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The importance of quality in the evolution and structure of the rice market in the USA

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Abstract

The U.S. rice industry has an international reputation for producing and marketing high quality rice. This reputation has resulted from careful research and breeding programs, improved cultural practices, modern and sophisticated rice drying, storage and milling, well-established grades and standards, rigorous inspection services and product promotion. The U.S. rice market structure is characterized by many farm producers, but a concentrated processing and marketing system, in which farm producer cooperatives have a dominant position. Production is concentrated in three production areas due to the availability of suitable soils and sufficient water. The intensity of production has resulted in high levels of investment in drying, storage and milling facilities. Domestic and foreign markets have been equally important for the U.S. rice industry.

Competition for foreign markets has been pursued through both price and non-price mechanisms. Quality assurance, logistical efficiency and promotion have been important non-price mechanisms. Improvements in these competitive dimensions by export competitors has compelled the U.S. industry to sustain and improve quality throughout the market channel. Growth in the domestic use of rice in the U.S., particularly for further processed products such as cereals, package mixes and other products has also reinforced the demand for quality assurance.

Keywords

- Rice quality, market structure

- USA

Introduction

Rice is a cereal grain with a long history of use for food, dating back some 5,000 years to its first cultivation in India and China. It is a widely produced food grain, presently supplying the primary food staple for more than one-half of the world's population.

By far the greatest proportion of both production and consumption of rice occurs in Asia where annual per capita consumption averages over 100 kg as compared with a world average of approximately 64 kg. Its relative importance in the diets of the rest of the world can be seen when it is noted that current United States utilization of rice amounts to approximately 12 kg per capita (Childs).

The acreage devoted to rice production in the United States usually averages less than 1 percent of the total U.S. crop land harvested. Also, the total value of rice output is relatively small as compared to other grain crops, usually ranking about sixth in farm crop cash receipts behind corn, wheat, soybeans, sorghum and barley.

The United States, however, is one of the largest rice exporters following Thailand and more recently, Vietnam. The competitive position of the United States in world rice markets has been based upon its supply of high quality rice. A comparatively efficient rice production and marketing sector has been augmented by government programs to stabilize producer incomes and promote export sales.

Because large percentages of rice is consumed in the country where it is produced, only 4 percent of total world rice production enters into international trade. Thus the world market in rice is characterized as being very thin. World rice markets are distinctly segmented by quality. Important characteristics include kernel size and shape, stickiness when cooked, degree of milling, percent broken, and fragrance. Efferson (1985) identified six basic types of rice traded in world market :

1) indica, high-quality, long grain, raw-milled rice,
2) indica, medium-quality, long-grain, raw-milled rice,
3) japonica short or medium-grain, raw-milled rice,
4) parboiled rice with any length grain and two speciality types
5) aromatic (fragrant) rice and 6) glutinous (waxy) rice.

Rice production and exports in the U.S. are dominated by high quality indica long-grain and medium grain and high quality japonica. The dominant rice quality type imported into the U.S. is aromatic rice.

2.United States Rice Market.

Domestic and export markets have been important outlets for United States rice production. Historically, export markets have been somewhat more important than domestic, but since 1984, the domestic market has grown steadily and has surpassed the export market since 1989. The domestic market includes rice consumed directly after the milling process and rice that is further processed. The brewing industry is the largest domestic user of milled rice for further processing.

Domestic Use.

Rice distributed domestically from mills and repackagers enter three principal outlet : direct food use, processed food and brewery use. Direct food use is the consumption of whole kernel rice directly after being milled. Processed food use is the consumption after other ingredients have been added or changes have been made in the composition of the kernels for use in the fermenting process. Although the use of rice in the beer industry is a form of processing, most data sources separate rice for brewing and rice for processed

food use into two distinct channels (Childs).

Total domestic use of rice increased 161 percent from 1970 to 1996. Per capita utilization increased from 4.5 kg in 1970 to 12.6 kg in 1996. The direct food use share of total domestic use for 1970 was 63 percent, but this has trended down to a share of only 54% in 1995 as processed use has increased. The market share of domestic rice use going into processed food increased from 15 percent in 1970 to 27 percent in 1995. The proportion of domestic rice use by brewers was 22 percent in 1970, increased to as high as 30 percent in 1978, but was only 19% in 1995.

Direct Food Use.

