during harvesting as reported by these farmers averaged 2.5 percent.

After harvesting, there were two methods that were available to farmers to process their coffee berries. The first method was to dry the berries immediately by sun-drying in a cemented area or portion of the road (79 percent), which lasted for five to eight days and longer during rainy months (13 to 16 days). One farmer respondents used a solar dryer and one a mechanical dryer. This is also known as dry processing. In one instance, it was also observed that the farmer was using a log and rolling it on top of the berries being sun-dried to break the pulp for decreasing the drying period. However, this resulted in a high percentage of broken coffee beans, thereby lowering its quality. Afterwards, the dried berries were passed through a dehuller and winnowed to extract the coffee beans.

The second method is known as the wet method, whereby only ripe berries are processed (21 percent of farmer respondents). The berries were passed through a depulper with running water or pounded to remove the pulp. Afterwards, the depulped berries were fermented for three to four days to remove the mucilage. Sun-drying of the beans took two to three days. These were then passed through a dehuller and winnowed to get the coffee beans. This wet method is commonly done in Cordilleras (highland areas) for Arabica coffee. The beans have better quality compared to those processed through the dry method since these were all coming from ripe berries.The processed coffee seeds are known as green beans.

Picture 5-25. Sun drying of coffee berries with nets as underlay and log rolling over berries


Picture 5-26. Mechanical and wooden depulpers used in wet processing of coffee


The moisture content of the dried berries and beans are critical to the buyers. For the dried berries it should be 12 to 14 percent in order to get a high recovery during the milling process. Theoretically, the recovery should be 60 percent beans. For the beans, the desired moisture content is 12 percent or less, irrespective of the method of processing, as desired by buyers. Farmers determined the moisture content of their dried berries/beans qualitatively, either by biting into them or by the rattling sound when dried berries were shaken.

The dried berries were then placed in plastic sacks weighing around 50 to 60 kg. Most of the farmer respondents (95 percent) reported that no loss in quantity was incurred during this stage. The small proportion of farmers who reported loss in quantity estimated that this amounted to an average of 1.5 percent, mainly due to spillage of the dried berries during the operation. For the dried beans that were processed by wet method, they were put into paper bags and other suitable container with a weight of 10 to 20kg/container.

Farmers sold their produce either as dried berries or beans. For those that were selling dried berries, they usually brought it to the place of the trader. In some instances, traders came to their house. Farmers also stored their dried berries waiting for a good market price (off season). When the farmers decided to sell the produce, the dried berries were brought to a mill for dehulling and winnowing. Bean recovery ranged from 50 to 60 percent based on the quality of the dried bean (moisture content, presence of foreign matter, pest/insect attack). As reported by farmers, bean recovery after the depulping and winnowing processes (milling) averaged at 51.5 percent, which translated into losses of 8.5 percent. These losses were due to broken beans (3.5 percent), black beans (fungal infection, 3.4 percent) and foreign matter (1.6 percent). The depulping machine also contributed to the inefficiency in bean recovery since most of the machines available in the countryside were primarily used for milling rice and corn and not particularly suited for dried coffee berries. For milling, farmers were charged a fee of USD 0.09 to 0.14/kg.

Picture 5-27.Rice mill used for dehulling dried coffee berries

Coffee beans were generally sold to traders (81 percent) by farmers with 10 percent of them selling directly to NPI, provided that the beans passed the company's requirements in terms of moisture content, percentage defect and cup taste. The price of NPI was being used as the buying price for Robusta beans in the country. In case the beans were rejected by NPI, the farmers had the option to either bring it back for further drying/re-sorting or to sell it to traders/wholesalers that abound near the buying station of NPI. Losses during transport of the beans to the buying stations of NPI or to traders/wholesalers were very minimal.

Farmers experienced various problems in cultivating coffee. These were mainly inadequate drying facilities particularly during rainy days, inadequate depulping/dehulling equipment, pest incidence, quality requirements of buyer and the high cost of transport.

Traders/wholesalers primarily collect the product and sell it on to other buyers/assemblers and coffee processors such as NPI, URC, CFC, Monk's Blend and specialty shops in MetroManila. The volume of coffee they were trading on a weekly basis ranged from less than 500kg to 3,500kg with an average of 1,076kg. They purchased in the form of green beans (64 percent), dried berries (25 percent) and fresh berries (11 percent). 54 percentbought directly from farmers, or else from a trading post (7 percent), weekly markets (7 percent) and others (32 percent). Coffee beans/berries were purchased by weight in either 10kg cans or 50 to 60kg sacks. Payment to farmers was done in a cash, based on the prevailing price of NPI.

The price of beans is based on the moisture content. The usual practice was to reduce the price by 12 to 14 percent based on the lowest grade that NPI will purchase the beans for. For traders purchasing fresh and/or dried berries, they were responsible for all the processing such as drying and milling as well as the corresponding costs to obtain the coffee beans. The price of fresh berries was 12 percent of the price of dried beans, while for dried berries it was 40 to 45 percent. In some cases, traders/wholesalers provided storage facilities to farmers without any charge. However, they reserved the right to purchase the produce when the farmer decided to sell it.

Coffee beans were then re-sorted to further remove the broken beans, black beans, immature beans (off-color) and foreign matter to meet the quality requirements of the buyer. Losses were incurred ranging from two to five percent with an average of 2.3 percent. Except for foreign matter, some trader did not consider the rejected beans as losses since they could sell it to other buyers at a very low price.

After re-sorting, the beans were placed in jute sacks for NPI and plastic sacks for other buyers. They used trucks and jeepneys to transport the commodity. Losses during transport also occurred ranging from less than one to three percent, with an average of 1.3 percent. These losses were due to the presence of holes in the sack and pilferage. Some of the problems encountered by trader/wholesaler respondents were a high moisture content (38 percent), pest affected beans (36 percent),the presence of foreign material (18 percent) and black beans (8 percent).

There were two corporate buyers/processors that were interviewed during the survey. One was NPI, a multinational company that produces a variety of food product, among them instant coffee,for consumers in the Philippines and abroad.It primarily uses Robusta. There are eight buying stations all over the country, where NPI purchased almost 80 to 85 percent of the Robusta beans produced in the Philippines. It priced the beans based on the prevailing international market price, which served as a benchmark price for farmers, traders and wholesalers in the country. A daily price was announced and made available by the company to interested parties.

Farmers, traders and wholesalers brought their coffee beans to the buying stations. Upon arrival, the beans were sampled for their moisture content, which should be 12 percent or less. Once they passed, another round of sampling per container was done. All the sampled beans were mixed together to get a representative sample for determination of quality (defect) and cup taste. There are three grades. Grade I coffee beans have less than or equal to 8 percent triage. Grade II coffee beans have between 8 and 12 percent triage. Grade III coffee beans have between 12 and 16 percent triage (Nestle, 2011). Grade I gets the highest price, the Grade II price is 2.2 percent less than Grade I, and Grade III price is 5.6 percent less than Grade I.

Coffee beans that passed the quality control were then rebagged in jute sacks weighing 60kg. The company provided jute sacks for free to persons who regularly deliver to them. Purchased beans were then loaded in a container van for transport to Cagayan de Oro where processing took place.Losses of coffee beans were minimal or non-existent since spilled beans were collected and returned to the container.

The other corporate buyer/processor was Monk’s blend, a coffee processor producing ground coffee for brewing. It is located in a monastery in San Jose, Malaybalay, Bukidnon. It primarily purchased Robusta and Arabica. The latter is used for blending purposes. A total of 50tons of Robusta and 10tons of Arabica were purchased by the company per year. All purchases were paid for in cash. It maintained another buying station in Cagayan de Oro. The moisture content of the beans should be 12 percent or less. Transport of coffee beans form the buying station to the monastery took two to four hours, depending on traffic. Minimal losses of less than one percent were incurred due to loss of moisture and/or spillage.

Once the beans arrived in the monastery, these were sorted accordingly. A total of five percent of the purchasewas rejected due to black beans (1.5 percent), broken beans (1.5 percent), insect damage (1 percent) and foreign matter (1 percent). Sorting was done manually and sorters were paid according to the weight of defects they had separated. The sorted beans were then placed in jute sacks for storage, awaiting roasting, grinding and blending.

Picture 5-28. Sorting of coffee beans and storing in plastic sacks at Monk's Blend

Total quantitativePHLalong the coffee supply chain was estimated based on the responses of the stakeholders (Table 5-15).Total loss reached 14.6 to 19.6 percent, depending on the buyer of the coffee beans. The highest losses were observed during the milling process (8.5 percent of loss). Based on a national average yield of 1,070 kg/ha in dried berries and assuming that 60 percent recovery after milling is attained, lossestranslate into 652kg/ha of dried beans. At a price of USD 1.98/kg for dried beans, total loss amounted to 95.2 to 127.8 kg/ha, valued at USD 188.50 to 253.05.

