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Gaps between the Quality of Rice Produced by Farmers and the Quality Requirements of Rice Processors

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ABSTRACT

This study aimed to identify the gaps between the quality rice grain produced by farmers and those required by rice processors or millers and to provide policy recommendations to bridge the gap between the two sectors of the rice industry. It involved market-oriented farmers, rice millers, and traders from three Northwest Luzon provinces covering their operation from 2005 to 2008.

Seven of the top 10 varieties were common choices rice processors and farmers. Farmers choose a variety mainly based on its high potential yield. Processors mainly sought for varieties with long grains, excellent eating quality and high milling recovery.

The post-production practices of farmers were largely contributory to the ultimate quality of rice they produced. Common sources of poor quality were improper drying, variety mixture, and presence of foreign materials resulting to lower price of up to Php 4.00 per kg of *palay*. Lack of drying facilities forced farmers to sell wet *palay*. Inappropriate drying facilities used increased presence of foreign materials. Insufficient price premium dampened incentives to segregate varieties after harvest.

To bridge the existing gaps between the qualities of paddy rice supplied by farmers and those demanded by processor, the government needs to prioritize investing on efficient mechanical dryers, or tap the private sector to invest on these facilities; and revise the existing standard in grading paddy rice to provide price premiums to varieties with superior qualities.

Keywords: rice, quality gap, farmer quality preference, rice processor quality preference, price incentive, variety mixture, drying facilities

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RATIONALE

Rice quality is influenced by characteristics under genetic control, environmental conditions, and processing techniques. The genetic makeup of a particular variety dictates to a large degree the grain quality characteristics. Marked differences in rice quality also occur as a result of the environmental conditions and cultural practices during the growth period of the plant. Handling, storage and presence of foreign materials likewise influence quality of the processed rice (UCCE, 2003).

To a great extent, the rice farmer is accountable to grain quality. His choice of variety, cultural practices, and post-production methods determine the quality of the grain that he sells in the market. The ultimate quality of milled rice depends largely on these factors that are controlled by the farmer and on the quality of equipment used by millers.

Market-oriented farmers usually choose a variety with outstanding agronomic features particularly yield performance, maturity duration and pest resistance. A variety has its own inherent qualities like grain size and shape, translucency, amylose content, etc. There are certain varieties like the IR64 which command a price premium in the market. The quality of the grain is likewise determined by the production environment. Plants that were poorly managed and exposed to pests and environmental distress produce grains of diminished qualities. Traders and processors devalue the buying price of grains that are discolored or pest-damaged. Drying methods remain a significant factor affecting the ultimate quality of rice. Rice dried on roadsides are exposed to grain breakage caused by running over by vehicles, pebble and dirt contamination. Delayed or insufficient drying causes grain discoloration and germination. Over-drying causes grain fissure. All these not only results to yield losses but reduce the marketability of rice.

The Philippine consumers consider the following rice quality criteria in order of importance: variety, purity, whiteness of polish, percentage of broken grains, and the presence of contaminants such as weed seeds and pebbles (de Padua, 1999). Rice processors respond to these demands that will ultimately determine the market price of rice. When buying paddy rice, they conduct visual inspection and sampling. They consider grain size and shape, moisture content, hull color, unfilled grains and variety for special rices. Grains that meet their milling standards command better prices. Low quality grains are bought far below the prevailing market price of ramble rice or may be totally rejected by processor buyers.

The prevalence of poor quality paddy sold by farmers has been a persistent problem of rice processors. The failure of farmers to produce paddy that meet the quality demanded by rice processors may denote either inappropriate practices and/or absence of price incentives to encourage farmers to produce high quality paddy.

OBJECTIVES

This study generally aimed to identify the gaps between the quality rice grain produced by farmers and those required by rice processors or millers. Specifically it aimed to:

- Determine the factors that influence farmers in planting a certain variety
- Identify production and post-production practices and problems of farmers that affect the quality of rice available for sale
- Identify varieties that have high marketability to processors

- Determine the qualities of rice preferred by processors
- Identify causes of downgrading of selling price or rejection to buy by processors, if any
- Measure the cost discrepancies between high quality and poor quality rice
- Provide policy recommendations to bridge the gap between the two sectors of the rice industry

REVIEW OF RELATED LITERATURE

Consumer preference. Quality is based on a combination of subjective and objective factors. The rank in importance of the criteria in evaluating quality depends on the consumer. Since rice is consumed as a whole grain, physical properties such as size, shape, uniformity, and general appearance are of utmost importance (UCCE, 2003).

The appearance of milled rice is important to consumers. Consumers prefer rice with translucent endosperm and pay a premium price for it. Grain appearance is largely determined by endosperm opacity or the amount of chalkiness in it; the greater the chalkiness, the lower the marketability. The chalky areas are not as hard as the translucent areas, hence more prone to breakage during milling (dela Cruz, 2002).

For eating quality, Filipinos prefer the type that is soft on cooking. Rice with a combination of high amylose content (AC) and intermediate gelatinization temperature (GT) is soft when cooked. Rice with high AC – low GT combination is hard. Most rice in the market has intermediate AC to satisfy the dominant consumer preference for soft textured rice (De Leon, 2005).

Laboratory analysis showed that Philippine rice labeled with a traditional variety name is usually a modern variety with shape or cooking characteristics similar to those of traditional varieties (Juliano, 1993).

Grain Quality. Good quality paddy means uniformly mature kernels; uniform size and shape, free of fissures, empty or half-filled grains, and free of contaminants such as stones and weed seeds (IRRI, 2008).

Rice quality is influenced by characteristics under genetic control, environmental conditions, and processing techniques. The genetic makeup of a particular variety dictates to a large degree the grain quality characteristics. Marked differences in rice quality occur as a result of environmental conditions and cultural practices during growth. These factors may under some circumstances have a greater impact on quality than inherited traits. Factors influencing quality other than genetics and environment are those associated with handling, storage and presence of foreign material (UCCE, 2003).

Many crop management factors have an impact on the quality of paddy. A sound paddy kernel is fully matured and not subjected to physiological stresses during its grain formation stage. Timely harvesting, threshing, drying, and stored properly can result in the production of good quality milled rice. Mixtures of chalky and immature kernels, mechanically stressed grain during harvesting threshing, delays in drying, and moisture migration in storage can result in broken and discolored milled rice. Blending/mixing different varieties with different physico-chemical properties during the post-harvest operations contribute to a large extent in the lowering of the milled rice quality produced. Purity is related to the presence of dockage in the grain. Dockage refers to material other than paddy and includes chaff, stones, weed seeds, soil, rice straw, stalks, etc. These impurities generally come from the field or from the drying floor. Unclean paddy increases the time taken to clean and process the grain. Foreign matter in the grain reduces milling recoveries and the quality of rice and increases the wear and tear on milling machinery (IRRI, 2008).

Sectors of the rice industry. Excluding the consumers, the rice system is composed of two groups: the production sector composed of farmers and the post-production sector composed of processors and traders. The interests of the two sectors are different and sometimes conflict. The primary occupation of the farmers is caring for the crop. The processor's activity starts when the grain is

delivered to his plant. With the advent of HYV and quality control requirements of the grain many of the millers have to connect to local paddy traders, who in turn have a direct contact to farmers (de Padua, 1998).

Although some of the quality characteristics desired by farmers, millers, and consumers may be the same, each may place different emphasis on various quality characteristics. To the farmer producer, quality grain is of good variety, filled, well-ripened, winnowed and cleaned, commands high farmgate price and in demand by traders, millers and consumers. To the trader, quality means dry, insect-free, undamaged grain, which will store well. To the miller, quality means grain batch is of pure or homogenous variety that gives a high milling recovery and a high head rice to brokers proportion. To the consumer, quality of milled rice means that it has good appearance, grain size and shape, and the preferred texture, flavor, and cooking properties (dela Cruz, 2002; Lantin, 1997).