The U.S. rice millers distribute rice for direct food through three principal outlet : retail, wholesale, and institutional (primarily restaurant trade). The shipments from the rice mills in 1994/95 were distributed as 35 percent to retail, 57 percent to wholesalers and 8 percent to institutions. The total direct consumption of rice for food in the United States has increased steadily since 1955, from 0.37 million metric tons (mmt) to 1.43 mmt in the 1994/95 marketing year (Setia et al, USA Rice Federation). That rate of increase is the result of both the increase in per-capita consumption and a population increase of about 100 million.

Other than regular milled rice, direct food use also includes rice that is processed differently at the mill locations or has special characteristics. Parboiled, pre-cooked, brown and aromatic rice types are classified as "specialty rice." Imports could also be included in this category because most of the imported rice is aromatic, including jasmine from Thailand and basmati from India and Pakistan. The domestically produced speciality rice use has increased from 212.7 thousand mt in 1986/87 to 302.2 thousand mt in 1994/95. Imports have increased since 1986/87 from 82.6 thousand mt to 222.3 thousand mt by 1994/95.

Domestic parboiled rice has historically made up the largest percentage of specialty rice distributions. In 1986/87, the domestically produced parboiled rice accounted for 50 percent of all specialty rice while pre-cooked and brown rice each accounted for approximately 11 percent of the total and aromatic rice (domestic and imported) comprised 28 percent. Aromatic rice, which is distinctive for its aroma, especially after cooking, has become more popular in its distribution since the mid-1980s (Wailes and Livezey). By 1994/95, aromatic rice had an equal share with parboiled rice in the domestic specialty rice market at 43 percent each while the pre-cooked and brown rice segments each held only 7 percent of the market.

Processed Food.- General.

Processed food use includes rice used by food processors and the beer industry. Rice as a food ingredient has been stimulated by an important policy change. Consumption of rice was decoupled from farm price supports with the 1986 legislation. The marketing loan provisions for rice allowed for a more competitive consumer price which had been constrained previously by the loan rate price floor. Processed food use of rice just prior to the 1986 legislation was 267 thousand mt. It increased to 346 thousand mt during the 1986/87 marketing year, and by 1994/95 amounted to 719 thousand mt, more than a 100 percent increase. As a result, numerous new markets for rice by food processors developed rapidly, includin : breakfast cereals, package mixes, pet food, rice cakes, candy, baby food, soups and frozen dinners (Childs).

Cereal processors are the main channel for processed food distribution. However, its share of the processed use of rice has slipped quickly with the strong expansion in the use of rice in package mixes and in pet foods. In 1986/87, the relative shares for cereals, package mixes and pet foods were 63, 20, and 6 percentages, respectively. By 1994/95, these shares had changed to 37, 20, and 28 percentages, respectively. Pet foods are a relatively new market for rice, and is the fastest growing uses of processed rice.

Brewers Use.

Rice used in beer production is the largest single processed market. Brewers use has grown slowly but steadily over the past two decades. In 1974/75, brewers used 276 thousand mt of rice, in 1984/85 319 thousand mt, and by 1994/95 483 thousand tons were used in beer production. Broken rice kernels are used in brewing; these are typically referred to as brewers rice or second heads (kernels that measure less than 3/4 of the whole kernel length). They are used as a fermentable carbohydrate adjunct by several of the major United States breweries. Some brewers prefer rice to corn grits because rice has a lower protein and lipid content (Yoshizawa and Kishi).

The demand by the brewing industry for rice has grown not only because of increased beer production, but

also because more rice is being used per barrel of beer. Throughout the 1960s and 1970s, roughly 3.5 pounds of rice were used per barrel of beer produced in the United States. By 1985, due to the growth of breweries that preferred rice, an average of 5 pounds of rice was used per barrel of beer produced in the United States. (Beer Institute, 1986).

Government Programs for Domestic Distribution.

Rice is distributed domestically in a variety of government programs as well as through commercial channels. Government food programs are designed to make rice supplies available for the elderly, school lunch programs, relief for disaster-stricken areas and distribution by non-profit institutions and organizations. Programs provide financial assistance in the form of packaging and transportation to a designated point in each state. From that location, rice is distributed to the various local recipients who are eligible through the state agencies.

All rice mills in the United States have the opportunity to process rice for government programs. Food program recipients place orders through their state agency for the commodities needed. The government then uses a bidding process for rice processors to supply the allotment necessary to meet the needs of the recipients. The costs of processing, packaging and transportation from the mill location are paid by the government.

