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CHAPTER X RICE: Post-harvest Operations

3. Overall losses

Postproduction losses of rice can be quantitative or physical which means a reduction in weight or volume of the final usable product from the potential yield or harvestable paddy. The losses can also be qualitative which means a reduction in value of the usable product due to the physical and chemical changes which diminish the grain size, cause poor appearance, taste, aroma, cleanliness due to admixtures or contaminants and chemical residues and other factors which the consumers of the product will otherwise undervalue or the grain standards authorities will degrade resulting in low demand for the product, low price or rejection and declaration as unfit for consumption by human or animal.

Losses are incurred in pre-harvest and post-harvest processing operations consisting of harvesting, threshing, cleaning, drying, storage, transportation and milling. The flow chart of loss components of each operation are shown in Figure 4.0.1, Annex 4.0 F. The theoretical estimated losses of rice incurred in each operation are shown in Table 4.0.1, Annex 4.0 T.

Values of loss percentages for the different post-harvest operations by method in each operation in China, Indonesia, and the Philippines are respectively shown in Table 4.0.2, Table 4.0.3 and Table 4.0.4, Annex 4.0 T. Losses of rice within the post-harvest system in the developing countries of Asia, West Africa and Latin America are shown in Table 4.0.5, Annex 4.0 T.

The percentages of loss components incurred in different methods of harvesting, threshing, and storage in Zheijang, China during 1987-1989 have been documented by Ren-yong et al., 1990 and values are given in Figure 4.0.2, Figure 4.0.3, Figure 4.0.4, and Figure 4.0.5, Annex 4.0 F.

The following summarises the wrong practices in each major field operation and processing activity lead to physical grain losses:

(a) Pre-harvesting

1. Planting varieties with admixtures of red rice, which are highly shattering, have low resistance to lodging and uneven maturity dates;

2. Poor weed, rodent and bird pest controls;

3. Harvesting too early or too late of the variety maturity date.

(b) Harvesting

1. Missing the secondary tiller panicles because harvesting by sickle of lowland rice is done by cutting the straw about 60 cm above the ground;

2. Delay in harvesting causing shattering losses during harvesting and transporting and handling of the harvested crop before threshing;

(c) Threshing

1. When threshing manually by beating the harvested crop against a wooden plank, some more rice grains remain in the threshed crop. In some countries, these bundles are threshed once again by treading with animal;

2. Rice grains scatter around when lifting the small bundles just before the manual threshing above;

3. Some grains stick to the mud floor and cannot be recovered;

4. Birds and domestic fowls feed on the grains.

Summary notes on field operations The following are some choices of technology which is characterised by the degree by which grain could be lost. Manually beating the panicles on a drum or wood block will shatter grains and needs a wide threshing mat. A portable manual threshing platform enclosed by cloth or plastic sheet or fine net will contain shattering. A pedal-operated thresher increases threshing productivity and minimises shattering losses. An engine-powered axial-flow thresher combines threshing and cleaning in most designs but inefficient designs could lead to non-thorough separating and cleaning functions. An engine-powered stripper harvester combines harvesting and threshing and minimises handling losses but can lead to substantial grain losses if the crop is lodged and the field is wet and has poor trafficability.

(d) Drying

1. Grains shatter from the stalks or spill out of the grain bags during transport and handling;

2. During sundrying, birds and domestic fowls feed on the grains; grains spill outside the drying area;

3. Overdrying the grain, especially when sundrying by traditional method;

4. Delayed drying or no grain aeration which causes stackburning.

(e) Storage

1. Stored grain is attacked by insect, rodent and bird pests due to

inadequate protection;

2. Storing for long term, grain with moisture content above 14 percent or storing grain with moisture content of 18 percent longer than two weeks under ambient conditions;

3. Theft and pilferage in grain warehouses.

The farmers in Lao PDR store paddy in bags or in bulk on a roofed elevated platform with removable stairs and supported by six posts. The walls are made of woven or pounded bamboo mat or slats. Rodents are kept out by enveloping each post by a galvanised iron sheet cone guard or a circular horizontal wooden plate barrier.

(f) Milling

1. Improper adjustments of milling equipment;

2. Spillage in traditional hand pounding methods;

3. Under or over-dried paddy.

Summary notes on off-field operations. Sundrying, the most widely used drying method for home-consumed rice by farming families in developing countries, needs concrete pavement facilities. Table 4.0.6, Annex 4.0 T gives values of losses in drying and storage.

Insect pests can not only cause physical losses but also affect the nutritive value of stored rice. Table 4.0.7, Annex 4.0 T gives the estimated losses in samples infested by *Sitophilus oryzae*.

The theoretical milling recovery is 71-73 percent, depending upon the variety of rice. In a well -operated modern mill, it is possible to obtain a milling recovery of 68-70 percent from a good variety of paddy.

Milling losses can be reduced by adopting small-scale modern rubber roll sheller and introducing parboiling of paddy before milling. The suggested mill for village level is cleaner ---- rubber roll sheller --- horizontal abrasive polisher. This combination is expected to give 66 percent milling recovery.

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CHAPTER X RICE: Post-harvest Operations

4. Pest control.

The estimated grain losses in storage due to pest infestation account for some 0.35 - 4.55 percent out of the total estimated grain losses in the post-harvest system of 2.63 - 31.3 percent. An insect population attains pest status through invasion, ecological changes and economic changes.

Invasion. The development of international trade has contributed greatly to the widespread habitat of insect pests. It is therefore important that the strict quarantine be part of the pest control system in a country.

Ecological change. The use of wide spectrum pesticides has reduced the population of natural enemies such as predators and parasites of major rice storage pests. The conditions therefore become more favourable to the rapid multiplication of major pests.

Socio-economic changes. The economic threshold is determined by market value of the grain, cost of control measures and consumer habits and taste. The rice damaged by a certain insignificant pest may lessen in value because of reduced tolerance of people for such condition of the commodity. The pest therefore becomes a significant or serious pest, although its population density did not change.

4.1 Relative status of major pest species

A pest is major if it is found in great number or in abundance. The rice weevil and the flour beetle are examples of such pest. A pest is minor if it is found in small number. A pest is primary if it attacks undamaged or sound grain, completes its development in it and initiates a chain of events in which other insects, fungi or bacteria feed on the damaged grain. The rice weevil is a primary pest. A pest is secondary if it attacks grain damaged or processed mechanically by grinding, milling, and handling or by the action of primary pests. The flour beetle, saw-toothed grain beetle and the rice moth are secondary pests.

4.1.1 Details of each major pest

(See Table 5.2.1, Annex 5.2).

4.2 Pest Control

Pesticide residues. (See Table 5.3.1, Annex 5.3).

Integrated pest management (IPM).

IPM is the use of all available tactics in a program to manage pest problems and minimise economic damage and environmental side effects (NAPHIRE, 1997). It involves the integration of biological, chemical and physical methods ones to control pests as well as other suitable and compatible to the system to keep the pest population at a level that will not cause any economic damage. The IPM program is built around the concepts of efficient warehouse design, high standard hygiene, minimum use of insecticides, use of methods that obtain as complete kill as practical and thorough inspection program.

The warehouse or storage structure at any level or size should protect the grain from water and moisture, keep the pests out or given no access for entry, facilitate loading and unloading, and be conveniently sited for handling and transport. A high standard of cleanliness and strict hygiene will prevent the build-up of damaging pest population by denying the pests of food and reduce the residual populations of insects and rodents in grain stores, surroundings and machinery. The program will also avoid seeding of clean grain with insects and infestation of adjacent stores as well as reveal possible structural weaknesses and paths ingress of water and soil moisture into the store.

The restriction of the use of pesticides to combinations with other control methods will enhance the oval effectiveness of the pest control program. Such restriction will help in reducing the potentially harmful residues, selection for resistance, environmental hazards and cost of treatment.