The farming management and field operations as well as the post-field operations determine the quantity and the quality of milled rice, the final product from agricultural production (Lantin, 1997). Production of good quality milled rice starts at the farm with good quality seeds, and crop care for uniform growth and grain size. The other factors that damage quality such as mixing of varieties, heat discoloration, contamination, insect damage in storage, fissuring during drying, breakage in milling, are controlled in the post-production operations (de Padua, 1998).

Decisions related to production of rice are important in attaining the quality desired for the processed grain. A chosen variety to be planted has inherent agronomic and grain characteristics. These characteristics in turn become factors influencing the ease, efficiency, grain loss magnitude, and choice of harvesting and threshing technology. They also affect the rate and quality of the drying process and the quality of dehusked rice and eventually the total recovery and quality of milled rice (Lantin, 1997).

Grain quality deterioration. Inappropriate technologies, unsuitable management techniques, and lack of knowledge on grain harvesting drying, storage and milling often result in quality deterioration and low market price of rice. Rice quality deterioration can be in the form of high damaged and yellow grain, incomplete milling, discoloration, impurities or undesirable odor or taste (Bell and Dawe 1998).

Grain deterioration may be measured in terms of losses in quantity and quality of the final milled rice product. Some of the factors contributing to deterioration are impurity, too high or too low moisture content, immature and unfilled grain, cracked kernel, chalky grain, and red rice and other impurities. Lantin (1997) describes how each major factor affects the grain quality:

- Moisture content of grain. Too high rather than too low (overdried) moisture content is the common problem encountered among the traded paddy because it is more expensive to overdry the paddy except when the method used is sundrying. High moisture content results in the rapid deterioration of the paddy because the grains continue to respire and heat builds up giving favorable conditions for mould to grow, fermentation to set and micro-organisms to multiply. Insects and mites will be most active when the equilibrium relative humidity inside the grain mass gets to about 60-80 percent aggravated also by the biological activities. The result is yellowed and damaged grains.
- Temperature. High grain temperature has damaging effects on the grain because of the increased respiration and reproductive activities of insects. Most insects infesting paddy complete their life cycles at temperatures of 15-45^{o}C while moulds and bacteria have a wide range of temperature (0-60^{o}C) for their activities.
- Insects and micro-organisms. Insects cause damage to the paddy by eating the food matter, causing reduced weight and volume of the grain bulk, as well as indentation and deformation of the kernels, which reduce the milling recovery. They also leave black marks on the kernels and increase the temperature in the bulk grain. They also contaminate it with their wastes and dead bodies. At high grain moisture content (25-30 percent) and high relative humidity (70-75 percent) the activity of fungi and bacteria also increase and cause further damage by discoloring of the grain, giving off or bad odor, causing off-flavor and producing mycotoxins.

- Impurities. Matter other than grain such as stones, dirt, sand, plastics, glass and metal bits as well as organic materials such as chaff, straw, empty grains, red kernels and seeds of weeds and other crops, animal and insect parts and even human hair constitute the common impurities in the grain bulk. The inorganic materials damage the mill and the organic ones rot rapidly, cause uneven distribution of moisture content and induce the growth of micro-organisms.
- Immature grains. While not exactly impurities, immature grains do lower grain quality by causing uneven distribution of moisture and themselves the favored food of insects, hence causing a chain of actions leading to increased infestation and quality deterioration.
- Thermal and mechanical stresses. The rapid rate of moisture removal induces stresses in the grain because of the differential expansion and contraction of the inner and outer layers of the grain. Fissuring occurs and eventually during milling, the grain breaks along the fissure lines. Accidental or unavoidable re-wetting by rain of dried grain as during retrieval from the sundrying floor, also cause stresses and eventually fractured kernels. A worse situation occurs when the grain is chalky or already damaged by insects and water as well as by mechanical handling and processing such as in threshing or sundrying.
- Mixed varieties. Harvests from different fields get mixed in the rice mill compound for various reasons. Milling of different sized grains results in poor quality rice because no one adjustment of the mill may satisfy the requirements of the non-uniform grain sizes.

Milling recovery. Recovering the maximum amount of endosperm or the edible portion of paddy grain with none or minimum brokens is the main objective of rice milling. Losses in milling could be qualitative and quantitative in nature. Quantitative or physical losses are manifested by low milling recovery while quality losses are manifested by low head rice recovery or high percentage of broken grains in the milled product (Lantin, 1997).

Generally, rough rice contains 20-22% hull and 8-10% bran. Hence, theoretically 70% milled rice is obtained (dela Cruz, 2002). In commercial milling, however, not all the paddy grains are whole grains. State of the art commercial mills properly adjusted and working with good quality paddy can yield 67% milled rice, with head rice (¾ to whole grains) above 70%. Poor quality paddy that is badly fissured can lower total milling yields as low as 60% (de Padua, 1998).

The big variables in the performance of rice mills are quality of paddy, maintenance of the machines, and operator skill. But new plants are increasingly becoming automated to minimize operator judgment. Mixing varieties with different sizes does not allow for proper machine settings (de Padua, 1998).

Milling of poor quality paddy will always result in poor quality milled rice, even if a state-of-the-art mill is used or the miller is experienced. Similarly, the use of good quality paddy by a well skilled operator may result in poor quality rice if the mill is not maintained regularly (IRRI, 2008).

The rice milling industry has little control if any of the variety supplied by farmers and traders. Moreover, the traders obtain their paddy from different farmers who are likely unaware or could not care less of the importance of purity of the variety they are planting because they are not given incentives by traders or millers for such specification (Lantin, 1997).

Quality incentives. Market provides incentives and disincentives for farmer's choice of variety through price signals, market margins and market channels (Joshi, 2002). Mill owners, who play an important role in the market, pay less for rice varieties that do not meet the standard of the most dominant variety in the market (Joshi, 2002). Quality incentives appear to be transmitted from wholesale rice prices through to rough rice prices in the Philippines (IRRI and IDRC, 1992). However, this transmission is not perfect. Philippine studies reveal the complexity of the transmission of information about quality from consumers to producers. The transmission of price and market signals and a greater degree of integration of the farm wholesale and retail market will be necessary to improve the farmgate price and to provide incentive to farmers to produce better-quality rice (Juliano, 1993).

Red rice or other admixture variety in the field could be rogued or pulled out since the rice plants are likely different in growth characteristics than the particular variety chosen for planting. Thorough weed control is important in preventing contamination of the grain with weed seeds and plant parts. Chalky, immature and unfilled grains could be avoided by timely harvesting which means also timely planting with respect to climatic conditions, insect infestation and synchrony with the planting by other farmers (Lantin, 1997).

Variety. Variety is the principal factor contributing to grain quality (Juliano, 1993). An informal survey conducted by the Department of Agriculture in 2002 identified 34 varieties among the top five choices of farmers. These varieties represented a mix of old and new official cultivars released. These varieties include the 10 most frequently grown varieties – PSB RC82, Rc18 Rc80, Rc78, Rc28, IR64, Rc74, Rc64, Rc14, and IR60. PSB Rc82 and Rc18 are among the NCT check varieties for grain yield and general performance while IR64 remains the standard variety for grain and eating quality (De Leon, 2005).

IR64 commands a premium price almost exclusively in the local trading scene. A study conducted by Roferos *et al.* (2004) suggested that many varieties, including those preferred by farmers, are very similar to IR64 in grain quality. These include PSB Rc78, Rc18, Rc80, Rc54, Rc64, Rc14 and Rc72H (De Leon, 2005).

Farmers' choice of a variety depends on its resource requirements. Farmers do not choose a variety that requires more labor, especially during the peak periods of labor activities. A variety that is more responsive to fertilizers and cash exposures is preferred (Ashby and Pachico, 1987).