Government programs in recent years have resulted in the distribution of between 0.4 and 2 million cwt. per year. Child feeding and family feeding programs have been the major beneficiary of rice distribution programs. White milled rice has been the principal rice distributed. Less than 4 percent of the total distribution has been brown or processed rice (breakfast cereal).

Carryover stocks.

Rice stocks include rough and milled stocks. Rough rice stocks are usually the largest proportion of carryover stocks and are stored on farms, at mills or in commercial warehouses. Milled stocks are stored primarily at the rice mills but also in commercial warehouses and transit facilities. Prior to 1986, price supports were maintained by accumulation of excess production in CCC inventory. The Food Security Act of 1985 essentially eliminated the role of government in carryover rice stocks due to the marketing loan provision. Since 1986, total carryover stocks have been reduced substantially and stabilized at approximately 26 million cwt. The stocks-to-use level has been between 16.5 to 20 percent, which was the range specified in the 1990 farm bill as a desirable for U.S. rice programs (Lynch, 1991). The 1996 FAIR (Federal Agriculture Improvement and Reform) Act eliminated supply controls, and decoupled price deficiency payments from rice production decisions thereby eliminating any control by the government of rice production necessary to maintain desirable stock levels (Nelson and Schertz, 1996).

U.S. Rice Exports.

In the 1990s, the United States has produced only 1.5 percent of the world's annual rice crop. During this period, six Asian nations (People's Republic of China, India, Indonesia, Bangladesh, Vietnam and Thailand) produced 78 percent of the world's annual rice output, averaging 419 million metric tons (rough rice) per year for the past seven years, 1990-1996 (Economic Research Service, USDA). U.S. production at about 7.8 million metric tons per year is very small when compared to the output of some other countries that depend heavily on rice for meeting much of their food requirements.

When comparing exports of rice, however, a quite different picture is evident. Though it ranks only sixth in total production, Thailand is the world's leading rice exporter. On average, 31 percent of world exports originated from Thailand from 1990 to 1996. Export shipments account for about one-third of Thailand's annual output. The United States, ranking eleventh in rice output, is the world's second leading exporter, providing 17 percent of total world exports. The U.S. export share, however, has declined significantly (from 21 percent in 1990 to only 12 percent in 1996) as U.S. rice consumption has expanded and production has remained relatively stable. The next three leading exporters (Vietnam, India, and Pakistan) have averaged a combined share of 29 percent of total world exports since 1990. The five leading exporters have supplied more than 75 percent of the world's rice exports over the past seven years.

Total U.S. exports increased through the 1970s from a 1.6 mmt level to a peak in 1980 of 2.89 mmt. Exports declined in the first half of the 1980s to a low of 1.87 mmt in 1985. The Food Security Act of 1985 reversed that trend by making United States exports more price competitive through the marketing loan. Export levels increased to 2.73 mmt in 1988, declined to 2.1 mmt in 1991 and peaked again at 3.3 mmt in 1994.

The composition of U.S. rice exports has changed over the past 20 years. In the late 1970s regular milled white rice accounted for nearly 58 percent of exports, followed by a 23 percent share for parboiled rice, 13 percent for brown rice, 4 percent rough rice and 2 percent broken. During the 1980s, the share of while milled rice declined to 47 percent, while the parboiled rice export share increased to 32 percent, and the other categories remained similar to their 1970s shares. Over the most recent years, since 1990, the regular while milled rice share has dropped further to only 40 percent, while rough rice exports have risen to nearly 10 percent. Export shares for brown, parboiled and broken have been 14, 33 and 3 percent, respectively in the 1990s. Approximately a fourth of U.S. rice exports in 1990s have been either brown or rough rice, shipped to destinations for further processing and added value.

Government Export Programs.

United States rice is exported through two primary transactional method : commercial cash exports and government-assisted export programs. Throughout the 1960s and until 1972, government exports accounted for more than half of total U.S. rice exports. Government exports were 29 percent of the total for the balance of the 1970s and averaged 37 percent in the 1980s. U.S. price supports effectively overpriced commercial U.S. rice on world markets during the early 1980s and by 1985 government assisted rice exports accounted for 49 percent of all U.S. rice exports. However, the increased role of government in rice exports during the 1980s reflected a change in the program with an increasing emphasis on commercial export credit programs relative to concessional sales. In the 1990s, the government assisted export share has declined to only 30 percent but is strongly trending downward, with the estimated share in 1996 at only 14 percent.

3.Organization of the Marketing System.

Overview.

The rice industry is the total of all value-adding operations that are performed during the production and marketing stages. Within each sector of the rice industry there are input supply, production, transportation, processing and marketing decisions.