Table 5-15. Summary of coffee PHL

Stakeholder	**Operation**	**Loss (in %)**
Farmer		
	Harvesting	2.5
	Milling	8.5
Trader/wholesaler		
	Sorting	2.3
	Transport	1.3
Buyer		
	Nestle	Trace
	Monk's blend	5.0
Total		**14.6-19.6**

5.9 Fishery

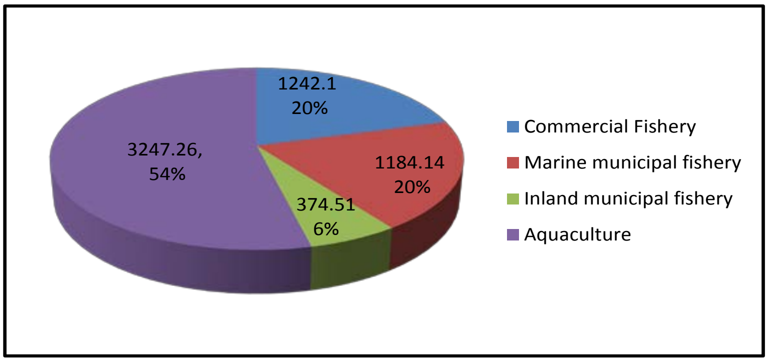
The Philippines is an archipelagic country composed of more than 7,100 islands. It has a water resource area that is many times larger than its land area. With 2.2 million sq km of highly productive sea, the country is blessed with vast fishery resources. Its aquatic resource is home to a variety of species of fish and other aquatic animals. A multitude of stakeholders depend on fisheries, including municipal and commercial fishers, aqua culturists, canneries, fish markets and various ancillary industries.

It is logical, therefore, that fisheries is an important sector of the Philippine economy. A consistent dollar earner with a huge export of fish and fishery products, it provides direct employment and income to around 1.6 million stakeholders and supplies a major part of the dietary protein requirement for the population. Indirectly, the sector provides employment to those engaged in fish marketing and distribution, fish processing, operation of ice plants and cold storages and those in related industries such as net making, boat building and others.

The fishing industry's contribution to Gross Domestic Product (GDP) was 2.3 percent at current prices (BFAR). This translates into USD 3.96 billion. The industry also accounted for 15 percent (USD 3.96 billion) of Gross Value Added (GVA) in Agriculture, Fishery and Forestry Group, totaling USD 25.65 billion at current prices, the largest share next to agricultural crops.

In 2008, the Philippines ranked 6th among the top fish producing countries in the world with a production of 4.97 million tons of fish, crustaceans, mollusks and aquatic plants (including seaweeds). By 2009 production had increased to 5.08 million tons valued at USD 5.01 billion. The largest share of production, i.e. 54 percent, comes from aquaculture, followed by commercial and marine municipal fisheries (BAS, 2011).

Figure 5-3. Volume of production (in 1,000t) of the various fishery sectors, 2010



67 producers, 43 traders and 59 wholesalers were interviewedfor the survey.Of the 67 producer respondents, 43 were from the aquaculture sub-sector, while 24 were from the marine capture. The majority of fisher folksoperate on a small scale in municipal waters, doing aquaculture. Their catches are either brought to the local market or purchased by traders/middlemen for transport to populated areas such as big towns and cities.The most commonly cultured species are milkfish ("bangus"), prawn, tilapia, siganids, prawns, crabs and Pangasius. The size of fishponds varies from one-fourth of a hectare up to 40 hectares, while for fish cages, the size ranges from 6x6x5m to 10x10x5m (length/width/depth). Estimated yield per hectare of ponds per year ranges from 1,500 to 8,000kg, depending on the culture system and technique being employed, and the species being cultured.The commonly caught marine species were tuna and tuna-like species, slipmouth, mackerel, roundscad, sardines, grouper, big-eye scad, squid, marlin, moonfish, siganids, rabbit fish, and crabs. Fishing grounds frequented by the respondents include: waters along the Ilocos coast, Manila Bay, San Miguel Bay, Cuyo East Pass, Visayan sea, Davao Gulf, Pujada Bay, Moro Gulf, Illana Bay, Celebes Sea, and the waters surrounding Palawan.

65 percent of producer respondents were members of a fishery organization/cooperative.They were provided with trainings, particularly on entrepreneurship, fish culture technology, coast watch, fish breeding, organic aquaculture, seaweeds culture, food safety/HACCP training and fish processing. The Bureau of Fisheries and Aquatic Resources (BFAR), the Department of

Trade and Industry (DTI), the Local Government Units and the University of the Philippines were listed as the main institutionsproviding these trainings.

Traders are categorized into assembler/wholesaler (56 percent), consignees (26 percent), agents (10 percent) and others (8 percent). Fish products/species being traded include bangus (fresh/deboned/smoked), dried fish, prawns/shrimps, tilapia, tuna and tuna-like species, carp, big-eye scad, sigani, and squids. The volume that was traded ranged between 50kg and 10 tons per day and was distributed to the various wet markets in the regions. Wholesalers/retailerstraded between 5 and 5,000kg per day.

Among the fishing gears commonly used were long line, handline, gill net, ringnet, Danish seine, purse seine, hook and line, fish pot and spear gun. Fishing boats used were the conventional non-motorized *banca*, motorized municipal fishing boats and small-scale commercial fishing boats. Fifty percent of the marine capture respondents indicated that they landed their catch in fish ports and the other 50 percent landed their catch along the beach. Interestingly, only two respondents noted ice plant as the only infrastructure available in their area. The estimated volume of catch ranged from 3,000kg/day using a gill net and hook and line up to 6,000kg/day using purse seine.

The culture period for aquaculture commodities ranged from three to eight months depending on the kind of species and the culture system being employed. For ponds, harvesting was done by draining the water or by using fishnets. Harvesting stocks from fish cages was done by simply lifting the nets and scoping the fish onto the container or Styrofoam boxes.

Only 53 of the 67 producer respondents provided information as to whether there were losses incurred during harvest. Out of these, 49 percentreported losses, with estimates ranging from less than 1 up to 30 percent, with an average of 5.47 percent. These were attributed to inadequate supply of ice, poor handling, undersize fish (rejects), net entanglement, bad weather and strong wave/current. In terms of quality loss, an average of 6.31 percent was reported with the similar range of less than one up to 30 percent. The lack of ice and poor handling technique were the main reasons identified.

Putting ice in the container to prolong the shelf life of captured fish was the most common practice of producer-respondents (81 percent), while 12 percent of the producer-respondents were not using ice at all. The remaining nine percent of producer-respondents sold their produce in live form.

86 percent of the producer respondents were sorting or grading their harvested/caught fish. This was being done manually by size/weight, quality or species. The most commonly used packaging materials or containers used were plastic tubs (“banker”), Styrofoam boxes, crates, coolers, plastic bags and sacks. The weight per container ranges from 2kg for crates up to 70kg for plastic tubs. In terms of losses during sorting/grading, 69 percent of producers observed no loss, and 31 percent indicated losses ranging from 0.01 to 20 percent of the total harvest. Average loss during this stage was 7.59 percent.

Marketing of the produce usually took place either early in the morning, late in the afternoon, or at midnight since it was the cooler part of the day. Timing was important in order to minimize spoilage and command a better price for the fresh fish. Nearly half of the producers transported their produce to the market and the other half indicated that their produce were sold right where they produced or landed to consignees, fish brokers, other traders including wholesalers and retailers, local walk-in clients and street vendors on a daily, weekly, and monthly basis. Prices often varied depending on size and quality, but the price differencewas not clear, although in general bigger and high quality fish commands a better price.

The most common mode of transport were tricycles, delivery trucks/fish carriers, insolated/freezer vans, boats, motorcycles and various types of public transport. Out of the total number of producer respondents that transported, only 36 provided an answer to the extent of losses incurred during this operation. Out of these, 69 percent reported that no loss was incurred, while 31 percent indicated otherwise. They experienced 0.01 to 10 percent loss. On average, a 3.32 percent loss was incurred while transporting the product to the market.

In terms of trading practices, traders were directly getting their fish products either from aqua-farms, trading posts, fish ports or landing centers. The mode of purchase was usually by weight or by containers (Styrofoam boxes, coolers, trays/crates, plastic tubs, among others), and the mode of payment was cash, next-purchase payment, or a combination of both, depending on the relationship between seller and buyer.

The distance from the point of purchase to the markets, as indicated by the respondents, was on average 118km. The nearest was 4km, while the farthest is 470km. The mode of transport used by land were insulated vans, delivery trucks and fish carriers. The products were transported either live, fresh, chilled or dried.

In terms of losses during transport, 39 percent of the trader-respondents indicated to have incurred either quantity or quality losses. On average, 11.01 percent of produce was wasted, ranging from 0.01 to 30 percent. An 11.11 percent reduction in terms of quality was also observed (range of 5 to 30 percent). Among the reasons cited were poor handling (including overloading during transport), lack of ice and delay in transporting.