Varietal mixtures is a common problem in the Philippines, where there is a proliferation of new varieties that compounds the problem of grading and segregating in-coming grain. With small land holdings, the harvested paddy comes in small batches of varying moisture content and purity. Further, farmers use their own seeds which are primarily mixed varieties, which result in non-uniform paddy kernels (de Padua, 1998).

Drying. Moisture content is the most important quality criterion for rough rice (Juliano, 1993). Paddy is harvested with moisture content of 24 to 26 percent (higher in the rainy season and lower in the dry season). It has a high respiration rate and is susceptible to attacks by microorganisms, insects and other pests resulting in losses in quantity and quality. Therefore, immediate drying of the grain after harvest is imperative to avoid its deterioration.

Harvested grain with high moisture content must be dried within 24 hours to 14% for safe storage and milling, or at most 18 percent for temporary storage of 2 weeks when it is not possible to dry any faster. However, re-wetting of the grain should be avoided to prevent cracking or fissuring which will have telling effects in milling. At moisture content of 14 percent or less, paddy will be less susceptible to fungal infestations and likely retain its germination potential. Its shelf life will likely be prolonged and its quality preserved (Lantin, 1997**;** Mejía, 2002).

Sun- or solar-drying of paddy is still the most popular and cheapest method even among medium-scale rice mills in developing countries because of the free heat energy although handling costs are high. However, it is unreliable particularly in tropical rainy countries like the Philippines, and the drying rate is not as controllable as mechanical dryers. The use of mechanical dryers at the small farm level, however, has not caught on because of its high initial cost, uneconomical operation and seasonal utilization (Lantin, 1997**;** Mejía, 2002**)**.

There is nothing wrong with sun drying if done properly. Sun drying is the cheapest method. Unfortunately sun drying of paddy is unreliable. The sun may not be available when it is most needed; if it rains for a week during harvest time the grain is likely to germinate, yellowed or rotten; when there is sun shine in the morning and the grain is spread out, a sudden rain storm can cause fissured grain; if the sun is hot, the workers prolong mixing the grain and the result again will be fissured grain. Sun drying of paddy is a major cause of lower head rice yield. Local millers claimed that the damage to grain quality

from sun-drying is more expensive than the cost of using heated air dryers. During the wet season, if there is no artificial drying capacity, it is not uncommon for the grain to sprout and rot before it can be dried (de Padua, 1998).

The Philippines has become notorious for its "highway dryers" (de Padua, 1998) since government- subsidized multipurpose pavements constructed in villages could not accommodate all the paddy rice o be dried especially during peak harvest time. This results to mixture in the paddy rice of small pebbles and other debris. Improper and over-drying in sundrying, which is difficult to control, may reduce head rice yield and aroma (Lantin, 1997).

The increased volume of paddy production of high yielding rice varieties and the adoption of advanced production technology, have created a problem of drying large quantities of wet grain at the shortest possible time to minimize the risk of spoilage. Fast drying can only be achieved by means of artificial or mechanical dryers. Sundrying is no longer adequate to meet the drying needs especially during the peak harvest of the wet season crop (Lantin, 1997).

Natural or field drying is also practiced by some farmers. It involves the reduction of paddy moisture while the grain is still attached to the panicle. This is achieved by letting the moisture of the field crop to decrease or by cutting the stalk and leaving it in the field to dry. Field drying is practiced by the farmers during rainy season to remove surface moisture on the cut panicles, grains, to reduce heating when harvested stalks are piled for threshing, and to reduce the weight for easier handling in the field (Lantin, 1997).

Paddy cleaning. Cleaning of paddy is an important post-harvest operation. It involves of the separation of undesirable foreign matter or materials, such as weed seeds, straw, chaff, panicle stems, empty grains, immature and damaged grains, sand, rocks, stone, dust, plastic and even metal and glass particles. The degree of cleanness of the paddy reflects to some extent the care applied during harvesting, threshing and handling (Lantin, 1997; Mejía, 2002).

Storage. Small-scale farmers often lack the resources to store large amounts of grain and do not have a large storage structure; they therefore are obliged to sell their paddy to traders or buyers immediately after harvest. They carry out no further processing (drying, cleaning and grading) because of the immediate need for cash, and there is a lack of incentive to dry, as there is no significant difference in price between wet and dried paddy. The paddy is only dried for safe storage, and then only the amount necessary for consumption or a little more for cash conversion or to sell at a better price (Mejía, 2002).

Prolonged storage under ordinary conditions even without the presence of insects and micro-organisms will cause grain deterioration in terms of color, texture, odor, flavor, and nutritive value because of uncontrolled moisture and temperature (Lantin, 1997).

METHODOLOGY

Location of the study. The study was conducted in Cagayan, Apayao and Ilocos Norte. Cagayan represents areas with problems in drying during the wet season. Apayao represents areas with available mechanical drying facilities. Ilocos Norte represents areas with typically minimal problem in production and drying.

Sampling and stratification. The respondents were stratified into three groups namely: market-oriented rice farmers, rice traders and rice millers. Only farmers who managed at least 1 ha of rice were included in the study. Rice traders and millers operating within the study provinces were included in the study. A total of 40 farmers, 16 traders and 19 millers were surveyed.

Survey instruments. Three sets of interview schedules were prepared. These were pre-tested in Ilocos Norte for refinement and improvement.

Data gathering. The survey was conducted in 2008. Data gathered covered relevant information for the last three years (2005-2007). Secondary data were obtained from key informants and other relevant sources to support the primary data gathered.

Analysis of data. All data gathered were consolidated, coded and encoded. Data were analyzed using descriptive statistics.

RESULTS AND DISCUSSION

Farmers' variety preference. During the wet season, NSIC Rc146 or PJ7 was generally the rice variety most preferred by farmers from the study sites, closely followed by PSB Rc82 (Table 1). During the dry season, the two varieties remained the top two preferred varieties, but their positions were reversed. Overall, however, at least 40% of the farmers planted PSB Rc82 in any season, making it the most preferred variety in all three provinces.

Table 1. Rice varieties preferred by farmers in Apayao, Cagayan and Ilocos Norte, by season.

	Rank	
Variety	**Wet Season**	**Dry Season**
PSB Rc82 (Peñaranda)	2	1
NSIC Rc146 (PJ7)	1	2
PSB Rc18 (Ala)	3	5
NSIC Rc132H (SL8)	4	4
NSIC Rc124H (Bigante)	5.5	3
NSIC Rc138 (PJ25)	5.5	8
NSIC Rc128 (Mabango1)	7	7
NSIC Rc122 (Angelica)	8	9
PSB Rc72H (Mestizo1)	9	6

PJ7 was the most popular variety in Apayao in both seasons, although fewer farmers planted it during the dry season (Table 2). Nevertheless, more than 50% of the farmers chose the variety every season. Together with SL8, it was the second choice of farmers from Cagayan during the wet season. However, its position drastically dropped during the dry season. One salient feature of PJ7 is its outstanding yield performance during the wet season when solar radiation during the production period is limited. Its popularity during the dry season is significantly reduced because of its shattering characteristics, a condition more prone during the drier months. Similarly, PSB Rc18 was more popular to farmers during the wet season because of this characteristic.

Generally, more farmers planted hybrid rice varieties during the dry season owing to the higher risk to weather aberrations and diseases during the wet months. In Ilocos Norte, however, Bigante was very popular in both seasons, claiming the highest spot during the dry season and the second spot during the wet season, shared with PSB Rc18. In Cagayan, SL8 and Mestizo1 both were the second choice of farmers during the dry season, the former maintaining its position during the wet season.

Table 2. Top five preferred rice varieties planted by farmers in Apayao, Cagayan and Ilocos Norte, by season.