An agricultural commodity marketing system, such as that for U.S. rice, entails not only producers of the commodity but a network of processing and marketing channels that facilitate the movement of the desired product to the consumers of that commodity.

Rough rice is produced on farms using seed and other productive inputs such as land, machinery and equipment, labor, fertilizers and chemicals and irrigation water. When harvested, rice typically contains from 15 to 22 percent moisture and must be dried to a moisture content of about 12 to 13 percent to prevent spoilage while the grain is in storage. Drying and storage is the first post-harvest stage in the market channel, a process that is carried out in either on-farm or commercial facilities.

Rice must be milled before it is consumable. Up to the point of milling in the market channel, the primary characteristic of rice is its size difference-- length of the rice kernel. Processing of rough rice is completed in mills that are designed to clean, hull and sort the grain kernels. Milling facilities further process rice into forms for direct consumption by consumers or for use in further-processed foods. Rice can be processed alternatively as regular milled, parboiled, pre-cooked or brown rice.

Once milling is completed, the market separates into domestic or export segments. By-products of the milling stage (bran or millfeed) have traditionally been used primarily for livestock feed. However, due to the potential cholesterol-reducing effects of bran, these by-products are beginning to be used in food products. Rice hulls are used for chicken litter, industrial products and increasingly as fuel fodder in industrial burners. United States food processors purchase their rice in one of its milled forms for further processing and use in their specific product lines. Processing at this stage of the market channel might involve only the addition of other ingredients for packages mixes or the use of rice for distilling in the brewing industry.

Once harvesting is completed, there are two major channels into which rice flow : 1) on-farm drying and storage and 2) commercial drying and storage. The on-farm drying and storage channel is self-descriptive,

while the commercial drying and storage channel is composed of both independent and cooperative facilities.

Producers of rice have a number of alternative pricing methods to market their rice, such as pooling, bidding, direct contracting and hedging. Each producer chooses the pricing method that best fits his or her risk behaviour and desired timing of the payment. With alternatives in prices, there also are alternative marketing methods.

Those producers who do not deliver their rice to a cooperative usually sell to a proprietary milling facility. In this case the farmers pay for drying and short-term storage before the rice is sold. Therefore, rice often remains in on-farm storage or commercial facilities until relocated to a storage facility at a milling site.

Drying and Storage.

Commercial warehouse and on-farm drying and storage are integral parts of the marketing channel. Farmers who do not possess storage facilities must have access to other storage facilities. Since rice is harvested over a short period of time, large surpluses accumulate as the crop is harvested. Milled rice is demanded for consumption on a daily basis throughout the year. The resulting imbalance of supply and demand creates the necessity of a post-harvest, pre-milling stage in the marketing process in which rice is stored until it is processed.

Beyond supplying space to store the grain prior to its milling, storage facilities also provide the drying process in order to maintain grain quality during extended storage periods. Rice is different from other cash grain crops (for which the bulk of consumption is in a crushed or flour state, as with soybeans and wheat, for example). Because rice is consumed in kernel form, care must be exercised through all stages prior to its milling to minimize the number of broken kernels. Exposure to rapid moistening or drying can cause cracks or fissures in the rice kernel (Kunze and Calderwood, 1980). Unsatisfactory drying of rice can have a dramatic effect on the milling quality of the grain. Cracks caused by harvesting or drying methods can cause broken kernels during the milling process, resulting in lower prices and losses in profits for farmers, drying facilities and mills.

On-farm drying and storage.

On-farm storage has been one means by which rice producers have been able to integrate into another stage of the marketing channel for their product. Producers may be able to improve their returns by investing in on-farm drying and storage facilities and performing that function themselves. Improved returns from such an investment can result because their own costs of drying and storage are lower than commercial rates or because greater care in handling of the rice leads to higher quality and price. One study showed that if producers are willing to accept the greater risk of price uncertainty, they can increase the price of their rice by providing their own drying and storage facilities (Elam and Holder, 1985). It was concluded that producers could realize a gain of up to 16 cents/cwt from that function, but the risks associated with post-harvested storage also lead to a variation of 22 cents/cwt in the net price received for their rice.

On-farm storage and drying facilities are located in every major rice-producing state, but no data are available on the number of farms with facilities or the total capacity of existing on-farm facilities. Since 1982, farm-stored quantities have declined in each state, due to lower production levels. The percent of on-farm stocks peaked at 37 percent in 1982, fell to as low as 25 percent in 1986, but increased in recent years to 34 percent.