Wholesalers and retailers were sourcing their fish products either directly from the producers, from trading posts, or from other traders who were delivering the products to them, or from other bigger markets. Usually, the produce was purchased by weight or by containers, and paid in cash either on the spot or at the next purchase. The mode of transporting the products from their source to the markets was by using delivery trucks or by using motorized boats.

In general, the products were in good quality during transport. They were transported live, fresh or chilled from midnight until around 9 o'clock in the morning or late in the afternoon. During these periods, the fish were still fresh. The containers used during transport were plastic tubs, plastic bags, Styrofoam boxes and coolers, among others.

The number of hours or days the fish and fishery products stayed on the shelves varied. Seven to 10 days for the dried or smoked fish products, and a few hours to a couple of days for fresh or chilled fish that were applied with ice. In terms of losses incurred by the wholesalers/retailers, an average of 12.56 percent of the volume traded/transported was reported by the respondents, with a range of 2 to 30 percent. In terms of quality, however, an average of 10.2 percent of the products marketed was observed to have reduced quality. Poor handling and lack of ice were the main reasons for the loss, while others also reported delays in marketing due to competition, supply glut, competition among products (i.e. fresh water vs. marine species) and high farm gate price which made it difficult to sell the produce at the wholesaler/retailer level.

Table 5-16 shows the average quantitative estimate of losses as reported by the various stakeholders along the supply chain. Total loss amounted to nearly 40 percent. The biggest loss was experienced on the producer side, amounting to 16.4 percent, while for the trader and wholesaler/retailer the extent of losses ranged from 11 to 12.6 percent.

Table 5-16. Summary offish PHL

Stakeholder	Operation	Loss (in %)
Producer		
	Harvesting	5.47
	Sorting	7.59
	Marketing	3.32
Trader		
	Transport/marketing	11.01
Wholesaler/Retailer		
	Transport/marketing	12.56
Total		**39.95**

5.10 Recommendations

As the analysis of the various agro-value chains showed, quantitative losses varied depending on the commodity. PHLranged from 11.28 to 64.3 percent, with the lowest occurring in corn and the highest in papaya. Furthermore, it can be observed that commodities considered durables (rice, corn and coffee) incurred lower losses (11.28 to 20.1 percent), while perishables (fruits, vegetables and fish) had higher losses (39.3 to 64.3 percent). This is due to the nature of the commodity. Perishables have high water content. They are thus susceptible to handling injuries and loss of moisture. They also have a short shelf life if not given proper handling and storage.

It is on the farmer side where high PHL for durables were incurred as critical factors are harvesting and drying operations. Drying is an important activity, which greatly influences the recovery of the commodity both in quantity and quality during threshing (palay), shelling (corn) and milling (coffee). Even though the data shows that a lower loss was reported for drying, higher losses were experienced by farmer respondents in subsequent activities (threshing, shelling and milling). For the perishables, PHL are greatly borne by the farmer and retailer, with the trader experiencing the least losses. At the farm stage, it is the sorting where produce is rejected due to improper production technologies used in producing the crop (10.4 to 31.9 percent).The retailer, who is at the tail end of the supply chain, absorbed all losses occurring due to improper handling practices along the commodity supply chain. For the fishery sector, PHL among the various stakeholders are more or less spread evenly. Icing or chilling the fish after harvest until it reaches the consumer is the primary factor that affects the degree of PHL loss in this sector. Hence, the following recommendations are made:

1. Provision of efficient equipment/machineries to producers: e.g. dryers, moisture meters, dehuller/depulpers for durables, and chillers and ice making machines for perishables. Dryers are very important in areas where harvesting of durables coincides with rainy days, sothat the drying process can be accelerated and a better quality product is produced. For perishables, lowering the temperature of the produce during transport can reduce losses caused by moisture loss and delay the development of diseases.
2. Development of service facilities and village level processing facilities: They could be operated by farming organizations/cooperatives in the area to service the needs of farmers/producers who pay for the services to recover investment and maintenance costs.

The facilities should be operated professionally in order to make them sustainable and profitable for the organization/cooperative. In addition, they can serve as marketing arm of the group.

3. Provision of tramlines, especially in hilly/mountainous areas where vegetables are produced: This will facilitate transport of produce and inputs, and reduce the cost of transport. The tramlines should be operated by trained personnel and paid for by users to recover investment and maintenance costs.
4. Capability building of various stakeholders in the supply chain: This will be in the form of trainings, seminars, tech-demo, etc. to emphasize the proper methods/technologies in postharvest handling of crops. Importantly, farmers/fisherfolks must be addressed too since product quantity and quality are influenced by production technologies. In addition, extension services of the lower government units must be strengthened.
5. Continue the development of the cold chain system in the country as well as change the attitude of consumers to accept chilled and/or frozen commodities especially for perishables.
6. Advocate changes in the policy of shipping lines for agricultural produce: For example,with regards to papaya, it had been shown that the use of 50kg crates for transport greatly reduce losses caused by mechanical injury (compression) compared to 65kg crates. However, the shipping line charges the shipper by container not by weight. Hence, the shipper is forced to use a bigger container to reduce transport costs. This hold true for other commodities, especially those coming from Mindanao.
7. Enhancement of research and development efforts in postharvest in order to develop new technologies and techniques to minimize losses: These should be affordable, sustainable and eco-friendly for various stakeholders along the supply chain.

Altogether, the study was carried out over a few months only and relies mainly on the estimates provided by various stakeholders. Therefore, a more comprehensive study involving actual measurement of losses in different growing seasons in the country should be undertaken to have better baseline information.

6 Thailand

Thailand produces a wide range of agricultural commodities on 21 million hectares, 21.8 percent of which wereirrigated in 2010. Around 93 percent of agricultural land was used to produce rice and other field crops such as maize, sorghum, cassava, sugarcane, pineapple, soybean, mungbeans and peanuts.In 2010 the agricultural sector contributed more than 10 percent to Gross Domestic Product (NESDB, 2012). The country is also the main food exporter in the world. Nevertheless, PHL can be high, depending on the sector.

Three commodities were selected for the study of PHL,conducted by the National Food Institute: rice, maize and cassava, whoseproduction systems, postharvest chains and losses, as well as technologies and supporting organisations will be analysed in the following.

Thailand is a well-known rice exporter and rice production is an important sector nationally. In 2010/2011, there were 3.7 million households engaged in rice production and31.7 million tons of rice were produced. Rice comes in three types: fragrant rice, white rice and sticky rice. In 2010 8.94 million tons of rice were exported, of which 2.36 million tons were the famous fragrant rice Hom Mali.

Maize production in Thailand, on the other hand, is only sufficient for domestic consumption. Only 411,113 households were involved in 2010/11 and total maize production was 4.4 million tons.The maize and cassava sectors are strongly linked: both are used in the feed industry, and growers often switch from producing cassava to maize and vice versa.

Cassava is becoming an important crop in Thailand. In the past, major production areas were in eastern parts of Thailand. Nowadays, northeastern and western provinces are the major production areas.Most of the production is used for the feed industry, but the cassava flour industry and ethanol industry raise demand for cassava. In 2010/2011, there were 440,959 households engaged in cassava production, on 1.1 million ha. Cassava production ranged between 22 and 30 million tons since 2008. Cassava products come mainly in three forms: chip, pellet and flour. The latter is the main exporting product, largely to China, European countries, Japan, Indonesia and Taiwan.

6.1 Rice

The typical rice farm in Thailand produces rice once a year, but where the irrigation system is well-constructed, rice farmers produce twice a year. First, farmers prepare the seedbed, using tractors and disc ploughs to break up the soil for planting the rice seed. For harvesting, a rice harvester is widely used. It cuts the rice and processesit to paddy during the harvesting process. Harvest machine operators not only take the rice from the field, but they also provide transportation to the rice mill.

In high land or on small farms, farmer use “Kiew”, a special purpose knife to cut rice. They then use a small area near their house to remove the rice from the stalk. Most of the rice harvesting in Thailand, however, is done by harvesting machine, as labor supply would be insufficient for manual harvesting.

At harvest, the moisture content of rice is around 20 to 25 percent, which after two to three months storage falls to 14 percent. There are various techniques to reduce moisture. The most popular is sun drying and using a cyclone dryer. The problem with sundrying is that the rice quality cannot be controlled. In the past, drying usually took place in the field. However, as the rice market developed, drying practices shifted to the rice milling manufacturer. Each milling factory has a big cement floor for drying. Rice farmers conduct drying only to reduce moisture content up to the price requirement standard to get the guarantee price. In some cases, farmers bear the cost reduction due to high moisture content. Small scale farmers might form farmers' groups to set up a sundry floor. And in some provinces where rice production is high, the rice milling manufacturer rents drying floor to the farmers. Notably, the cost of moisture content reduction is considerable. It is carried by one of the actors along the chain, depending on the bargaining power of rice farmer, sundry operator and rice mill manufacturer.