Variety	Rank					
	Apayao		Cagayan		Ilocos Norte	
	WS	DS	WS	DS	WS	DS
PSB Rc 82 (Peñaranda)	3	2	1	1	1	4
NSIC Rc146 (PJ7)	1	1	2.5	5	5.5	
PSB Rc18 (Ala)	2	5.5		5	2.5	4
NSIC Rc124H (Bigante)	4	3.5		5	2.5	1
NSIC Rc128 (Mabango 1)	4	3.5			5.5	
NSIC Rc 138 (PJ25)	4		4			
NSIC Rc132H (SL8)		5.5	2.5	2.5		4
PSB Rc28 (Agno)			5			
PSB Rc72H (Mestizo1)				2.5	5.5	4
C4					5.5	4

Farmers' criteria in choosing a variety. Overall, yield potential remained the most important criterion of the farmers from all sites in choosing a rice variety in both seasons (Table 3). This is supported by the varieties preferred by farmers in Table 1. Except for Angelica and Mabango 1 which were preferred for their excellent eating qualities, all the rest were high-yielding varieties with yield potentials of at least 7 t/ha (Figure 1).

Table 3. Criteria of farmers in choosing a variety, Apayao, Cagayan and Ilocos Norte, by season.

Criterion	Rank	
	WS	DS
Yield potential	1	1
Maturity	2	2
Resistance to prevalent insect pests	4	3
Resistance to prevalent diseases	5	4
Water stress tolerance	10	10
Plant height	11	11
Shattering resistance	3	5
Lodging resistance	6.5	8
Submersibility tolerance	8	7
Grain shape and size	6.5	6
Eating quality	9	9
Preferred by buyers	12	12

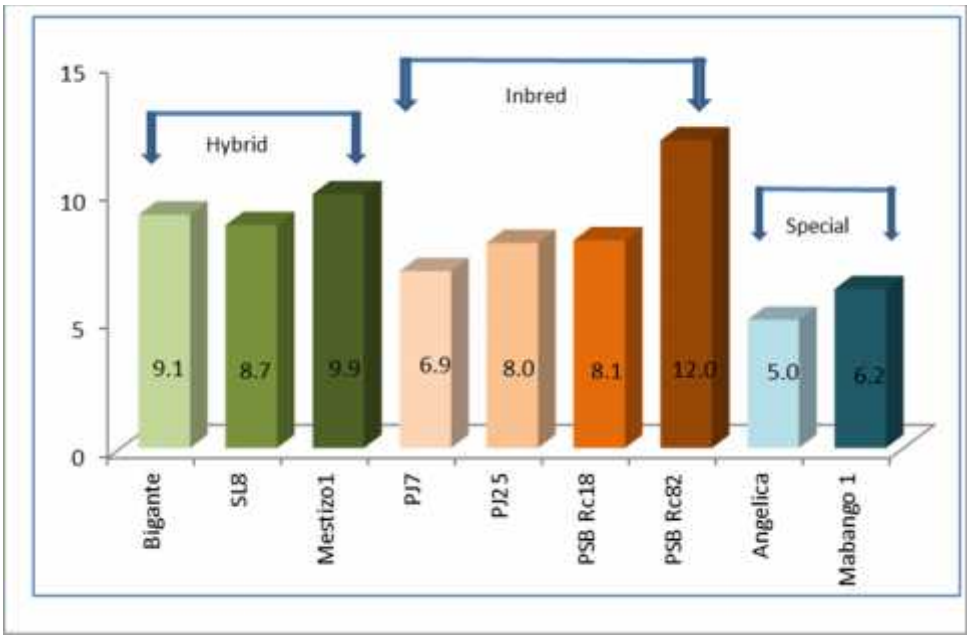

Figure 1. Maximum yield of preferred varieties of farmers from Apayao, Cagayan and Ilocos Norte.

Except for yield potential which was consistently the primary criterion of farmers in all provinces, the other bases of variety choice varied among the three provinces and between seasons. Table 4 shows that farmers in Apayao considered lodging resistance as the second most significant attribute of a variety during wet season because the province is exposed to heavy rains and typhoons during this production period. This degree of importance was endowed to disease resistance during the dry season. Least important were buyers' variety preference and plant height in both seasons.

Table 4. Criteria of farmers in choosing a variety, by province, per season.

Criterion	Rank					
	Apayao		Cagayan		Ilocos Norte	
	WS	DS	WS	DS	WS	DS
Yield potential	1	1	1	1	1	1
Maturity	7	6	2	2	3	2.5
Resistance to prevalent insect pests	4	3	3	3	8	5.5
Resistance to prevalent diseases	4	2	4	4	8	8.5
Water stress tolerance	7	8	11	10	10.5	8.5
Plant height	11	11	8.5	8.5	12	11.5
Shattering resistance	4	4	5	6.5	2	2.5
Lodging resistance	2	6	8.5	11	4	4
Submersibility tolerance	7	6	10	8.5	5	5.5
Grain shape and size	9	9	6	5	6	11.5
Eating quality	10	10	7	6.5	10.5	10
Preferred by buyers	12	12	12	12	8	7

The maturity period of a variety was the second most important consideration of farmers in Cagayan in both seasons. During the wet season, farmers preferred short-maturing varieties so that they could harvest their rice crop before the onset of the heavy rains in September. Maturity was likewise crucial in the province during the dry season because many areas have limited irrigation water sources at the latter part of the production period. Buyers' preference was the least important consideration in both seasons. Farmers in Apayao and Cagayan were not very responsive to varieties preferred by buyers because they were not given incentives to do so. All varieties were classified as "ramble" by the buyers, including special rice varieties.

In Ilocos Norte, shattering resistance was also a major concern of farmers in the choice of variety to plant during the wet season. This is understandable as typhoons frequently pass through the province during the wet season and grains mature fast because of the very hot climate during end part of the dry season. The farmers also preferred short-maturing varieties during the wet season to be able to establish their dry season rice early and minimize risk of scarce irrigation water during the dry season. Least important was plant height. Farmers from this province were more responsive, however to varieties preferred by buyers because some varieties like Mestizo1 was paid a PhP1.00/kg price premium,

Production practices and problems. Management practices of farmers in raising rice contribute to the ultimate quality of their produce. Market-oriented farmers need to raise their crop properly to be able to produce good quality grains.

The use of quality seeds ensures that the inherent characteristics of a variety are preserved and also variety mixture is avoided. At least 88% of farmers in each province used good quality seeds for planting either totally or partially (Figure 2). However, almost a fifth of farmers in Cagayan used only recycled seeds. The absence of irrigation facilities appeared to be discouraging these farmers to invest on quality seeds. While majority of farmers in Apayao (85%) and Cagayan (75%) claimed that their variety choice was always available, only 67% in Ilocos Norte agreed. They further averred that they could hardly find alternative varieties with similar characteristics as their choice.

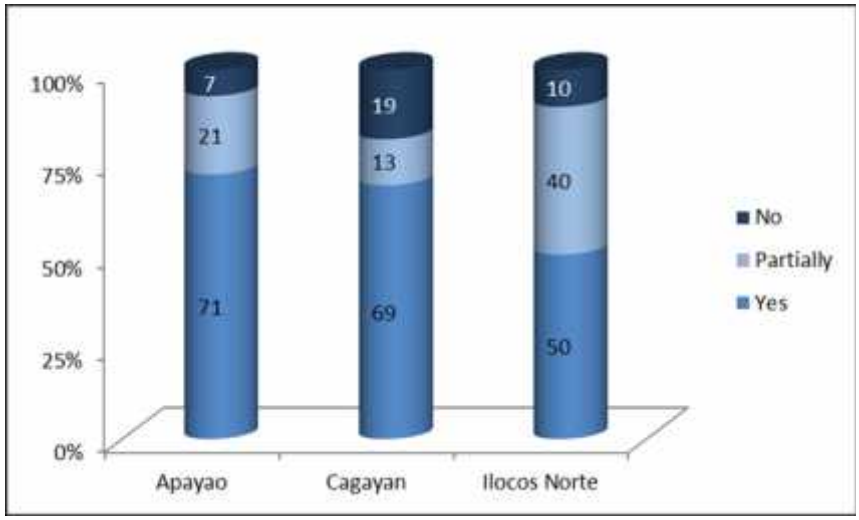

Figure 2. Proportion of farmers using quality of seeds, by province.