The complete kill is important in delaying population build-up and in reducing the rate of selection for resistance. Proper fumigation will control established infestations and in combination with barrier sprays of residual insecticides, will protect the grains against re-infestation.

Inspection and sampling activities are the means to obtain accurate qualitative information and data on the status of infestation of the grain. A pest and damage monitoring system is important in the overall efficiency of the pest control measures.

Elements of IPM

There are four basic elements of IPM, namely, natural control, economic levels, sampling and insect biology and ecology.

Naturally occurring growth suppressive factors may be utilised. The gas composition may be manipulated to hinder the growth and development of the pest

The economic threshold level (ETL) rather than the calendar-based application of pesticides will minimise the use of harmful chemicals and maximise the use of no-chemical methods of control.

The status of pest infestation, damage, level of losses and the population of beneficial insects and population trends of the harmful ones are determined by sampling which is a tool to apply ETL.

The knowledge of the biology and ecology is essential in utilising effectively the above three elements.

Components of IPM

The following components are utilised in the practice of IPM:

Biological control. The pest is controlled by a parasitoid, a predator or a pathogen to manipulate the reproductive processes, behaviour, feeding and other biotic aspects of the pest. A parasitoid resides and feeds on the host pest itself which eventually dies. An example is *Anisopteromalus calandrae* a small wasp which feeds on the beetle larvae of *Sitophilus spp*. and *Rhyzopherta spp.* A predator kills and feeds on one or more hosts and seldom resides or rides on them. A pathogen is a disease-causing organism, which is normally targeted specific and harmless to non-target organisms. It is easy and cheap to culture. Pheromones are chemical messages released by organisms to influence the behaviour (usually sexual) of the other organisms of the same species. Pheromones may be employed as attractant to prevent mating of the target species by misleading them. Host resistance to insect attack makes use of the natural built-in protection. For example, it is more advantageous to store rice as paddy than as milled rice because of the protective husk. Some varieties may have degree of tightness of the husk, which make them either susceptible or resistant to certain pest species. The use of sterile insects may be effective but it is resisted by those concerned. Neem (Azadirachta indica) leaves are used as insect repellent in the grain store in Indian households.

The constraints on the potential use of biological control of stored grain pests have been cited as follows:

(a) Predators, parasites and sterile insects found among the grains are themselves contaminants;

(b) Chemicals used to treat grains in store are toxic also to the beneficial insects;

(c) Predators and parasite attacks on pests are usually limited to the superficial layers of the large bulk of the stored grain;

(d) Pathogens do not thrive well in conditions of grain stored according to the recommended practices;

(e) Consumer rejection of the pathogen-contaminated rice.

Physical control. The physical method of controlling pests in storage includes the following:

(a) Hygiene and physical removal of infestation nuclei, including commodity residues, secondary or unproductive primary hosts for field pests. Cleaning should involve brushing and washing and disposal of all residues containing or supporting live insects. The rice mill machinery and premises are always a potential hosts of insects and should be cleaned regularly with special efforts made before any long gaps in operation to prevent the old and new resident pests from multiplying before the next milling season comes.

(b) Physical exclusion of the pests from the stored grain in the form of hermitic and controlled atmosphere storage requires gas tightness to be effective. Gas tightness through sealing is effective not only in keeping insects out but also in fumigation, single-treatment controlled atmosphere and heat disinfestation.

(c) Drying hinders the attack of most insects and fungi on the stored grain.

(d) Cold ambient temperatures during harvest and storage reduce the activities of insects. Refrigeration is the alternative in places like the tropics to take advantage of the effect of low temperature on insect pests.

(e) Aeration with cold ambient air as a means of effectively controlling pests in cold and temperate climates will not be as effective in semi-tropical and tropical conditions where temperatures are above 15 to 18^{o}C required to prevent rapid increase of insect population. However, aeration of the grain bulk can be effective in preventing local hot or wet spots, which favour insect growth and development.

(f) Hermetic (airtight) storage confines the grain inside a sealed enclosure wherein the respiration of the grain and the associated insects and fungi will deplete the oxygen and replace it with lethal amounts of carbon dioxide generated by them. The process is simple, self-regulating, and requires no added pesticides, inert gas or energy inputs. Maintenance of the hermetic seal of the storage structure and moisture migration are problems involved in this method. Studies of the use of plastic enclosure for outdoor storage intended to be used by farmers' co-operatives and small-scale traders and millers were conducted by NAPHIRE (1997) in collaboration with the Commonwealth Scientific and International Research Organisation (CSIRO) of Australia and the Agricultural Research Organisation (ARO) of Israel. Results indicated that paddy at 14 percent moisture content could be stored for three months without being damaged. The locally available nylon fibre-reinforced polyvinyl chloride (PVC) plastic material of thickness 0.60 mm could be used for five years. The capacity of the heat-welded enclosure was 6 tons of paddy. The volcani cube (Israel) made of PVC food grade liner of 0.83 mm thickness and closed by polyurethane zipper, could be made for capacities of 5, 10 and 20 tons of paddy. The volcani cube could be re-used and last for 10 years provided that it is cleaned and properly stored after each use.

(g) Controlled atmosphere which although similar in form to hermetic storage, is different from it in that the carbon dioxide gas is supplied from the outside. Storage period could last from 9 to 16 months. No risks of toxic chemical residues are present.

(h) Inert dusts in the form of ground rock or wood ash have been used to control insects in subsistence level grain storage systems. They may be used at rates above 30 percent of the weight of the grain. Dusts made of silica aerogels, various clays, diatomaceous earth, activated carbon, pyrophylite and a number of other silicates kill insects by absorbing or abrading the waxy layer from their cuticle causing desiccation and death. Dusts do not eliminate the residue problem although they are not toxic. They are unpleasant to handle. Promising inert dusts for on-farm storage in developing countries are the low-cost and easily applied silica aerogels and the diatomaceous earth as they are not toxic.

(i) Physical shock and disturbance can kill insects due to physical stress and damage due to handling and processing of the grain.

(j) Artificial light regimes can affect the photoperiodic responses and mating of insects. However, the potential for response by insects to visible, ultraviolet and infrared radiation for control has yet to be realised.

Chemical control. Chemical control methods have the advantage of effectiveness, simplicity, versatility, low cost and immediate availability. However, synthetic insecticides must be regarded as adjunct to good warehouse management, to reinforce hygiene and sanitation, to enhance effectiveness of available storage facilities, and to complement physical methods. It is not intended to replace good warehouse keeping or regular inspection for infestation or deterioration. The main types of insecticide treatment are as follows:

(a) Structural treatment (residual spray application). The surfaces of warehouses, storage bins, transport vehicles and other structures and machinery are sprayed with chemical which will not only kill the insects directly hit by the spray but will also leave a deposit on the treated surface which will be toxic to walking insects. Spraying may be done during the cleaning of the storage facilities before intake of new stocks or along with fumigation or spraying of stock in storage. The residual deposit decays with time and its effectiveness depends on the chemical and the climatic conditions prevailing.

(b) Space treatment. Fogging or space spraying is intended to control flying insects not controlled by the residual spray and those coming into the storage warehouse. Spraying is done usually at dusk hen insects are most active. Chemicals with knockdown action such as pyrethrin, lindane, and dichlorvos aerosols and strips or smoke or fog are used in space spraying. Dichlorvos plastic strips hung inside the warehouse at a density of 1 strip /30 cubic meters of space will be effective for flying moths.