Commercial Drying and Storage.

Commercial drying and storage facilities are the alternative to on-farm facilities and include both independent and cooperative facilities. Commercial plants are important to the industry's market channel. December 1 of each year is used as an indicator of the largest supply period of the year. Warehouse dryers have typically held more than 60 percent of U.S. rice stocks in recent years. California warehouses stored the largest percentage in commercial facilities. Louisiana and Mississippi held the lowest percentage of rice stocks in commercial facilities because of the greater supply on-farm storage space in those states.

The number of commercial warehouses has been increasing since the mid-1960s (Smith et al). Fluctuations have occurred in the number of facilities within states, and certain capacity ranges have declined. Commercial storage facilities with less than 400,000-bu capacity have shown the only decrease in number over recent years. This could have resulted from expansion of existing facilities as well as forced exit due to

non-competitiveness associated with size economies.

The combined five-state data indicate that the total number of facilities has increased continuously since 1965, with the largest increase in the over 1,200,000-bu capacity category. The greatest number of facilities is in Arkansas, with commercial rice dryers increasing by 44 percent since 1965 and by 10 percent between 1982 and 1986. By 1986, Arkansas had 35 percent of all dryers in the five states and 38 percent of the facilities with capacities greater than 400,000 bu. Texas has shown the greatest decrease in warehouse capacity. Higher production costs for rice in Texas led to a shift to other crops more quickly than in other rice-producing regions.

Dryer facilities are affected by government policy changes. A year such as 1981 is a good example of the effect the government can have on the entire market channel. The 1981 Farm Bill placed the producer loan rate above world rice price levels. As a result, production levels for 1981 were the highest ever, reaching 183 million cwt and causing a shortage of storage.

Local dryer cooperatives not affiliated with marketing cooperatives are also available as a marketing alternative. These facilities may either market rice to a mill for the producer or act only as a drying and storage facility. In Texas, the majority of the non-affiliated cooperatives' marketing decisions are made by the individual producer.

Since the early 1970s, the number of cooperative facilities has increased by a smaller percentage than independent facilities--the number of cooperatives increased 29 percent while independents gained 56 percent--both types had increases in capacity of more than 100 percent. It thus appears that the capacity increase is most likely due to an expansion of existing facilities operated by cooperatives while the growth of independents was due primarily to increases in the number of new facilities (Smith et al).

Rice Milling.

The milling sector of the United States rice industry receives, stores, processes, packages and distributes rice. Compared to the number of storage and drying facilities, there are relatively few rice mills. The size of individual mills and the degree of vertical integration of mills has also increased, creating a more concentrated sector with a smaller number of firms possessing a larger proportion of the nation's milling capacity.

The milling stage includes receiving rough rice from storage facilities in the surrounding production area, milling activities and shipping the milled rice. Mills must have available storage space for their rough rice. This is working storage to hold rice destined for processing within a short period of time; some mills also have attached drying facilities. The major function of local rice dryers and storage facilities is for longer-term storage until the mill itself has working storage available for rough rice. Rice mills must also have clean rice storage to facilitate orderly marketing arrangements.

Direct processing in mills includes the cleaning, shelling and sorting of rough rice. Sorting of rough, brown, or white rice is done according to size, grade, and colour, with several types of rice being processed for direct food use. Regular milled white rice has the hull and bran layers removed by friction or abrasion; brown rice is similarly processed, but the bran layer is retained on the kernel. Mills are of two basic types, regular and parboil. Nearly all mills are capable of producing white and brown rice. Because of the need for uniformity in milling, due to screening and calibrations on hullers and bran removal equipment, mills typically process in lots of like varieties. Parboil mills have preferences for certain varieties that are uniform within the parboiling process.

Understandably, as one moves from the producing sector to the processing sector in most agricultural industries, the number of active firms drops sharply. Such a situation is found in the rice market system in which the milling sector has the smallest number of firms of any other sector in the industry. In 1985, there were about 12,000 rice farms, approximately 300 dryers and 66 rice mills in the U.S. rice industry. A number of studies have addressed such structural characteristics of the milling industry as the number of mills, their location and their size (Godwin and Jones, Holder and Grant, Wailes and Holder, 1987). Prior to 1978, rice mill numbers had decreased to as few as 40 due to the larger size required for mills to remain competitive. Milling technology increased at such a fast pace that a large number of mills were forced out of business by newly remodelled, more efficient mills. However, by 1985, 66 mills were in operation, a consequence of the greatly expanded output of rice that was generated by farm policy changes in 1978 and 1981. While the number of U.S. mills increased by 50 percent between 1978 and 1985, the number of active mills in Arkansas increased by over 160 percent.