The provision of the appropriate fertilizers requirement of the rice crop likewise affects the quality of the paddy rice produced. Farmers in Cagayan said that they could not apply fertilizers at the proper time because of excessive water during the wet season (38%) and insufficient water during the dry season (25%). Excessive water in the rice fields in Cagayan occurred at tillering stage in both seasons. Insufficient water occurred at panicle initiation during the wet season and tillering and booting stages

during the dry season. These problems were not prevalent in Apayao and Ilocos Norte owing to the presence of irrigation facilities and better drainage systems.

Many farmers in Apayao (21%) claimed that the quality of the grains they produced was affected by Bacterial Leaf Blight during the wet season. Roughly one-fifth of farmers in Cagayan (19%) said that the tungro disease lowered the quality of their paddy rice in both seasons.

Lodging deteriorates the quality of paddy rice especially when there is water in the field. Grains discolor, form spots or rot when the panicles are soaked in water for a long time. These conditions reduce the marketability of paddy rice. Lodging is experience by 29% of farmers in Apayao during the wet season in up to 50% of their crop. In Cagayan, as much as 100% of the rice crop of some farmers lodged during the dry season.

About one-fourth of the farmers claimed that harvesting was usually delayed because of continuous rains during the wet season. Weather aberrations during DS 2008 caused delay in harvesting of the rice crop of almost one-fifth of farmers in Cagayan. The problem is much more serious as 40% of the farmers harvested their rice crop beyond the 75-85% mature grain standard.

Post-production practices and problems. Manual threshing is practiced only in Cagayan. Overall, 82% of the farmers used mechanical threshing either solely or in combination with manual threshing. It was a common practice of farmers, however, of letting the cut paddy dry in the field for three days before threshing. This practice caused losses because many grains are detached from the panicles, especially the shattering varieties. When the weather is humid, cloudy or raining, the grains in the piled cut paddy may discolor or sometimes germinate.

Drying is a prevalent problem of farmers during the wet season. Continuous rains prevent farmers from drying their paddy rice immediately after threshing. In WS 2006, a large portion of the produce of farmers in Cagayan rotted. Limited drying facility is a common problem in Apayao (57%) and Cagayan (56%). In fact 29% of farmers in Apayao, relied solely on paved roads in drying their paddy rice. Overall, 10% of farmers from the three provinces exclusively used the road to dry their paddy rice (Figure 3).

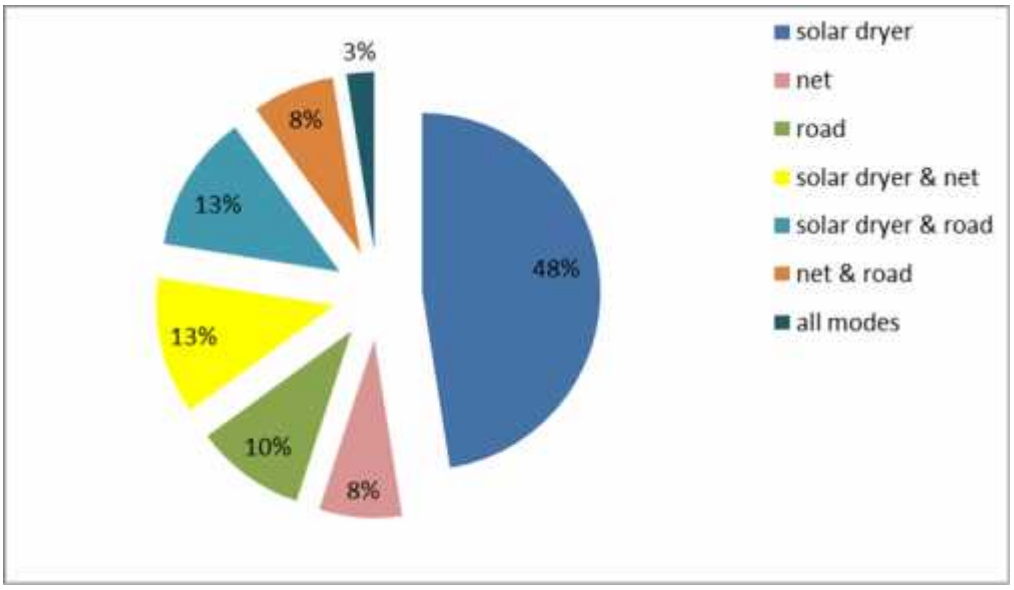

Figure 3. Method of drying paddy rice in Apayao, Cagayan and Ilocos Norte.

Fewer farmers in Ilocos Norte used the road in drying their paddy rice apparently because of local ordinance restrictions. Unlike in Cagayan where drying proliferates even in national roads, Ilocos farmers used only barangay roads. Using the road for drying exposes the paddy rice to foreign materials like small stones, pebbles and dirt, and grain fissure and breakage from being run over by passing vehicles. Nevertheless, concrete solar pavements remained most prevalently used (48%) in the study sites. Plastic nets were most commonly used in Ilocos Norte, indicating that farmers in this province were more concerned in avoiding impurities on their paddy rice.

The proportion of farmers who observed segregation of their produce by variety consistently declined from drying, storage to selling time (Figure 4). By the time the farmers sold their produce, only half of them claimed that their paddy rice was still segregated according to variety. The existing structure of the market where excellent varieties were prevalently not yet provided with price premiums had not given farmers the incentive to be observant in variety segregation.

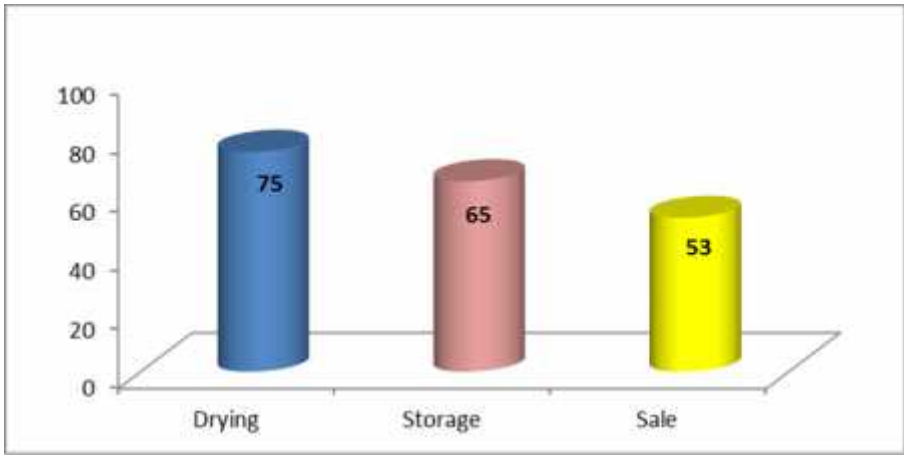

Figure 4. Proportion of farmers observing post-harvest variety segregation in Apayao, Cagayan and Ilocos Norte.

Downgrading of paddy rice due to poor quality. On the average, half of the farmers in all sites said that they received reduced prices of their paddy rice because of poor quality during the past three years (Figure 5). More farmers in Cagayan (69%) reported downgrading than the other two provinces. The production and post-production conditions of Cagayan farmers were less ideal because of irrigation water constraints, more unfavorable weather conditions, and insufficient post-production facilities. The aberrant weather conditions in the past three years aggravated the situation. Even farmers in Ilocos Norte who normally did not face serious problems in rice production were significantly affected by the recent changes in climate.