(c) Grain protectants. These insecticides will prevent infestation when applied on grains. It is intended for light infestation only at the time of treatment and is not a substitute for fumigation in case of heavy infestation. In general, it should be avoided as it may accelerate the selection of resistant strains. The choice of insecticides to use is quite limited, as safety should be a prime consideration. Studies by Sayaboc, et al., 1996, of resistance of major insect pests to pyrethroids and organophosphates, revealed high resistance of the lesser grain borer *(Rhyzoperhta dominica)* to phosphine, in contrast to the low resistance of flour beetle *(Tribolium castaneum)* and susceptibility of rice weevil (*Sitophilus oryzae*).

(d) Surface spraying. The insecticide is applied on the surfaces of bulk grain or bags of grain. Examples are pyrethrum synergized with piperonyl butoxide, pirimiphos-mythl, chlopyrifos-methyl, tetrachlorvinphos, fenithrothion and metacrifas at about 1 to 2 percent concentration.

(e) Fumigation. A fumigant is a volatile pesticide, which exerts toxic action in the gaseous or vapour phase. The most common fumigants used world-wide are methyl bromide and phosphine. Fumigation is effective because of thoroughness of application but fumigants used to control pests are generally toxic to humans and plants; may be corrosive, flammable, leave harmful residues and produce offensive odours. In application, it is best to monitor the atmosphere inside the warehouse with appropriate test equipment and the threshold limit value should conform with that recommended by the American Conference of Government Industrial Hygienists (1983-1984). The most common deficiency in fumigation is the neglect of hygiene and stock management resulting in the necessity of frequent fumigation and consequently, the hazards of excessive bromide residue accumulation in the grain. Phosphine complements the use of methyl bromide, especially in vertical storage, Sayaboc et al., (1996) found that the use of 2 g phosphine per ton of grain at seven-day exposure time will effectively control insects at all their life stages. Other fumigants, which are used occasionally, are hydrogen cyanide, carbon disulfidem ethylene dibromide, chloropicrin, methyl chloride and carbon tetrachloride. A tolerance value of 0.1 ppm expressed as PH_3 , is recommended in international trade of cereals.

Two or more components of pest control can be combined in an integrated program. However, in a storage ecosystem, hygiene and good warehouse management are basic requirements and the IPM system is but supplementary. The combination of two or more of the following practices will constitute an effective pest control program.

(a) Improved harvesting and threshing techniques;

(b) Judicious use of insecticides;

(c) Use of ambient aeration and refrigerated aeration;

(d) Atmospheric gas modification;

(e) Thermal disinfestation;

(f) Irradiation techniques;

(g) Insect resistant packaging;

(h) Insect growth regulators;

(i) Biological control;

(j) Use of resistant varieties.

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CHAPTER X RICE: Post-harvest Operations

5. Economic and social considerations

The straightforward method by which farmers can add value to the paddy is by drying it to a marketable moisture content. In most of the tropics the equivalent moisture content is 14 percent wet basis. When paddy is dripping wet as in the case when harvest time occurs during monsoon rain and a series of cloudy days will likely follow the rainy days, it is critical that the moisture content of the paddy be reduced to skin dry condition within 24 hours after harvest. An interim safe moisture content is 18 percent for a 2-week storage under dry and protected conditions or at most 20 percent for a few days storage with occasional stirring and aeration. The choice of how far down the moisture content should go depends on the urgency of reducing the moisture content of the bulk of the grain to a safe moisture level. A flash dryer will remedy the situation on an emergency basis. This moisture content will at least be a first aid in saving the paddy from deterioration and will give the farmer enough time to organise and implement a drying system or sundrying depending upon his resources. Under most circumstances however, the farmer will opt to sell the paddy at a low price to a trader or rice mill because the small holder is generally averse to risks. The alternative is government action to provide drying and storage facilities at strategic areas. This is what the grain agencies like BULOG in Indonesia and the NFA in the Philippines are doing to a limited extent. These government agencies also encourage the formation of farmers' co-operatives in rice milling with drying facilities.

For very small holders, the problem of saving the wet grain harvested during the monsoon rains needs to be solved. Even if there were a government facility for drying paddy, the small quantity and most often the cost of transporting the paddy becomes an additional financial burden which the marginal farmer will not likely take. An option is to aerate the small amount of paddy by piling it into small heaps to expose as much surface area of the grain to the atmosphere and prevent heating up of the bulk due to microbial action and grain respiration. This procedure will require frequent turning over of the grain. A meticulous farmer will even scoop out the thin upper layer of each heap to form another heap, which is drier than the grain beneath and at the bottom especially with an initially dripping wet grain. If available, a manually or pedal-operated blower or engine-powered blower used for field winnowing may be used to increase the aeration process. A household electric fan will also be useful and in fact being used by farmers. It is best to have the bottom of the heap to be resting on a fine mesh net on a platform with slatted floor to increase underneath aeration and to drain any gravity moisture from the grain heap. These are emergency measures for the small holder and will be impractical or will require much labour or space for a commercial scale operation. Nevertheless, in the absence of drying facilities the above procedure can be adopted as an emergency measure or first instance solution until favourable sundrying weather comes.

The rising cost and non-availability of labour due to increasing employment opportunities in industry in some developing countries, particularly in Asia, has increased the adoption of mechanisation of rice production and post-harvest operations. The small size of fields, however, limit the powered machines to pedestrian tractors and machinery which also determine the scale and method of operations in harvesting, threshing, in-field handling and field-to-road paddy and straw transport of paddy.

Unless major policy directions leading to more efficient field operations than in the small-sized fields are instituted, the field operations in harvesting and threshing will likely remain as it is for a long time although small-scale powered machines will increasingly be utilised. One of such policy directions is the land reformation and consolidation as has been done to some degree in Japan and in Taiwan, province of China. Due to increasing demand for small-scale machinery mainly for custom service operations by small village entrepreneurs, the local manufacturing industry has been progressing and gradually increasing the quality of farm machines as well making them more affordable than before. In most developing countries, the power unit, the small engine ranging from 5 to 10 kW, remains as an imported item and is a major high cost component of a machine. However, a given engine may be used for a variety of small machines ranging from land preparation, crop establishment and care, irrigation, harvesting, threshing, transport, drying, and perhaps, in-field hulling of paddy. An increased support in rice production and post-harvest machinery research and development as well as agricultural and industrial extension will eventually lead to minimised post-harvest losses and reduced costs. Improved timeliness and efficiency of operations resulting from appropriate machinery and its proper maintenance will redound to the benefit of the small holders.

The use of combines as a step towards mechanisation has had a forward linkage with post-harvest operations. The large volume of paddy being turned over to the processing plants in a short time has put pressure on the drying and storage facilities in Thailand, a major exporter of rice. Large capacity dryers are now being manufactured locally and have large demand, at least for the present. Because of lack of incentives for the farmer to dry paddy, the drying operation will continue to be an adjunct operation of rice milling and will take place at the rice mill site using mechanical dryers combined with mechanised sundrying whenever feasible because of its low cost especially due to free, albeit unreliable (during rainy season) heat energy. Sundrying with complementary mechanical drying will be a main drying operation to take advantage of the sun's free heat energy and the environmental friendly feature of the technology. Mechanised and precision-controlled sundrying (still a neglected area for technological innovations, though sundrying is widely used) in combination with artificial or forced-heated air-drying is a pertinent subject of research and development now and in the future.

The concept of increasing the income of small holders through value-adding in paddy or engaging in primary post-harvest operations at the farm level remains a question under the present system of low incentives or non-recognition of such added value either by design and necessity or by trade practices in most developing countries. The farmer will have larger margin of profit and therefore incentive if he dries paddy during the wet season. Only a few farmers will recognise and adopt this concept, as some sort of drying facilities will be needed. A government campaign and assistance will perhaps make more farmers adopt the value-adding concept rationalising that social benefits will accrue in terms of lessened post-harvest losses, better grain quality and self-sufficiency in the staple. Perhaps the more easily adopted technology is to make the production and field harvest and post-harvest operations of threshing, handling and transport more efficient through better infrastructures and this is also normally a government initiative and at best a community action.