Picture 6-1. Harvesting machine and knife

As drying shifted to the rice milling manufacturer, the key point of PHLat farm level is now farm management and how the farmer selectsthe suitable harvest time. In most areas there are rice harvesting operators available to farmers. They are specialized in harvesting at maximum yield, and in return receive not only the rental cost of machine, but also a share of the selling price. PHLfor the rice farmer is minimal – an estimated 5 to 10 percent – especially in the dry season. In some areas, however,harvest machines are in short supply and farmers have to reserve a time for harvest. This could lead to early or late harvest, becausecancelling the reserved time slot with the harvest machine operator could mean that the farmer is left without harvest machine.

Transportation plays a crucial role in the postharvest chain. Transport operators work together with harvesting machine operators. They have information on selling price and good buyers, and they play an important role for the development of harvesting machines.

In2011 there were over 36,300 rice milling manufacturers in Thailand. The high number of rice milling factories has led to farmers directly selling to mills instead of stocking paddy.In order to get a high milling yield, millers have to reduce the moisture to 13 percent. There are two types of storages:paddy dumped on the floor in the storage house or put in bags. The first is prepared for milling, while the latter method is used for rice aging, producing a higher rice quality. Altogether, the largest share of PHL occurs at the milling stage.

Picture 6-2. Paddy bags and storage

Table 6-1. Rice PHL: Causes, effects and measures

Stage	Causes	Effect	Measures
Physiological maturity	Delayed or early harvest Varieties susceptible to diseases and pests	Losses in quality and quantity	Timely harvest Planting resistant varieties
Harvesting	Poor soil condition, e.g. wet soil	Losses in quantity	Timely harvest
Mechanical damage during harvest	Poor handling Poor threshing or shelling practices	Low harvesting yield	Careful handling of produce Threshing and shelling methods should minimize damage
Drying and storage	High temperatures Storage pests and fungi Insufficient drying before storage Moisture in storage area High relative humidity	Losses in quality, such as high level of broken milled rice	Avoid artificial drying Control storage pests Dry produce sufficiently before storage

Institutional support is provided by many players: e.g., there is one government agency responsible for rice development, called the Rice Department. In addition, there are rice research centers in major rice growing areas. The centers train, develop and distribute rice varieties to farmers. In order to distribute sufficient rice seed to farmers, R&D centers set up farmer production groups in each province. Members of these groups produce only rice seed for the center to redistribute for farmer.

The Ministry of Commerce sets the rice standard for growers and rice mills to support agricultural development and trade. Furthermore, Kasetsart University and the National Science and Technology Development Agency (NSTDA)work together to develop new varieties based on needs in specific areas. NSTDA as an organization under the Ministry of Science and Technology conducts also DNA laboratory services to inspect the rice variety mixture on the field.

Besides this, private companies play an important role in rice development. They develop specific varieties for farmers in different regions and they work closely with the rice research centers to supply rice seed.

6.2 Maize

Maize and cassava are grown in rotation and have the same value chain. Maize is grown in two seasons: March to June and July to August.It can be harvested by handor machine. As maize shelf life depends mainly on temperature and humidity, growers have to manage those factors to ensure high quality output. It is recommended to lower the moisture content to reduce the risk of alphatoxin. Field pre-drying techniques are fairly widespread: growers use pre-dried standing in the field before proceeding to hand-harvest the ears. But this procedure entails great risks of product loss, especially if the varieties grown are particularly sensitive to rain, humidity and pest.

When the maize is properly dry, pickers pull the ears from the stalks. The removal of the husks is done on the field during harvest. In large areas, growers use a harvesting machine, such as a corn snapper, corn picker-husker, corn picker-sheller or corn combine harvester. Harvesting by machine is fast, especially when labor is in short supply. However, the effectiveness of machine harvesting varies, and the harvesting technique used may lead to damage. In addition, during the wet season, machines canproduce a low harvesting yield.

In the past, maize growers conducted most of the postharvest operation. They milled their output in the field and stored it in basic storage facilities. Nowadays, farmers' postharvest practices are limited as business practice forced growers to concentrate on grain quality and to transfer the maize for further processing, such as sundry operations by either private middlemen or cooperative groups.

Drying takes place mainly at sundry operators, where the maize is spread for two to three days on a large sundry floor. Where growers form cooperative groups, they use the cooperative sundry floor to temporarily store their maizeuntil they get a satisfactory price. But this practice may increase PHL (Table 6-2).

Most PHL for maize occurs due tobio-deterioration and during the drying process. An estimated 5 to 10 percent of losses occur during harvest. In some cases, growers have to take maize out of the field and put them onto the cement floor, which may decrease quality and increase the risk of toxin. In the wet season, growers face problems of high moisture content and high costs of labour, which affects harvest and can lead to early or late harvest. In the late dry season, farmers often harvest early for fear of rain. This, however, means that the drying process will be longer, during which damages to the production might occur. Farmers might therefore decide to quickly sell maize to middlemen, accepting a price cut of up to five percent compared tomarket price.

During drying, even though operators are very familiar with the procedures, problems may arise, such as a shortage of sundry floor and storage during high season and development of alphatoxin during drying and storage. The strategy of the operators is therefore to transfer maize to further processing as swiftly as possible.

Table 6-2.Maize PHL: Causes, effects and measures

Stage	Causes	Effect	Measures
Physiological maturity	Delayed harvest (increased exposure to pests, livestock and animals) Varieties susceptible to diseases and pests	Losses in quality and quantity	Timely harvest Planting resistant varieties Protecting crops from livestock, etc.
Harvesting	Poor handling Poor threshing or shelling practices Termites and rodents	Losses in quantity	Careful handling of produce Pest control Timely harvest
Mechanical damage during harvest	Poor handling Poor threshing or shelling practices	Quality decreases, increased vulnerability to pests and diseases	Careful handling of produce Threshing and shelling methods should minimize damage
Drying and storage	High temperatures Storage pests and fungi Insufficient drying before storage Moisture in storage area High relative humidity	Losses in quality Possible production of mycotoxins Swelling and germination of grain	Avoid artificial drying Control storage pests Dry produce sufficiently before storage Storage facility should be moisture proof and adequately aired

Source: IRRI

In terms of support, the following institutions play an important role for maize production and itspostharvest value chain:

- Ministry of Agriculture and Cooperatives: it has the powers and duties with respect to agriculture, water sourcing and irrigation development, agricultural promotion and development, and promotion and development of the cooperative system. Its mission is to promote agricultural units and to encourage them to be self-reliant, to promote production of agricultural produce and food that meet market demand and consumer standards, to research and develop the infrastructure for agricultural production, and to develop and transfer agricultural technology focusing on effective, sustainable and environmentally friendly use of agricultural resources.
- Department of Agriculture: its mission includes research and development, and the provisionof information services to growers and the private sector. Its organizations relating to growers include the Field Crop Research and Energy Crop Institute, the Research and Development Institute and the Postharvest and Agricultural Processing Institute.
- Department of Agricultural Extension: it is responsible for agricultural promotion. The department has provincial offices all over Thailand, and growers can use the offices for information services and for establishing links with other organizations.
- Department of Cooperative Development: it focuses on cooperative and farmer groups, providing capital and equipment to enhance the production and marketing

capacity. In the case of cassava, rice and maize, some cooperativeshave received sundry cement floor, equipmentsuch as a harvesting tractor or training.

- Ministry of Commerce: itintroduced an export standard for maize, among others.

6.3 Cassava

The production of cassava is strongly influenced by three factors, which also play an important role for productivity along the postharvest chain, i.e. variety selection, soil management and crop management (Figure 6-1). Farmers use a large number of varieties, some of them unregistered, which produce high yields but are not supported by the institutions (DOA and Kasetsart University) in case of production problems.A widespread problem currently faced by cassava growers is infestation by the Phenacoccus manihoti insect. To counter this, growers need to have a good crop management practice. Each cassava variety has a recommended harvest time for optimum yield. However, farmers take other – economic – factors into consideration when deciding on the harvest time, e.g. price, distance to processors and availability of harvesting machine.

Figure 6-1. Key issues for cassava productivity

At harvest, cassava growers use a harvesting machine, mostly provided by harvesting operators.Harvesting machines are well developed in Thailand, but losses due to technical problems still amount to an estimated 5 to 10 percent. Harvest is very time consuming. It is estimated that one machine can harvest 0.8 acres/day and requires 10 to 20 workers, who have to take the cassava root from the harvesting range, cut it and loadit on a truck.

Swift transportation after harvest is the key to good cassava quality. The period between harvest and further processing should not exceed two days, or else there will be PHL due to loss of starch content and other damage (Table 6-3).

Table 6-3. Starch content and damage to cassava roots after harvest

Days after harvest	Starch (in %)	Damage (in %)
0	23.01	0
2	23.07	1.62
4	20.07	10.80
6	13.13	23.92
8	9.94	35.21

Source: Pungpetch et al., 1979

There are middlemen or primary processing operators who provide transportation for growers. In some areas, where production is not far from the factory, growers have their own truck for transportation. An important step in transportation is the arrangement of cassava roots on the truck to prevent damages, especially bio-deterioration.