Table 5 reflects the factors perceived by the farmers which caused the downgrading of the quality of the rice they sold in the past three years. Except in WS 2007, poor drying was the primary cause of downgrading in the price of paddy rice sold by farmers. The excessive rains during the season particularly at harvest time forced farmers in Cagayan to sell their wet produce at much lower price. In WS 2006, downgrading was due to damages from diseases and discoloration of improperly dried grains because of the very wet climate during the season. The dry spell that occurred during most part of WS 2007 coupled with the typhoon at the latter part of the season caused lodging of the ripening rice crop of farmers in Apayao. Downgrading in the price of the farmers due to poor quality of paddy rice was less prevalent during the dry season.

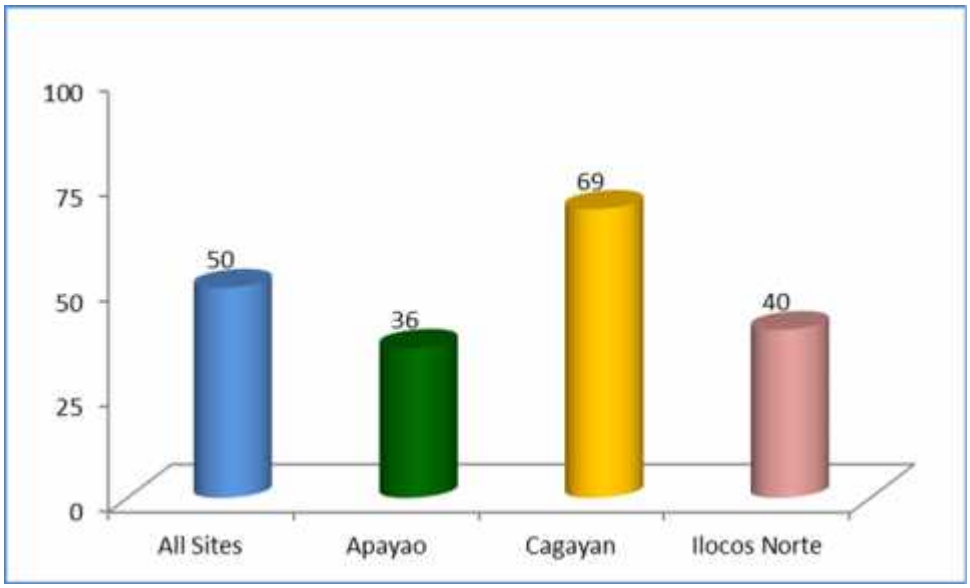

Figure 5. Proportion (in %) of farmers reporting downgrading of paddy rice due to poor quality.

Table 5. Perceived factors affecting quality of paddy rice sold in the past 3 years.

Factor	Rank					
	WS 2005	**DS 2006**	**WS 2006**	**DS 2007**	**WS 2007**	**DS 2008**
Insufficient fertilizer applied	3.5	6	6.5		6.5	4.5
Excessive water during the season	2	6	2	4	1.5	
Lack of water during the season		1.5		1.5		1.5
Insect pest damage	6.5	6	6.5	4	6.5	4.5
Disease damage	6.5		3.5		4	
Lodging	6.5	6	6.5		3	
Delayed harvesting	3.5	1.5	3.5	1.5	1.5	1.5
Poor threshing	6.5	6	6.5			
Poor drying	1	3	1	4	6.5	4.5
Pebble/gravel mixture					6.5	4.5

Processors' referred rice varieties. Seventy-seven percent (77%) of the processors said that the have variety preference when buying paddy rice. Table 6 shows the list of the varieties preferred by processors (traders and rice millers) of paddy rice. This includes 6 PSB and NSIC inbred and 2 hybrid varieties, and 2 IR varieties. PSB Rc18 ranked first among the varieties sought by these commercial buyers. Buyers also continued to seek for IR42 and IR64 varieties. A few rice traders also mentioned Jasmine rice, a very popular premium quality imported rice variety, but is not grown in the country.

Table 6. Top 10 varieties preferred by traders of paddy rice from Apayao, Cagayan and Ilocos Norte.

Variety	Rank
PSB Rc18 (Ala)	1
NSIC Rc134 (PJ21)	2
IR42	3
NSIC Rc138 (PJ25)	4
NSIC Rc122 (Angelica)	6
NSIC Rc146 (PJ7)	6
NSIC Rc132H (SL8)	6
PSB Rc72H (Mestizo1)	8
IR64	9.5
PSB Rc82 (Peñaranda)	9.5

These varieties were sought by traders because of specific qualities. Six of the top 10 varieties were preferred for their long grains and an equal number for their good eating qualities and excellent milling recovery (Table 7). The two IR varieties and SL8 were claimed to have heavy grains. Mestizo1 was sought for its aromatic grains and good eating quality.

Table 7. Characteristics of the rice varieties desired by traders Apayao, Cagayan and Ilocos Norte.

Variety	1	2	3	4	5	6
IR42	√	√	√			
IR64		√		√		
Angelica	√		√	√		
PJ7	√			√		√
PJ21						
PJ25	√					√
PSB Rc18	√		√			√
Mestizo1			√	√	√	√
PSB Rc82	√			√		√
SL8		√	√	√		√

Desired characteristics:

1 - long grains
2 - heavy grains
3 - high market price
4 - good eating quality
5 - aromatic
6 - high milling recovery

The three PJ varieties were claimed by traders to have similar characteristics as some traditional varieties namely: PJ7 for *Milagrosa*, PJ21 for *Pino* and PJ25 for *Palpal-id*. PSB Rc18 was matched with *Bungkitan* and *Raminad* while SL8 with *Los Baños*. All these traditional varieties have superior cooking quality. There were claims from key informants that PSB Rc18 is being sold in the market as *Dinorado*. If this information serves as an indicator, then the sought-after PJ varieties are also being processed and sold as traditional varieties which remain to command higher prices in the consumer market. This observation is supported by IRRI and IDRC (1992) who found out that variety names in the retail market do not always correspond to the actual variety. The actual grain characteristics of the varieties preferred by the processors are reflected in Table 8.

Table 8. Grain characteristics of the varieties preferred by processors in Apayao, Cagayan and Ilocos Norte.

Variety	Grain Length	% Milling recovery	% Amylose	G.T. Score	% Head Rice	% Chalky Grains
IR42	M-L	68.4 G1	H			
IR64	L	68.8 G1	I			
Angelica	7.0 L	65.4 G2	22.5 I	3.8 HI/L	47.3 G2	5.1 G2
PJ7	6.7 L	65.5 G1	22.3 I	6.9 L	47.7 G2	4.6 G1
PJ21	6.5 M	67.2 G1	22.1 I	7.0 L	47.7 G2	9.1 G2
PJ25	7.0 L	68.2 G1	23.1 I	6.8 L/I	35.6 G3	9.6 G2
PSB Rc18	6.80 L	65.6 G1	21.5 I	4.12 HI/I/L	42.1 G2	3.4 G1
Mestizo1	7.0 L	68.7 G1	21.4 L	6.6 L	34.5 G3	7.5 G2
PSB Rc82	6.7 L	70.0 G1	21.5 I	3.0 HI	44.7 G2	5.0 G1
SL8	6.9 L	66.7 G1	23.4 I	5.0 HI/L/I	41.0 G2	15.1 aa

Source: PhilRice

Grain qualities important to processors. Table 9 reflects the qualities that the traders and rice millers gave importance to when purchasing paddy rice. Foremost was that the paddy rice has 14% moisture content. They checked moisture content when buying by biting the grain. Long-grained paddy rice was likewise very important to them. One trader sought for insecticide-free paddy rice indicating that rice with this quality has an expanding market base.