5.1 General overview

Once the rice crop has produced the grains approaching the potential yield for the variety under a given cultural practice, soil and climatic conditions as well as a set of inputs and other factors in production, the actual amount of grain finally retrieved from the plant after all stages of processing does not normally match that yield. There are numerous ways by which that yield already in the plant could be lost and so does the opportunity for it to be of use as food or something else. This situation occurs because there are many steps to be taken in bringing that yield from the plant to the rice bowl. Each step in the production and processing entails a certain degree of reduction depending upon the technology used and the care given to prevent or minimise losses. The rice crop losses are reported as lumped as percentage of the yield per hectare.

The post-harvest operations begin at harvest and ends at the storage of the milled rice. The range of processes discussed here does not consider the costs and losses in delivery of the rice to wholesalers and retailers from the rice mill, in cooking, and finally in serving the rice food in the plate or bowl of the consumer.

The grain losses in the field may be incurred during pre-harvest period and at harvest time. Normally, the longer the harvested grain is left in the field, the higher the chances of incurring grain quality deterioration and spoilage due to weather, stackburning and delays in drying as well as physical loss due to rodents, pilferage, and other causes. Depending on whether the variety is shattering or non-shattering, field losses of the grain may be small or large even if the rice crop is still standing. Wind, rain and degree of maturity of the crop can have a large effect on the magnitude of such losses for a given variety.

5.2 Major problems

Harvesting and threshing are major problems in field operations while drying of the paddy is critical as a post-harvest operation. Since milling is an industrial process which can easily be controlled inside a building, the problems related to this process are determined by the quality of the paddy received by the mill. The critical factor is the drying of the paddy immediately after harvest. In some developing countries, drying of the surplus paddy for the market is not normally carried out by the small-scale farmers. Wet or freshly harvested paddy is sold directly to traders or to the rice mills and rice milling co-operatives. Somehow, the farmers avoid the risk of crop deterioration by disposing off the crop immediately. The problem of drying is passed on to the trader or rice mill owner but the farmer gets a low price for the undried paddy. The bottlenecks in post-harvest processing should be solved using the systems approach.

In harvesting and threshing the quality of the harvested crop, the degree of losses incurred and the efficiency of the operations and hence, overall costs are affected by factors related to the weather, variety of the rice, and the technology used. Harvesting and threshing during the monsoon season bring about problems of wet and lodged crop, high moisture grain which is susceptible to spoilage due to fungal and microbial invasion, difficulty in threshing, grain handling and transport regardless whether the methods are mechanical or manual, and the critical need for immediate drying of the paddy. It is obvious that one problem in a process stage affects the quality and efficiency of the next stage and mitigating measures at that stage are needed. This chain reaction continues up to the milling process until the semi-final product, milled rice is produced.

The same problems appear to be magnified for small holders because of scarce resources to do mitigating measures like quick drying or transport to the market of wet paddy. They have lesser capability to absorb losses than the big landholders or commercial rice producers. They are forced to sell the paddy at very low price which may be the best thing to do under the circumstances to prevent greater losses, if not total loss.

5.3 Proposed improvements

The sale of the paddy, the final product from the farm, is the major if not only means by which the farmer, especially the small holder, can benefit from rice production. Straw, the only other by-product of rice production in the farm but has not been fully tapped by most farmers, except in places where it has market value as animal feed or thatch.

An increase in sales proceeds of means increased income. This increase in income can be achieved through increased quantity and improved quality of the product. Increased quantity is achieved through enhanced productivity of the cropping system and increased amount of production through improved production technologies as well as reduction of losses in the field. Improved quality of the paddy can be achieved essentially though variety selection in terms of eating quality, improved crop care (irrigation, pest and weed control), optimum harvesting time, and improved post-harvest processing. Field processing activities, including harvesting, threshing, cleaning and handling are more for retaining that quality or preventing grain deterioration rather than improving it.

Unfortunately, the small holder usually participates in the post-harvest processing stage only at harvesting, threshing and handling which may still be considered as the tail end of the farm production system because the product is considered as raw material and no value has been added so far. The concern is more of sustaining the quantity and the quality of the crop as produced, that is to add value and prevent the paddy from deteriorating.

The small holder does not have the capability or resources and the incentive (in many places) to do any further processing. Attempts by government extension services to promote drying at the farm level of paddy for sale have not been successful because the economic benefits for the farmers are not significant in terms of labour inputs and capital costs involved as well as the affordability to wait for higher prices of paddy. Any incentive from the paddy trading industry in terms of value or price increase given to the farmer to dry the paddy is usually very low, so that the farmer is forced to sell the wet paddy at a low price or else the paddy will deteriorate and will have zero or near zero value. The small holder family only dries the paddy retained at the household for immediate family consumption and for food and cash security at least until the next harvest.

After the field post-harvest procedures and activities have been optimised, such that production has been maximised, losses have been minimised, and the excellent quality of paddy have been attained, a possibility of the small holder increasing the cash income is an increased efficiency of the traders and millers of the traded rice in their operations and passing on part of the savings in costs to the small holder through better paddy prices. This is at best theoretical, as the traders and millers will likely keep the windfall from such efficiencies rather than share it with the producers or they are more likely to share such efficiencies to consumers. Only increased competition, increased market demand for rice or reducing supply by lowering production (indeed a counter-productive method) with no government intervention by importation of rice will increase the price of paddy.

Rice processing and trading co-operatives among farmers have been successful in many places in assuring farmers a fair price for their paddy and enabling them to get benefits from the processed and traded rice by virtue of their share of ownership of the processing facilities and the business. This strategy has been promoted by governments but is beset by problems of lack of management skills and capital investment costs. While there are success cases, there are also failures of attempts to organise and sustain rice processing co-operatives.

Perhaps an effective strategy is to empower the farmers to process the paddy (at least partly) in the farm by hulling it and trading the brown rice for further processing by the rice milling co-operatives or the private commercial mills. Brown rice can have a separate path leading to a niche market among the health-conscious consumers is developed countries. This alternative will entail not only innovative approaches to the technology but also changes in the pattern of field production, trading, storage and consumption of rice.

The reduction of field losses in harvesting and threshing can increase the profits of the small holder. Shifting from the manual to the proven efficient mechanical method of harvesting will greatly reduce harvest losses. The fast rate of harvesting and threshing enables a timely removal of the grain from the field which may be critical during the monsoon season. Drying the crop by the small holder aimed at increasing value of the paddy has not been a popular activity because of the low returns from the drying process. However, very wet paddy resulting from a rainy harvesting and threshing episode, will command a low price unless it is dried properly. In such a case the margin of profit may be high as the choice could be between a total loss or no profit and reduced profit due additional expenses in drying. Small portable axial-flow threshers which have been originally designed by IRRI are now being manufactured and distributed locally in many developing countries. Pedal-operated threshers have been accepted in the terraced fields in the highlands because of their portability and affordable costs, especially if made locally.

In Myanmar, the system of mechanical threshing has increased in popularity among farmers because of the significant benefits derived from their use. From observations in the adoption of mechanical technologies such as mechanical threshers in developing countries, the custom operation by a local entrepreneur who buys the machine such as a thresher, appear to be a popular and fast process. Custom services in threshing and cleaning of paddy benefit the farmer because of the faster output and cheaper rates. The system spares the farmer the investment and operational costs of the machine and may not be viable from the ownership consideration. The utilisation of the rice husk as domestic cooking fuel has increased in popularity in Myanmar perhaps because of the aggressive manufacturing and marketing by a local fabricator of a Vietnam-designed rice husk stove which has been modified by IRRI.