Picture 6-3. Cassava transportation by truck

In Thailand, there are three main types of cassava use: cassava flour, feed and energy manufacturing. A new sector, which is increasingly absorbing cassava roots, is the syrup industry. Cassava flour, syrup and energy manufacturers use fresh cassava roots, while feed manufacturers can use dry cassava for their production. The distance of cassava growers and flour, syrup and energy manufacturersis usually in the range of one to two days transportation.Cassava producers for the feed industry, however, are widely found all over Thailand.

For those, fresh cassava roots are pre-processed by either sundry flooroperators or agricultural groups, especially cooperative groups. The roots are chipped using a locally manufactured machine, sundried on cement floorfor three to four days to reduce moisture, during high season put into cyclone to prevent damage from moisture, stored and sent to the feed industry, which produces cassava pellets for animal feed by grinding, steaming, pelleting and cooling the pre-processed cassava chips. There are no estimates available for loss during the drying process, but loss caused by wind and fermentation of chips are common problemsof cassava sundry operators.

Picture 6-4. Sundry operator, the local chipping machine and chipping equipment

Flour manufacturers and the ethanol industry buy the roots at factory price. This means growers or middlemen have to bear the transportation costs. All cassava output surrounding manufacturing is accepted. But at purchase, the roots are graded and inspected. In terms of quality requirements, foreign material and soil should not be greater than three percent, and the percentage of starch should be at least 20 percent.

Picture 6-5. Fresh cassava roots and starch check

The selling behavior of growers depends on the distance to manufacturing. In areaslocated further away from processing, growers sell fresh cassava to middlemen, who play an important role in postharvest management. As growers do not wish to keep their product in the field for too long in order to prevent crop damage, they usually sell the production at off-farm price. The middlemen know how to manage fresh cassava for high return. Theycalculate the volume of fresh cassava in a certain area, collect them by sending trucks to growers and transfer the fresh roots directly to the factory. Thus, the postharvest operation is shifted from growers to middlemen, who have better information in determining how to manage the cassava output.

Table 6-4. Cassava PHL: Causes, effects and measures

Stage	Causes	Effect	Measures
Physiological maturity	Delayed harvest or early harvest Varieties that are easy to harvest	Losses in quality and quantity	Timely harvest Planting resistant varieties
Harvesting	Proper machine and labor	Losses in quantity High % of roof left in the ground	Use machine with enough worker Timely harvest
Mechanical damage during harvest	High percentage of taking roots out of the ground	Use more workers for machine	Develop new equipment to have high percentage of extracting cassava roots
Drying and storage	Improper moisture content in storage area	Losses in quality; cassava chips fermented	Use hot air in wet season

Source: NFI interview, 2012

A number of institutions provide support for cassava production and postharvest operations:

- The Ministry of Agriculture and Cooperatives, which is responsible for supporting growers. Major departments are the Department of Agriculture and the Department of Agricultural Extension. In addition, the government encourages growers to establish cooperative groups. Thus, the Department of Cooperative Development plays an important role for networking.
- Kasetsart University is well known for developing new improved varieties for the cassava sector, such as KU-50, which is used in most of the cultivated area.
- The Technology Suranaree University in Nakorn Ratchasima Province plays an important role in technical consultation for helping growers. The main project aims at solving the problem of hardpan, where soil overuse leads to a very dense layer of soil. Researchers work with growers and flour manufacturers for alleviating these hardpan problems.
- In the non-government sector, the Thailand Tapioca Development Institute (TTDI) is involved in cassava development. TTDI diagnoses cassava yield and emphasizesgood practice of cassava plantation, e.g. by use of proper variety and production management.

6.4 Recommendations

The cassava industry is a fast growing sector in Thailand and manufacturers require more cassava root. The key to the cassava sector is to provide high yield harvesting machines that are easy to use, leave less roots in the ground and requirefewer workers for operation. By reducing labour input, the new harvesting machines could also have a beneficial influence on the selection of harvest time. The pilot project at Kasetsart University for a cassava harvesting machine improves the harvesting capacity by 10 percent, which is equivalent to

3.3 million tons per year (NSTDA, 2011). The development of harvesting machinesshould therefore be the first priority for improving the cassava sector.

In addition, sundry techniques are widely used all over Thailand for cassava pre-processing. The practices of operators differ from area to area. Problems such as loss from wind and fermentation of chips, which reducesthe starch quality,are common. With the introduction of improved harvesting machines and drying practices, cassava output would increase without having to increase production area.

Methods to reduce PHL in the rice sector are more or less of the same priority as cassava. The well-developed rice business system requires rice farmers to deliver more rice to further processing. Harvesting operatorsplay an increasingly major role in high harvesting yield. Choosing theright harvest time is crucial for rice output and quality. They drying process is very important too, as it has a direct effect on the milling yield.

Maize PHL are not easily observed by growers, because of the practice of moving maize to next step operators as fast as possible. This strategy makes maize-end users and feed manufacturers bear the risk of loss.

Table 6-5. PHL analysis summary

Point of losses (in order of priority)	Yield loss	Supply chain actors
Cassava		
1. Harvest	Root left on ground in case of lack of labor, approximately 5%	Growers, middleman
2. Drying	Primary processors have not enough sundry area Price reduction	Primary processors
3. Storage		Primary processors
4. Bio-deterioration	Early or late harvest	Growers, middleman
Rice		
1. Harvest	Early or late harvest	Growers, harvesting operators
2. Drying	Moisture content reduction would increase milling yield	Growers, harvesting operators, Rice milling
3. Storage	Improper fumigation	Rice milling
4. Bio-deterioration		Rice milling
Maize		
1. Bio-deterioration	Loss of weight Alpha Toxin	Growers
2. Storage	Good storage practice for high season to avoid damage from moisture content	Middleman, sundry operator Further processing
3. Drying	Insufficient sundry area might damage maize quality	Middleman, sundry operator
4. Harvest	Early or late harvest	Growers, harvesting operator

Table 6-6. Findings and recommendations for cassava, rice and maize

	Findings	Recommendations
Cassava	Harvest machine improvement needed	Introduce new harvesting machine to reduce loss
	Early and late harvest may affect cassava weight	
	Various varieties used	Encourage use of certified cassava varieties
	Problems of toxin in wet season	
Rice	Early harvest when 3 rounds per year grown	Encourage high quality standard
	Mixed varieties found	
	Harvesting machines in short supply in high season	Encourage harvesting operators
	Loss when harvest in wet season	
Maize	Insufficient sundry floor	Encourage growers' groups
	Loss when early harvest	Training on good practice in maize storage at grower and further processing stage
	Improper drying might create alpha toxin	

From the findings of the study it is clear that agricultural production and the behavior of growers in Thailand is dictated by business decisions. As described above, growers transfer PHL to primary processors and other stakeholders such as harvesting operators, middlemen and sundry operators.In order to influence the practices of growers, it is suggested that supporting units, government and non-governmental organizations, should focus on

- the development of new harvesting machines, especially for cassava
- the reduction of sundry costs to growers, as sundry techniques for reducing the moisture content is crucial to all three sectors; for maize growers supporting the development of cooperative sundry floors would be beneficial
- the introduction of commodity standardsto change growers'postharvest practice, e.g. in the rice sector a high grade standard would encouragefarmers to change their farm management, including the care for plantation and selection of harvest time; in cassava, the introduction of a clean cassava standard would force cassava growers to look after their field regularly, producing an immediate three percent pay-off for farmers
- the consolidation of a national training course on postharvest practice, with practical use and easy access to training documents and materialsfor growers.