As scale economies in rice milling contribute to the growth of large firms, this sector becomes more concentrated, with fewer firms handling the bulk of product passing through the system. Thus, the degree of concentration or "concentration ratio" -- the proportion of total output handled by a few of the largest firms in the industry -- can be used to indicate the degree of potential competition in the industry. In the U.S. rice industry, the concentration ratio for the eight largest milling firms has increased from 66 percent in 1963 to 75 percent in 1982, meaning that in 1982 the eight largest firms milled 75 percent of U.S. rice, while the other 58 mills processed the remaining 25 percent (U.S. Dept. of Commerce, Census of Manufacturers).

Competition for the procurement of rice in different regions is not feasible, in some instances. Mills in California and the southern rice regions, for example, are unable to compete with one another because of the great distances involved. But competition does exist among mills in the southern states. Texas mills obtain some of their rice in Louisiana, and much of Missouri rice is purchased by Arkansas mills.

Although the number of mills in the United States in 1989 is very similar to the number in the early 1960s, there has been considerable structural changes within the milling sector. A number of mergers and acquisitions have resulted in a more concentrated sector. Individually owned, single-rice mills have been replaced by larger facilities. However, data show that the number of very small mills is increasing, possibly due to the increasing markets for specialty products and an increasing demand for rice by the ethnic population (Wailes and Holder, 1987).

Transport Mode.

Nearly all rough rice is shipped by truck from farm and commercial storage to mills. A survey of rough rice flows for 1982/83 showed that 96 percent moved by truck and 4 percent by rail (Wailes and Holder, 1985).

4.Pricing Practices and Strategies.

Marketing Methods.

Rice producers are active in price discovery with alternative marketing methods and associated rules and regulations for each method. Within the rice industry, there are organized pricing methods and also direct sales agreements between the producer and the mill. The marketing of rice differs among individuals and producing areas. For instance, producers in Arkansas and California market their rice primarily through marketing cooperatives located in each of those states. Louisiana and Mississippi rely on direct sales or a bidding process.

Marketing agencies are available in all the southern rice-producing states that act only as a selling agency. These agencies can be either independent firms or cooperative marketing associations. There is no physical handling of the commodity by independent selling agencies. Samples of the rough rice are delivered from either the producer or the commercial storage facility. The rice sample is shelled and milled with a small huller and miller, and is graded by the selling agency. Interested buyers representing mills arrive on sale days and physically inspect the sample. A sealed bid method is used to sell each lot (a "lot" being defined as a specific quantity of rice that a farmer has placed for sale). After receiving the bid, producers usually are given 24 hours to respond to the offer. On acceptance of an offer, ownership is transferred by the selling agency with the buyer paying transportation costs of moving the rice from the storage facility.

The Louisiana Farm Bureau Marketing Association has a rice sales desk for marketing their members' rice. An estimated 20 percent of Louisiana's rice marketing for the 1987 crop year were sold by the Louisiana Farm Bureau. Arkansas has three independent rice marketing companies, which marketed an estimated 6 percent of production in the 1987 crop year. Between 40 and 50 percent of Mississippi rice production was marketed by the bid and acceptance method. Texas, with 17 sales desks, has the greatest number of agencies that market rice by the bid and acceptance method. Marketing by this method are estimated to be more than one-third of Texas' total rice output. California was the only state not using marketing associations as a method of marketing rice, primarily because of the dominance of marketing cooperatives in that state.

Most rice marketing agencies charge a flat-rate fee per unit (bu or cwt) for sales they make. Some agencies

offer services to producers beyond that of marketing rice. They allocate payments from gross rice sales to creditors owed by the producer. These creditors may be commercial drying and storage companies, land owners, water districts and others. Once these payments are made, the producers have received their net earnings from their marketing.

Rice marketing agencies perform an important function in the marketing of rough rice. Especially before futures markets were established for rice, and because of the dominance of cooperatives in the industry, there was no other price discovery mechanism on which farmers could depend to determine the value of their rice.

Cooperative Pooling.

Rice marketing cooperatives in California and Arkansas use a seasonal pool for storage and payment to their producer members. Roughly 70 percent of the rice production of these two states is marked in this manner. Rice that is delivered to cooperative dryers is sampled and graded. The rice is then commingled with other producers' rice of like quality. A partial payment is made to producers at the time they deliver their rice to the cooperative, with additional payments made to them later in the year. Costs associated with drying and storage are also pooled. Producer members pay a base rate per unit of rice, with discounts and premiums given for quality and moisture content differences.