5.4 How has the introduction of the improved technology affected income/responsibilities between genders?

In most small rice farms in developing countries, women play a major role not only in production but also in post-production operations. In many countries, women are involved in or do most of the manual harvesting, threshing, winnowing, handling and sundrying drying. The men do the hauling and operate any powered machine if it is used while the women act as helpers.

In general, postproduction technology development and transfer programmes have been carried out on the assumption that the technology is either sex-neutral or that men are the main users and decision-makers. This assumption is often incorrect because women and other household members have quite different technology needs than men because of their different knowledge, experiences and skills, physique, stamina, etc.

Women workers are usually the first ones to be affected by a new technology introduced to improve processing. A powered machine will immediately displace women or relegate them into lesser tasks as helpers as the men take over the machine, be it a power tiller-mounted harvester or an engine-operated thresher. A pedal-operated thresher, however, fits the physique of women and is therefore accepted as a labour-saving device where mostly women do traditional harvesting and threshing.

Sundrying of paddy for household consumption is also a traditional task of women. Men do assist in the handling of the bags or containers. Since mechanical or forced heated air-drying is usually done by rice traders and millers, women are not much affected by such technology.

Most rural women in developing countries are traditionally responsible for pounding rice using the mortar and pestle or the beam hammer/pounder (*dheki*). Where the steel huller mills have been introduced, these traditional methods fade away. In most cases the substitution has been beneficial to the women because of the great relief from the arduous work or otherwise, because their family income has contracted. Sometimes, the change has given them the opportunity to explore other means of income generation, a luxury they could ill afford because their time is being used up by the major family obligation of milling rice which is just one of their several domestic tasks. At the worst perhaps, the displacement of women from their income generation of hand-pounding of rice for sale in the community (a marginal micro-enterprise at that), is temporary as some well-to-do community consumers would still prefer the pounded rather than the milled rice during the transition stage. With a small rice mill, such as IRRI micro-mill modified from a Chinese design, a women's group in the Philippines was able to increase income and obtain the bran for animal feed. The milling micro-enterprise was easily patronised by the villagers who were spared the time and effort to go to the far commercial rice mill to have their paddy milled. In effect, the introduction of the technology on a pilot basis has given economic and social benefits.

In a rural appraisal on the roles of the different household members in the postproduction of rice and other crops in Isabela and Quirino provinces in the Philippines, the following activities of women were observed (Paris and Duff, 1989):

Harvesting. Performing this task varied according to the culture and economic need of the family. In one village, men dominated harvesting because they were considered fast workers and could stand tougher jobs (exposure to sun or rain for long periods while at work). In another village of another province, harvesting was dominated by women and children (8-14 years old) because they were available or left behind during the harvest period as the men folk did the land preparation immediately after harvesting their own fields or worked as hired labour. In some cases, men looked for harvesting/threshing jobs in neighbouring villages where payment was in the form of in-kind share of the harvest which was larger than wage or contract work paid for in cash.

Threshing. Mechanical threshers were adopted because of their efficiency, less grain loss and immediate recovery of the threshed grain within the day compared with hand threshing which must be closely supervised by the farmer-owner to control losses and technical pilferage (not threshing thoroughly to give more yield to gleaners who are relatives of the threshing labourers). Mechanical threshing was dominated by the crewmen of the hired thresher. They performed the feeding of the harvested rice, bagging the threshed grain, sewing the bags and stacking them at the threshing site. Other men did the in-field and field-to-road transport as well as loading on the transport vehicle, consisting of animal-drawn sled or cart or motorised tricycles, trailers pulled by small tractors, jeepneys, pick-up trucks and lorries which were usually hired by the buyer of the harvested paddy. Depending upon the distance, the transport job was paid for separately from harvesting.

Gleaning. Women and children, usually the relatives of the hired labour for the threshing operation, tried to recover grains from the straw or threshing yard. Landless and marginal farmers sometimes did gleaning to augment family income. Each gleaner could recover about 25 kg of paddy in a day.

Hauling. Men usually dominated this job, which required strength and stamina. Women assisted in lifting the bag onto the shoulder or head of the men.

Drying. When sundrying the grain, men did the hauling, loading and unloading on the drying floor while the women and children took turns in spreading, stirring and watching over the grains to be dried. They also assisted the men in bagging and loading of the grains at the end of the drying period.

Storing. Most of the grains were sold immediately to the buyer. Only about 800 to 1500 kg were stored per farm household per season. Storage could be in bulk or in sacks in one corner of the house, in bamboo baskets or wooden boxes. Sometimes the grain was stored in a warehouse which could be a separate shed or an extension of the house with galvanised sheet roofing and wooden or concrete walls and floors.

Marketing. In one village, farmers sold their paddy in buying stations located outside the village from where they could obtain cash payments and loans and farm inputs. In another far-away village, buyers pick up the grains using big trucks to ensure payment from farmers who obtained loans or advanced payments from them. Both the father and the mother decided on the volume and price of the grain to be marketed but the mother usually managed and kept the proceeds after marketing.

The above observations in the post-harvest operations for rice may vary from country to country, depending upon the culture. However, in most developing countries in Asia, women do share a major portion of the labour inputs in such operations.

In the northern mountain provinces or Lao PDR where exchange of labour is still practised, especially in subsistence level farming in the slash and burn cultivation of rice, the whole handling job from harvesting to storage is done without any cash payments - only food and drinks and return labour. Women usually perform the hauling and piling of the harvested stalks to the threshing site, and the cleaning or winnowing operation. Some women participate in the actual threshing operation itself, which is predominated by men.

Custom threshing operation by engine-powered threshers is becoming popular in extensive lowland rice areas near urban centres.

In Bhutan, women haul the harvested stalks to the house and if the grain shatters due to over maturity or varietal characteristic, losses are incurred at various actions such as in lifting, carrying and laying down the harvested bundle.

In the Philippines, women had greater than 50 percent involvement in post-harvest activities, mainly in sundrying and marketing. Women were significant participants in the disposal of output, specifically in marketing decisions such as where and when to sell and what selling price. Women contributed 17 percent and 26 percent of the family labour used in harvesting of wet and dry season rice, respectively. They contributed 16 percent and 19 percent in total post-harvest activities.

Few alternative employment opportunities or rural industries existed to absorb the displaced labour at the time the machines were introduced. Caution should be exercised in introducing any labour-displacing technology such as mechanical harvesters in a labour-surplus, low-wage environment.

Decisions on which type of rice mill is to be used for milling the family grain are often made by women, especially when they are involved in backyard swine production. While increasing milling recovery of such rice mills, the reduced bran-rice mixture and brokens decreases the value of the by-product as animal feed, an important feed in backyard swine production in the Philippines.

Any intervention, which eliminates the Engleberg type rice mill or improve it to increase the milling recovery, will bring about socio-economic problems and choice of any other alternatives. Using other feed ingredients such as crop residues to reduce the rice bran requirements is a potential solution to the problem.

The decline in demand for female labour adversely affects the category of rural women at risk- those belonging to landless householders or without sufficient land to support their families. This situation aggravated further when the female is head of a household with children. With the introduction of small power threshers in the early 1980s, the time spent by women in harvesting and threshing decreased from 8 h/ha in 1975 to 3 h/ha in 1980. On the other hand, use of portable threshers decreased turn-around time for rice production and enabled farmers to grow two crops of direct seeded rice in a year.

In Bangladesh, rural women are responsible for most post-harvest operations, particularly processing which is a carried out near or on their homesteads. Rural electrification stimulated the rapid spread of small, inexpensive, electrically-driven mechanical rice mills in the early 1970s. By 1979, about 23-26 percent of total rice production was machine-milled and labour productivity was substantially higher (5.6 t/man-day) for machine milling compared to the manually operated *dheki* mill (0.2 t/man-day).