7 Vietnam

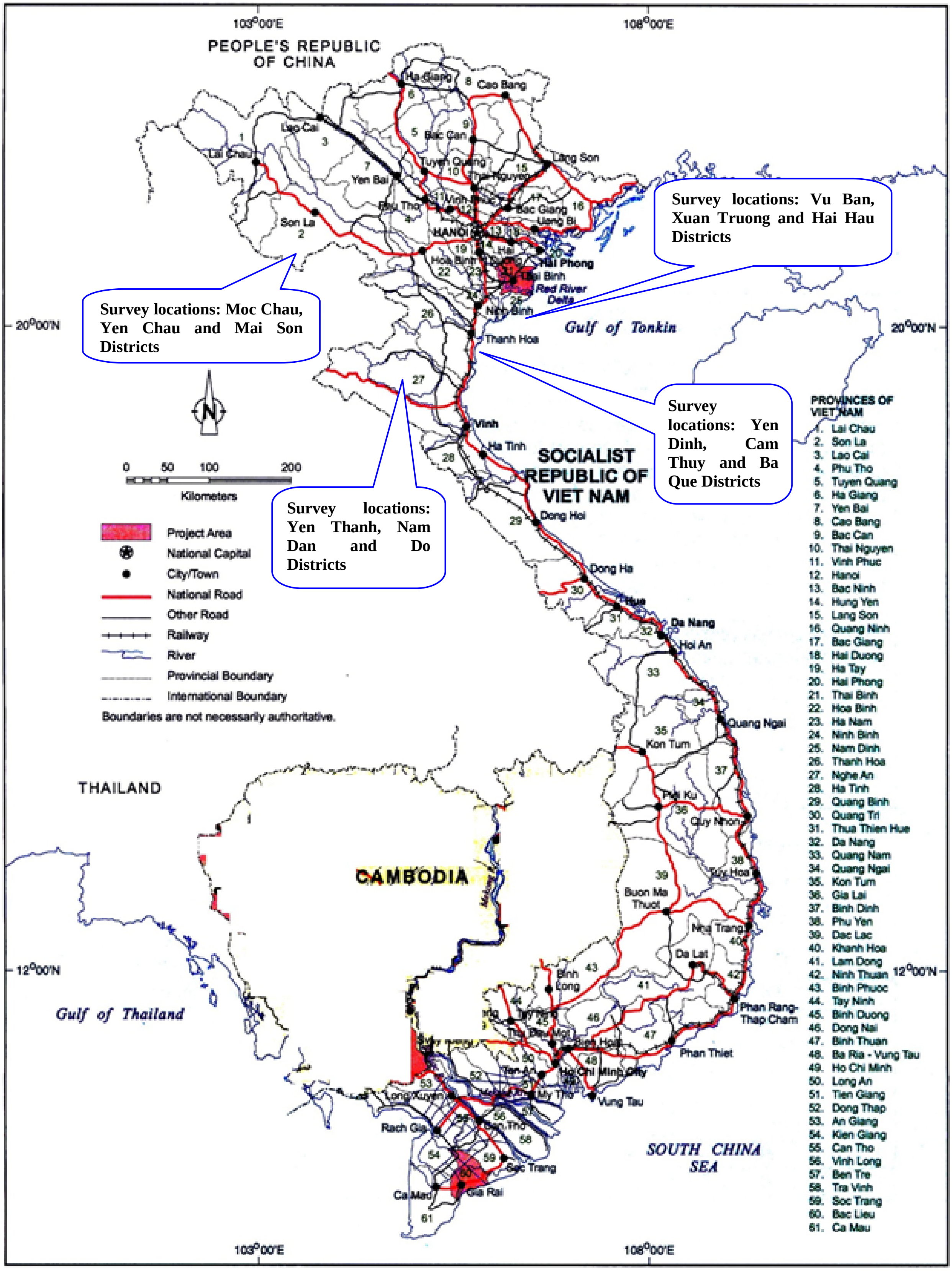
From a country used to import food, Vietnam has transformed its agriculture over the last 30 years to become the second largest rice exporter in the world. Thanks to technological advances, e.g. in seed, farming, fertilizer and pesticides, the yield of staple food crops such as rice, maize and cassava has made remarkable achievements and annual total output of agro-products is increasing. Between 2005 and 2012 average annual increase of agricultural production reached 22.8 percent. Every year, the agricultural sector contributes about 13 to 20 percent to total GDP, nearly 15 percent to export and provides jobs for almost half of the rural workforce. Over the past decade, with a growing rate of commodities and export-oriented products, Vietnam's agriculture has been commercialized at a relatively high level to approach the world trading system with a rate of export turnover of 30 to 40 percent. In 2011 the export value of agro-forestry and fishery products was approximately USD25 billion, out of which the highest value was agro-products with a share of 33 percent.

Rice, the first most important staple food crop of Vietnam, has been cultivated mainly in the Red River Delta (RRD) and the Mekong River Delta (MRD). By 2011 the rice production area reached 7.7 million hawith a yield of 5.5 tons/ha. Rice output increased to 42 million tons. The country exported 7.35 million tons of rice for USD3.5 billion.Maize, the second most important staple crop, can grow well either in lowland or dry high land, producing high yield. Among the agricultural crops, the maize growing area makes up more than 10 percent. It has increased to 1.1 million ha with a yield of 4.09 tons/ha and an output of 4.6 million tons in 2011.Cassava, the third most important crop, grows well on hilly and sloping land, i.e. in midland, mountainous areas and plateaus.In 2010, the nationwide total area under cassava was estimated at nearly 0.5 million ha with a total output of 8.5 million tons. Yield increased from 15.78 tons/ha in 2005 to 17.17 tons/ha in 2010.

Despite agricultural industrialisation and modernisation,food production in Vietnam still highly depends on natural conditions and is affected by disasters and pests. To increase annual output by one percent, a huge investment of labour, seeds, fertilizers, pesticides, irrigation and many other governmental support policies are required. But every year there are considerable losses caused by spillage, pests, mold etc.A number of state policies, programs and projects were devised to reduce PHL, e.g. by supportingscience and technology, as well as the purchase of machinery and equipment for agricultural production, processing and storage. Annual average rice loss due to weaknesses and inadequacies in the postharvest stage, however,still amounts to 12 percent, or 4 million tons, which is equivalent to the total rice output of Hanoi, Thai Binh, Nam Dinh and Hung Yen Provinces. The rate for maize nationwide was 18 to 19 percent of production.

The following study was conducted by the Vietnam Institute of Agricultural Engineering and Postharvest Technology (VIAEP) to determine current PHL along the various stages of staple food crop chains in Vietnam and to devise strategies to minimize losses, ensure food security and implement programmes on hunger alleviation and poverty reduction for farmers. Secondary and primary data was researched, including a survey and Participatory Rapid Assessment (PRA) workshops at village and professional level. For the survey Son La, Nam Dinh, Thanh Hoa and Nghe An Provinceswere selected (see Map 7-1), as they are considered typical localities of rice (Nam Dinh, Nghe An and Thanh Hoa), maize (Nghe An, Son La and Thanh Hoa) and cassava(Nghe An and Thanh Hoa) cultivation in Vietnam.

Map 7-1. Survey locations in Vietnam



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7.1 Rice

Rice harvest in Vietnam is either manual,semi or fully mechanised. Usually, the rice is cut and gathered in a pile before being transported to the edge of the rice field or the threshing sites. The use of a combine harvester is still modestin the surveyed provinces, i.e. for 10 percent of the rice cultivation area in Nam Dinh, but only five percent in Nghe An and Thanh Hoa. The main reasons are small plot sizes of cultivated land, many turnings at the head and end of each plot and lack of skilled operators. Following harvest, the rice is threshed, after which it undergoes pre-cleaning, drying, further cleaning and storage. It is then milled and transported to the selling sites.

Some rice varieties have a higher resistance against mechanical impact while being harvested. It shows in low grain fall and includes aromatic varieties of BC15, BT and some hybrid ones. Meanwhile, other varieties with a high risk of lodging due to strong wind or grain fall during harvestare still grown in some localities such as Thanh Hoa and Nghe An. As a consequence, when harvested by machines, many unharvested rice hills remain in the field. To solve those constraints, some new varieties with hard stem, little lodging and good resistance against mechanical impact during harvest are introduced to replace old varieties.

Harvesting conditions are found to have a considerable impact on losses along the rice value chain. In favourable weather the loss ratio of rice at harvest is usually low for all varieties. In unfavourable weather, however, the loss ratio of varieties with high risk of lodging, grain fall and less resistance against mechanical impact will be very highat the harvest and transport stages.To reduce PHLs, managers of many localities have provided guidance on cultivation time to avoid the frequently bad weather. Namely, in Yen Dinh District (Thanh Hoa Province) rice cultivation starts ahead or behind seasonal time by 20 days. This limits the adverse impact of the weather on postharvest activities.

Using manual methods for harvest always prolongs harvest time, especiallyunder unfavourable weather conditions, leading to a high loss rate. Besides, hired labour for rice reaping is becoming increasingly common, but poor labour awareness and hurry in cutting causesmore grain to fall and unharvested ears of rice to remain in the field. Compared to mechanical harvest by combine harvester, PHL in manual harvest are higher. But even the currently used Chinese rice combine harvesters have a high rate of loss due to grain being blown away with straw and lodged rice not being cut.

When harvest is ahead of time, the ratio of immature grains is high. Thus, while threshing, the rate of grains blown away with straw increases. This often appears to be the case in areas where harvest time is in a race against time to avoid flooding. Rice harvesting on time is a big problem in many localities, because rice fields are scattered and labour is in short supply. Therefore, harvest is mostly behind time. This is a major cause for increasing the ratio of lodged rice in the field and grain fall when harvested.

The problems mentioned are typical for those encountered throughout the country's rice cultivation area. Output loss rate of rice during the harvest stage in MRD is 3.9 percent, and 1.3 percent in the RRD and central Vietnam. The harvest stage is mechanized to some extent, but still only 23 percent for the whole cultivated area of the RRD and 36 percent for the MRD.