Cooperatives are an important element in the structural makeup of the rice industry. The Rice Millers' Association indicates that cooperatives processed 50 percent of the 1987 rice crop. Cooperatives within the rice industry are usually more vertically integrated than most other farmer cooperatives. This integration extends from provision of seed rice, machinery, fertilizers and credit to produce the crop to drying and storage, milling and transportation into the channels of product distribution.

The major cooperative strength within the industry comes from four marketing cooperatives, two in Arkansas and two in California. These cooperatives allow their producers to be vertically integrated from the production stage through marketing the milled rice to consumers. Profits realized from drying and storage, milling and marketing are returned to producers. Producer members of the marketing cooperatives are usually also members of locally affiliated dryer cooperatives. This system of membership is synonymous with a centralized cooperative in which producers are members of the larger marketing cooperatives.

Cooperatives contract for the delivery of rice from their members by the end of June. The type of rice and the number of acres planted are specified. Contract terms differ in that some cooperatives have penalties for grain not delivered. Membership contracts specify that the cooperative will determine the grade, weight, milling yield, class and quality of all delivered rice. The rice may then be pooled before or after milling with like grade, class and quality of rice.

Private Contracting.

Rice can also be sold green (ownership is transferred directly after harvest) through a private contract between the producer and the mill or at a public sale. It was estimated that 25 percent of the rice marketed in 1984 was sold in this way (Dismukes, 1988). Texas, Mississippi and Louisiana producers favour this method of marketing.

Government Marketing.

The Commodity Credit Corporation (CCC) is another market channel that producers use to market their rice. Since the 1985 Food Security Act, which had a major goal of reducing rice stocks, very little rice has been accumulated by the CCC. The CCC acquires rice by offering non-recourse loans to producers. If the price to be received by producers is less than the loan rate set each year by the Secretary of Agriculture, the producer may choose to forfeit the rice, and the CCC takes delivery of a producer's rice in full payment of the loan outstanding. With the addition of the marketing loan mechanism, the producer may sell the rice even if the price is below the loan rate by as much as 50 percent in 1986-87, 60 percent in 1988 and 70 percent in 1989-90. The difference is retained by the farmer and is called the loan deficiency payment.

Futures Market.

Another pricing mechanism, or even a marketing alternative, is the futures market. Rice futures (#2 long grain) are traded on the Chicago Rice and Cotton Exchange. Futures markets allow hedging opportunities for

producers and handlers of rough rice, with speculators thus assuming a share in the risk of price fluctuations.

The rice futures market currently is a very "thin" market. For example, there were only 13 million bu of rice on open interest as of February 16, 1988, while soybean open interest futures contracts amounted to 622 million bu. These quantities comprised 6.7 and 32.7 percent of the rice and soybean crops, respectively (Chicago Board of Trade, 1987). The thinness of the rice futures market can lead to large price fluctuations on days of heavier trading. The major benefit of an active rice futures market would be that of a price discovery system similar to that for other grains.

Rice futures contracts that are not offset by an opposite futures transaction before the last day of trading for that contract month must be delivered. Delivery of rice on a futures contract must be an alternative to permit the futures and cash price to converge as the contract month approaches. Once the short (sell) and long (buy) contracts are matched by the Board of Trade Clearing Corporation, each person is notified. Delivery points for short contract holders (sellers of contracts) are in 12 designated counties in Arkansas. The price is determined by using the settlement price on the last day of trading for that contract. Storage charges for the rice must be paid by the seller through the delivery day. Price is adjusted by discounts and premiums over the par milling yield of the contract, which is 55/70 (the number 55 represents the percentage of whole kernels, and 70 represents the percent total milling yield). Premiums and discounts are 1.75% for each percentage point difference in whole kernels, and 0.5% premium or discount for above or below 15% broken (Chicago Rice and Cotton Exchange, 1988).

Producer Prices and Rice Quality.

Producer prices are typically based on milling yields with discounts and premiums for various quality characteristics, including foreign material, damaged kernels, etc. Due to the fact that only a few varieties are grown each year and they each have unique processing quality characteristics, prices will vary by variety in addition to the specific quality characteristics reflected in grades and standards.

Adjustments for quality in the market channel.