The improved mills have benefited farm families by reducing the participation of female household labour in this arduous task and by lowering the cost of hired labour. The mills also increased milled rice output and reduced processing losses. It was estimated that household labour for husking declined from 58 percent to 55 percent and hired labour from 32 percent to 16 percent.

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CHAPTER X RICE: Post-harvest Operations

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CHAPTER XI QUINUA: Post-harvest Operations

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1 Introducción

La quinua (*Chenopodium quinoa Wild*) se cultiva en zonas áridas y semiáridas de los Andes. Tiene una gran adaptabilidad, tanto en latitud como en altitud, encontrándose en el Perú desde Tacna hasta Piura, y desde el nivel del mar hasta los 4 000 metros de altura.

Por sus características nutricionales, contenido de proteínas, vitaminas y minerales, constituye una de las bases en la alimentación del poblador altoandino.

Posee una proteína de alto valor biológico. Por su elevado contenido de lisina y su balance de aminoácidos esenciales, resulta comparable a la proteína de origen animal.

Se usa ampliamente, tanto en la alimentación humana, como animal, empleándose las hojas y tallos tiernos como verdura de hojas, hasta la fase del inicio del panojamiento, luego se consumen las panojas tiernas en reemplazo de verduras de inflorescencia, y el grano maduro, directamente o procesado.

Industrialmente se obtienen los siguientes productos: quinua perlada, hojuela de quinua, quinua precocida, quinua instantánea, fideos, sémola, galletas, expandido, etc.

Esta planta presenta una gran variabilidad y diversidad de formas. Se pueden clasificar sus variedades o ecotipos en 5 categorías básicas, según su adaptación a las características geográficas: quinuas del valle, quinuas del altiplano, quinuas de terrenos salinos, quinuas del nivel del mar y quinuas subtropicales. En el cuadro 1, se muestra las principales variedades de quinua que se cultivan en el Perú, y en el cuadro 2, la disponibilidad de semilla según las Estaciones Experimentales, siendo las principales en orden de importancia las variedades Hualhuas, Mantaro, Blanca de Junín y Salcedo INIA.

Según el estudio de demanda de quinua, elaborado por el convenio ADEX/USAID/MSP/COSUDE para el año 1 996, el consumo percápita estimado en el

Perú fue de 0,517 kg con tendencia a ir incrementándose en los próximos años. Esto se logrará presentándole al consumidor una serie de alternativas a base de quinua y además haciéndole conocer las bondades nutricionales del producto.

Cuadro 1: Principales variedades de quinua

Variedades o ecotipos	Altitud msnm	Color de grano	Sabor	Periodo vegetativo
Blanca Junín	1 500-3 500	Blanco	Dulce	160-180
Rosada Junín	2 000-3 500	Blanco	Dulce	160-180
Nariño Amarillo	800-2 500	Blanco	Dulce	180-200
Marangani	800-3 500	Amarillo	Amarga	60-180
Quillahuaman INIA	800-3 500	Blanco	Semidulce	160-180
Tahuaco i	1 500-3 900	Blanco	Semidulce	150
Kancolla	800-4 000	Blanco	Dulce	140-160
Cheweca	1 500-3 500	Amarillo	Dulce	150-180
Chucapaca	800-3 900	Blanco	Semidulce	150-160
Kamiri	800-4 000	Blanco	Semidulce	150-160

Camacan II	800-4 000	Blanco	Semidulce	150-160
Rosada Cusco	800-3 500	Blanco	Semidulce	160-180
Real	500-4 000	Blanco	Semidulce	110-130
Boliviana Jujuy	500-3 500	Blanco	Semidulce	100-120
Sajama	> 3 500	Blanco	Dulce	150-170
Blanca de Juli	---	Blanco	Semidulce	150-180
Mantaro	1 500-3 500	Blanco	Semidulce	---
Hualhas	1 500-3 500	Blanco	Semidulce	---
Salcedo INIA	---	---	---	---

FUENTE: Ministerio de Agricultura - Instituto Nacional de Investigación Agraria - Programa Nacional de Investigación de Cultivos Andinos. Junio - 1997.

Cuadro 2. Disponibilidad de semilla de quinua en el Perú según estaciones experimentales año 1 997.

Estación Experimental	Cultivar	Categoría	Disponibilidad (kg)
EE. Santa Ana -	Mantaro	Básica	5 000

Huancayo		Registrada	1 430
	Huancayo	Básica	380
	Hualhuas	Básica	2 900
		Certificada	10 020
		Registrada	1 500
EE Illpa-Puno	Sajama	Básica	90
	Blanco de Juli	Básica	135
	Kancolla	Básica	29
	Tahuaco I	Básica	497
	Kamiri	Básica	07
	Cheweca	Básica	16
	Chucapaca	Básica	22
	Salcedo INIA	Básica	938
EE Andes-Cusco	Blanca Junín	Básica	2 225
	Kancolla	Registrada	219
	Cheweka	Registrada	265
EE. Baños del Inca	Amarillo Marangani	S/I	S/I
	Nariño	S/I	S/I

	Blanca de Junín	S/I	S/I
EE. Canaan - Ayacucho	Ayacuchano	S/I	S/I
	Blanca de Junín	S/I	S/I

FUENTE: Instituto Nacional de Investigación Agraria - 1 997.

S/I : Sin información.

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CHAPTER XI QUINUA: Post-harvest Operations

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2 Producción, importación-exportación

2.1 Perú: Producción Nacional

En los últimos años (1 994-1 997) la producción anual de quinua ha fluctuado entre 14 000 a 24 000 TM y la superficie cosechada entre 19 000 a 26 000 Has. En el año 1

997 se observa un incremento en la producción y área cosechada, respectivamen-te (Ver cuadros 3 y 4), debido al casi obligatorio uso de la quinua como un insumo en el programa de desayunos escolares (sólidos y líquidos).

El rendimiento nacional se mantuvo entre 700 a 800 kg/Ha en promedio, tal como se muestra en el cuadro 5, alcanzándose los mejores rendimientos en la región Arequipa.

Los mayores productores de quinua a nivel de la región en orden de importancia son: José Carlos Mariátegui, Andrés Avelino Cáceres e Inca, concentrando entre las tres alrededor del 90% de la producción nacional (Ver cuadro 6).

En el cuadro 7 se presenta la producción de quinua por mes, para los años 1 995 - 1 996, del cual se desprende que los meses de mayor producción son entre abril y junio (Ver gráfico 1).

Cuadro 3. Perú: Producción de quinua a nivel nacional y por regiones 1992-1997. (TM)

Regiones	1 994	1 995	1 996	1 997

Nor Oriental	82	120	142	105
La Libertad	93	237	253	274
Chavín	267	357	642	456
Lima	5	32	3	0
Libertadores Wari	872	1 137	1 185	1 268
Arequipa	169	129	164	156
José Carlos Mariátegui	11 744	8 364	4 756	14 191
Inca	1 129	1 245	797	3 897
Andrés A. Cáceres	2 267	2 152	3 128	2 881
TOTAL	16 128	13 773	16 070	23 228

FUENTE: Ministerio de Agricultura: Estadística Agraria - años 1 994 - 1 997 (Setiembre).

Cuadro 4 : Superficie cosechada de quinua a nivel nacional y según regiones (Has).

Región	1 994	1 995	1 996
Nor Oriental	130	154	162
La Libertad	118	277	346

La Libertad	[illegible]	[illegible]	[illegible]
Chavin	320	385	612
Lima	4	27	2
Libertadores - Wari	1 270	1 521	1 581
Arequipa	120	103	120
José Carlos Mariátegui	15 380	12 555	11 708
INCA	1 204	1 275	870
Andrés A. Cáceres	2 151	2 432	3 343
NACIONAL	20 697	18 729	26 124

FUENTE: Ministerio de Agricultura - OIA: Producción Agrícola 1 994 - 1 996.