Table 9. Importance of grain quality variable to traders and rice millers in Apayao, Cagayan and Ilocos Norte.

Quality	Percent (n = 35)				
	Never important	Not so important	Neutral	Slightly important	Very important
Long grains	-	3	3	11	83
Slender grain	6	3	17	37	37
Variety	3	3	23	34	37
Absence of weed seeds	3	3	26	29	40
Absence of small stones	3	9	26	29	34
No chalky/immature grains	3	-	6	26	66
No damaged kernels	6	6	20	31	37
No contrasting variety types	3	9	20	40	29
No red kernels	6	9	26	34	26
No discolored kernels	6	9	11	31	43
14% moisture content	6	-	3	-	91
Insecticide-free	-	-	-	-	3

They claimed that the most common quality problems they encountered when buying wet season paddy rice was high moisture content (83%) followed by chalky or immature grains (65%). Although there

were fewer buyers claiming quality problems during the dry season, they had the same major quality problems, only this time their positions were reversed (Table 10).

Table 10. Common quality problems in the paddy rice bought by traders in Apayao, Cagayan and Ilocos Norte.

Quality Problem	Rank	
	WS	DS
Presence of weed seeds	4	4
Rice straw / crop residues	5	
Chalky & immature grains	2	2
Damaged kernels		
Contrasting variety types	3	3
Discolored kernels		5
High moisture content	1	2

Price discrepancy according to quality. Traders downgrade the price of paddy rice with quality problems. The most common cause of downgrading was high moisture content, chalky or immature grains, damaged kernels and contrasting variety types (Table 11). Traders bought wet paddy at a price lower by PhP1.50 – PhP4.00/kg than dry paddy rice. On the other hand, skin-dry paddy rice was bought PhP0.30 – PhP2.00/kg. The processors had the capacity to dry 0.5t to 15t of paddy rice in a day, or an average of 6.2t/day. Roughly 89% of the processors bought wet or skin-dry paddy rice from farmers with 94% of them purchasing wet and skin-dry paddy in both seasons. While 61% still used pavements in solar drying, the rest combined this method of drying with the use of mechanical dryers. Although 33% owned mechanical dryers, the others rented the drying facilities. There were concerns though among users on the high cost of mechanical drying and the inferior quality of paddy rice dried using the mechanical drier. Some claimed that the dried paddy grains were chalky and discolor when stocked for a long time. More than half of the processors (54%) clamored for superior quality mechanical drying facilities.

Table 11. Quality problems causing downgrading in the price of paddy rice bought by traders in Apayao, Cagayan and Ilocos Norte.

Quality Problem	Percent		
	Not Significant	Significant	Very Significant
Presence of weed seeds	20	51	29
Presence of small stones	29	54	17
Chalky & immature grains	9	17	74
Damaged kernels	14	54	31
Contrasting variety types	14	63	23
Red kernels	23	46	31
Discolored kernels	17	37	46
High moisture content	3	9	89

Dry paddy rice bought by traders was given corresponding grades according to its quality. Table 12 shows that the difference between the buying price of premium and Grade 1 rice ranged from PhP2.50 – PhP5.00 per kg paddy rice in the past three years. This translates to PhP10,000 – PhP20,000

additional income among farmers if they sell premium quality instead of Grade 1 paddy rice. The discrepancies between the successive lower rice quality grades were slightly smaller ranging from PhP1.00 – PhP4.00 per kg of paddy.

Table 12. Price discrepancies of paddy rice in Apayao, Cagayan and Ilocos Norte according to quality grade.

Season/Year	**Price Difference (PhP/kg)**		
	Premium & Grade 1	*Grade 1 & Grade 2*	*Grade 2 & Grade 3*
WS 2005	0.50 - 2.50	0.50 - 2.00	0.50 - 1.00
DS 2006	0.50 - 2.50	0.50 - 1.00	0.50 - 3.00
WS 2006	0.50 - 2.50	0.50 - 2.00	0.50 - 3.00
DS 2007	0.50 - 2.50	0.50 - 2.00	0.50 - 3.00
WS 2007	0.50 - 5.00	0.50 - 2.00	0.50 - 3.00
DS 2008	0.50 - 5.00	0.50 - 4.00	0.50 - 3.00

Farmers' vs. processors' variety preference. There was a strong congruence in the varieties preferred by farmers and those sought by processors as indicated by the 7 common varieties in the top 10 list of each group. However, the most popular farmers' variety choice, PSB Rc82, ranked merely 10th among the preferred varieties of processors. PSB Rc18, on the other hand, was not only highly preferred by farmers but likewise processors. Bigante, which emerged as one of the popular varieties among famers because of its very high yield potential, ranked merely 13th among the desired varieties of processors. Mabango1, a recently released variety, has a potential of being highly accepted by processors in the near future because it is aromatic and has a very excellent eating quality.

The farmers were aware of the varieties preferred by the processors (Table 13). The farmers were accurate in identifying PSB Rc18 as the most preferred variety of processors. They were likewise aware of the continuing demand of the traders for the IR varieties and their emerging demand for Jasmine rice.

Table 13. Farmers' perceived variety preference of buyers in Apayao, Cagayan and Ilocos Norte.

Variety	**Rank**
PSB Rc18 (Ala)	1
IR42	2
NSIC Rc122 (Angelica)	3
NSIC Rc134 (PJ 21)	3
PSB Rc72H (Mestizo1)	3
NSIC Rc146 (PJ7)	4
Jasmine	5
IR64	6

Although PJ21, the 2nd top choice of processors was not yet popular among the farmers, it is very likely that it will be accepted by farmers quickly owing to its superior yield potential over its more popular

PJ relatives. IR42 and IR64 have very low probability of being supplied by farmers in the rice market because their seed materials are not as available as the more recent PSB and NSIC varieties.

Grain quality problems. Farmers acknowledge that they need to improve their current production and post-production practices to produce high quality rice. They recognized that they have to prioritize on improving their current post-production practices (Table 14).

Table 14. Production and post-production practice perceived by farmers to be improved to produce quality rice.

Practice	Rank
Post-harvest practices	1
Nutrient management	2
Water management	3
Insect and pest management	4

If given price incentives, the farmers were willing to improve three of their current post-production practices (Figure 6). Roughly 88% of the farmers said that they are willing to dry their paddy rice at 14% moisture content. Also, they were keen in ensuring that they produce is free from foreign matter and to segregate them by variety.

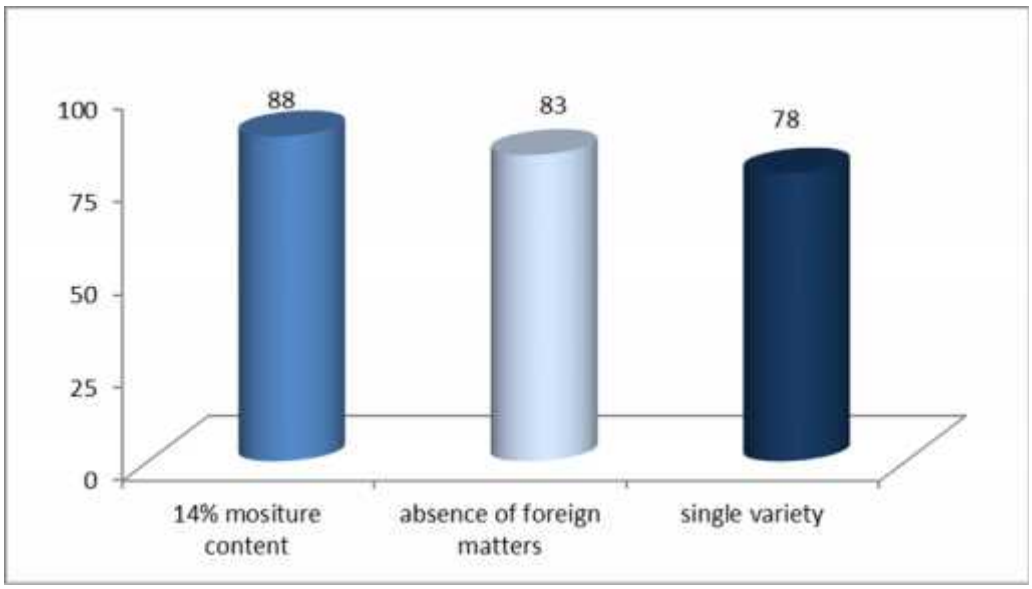

Figure 6. Quality variables farmers are willing to improve with price incentives.