Presently, all of the harvested rice is transported by simple carts driven by humans or animals, powered vehicles or small trucks. Hence, the ratio of grain fall is limited. The rice is usually transported to the ends of the path at the edge of ricefield or an empty site near the field to be threshed. The transport distance is short, leading to fewer losses.

In Nam Dinh, a plain province with good traffic infrastructure in the field network, transport of harvested rice from fields to threshing sites is relatively good. The harvested rice is usually transported by built-in twelve-HP-diesel-engine vehicles and two-wheel carts drawn by buffalo.Threshing activities often take place right in the field.In Nghe An Province, the inter-field traffic system is not favorable to transport. Harvested rice is generally transported to the home yard. Common means of transport are shoulder pole, pack-bike or carts drawn by buffalo. Average loss is 2.2 percent. In Thanh Hoa Province, the inter-field traffic system is not good for transport. About 50 percent of rice is threshed right in the fields. Common means of transport are also shoulder pole, pack-bike or carts drawn by buffalo.

Rice losses during threshing mainly depend on varieties, time of harvest, types of threshers and skills of operators. The loss rates in Nam Dinh, Nghe An and Thanh Hoa are 2.4 percent, 3.2 percent and 3.2 percent, respectively. Around 80 percent of harvested rice is threshed by powered machines. The rest is threshed by either pedal threshers or other methods (mostly in mountainous districts of Nghe An and Thanh HoaProvinces). The loss ratio when threshing dry rice is lower than that of threshing wet rice. In Nam Dinh Province, 100 percent of the threshing is machine powered. Canvas is used for collecting threshed grains. Thus, spillage of grain is limited. Rice grain blown with straw is rather low, because harvested paddy is dry at threshing. In Nghe An and Thanh Hoa Provinces, rice threshing machines are power or pedal operated. Threshing activities often take place on home yard or empty ground sites. Rice grain blown with straw is high, because the rice is wet at threshing.

In the RRD almost all of the commercial rice is dried in the sun on large drying platforms, leading to a high rate of loss. Only rice seeds are dried by driers, but this is a very small volume due to high equipment costs, which are often not affordable for farmers or production units.Even so, dryers are mainly horizontal batch bed-type with low cost, simple technology. As a result, technological parameters and product quality are difficult to be controlled.

To dry paddy farmers take full advantage of flat platforms like brick or concrete yards, concrete roofs, empty ground sites and edges near the highway. When using the sun drying method, the drying time is prolonged. In Nam Dinh, the weather during harvest is more favorable than in other localities, so sun drying takes only three to five days. Dried on canvas, rice is easily gathered when it rains and the loss ratio is limited with an average of 1.4 percent.

In the mountainous districts of Nghe An and Thanh Hoa Provinces, however, weather during harvest time is often unfavorable because of heavy rain and storm. Drying time is prolonged over five to seven days or more. Therefore, the loss rate due to spillage, germination etc. is high.Especially in the case of commune adopted combine harvesters, newly harvested rice grain is piled up in great bulk for some days, causing heat inside the bulk and damaging grain.Average losses amount to 2.9 percent (Nghe An) and 4.2 percent (Thanh Hoa).

Rice is often cleaned and sorted by electric fans or box winnowers. Sometimes cleaning is done by wind. Average rates of grain loss in cleaning and grading in Nam Dinh and Nghe An are lower than those in Thanh Hoa.

Commercial paddy is usually stored short term and the loss rate is lower than that of paddy stored for family need. Each family usually stores about 500 to 700kg.Safe moisture content for storage of rice is around 13 to 14 percent.Losses of rice during storage are often caused by insects (one to two percent) and by rats (at a very high rate). Loss of rice stored in corrugated, wooden barrels or boxes is lower than for rice stored in PP packing. In Nam Dinh Province, paddy is often sold immediately after harvest or when the price is good. It is often sold to traders at the farmer’s home. The amount of rice used for family needs is not much, but rice is stored in PP packing, so it is often eaten by mice. In Nghe An Province, all of the rice is stored in wooden or tin/metal containers to avoid mice damage. The average loss rate is two percent. In Thanh Hoa Province, rice is stored for a long time in PP packing. Again, there is high damage by mice and weevils.

At a small scale, rice storage is conducted in traditional ways with less innovation and use of scientific and technical achievements to prevent pests and fungi. In addition, knowledge of farmers about techniques for preventing insect and fungi damage is very limited, especially for farmers in the midlands. In lowland intensive rice-growing areas such as Yen Dinh District (Thanh Hoa Province), farmers wish to sell rice to traders immediately after harvest to limit losses to about five to six percent.

Enterprises often store paddy and rice for a short time only because of lack of modern stockpiles. Stockpiles in the national system are about 150 pieces to store paddy with three common types such as roll stocky, A1-type stockpile and Czech ready-steel-made rocky frame stockpile, distributed in 64 provinces with a total amount of 178,757 tons of paddy and 183,606 tons of rice. Recently, many new stockpiles have been built in the MRD. A common current measure is to use phosphine to fumigate the grain bulk in the rice stockpiles. But almost none of the stockpiles can meet technical requirements because of lack of natural air ventilation. Many stockpiles are located in inconvenient places, far from production areas and ports. Non-state owned enterprises have not invested in modern stockpiles due to limited funds. Also, they have not seen clearly the benefits of investment.Staff of the National Reserve Department, however, researched and applied technology for rice storage with nitrogen (N_2), carbon dioxide, deoxidiser and vacuum. The results showed that time of storage of rice could be prolonged from one to two years with good quality.

Qualitative losses are results of many factors such as chemistry, biochemistry, physics, physiology etc., as well as poor management and outdated postharvest technology. During storage, many types of fungi and bacteria appear and develop rapidly. They cause significant reduction of amino acids and loss of protein. This reduction and loss brings about changes of color, smell and taste,mold contamination, reduction of nutritional value and market value, and can even cause food poisoning in humans and animals.

At the milling stage, losses are mainly results of inappropriate technology. Many milling plants are too old and outdated to be used. Also, losses come from mixed seeds, spillage during transport etc. The loss rate in this stage of rice in MRD was three percent, in RRD and the central region 4.4 percent.

In the surveyed localities, rice for local domestic consumption is commonly milled by two-stage machines. Losses are mainly due to spillage, but the loss rate is lower than that of one-stage milling machines.In Nghe An Province rice is milled by one-stage milling machines, so a high proportion of bran reduces the recovery rate of rice, which leads to an increase of the loss rate.Currently, farmers cannot control the moisture content of grain before milling. When paddy is milled at a moisture content of more than 16 percent, the quality of the finished rice will be degraded and the loss rate amounts to more than three percent.

The qualitative decrease also shows clearly in a low recovery rate (nationwide average rice recovery rate is 63 to 65 percent), in an increased rate of broken grains because of improper technical process of harvest. Although milling has been mechanized at a high rate, the rice processing system is divided into piecemeal, different varieties of rice are purchased from small millers and are subsequently mixed. This leads to an increase of percentage of broken rice, a qualitative decrease of finished rice, which is reflected in a lower price.

The following table provides the results of the average rate of rice losses along the postharvest stages in the selected provinces. Total average losses range between nearly 9 percent (Nam Dinh Province) and 17 percent (Nghe An and Thanh Hoa Provinces).Nationwide, the rate of PHLs of rice due to weakness and inadequacies in the postharvest system was 12.7 percent in MRD, and 11.6 percent in RRD and the central region.

Table 7-1. Average rice PHL rates in three selected provinces in Vietnam

Province	Loss rate (in %)								Total loss (in %)
	Harvest	Transport	Threshing	Drying	Cleaning	Grading	Storage	Milling	
Nam Dinh	2.22	0.55	2.43	1.40	0.28	0.10	2.02	0.37	8.75
Nghe An	2.66	2.17	3.19	2.98	0.76	0.44	1.95	2.07	17.13
Thanh Hoa	3.57	1.32	3.21	4.15	0.32	0.07	3.88	0.28	16.98

7.2 Maize

Like rice, there are maize varieties with high yield, low tumbling and good resistance against insects, but farmers continue to cultivate many varieties with less resistance against rain and wind and a high risk of insect and mold damage right in the field, such as KN54 and KN64. The selection of those varieties contributes to increased PHL rates. During harvest, losses are mainly due to quality reductions by fungi like aflatoxin and ochratoxin, which develop quickly when harvesting in rainy times. Currently, in the identified provinces 100 percent of maize is manually harvested, for maize harvesters cannot be applied in milpas.

The loss rate of one percent in Nghe An is the lowest among the three provinces, because farmers cultivate hard-stalk varieties, which have a good resistance against lodging in windy weather and good husk. Meanwhile, the losses in Son La and Thanh Hoa are 2.8 percent and 2.4 percent, respectively. They are higher than those in Nghe An, because weak-stalk varieties are cultivated.