Cuadro 5. Perú: Rendimiento promedio de quinua a nivel nacional y por regiones 1 994 - 1 997 (TM/Ha)

Regiones	1 994	1 995	1 996	1 997
Nor Oriental	631	779	877	680
La Libertad	788	856	827	793
Chavín	834	927	1 052	976

Lima	1 250	1 185	1 500	-
Libertadores Wari	687	748	750	671
Arequipa	1 408	1 252	1 367	1 430
José Carlos Mariátegui	764	666	833	824
Inca	938	976	916	1 230
Andrés A. Cáceres	1 054	885	936	1 008
NACIONAL	803	735	859	S/I

FUENTE: Ministerio de Agricultura: Estadística Agraria. Años 1 994 - 1 996 y 1 997 (Setiembre).

S/I: Sin información.

Cuadro 6. Perú: Producción a nivel nacional de quinua y por principales regiones. Años 1 994 - 1 997 (TM).

Regiones	1 994	1 995	1 996	1 997*
José Carlos Mariátegui	11 744	8 364	9 756	14 191
Andrés A. Cáceres	2 267	2 152	3 128	2 881

INCA	1 129	1 245	797	3 897
Libertadores-Wari	872	1 137	1 185	1 268
Otros 1>	617	475	1 204	991
Nacional	16 629	13 373	16 070	23 228

FUENTE: Ministerio De Agricultura - OIA "Producción Agraria". Años 1 994 - 1 997.

** Proyectado*

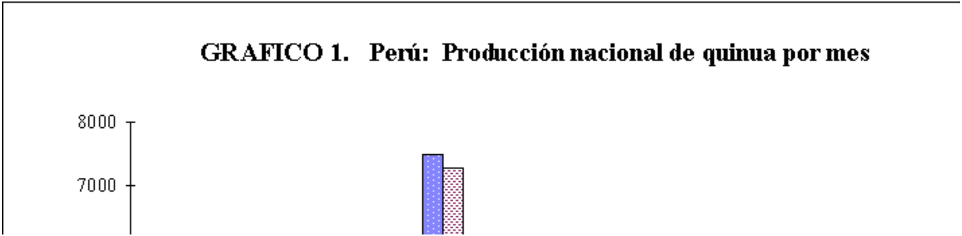
1> Nor Oriental, La Libertad, Lima, Arequipa

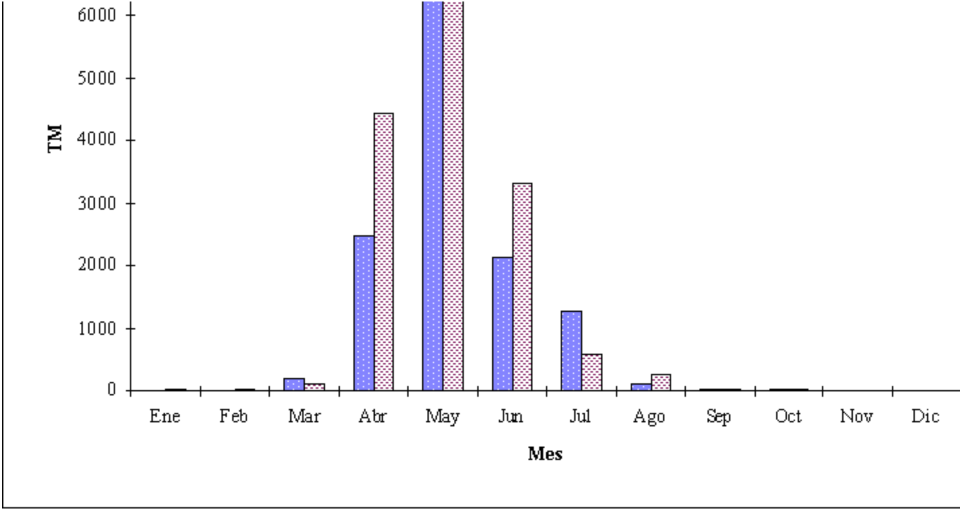
Cuadro 7 Perú: Producción nacional de quinua por mes, 1 995- 1 996 (T.M.)

	Años	
Meses	**1 995**	**1996**
Enero	0	36
Febrero	6	20
Marzo	200	112
Abril	2 484	4 417

Mayo	7 494	7 270
Junio	2 123	3 302
Julio	1 288	599
Agosto	117	260
Setiembre	27	18
Octubre	27	20
Noviembre	0	6
Diciembre	0	10
TOTAL	**13 773**	**16 070**

FUENTE: Ministerio de Agricultura - OIA "Estadística Agroindustrial". Año 1 995 - 1 996.





2.2 Perú: Exportación

Entre los años 1 993 - 1 996, el volumen de exportaciones ha experimentado un franco crecimiento. De 45 300 kg que se exportó en el año 1 993 se ha incrementado a 181 400 kg en 1 996 o en términos de Precio FOB, de $ 65 000 a $ 250 600 dólares, respectivamente.

Los principales importadores de la quinua peruana en el año 1996 en orden de importancia fueron: Japón que representó el 42% de las exportaciones totales, Estados Unidos con el 24%, Alemania con el 16% y Canadá con el 18%. Cabe resaltar que los mercados alemán y canadiense, abiertos recientemente, avizoran un enorme potencial (Ver cuadro 8).

En el cuadro 9 y gráfico 2, se aprecian las exportaciones mes a mes de quinua en el año 1 996, siendo los meses de abril y diciembre los de mayor cuantía.

Cuadro 8 : Perú: Exportación de quinua, según país de destino: 1993 - 1996.

	Cantidad (kg)				Valor FOB (en US $)			
País	1 993	1 994	1 995	1 996	1 993	1 994	1 995	1 996
Argentina	3 050	---	---	---	3 000	---	---	---
Ecuador	---	---	20 000	---	---	---	4 000	---
Francia	6	150	---	800	2	184	---	800

EE. UU.	37 154	24 830	40 985	43 000	52 894	33 747	29 848	59 100
Venezuela	---	---	152	---	---	---	144	---
Japón	5 042	22 157	---	76 300	9071	35 620	---	112 700
Alemania	48	---	---	28 200	33	---	---	38 700
Austria	---	2 000	---	---	---	1 000	---	---
Canadá	---	---	---	33 100	---	---	---	39 300
Total	45 300	49 137	61 137	181 400	65 000	70 551	33 992	250 600

FUENTE: Superintendencia Nacional de Aduanas. Ministerio de Agricultura - Oficina de Información Agraria.

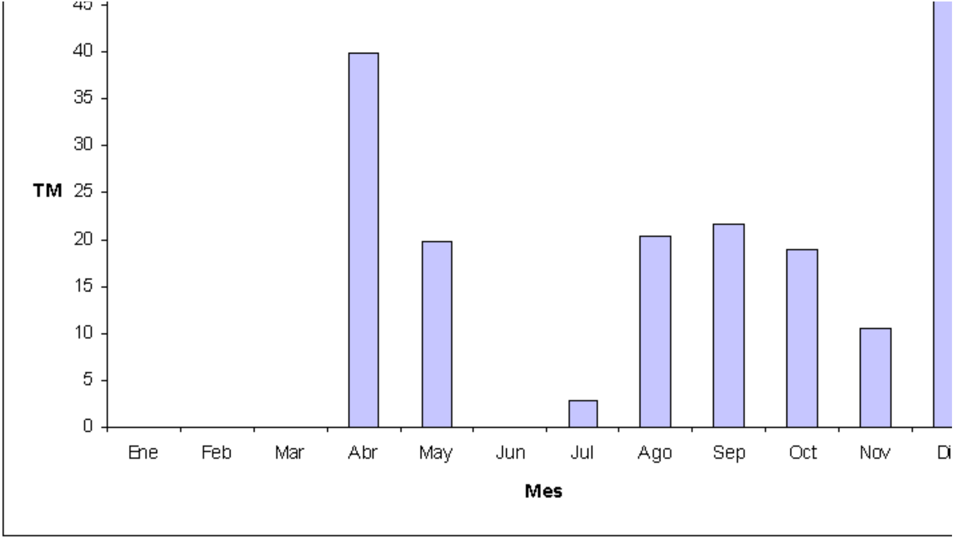
Cuadro 9 Perú: Exportación de quinua, según mes, 1996. Partida arancelaria Nandina: 1008901000