CONCLUSION AND RECOMMENDATION

Poor quality paddy sold by farmers has been a persistent problem in the rice industry. Farmers seemed unresponsive to the demand of processors for high quality rice. The production and post-production practices of farmers contribute significantly to the ultimate quality of rice the farmers sell in the market.

This study therefore was conducted to identify the gaps between the quality rice grain produced by farmers and those required by rice processors or millers. Ultimately, this study aimed to provide policy recommendations to bridge the gap between the two sectors of the rice industry.

The study was conducted in the provinces of Apayao, Cagayan and Ilocos Norte involving three groups of respondents namely: market-oriented farmers with at least 1 ha rice area and planting rice in both wet and dry seasons; rice millers who also perform rice trading; and traders. The survey was conducted in 2008 with the use of three sets of pre-tested questionnaires. The data gathered covered the three-year operations of the respondents from WS 2005 to DS 2008.

Seven out of the top 10 varieties preferred by processors were likewise the choice variety of farmers. PSB Rc18 was highly preferred by both farmers and processors. Farmers choose a variety mainly based on its high potential yield. Processors mainly sought for varieties with long grains, excellent eating quality and high milling recovery. PSB RC18 met all these qualities. Bigante, one of the popular varieties among famers because of its very high yield potential, was not included among the top 10 desired varieties of processors. The high yield potential PSB Rc82 in any season will assure its continued patronage by farmers but it may remain to be classified as ordinary rice.

Recent aromatic and special rice varieties are highly likely to become mainstays among farmers' choice if traders and buyers provide price premiums for them. IR42 and IR64 have very low probability of being supplied by farmers in the rice market because their seed materials are not as available as the more recent PSB and NSIC varieties. However, there are now numerous new varieties that possess similar qualities. There are suggestions that PSB and NSIC varieties are now being marketed as special rice but bearing the names of famous traditional rice varieties.

The post-production practices of farmers had more bearing in contributing to the ultimate quality of rice they produced. High moisture content was the most prevalent cause of price downgrading by buyers. Farmers in Cagayan had problems in drying their wet season paddy rice due to continuous rains at harvest time. Improperly dried paddy was bought by traders from PhP1.50 to PhP4.00 lower than its dry equivalent.

Although most farmers utilize concrete pavements for drying, concrete roads were solely used for drying by roughly 29% of the farmers in Apayao. Using the road for drying exposes the paddy rice to foreign materials like small stones, pebbles and dirt, and grain fissure and breakage from being run over by passing vehicles. Poor drying practices will remain a major problem in the rice industry unless the government addresses soonest.

The proportion of farmers who observed segregation of their produce by variety consistently declined from drying, storage to selling time. By the time the farmers were ready to sell their produce, only half of them observed variety segregation. The existing structure of the market where excellent varieties were prevalently not yet provided with price premiums had not given farmers the incentive to be observant in variety segregation. Only some traders in Ilocos Norte offered a price incentive of PhP1.00 per kg of Mestizo1. All the other varieties were classified as "ramble" by the buyers.

The price discrepancy between Premium and Grade 1 rice at 14% moisture content ranged from PhP2.50 – PhP5.00 per kg paddy rice in while the discrepancies between the successive lower rice quality grades ranged from PhP1.00 – PhP4.00 per kg of paddy in the past three years. If only farmers ensured that their paddy rice is of excellent quality, they would be able to increase their income from rice farming significantly.

The farmers recognized that improving their current post-production practices is of utmost importance. If given price incentives, the farmers were willing to improve three of their current post-production practices. Roughly 88% of the farmers said that they are willing to dry their paddy rice at 14% moisture content. Also, they were keen in ensuring that their produce is free from foreign matter and to segregate them by variety. Currently, however, only the rice processors i.e. the traders and millers make

use of mechanical dryers. And unless drying facilities are made available to farmers, they will never be able to realize their intent to sell their paddy rice at its ideal marketable moisture content.

Based on the findings from the study the following are the policy recommendations:

- The government needs to prioritize on the construction of communal irrigation facilities in all areas planted with two croppings of rice like many fields in Cagayan. The province is practically traversed by the largest river in the Philippines, the Cagayan River.
- With the large average farmholdings of farmers in Apayao and Cagayan, banning the use of roads with heavy traffic in drying paddy rice will never be observed by farmers especially in locations with limited multi-purpose solar pavements. The advocacy on synchronous planting means farmers will always be likely to have limited space to dry their paddy at peak harvesting. This problem is more serious during the wet season when continuous rains prevail at harvest time that drying paddy rice in its storable moisture content becomes next to impossible. The government, therefore, should either invest on efficient mechanical dryers, or tap the private sector to invest on these facilities in areas with problems in drying.
- There is a need for the government to revise the existing standard in grading paddy rice to provide price premiums to varieties with superior qualities. This will encourage farmers to grow these varieties, even those with lower yield potential than the dominant high-yielding ordinary rice.

LITERATURE CITED

Ashby, JA and Pachico, D. 1987. Agricultural Ecology of Mid-Hills of Nepal (eds BL Turner II and SB Brush) Comparative Farming Systems

Bell, MA and D Dawe. 1998. Increasing the impact of engineering in agricultural and rural development. IRRI Discussion Paper Series No. 30, International Rice Research Institute, Los Baños, Philippines.

Clampett, WS et al. 2004. Improvement of rice grain quality. RIRDC Publication

dela Cruz, NM. Rice grain quality evaluation procedures. IRRI

De Leon, JC. 2005. Rice that Filipinos Grow and Eat. Discussion Paper Series No. 2005-11. Philippine Institute of Development Studies

de Padua DB. 1999. *Postharvest Handling in Asia 1. Rice*. International Rice Research Institute

de Padua, D. 1998. Rice post-harvest e-mail conference draft summary. FAO Rome

IRRI. 2008. What is required for producing good quality milled rice? www.knowledgebank.irri.org/riceMilling/Milling_lesson02.htm

IRRI and IDRC. 1992. Consumer Demand for Rice Grain Quality. (eds. LJ Unnevehr, B Duff and BO Juliano)

Joshi, KD. 2002. Participatory Plant Breeding in Rice in Nepal. (eds DA Cleveland and D Soleri). Farmers, Scientists and Plant Breeding. CAB International

Juliano, BO. 1993. Rice in human nutrition. IRRI and FAO

Lantin R. 1997.**:** Rice post-harvest operation. A chapter for the post-harvest compendium within Information Network on Post-harvest operations (INPhO)

Mejía, DJ. 2002. An overview of rice post-harvest technology: use of small metallic silos for minimizing losses. Proceedings of the 20th Session of the International Rice. Sustainable rice production for food security. Bangkok, Thailand, 23-26 July 2002

Roferos, LT, BO Juliano andAdR Felix. 2004. Improving grain quality beyond IR4. Plenary Paper, 17th National Rice R&D Conference, PhilRice, Muñoz, Nueva Ecija

UCCE. 2003. *Concepts of Rice Quality*. Rice Quality Workshop. UC Cooperative Extension: Rice Project http://www.plantsciences.ucdavis.edu/uccerice/QUALITY /contents.htm