Following harvest, maize is transported to the farmer’s home for husking, drying and shelling, or to the path near the cornfield where the production will be sold. During this transport, a loss of one percent occurs in Nghe An, which is the highest among the three identified provinces. Maize is being picked here in unfavourable weather with sudden rains and it is transported in bulk by shoulder poles or buffalo-drawn carts. On the contrary, Son La and Thanh Hoa have only a half as many losses. The reason for such a low rate is that the picked corn-on-the-cob is put in bound packing and transported by buffalo-drawn carts or built-in twelve-HP-diesel-engine vehicles.

In all three provinces, maize is shelled by hand shellers or powered machines. Therefore, the loss rate is almost the same and rather small.Presently, the quantity of powered maize shellers is still small at about 10,000 pieces and hand maize shellers at about 10 million pieces nationwide.

During drying, Son La only has a loss of 0.12 percent, which is the lowest among the three provinces. The main reason is that immediately after picking maize is sold or dried in a house on stilts. In Nghe An and Thanh Hoa losses are higher at 1.8 and 2.4 percent, respectively. Here, the maize is dried in the sun.Drying maize by dryers is still not common. Only 10 to 15 percent of maize are machine-dried nationwide, with low level equipment and technology. Dryers are horizontal batch bed types with low cost, simple technology, which raises difficulties for controlling product quality and equipment parameters.

In the next step, the cleaning stage, Nghe An has a higherrate of loss as varieties with bad resistance against rot and weevils are cultivated.Rice and maize are often cleaned by electric fans or box winnowers, and sometimes by wind.PHL of maize during the threshing, drying and cleaning stages amounts to seven to eight percent in Vietnam.

Since there is a shortage of modern stockpiles, farm households usually store maize only for a short time before selling.They cannot gain initiative in the sale and they have to sell at depressed prices.Most of the commercial maize produced in Nghe An is sold immediately after harvest. Farm households only store enough maize for livestock needs.

In Thanh Hoa and Son La Provinces, on the other hand, commercial maize is stored for up to four to five months in inadequate conditions, in PP packing or on the floor of a house on stilts, where the maize is easily damaged by the environment or insect intrusion.In Son La chemical preservatives are applied to store maize, but their efficiency is not very high because of poor conditions of stockpilesand limited knowledge of farmers about techniques to prevent insects and fungi, especially among farmers in midlands, mountainous areas and Central Highlands. Misusing regulations and wrong dosage of chemical preparations in maize storage is quite common.

Currently common methods are phosphine fumigation in storage facilities.Losses of maize after six months of storage without preservatives to eradicate insects can reach up to 20 percent. For hybrid maize conventional ways of storage are not appropriate, because it is easily damaged by mothswithin just two months.The annual average loss rates in maize storage amounts to seven percentin Vietnam.

During the milling stage losses occur, similar to rice, due to inappropriate technology. Many milling plants are too old and outdated to be used, so that losses for maize (grain) reach four percent at this stage. To sum up, weaknesses and inadequacies along the postharvest stage led to nationwide losses of maize between 18 to 19 percent. The total average loss rates of maize along the postharvest chainin the selected provinces of Nghe An, Son La and Thanh Hoa range from 10 to 13 percent, which is at the lower end of maize PHL estimates. This is explained by the fact that maize production and postharvest operations took place under favorable weather conditions in 2011.

Table 7-2. Average maize PHL rates in three selected provinces in Vietnam

Province	Loss rate (in %)								Total loss (in %)
	Harvest	Transport	Shelling	Drying	Cleaning	Grading	Storage	Grinding	
Nghe An	1.10	1.03	1.14	2.40	0.63	0.32	2.04	1.26	9.92

Son La	2.80	0.54	1.13	0.12	0.01	0.14	5.42	.0034	10.19
Thanh Hoa	2.37	0.16	1.11	1.97	0.12	0.00	6.83	.0137	12.69

7.3 Cassava

Cassava production and postharvest operations were studied in two provinces in Vietnam: Nghe An and Thanh Hoa. After harvest, cassava is typically gathered in a pile and sold right in the field or transported home for cleaning and grading. At the farm, cassava is further dried as a whole tuber or after primary processing (i.e. slicing or chopping).

In the selected provinces, loss rates during harvest and transport stages are quite high due to missing/not uprooted and/or broken-down tubers during harvestand spillage during transport. Current high-yield varieties, such as K94,that have been seen in many localities, could help reduce loss rates. Tubers of these varieties are short and grow in clusters. Therefore, they are at lower risk of broken or missed tubers while harvested, and PHL as a result is low.

The drying stage of cassava is very poor, mostly limited to sun drying. Only a small volume of cassava is dried – by simple equipment and technology. Loss rates in sun drying of sliced and chopped cassava is rather high, because they are easily contaminated by mold or quickly rot when they get wet by rain.

After being traded, dry cassava tubers are re-dried and sold to animal feed processing companies by the traders. Presently, dryers are horizontal batch bed types – as in rice and maize processing – with low cost, simple technology and limited control over product quality and equipment parameters.

In terms of storage, farmer's households only keep enough cassava for their family needs. Storagelacks innovation and use of scientific and technical achievements to prevent pests, mold and micro-organisms. With conventional ways of storage, where the dried cassava is stored on the floor of house on stilts, the loss rate is very high for cassavaafter only four months, mainly because of moths. In addition, knowledge of farmers about techniques for prevention of insects and mold is limited, and misuse of regulations and dosage of the chemical preparations for cassava storage is relatively common.

Table 7-3 below shows the average rate of cassava losses in all the postharvest stages of the identified provinces. It ranges from 8.7 percent in Thanh Hoa to 9.6 percent in Nghe An, which is close to the minimum value as assessed by the PRA workshop. Cassava production in 2011 in the two provinces took place in favorable weather conditions, where dry fields, timely harvest and proper application of harvest technology limit losses during production and postharvest.

Table 7-3. Average cassava PHL rates in two selected provinces in Vietnam

Province	**Loss rate (in %)**					**Total loss (in %)**
	Harvest	**Transport**	**Treatment**	**Drying**	**Storage**	
Nghe An	3.34	2.21	0.53	0.30	3.22	9.60
Thanh Hoa	2.51	0.68	0.53	1.77	3.17	8.66

7.4 Recommendations

The study across four provinces found high loss rates for the selected products, varying depending on location and postharvest chain operations:

- Rice: PHL between 12 and 16 percent.In plain districts PHL ranges between 8 and 12 percent, in midland districts with erratic weather PHL range between 12 and 16, or even up to 20 percent in adverse weather conditions.
- Maize: PHL between 8 and 12 percent when dry maize grain and corn-on-the-cob are stored for one to two months and chemicals are used to control insects and mice. If no chemicals are used, PHL increases to 16 percent. The lowest PHL is about 2 to 3 percent, when maize is sold immediately after harvest.
- Cassava: PHL between 8 and 12 percent when dry sliced cassava and tubers are stored for two to three months. If stored for longer than three months, the PHL exceeds 12 percent, but this is only the case for cassava used for family needs, which amountsto a small volume. Again, the lowest PHL of about 2 to 3 percent occurs when cassava is sold immediately after harvest.

PHL appears in all postharvest activities along the value chain of rice, maize and cassava in Vietnam.Based on the findings of the study, it is clear that to reduce PHL many stages require investment and innovation, e.g. for variety selection, land preparation, cultivation, crop-care and irrigation, fertilizer and pesticide application,and equipment and technology for harvesting, drying, storage and processing from raw materials to finished products. This would help minimize losses in each activity and reduce total losses in the chain of postharvest activities, thus increasing farmer income and contributing to a program of hunger eradication and poverty reduction.

Cultivated areas under rice, maize and cassava should be professionally organized according to high technological levels and should be partially or completely mechanized appropriate to the characteristics of small plots of land and scales of households. The stages including variety selection, land preparation and cultivation, harvesting, primary and secondary processing, and storage should receive services by companies or groups to help adopt proper techniques and technologies to ensure quality products from the first stage of production to the time in stockpile.

In the short term, to limit PHL the following recommendations are made:

- Selecting and adopting crop varieties with good properties and quality such as high yield, good resistance against pests, lodging, grain falling, etc.
- Conducting research and tests on agricultural machines, equipment and facilities, especially reapers/harvesters, dryers, stockpiles etc., which are appropriate to production conditions of localities in the North and Central Vietnam.
- Organizing training courses on farm technologies, operation of farm machinery and equipment, especially on rice reapers and combine harvesters for farm operators. In the case of rice, for instance, it was found that current harvest losses caused by rice combine harvesters can reach six percent, mainly because the operators are unskilled. If operators were properly trained, the loss could be reduced to two to three percent and costs would be lower than semi-manual harvest.

- Transferring technologies and supporting investment in grain drying for intensive rice production areas.
- Doing research and transferring removable storage facilities, convenient for farm households in shortage of space for storage.Households should be equipped with simple and low-cost facilities such as wooden or tin containers, to prevent damage from mice and insects or weevils.

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