Mes	Cantidad(TM)	Valor FOB (miles US $)	precio FOB (US $/Tm)
Enero	0	0	0

Febrero	0	0	0
Marzo	0	0	0
Abril	39,9	61,8	1 548,8
Mayo	19,7	27,0	1 369,2
Junio	0	0	0
Julio	2,9	4,5	1 567,0
Agosto	20,2	21,7	1 071,6
Setiembre	21,7	29,5	1 357,9
Octubre	18,8	26,0	1 386,3
Noviembre	10,5	14,5	1 383,7
Diciembre	47,8	65,7	1 375,1
TOTAL	181,4	250,6	1 381,5

FUENTE: Ministerio de Agricultura - OIA. Estadística de Comercio Exterior. 1 993 - 1 996.

Gráfico 2. Perú: Exportación de quinua por mes - 1996



2.3 Perú: Importación

El Perú no autoabastece toda su demanda interna de quinua. Según las últimas estadísticas se ha importado en los últimos años de 96 000 kg a 562 519 kg. En términos de valor CIF, de $ 78 000 a $ 424 008 dólares (Ver Cuadro 10), siendo este crecimiento mucho mayor respecto a la exportación debido a que la quinua boliviana es más cotizada por una mejor presentación, menos impurezas, mayor tamaño de granos, cualidades que el consumidor peruano en la actualidad exige.

Cuadro 10 : Importación de quinua, según país de origen: 1 993 - 1 995.

	Cantidad (kg)			Valor CIF (US $)		
País	1 993	1 994	1 995	1 993	1 994	1 995
Bolivia	96 000	150 000	562 519	78 000	117 000	424 008

FUENTES: Ministerio de Agricultura: Estadística de Comercio Exterior Agrario.

1 993 - 1 996.

Exportaciones Tradicionales y no Tradicionales - 1 995. Secretaría Nacional de Comercio.

2.4 Bolivia y Ecuador

En cuanto a la producción de quinua en Bolivia y Ecuador, ambos países hasta el año 1990, han experimentado un crecimiento importante, tal como se puede observar en el cuadro 11. El Ecuador ha crecido significativamente por su alta productividad, obteniendo en promedio 2 000 kg/Ha frente a Perú con 860 kg/Ha y Bolivia con 644 kg/Ha, lo cual incide en que sus costos de producción sean menores, para mayor detalle, observar el cuadro 12.

En el anexo A se presenta un diagnóstico de la situación, perspectiva y bases para un programa de promoción de cultivos de quinua para el año 1 990, en los países que pertenecen a la ex-Junta del Acuerdo de Cartagena, hoy Comunidad Andina. Se observa que Bolivia ha venido trabajando con visión en las últimas décadas y con planes a largo plazo en desarrollar la quinua para su mercado interno y de exportación. Así, por ejemplo, en la Investigación Genética y Agronómica y de Transferencia de Tecnología. En cuanto a Postcosecha, Almacenamiento y Transporte cuenta con el mismo desarrollo. En Transformación Agroindustrial el Perú y Bolivia están en ventaja frente a Ecuador, porque ambos países usan alta Tecnología en el procesamiento de la quinua. En cuanto a perspectivas, el mercado interno se presentaba favorable para el autoconsumo en países como Perú, Bolivia y

Ecuador y un limitado mercado en Colombia y Venezuela; en cambio el potencial del mercado externo era alentador, debido al valor nutritivo de la quinua y sobretodo por ser un producto orgánico.

Bolivia en el año 1 990 exportó 344 508 kg de quinua a un valor FOB de $ 292 300 dólares y en el año 1 995, 1 346 511 kg por un monto de $ 1 398 871 dólares. Es decir la exportaciones en sólo seis años crecieron aproximadamente cuatro veces (Ver cuadro 13).

En 1 995, Bolivia exportó principalmente a Estados Unidos, Perú, Alemania y Ecuador, tal como se puede observar en el Cuadro 14. Cabe resaltar que Perú es uno de los principales compradores, sin considerar el ingreso ilegal (contrabando) de la quinua boliviana que se estima en alrededor de 1 500 TM/año.

En cuanto a exportación de quinua por parte del Ecuador no se tiene referencia estadística.

En años recientes, la quinua se está haciendo cada vez más popular, debido a su excepcional aporte nutritivo, en los mercados de EE. UU., Europa y Japón.

El consumo actual de quinua en USA es de aproximadamente 1 400 TM al año, la mayor parte de procedencia boliviana. El valor del mercado de exportación de quinua a los EE. UU. es de un millón de dólares anuales, aproximadamente.

Cuadro 11. Comparativo de la producción de quinua entre Bolivia, Perú y Ecuador 1982 - 1 990. (TM).

Años	Bolivia	Perú*	Ecuador
1 982	15 785	14 796	50
1 984	16 641	11 993	41
1 986	20 631	7 088	135
1 988	22 600	13 385	553
1 990	18 069	3 500	1 200

FUENTE: IICA "Estudio de Mercado y Comercialización de la Quinua Real de Bolivia", 1 991.

* ADEX/USAID/MSP/COSUDE "Quinua Estudio de la Demanda", 1 996.

Cuadro 12 : Comparación de costos de cultivo de quinua en Bolivia, Ecuador y Perú.

(datos a 1 991).

	Bolivia		Perú		Ecuador
	1/	2/	3/	4/	5/
Costos US $/Ha	218	195	331	167	348
Rend. Kg/Ha	644	552	860	415	2000
Costo US $/TM	339	353	383	402	174
Precio venta US $/TM	460	460	550	350	400
Utilidad US $/Ha	78	59	142	61	452

FUENTE: IICA. "Estudio de Mercado y Comercialización de la Quinua Real de Bolivia" (1 991).

1/ Sistema Mecanizado
2/ Sistema Tradicional
3/ Cultivo comercial
4/ Sistema Tradicional
5/ Tecnología Mecanizada y Cultivos Comerciales

Cuadro 13. Exportación Boliviana de quinua, 1 990-1 995.

Año	kilos brutos	Valor US $
1 990	344 508	292 300
1 991	619 588	621 270
1 992	484 370	563 065
1 993	541 736	670 065
1 994	1 172 548	1 446 683
1 995	1 346 511	1 398 871

FUENTES:

- Compendio Estadístico de Exportaciones no Tradicionales 1 990 - 1 994. Secretaría Nacional de Comercio - SIVEX.

- Exportaciones Tradicionales y no Tradicionales - 1 995. Secretaria Nacional de Comercio.

Cuadro 14. Bolivia: Exportaciones de quinua según país de destino, 1 995.

País	Kilos brutos	Valor US $

País	Kilos brutos	Valor US $
Alemania	157 969	235 430
Chile	990	1 600
Estados Unidos	480 138	593 690
Ecuador	90 000	75 040
España	895	703
Países Bajos	54 000	68 400
Perú	562 519	424 008
TOTAL	1 346 511	1 398 871

FUENTE: Exportaciones Tradicionales y no Tradicionales - 1 995. Secretaría Nacional de Comercio.

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CHAPTER XI QUINUA: Post-harvest Operations

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3 Composición y valor nutricional. Usos