Due to the high degree of vertical integration, in the market channel, primarily through producer cooperatives, observations on price adjustments for quality in the market channel are not easily determined. Export prices are adjusted by percent broken and grade classification based on criteria that vary by export country (The Rice Council for Market Development).

Price Dissemination.

Milled rice prices, F.O.B. mill and C&F ARAG (composite of ports near Rotterdam) by quality are reported weekly by the USDA, Agricultural Marketing Service ***Rice Market News***. Information on rough rice prices is less available. USDA monthly rice prices are reported for all rice only, with no separate estimates by rice type or grade. The monthly price estimates are based on rough rice prices and quantities reported by independent buyers and mills and on rough-equivalent milled rice prices and quantities by rice cooperatives. The use of essentially two price concepts in addition to aggregation over quality differences contributes to concerns about the representativeness and lack of quality signals in the reported price series. Louisiana market prices by grade, variety and milling yield are reported in the Rice Market News occasionally.

Summary of price-quality sophistication.

The level of sophistication of price and quality relationships within the U.S. rice industry is high. However, knowledge of the relative value of quality differences is not easily available to farmers, given the lack of published price data by the USDA and the relatively small number of buyers of rough rice. Premium and discounts for quality characteristics are widely used. The emphasis on quality in varietal selections influences the choices available to producers and mills. Considerable communication among mills, producers and breeders transpires to maintain production which meets the quality requirements of the mills. Because quality is influenced and controlled from production to final processing, all sectors in the market channel can be analyzed in terms of quality issues.

5.Measurement of Quality in the Market Channel

Important quality attributes.

Milling, processing, cooking and nutritional characteristics are of great importance in determining and measuring quality of rice. There are many diverse uses of rice both domestically and for export. Even for the same use, very different tastes and preferences exist especially in terms of grain size, stickiness and flavour with distinctions based along cultural and ethnic aspects of consumers. Therefore, quality factors are based upon characteristics important to end-users. Quality determination is based upon objective and subjective criteria. The relative importance of each factor depends upon the particular end-use. Because most rice, unlike other cereals, is consumed as a whole grain, the physical characteristics of the whole grain such as shape, size, uniformity, colour and general appearance are the most important quality attributes for rice (Webb, 1985).

Rice quality is influenced by genetic and environmental factors. In the United States, rice varieties are selected in a highly collaborative state-federal breeding program at the experiment stations of Arkansas, California, Louisiana, Mississippi and Texas. Unlike other grains and cereals produced in the United States, private rice breeding and seed companies have only a very minor share of the breeding and seed market. This is probably due in part to the relatively small scale of the rice seed market (approximately 3 million acres), the high cost (labor) of developing hybridized rice seed, and the efficiency of the current system where the state-federal breeding programs in collaboration with state seed foundation programs work closely with the industry in producing varieties with desirable end-use qualities. This system is enhanced by the USDA National Rice Quality Laboratory at Beaumont, Texas, which assesses cooking and processing qualities of developmental varieties.

Environmental factors include influences such as weather and cultural practices during the field growth of the rice plant as well as timing, duration, purity of harvest and post-harvest operations including drying and storage, handling and transportation, milling and packaging. A number of books and handbooks contain extensive reviews of rice quality and testing. Included in this group are Houston (1972), Juliano (1985), IRRI (1979), Luh (1980), U.S. Department of Agriculture (1975) and Wolff (1982).

Quality Characteristics Common to all Users.

The most important quality characteristics common to all users include :

- 1) milling qualities -- milling yield, size, shape, weight, uniformity, and general appearance (translucence and colour) and
- 2) cooking and processing qualities -- percent amylose and alkali spread (Webb, 1985).

The milling qualities include physical characteristics which in the United States most importantly differentiate rice into long, medium and short-grain. Webb (1985) summarizes characteristics and provides average values and ranges for physical properties by class of rice. Milling yield is of obvious importance since this is a measure of the head (full grain) and total (full plus broken) yield of rice. Because most rice is demanded and consumed as a whole grain, a premium is attached to rice that yields a higher percent of whole grains. Milling yields are influenced by many factors including a high degree of heritability. Physical abnormalities such as chalky, peck (insect damage), heat damage, etc. all typically lower milling yield but also lower grade. End-uses for which a higher milling yield is a meaningful quality characteristic would include brewery and flour use. In fact a higher milling yield would generally increase the cost of brewer's rice and flour given the resulting relative shortage of broken.

Cooking and processing qualities which are important across users include texture and stickiness. Distinct preferences for dry, fluffy, separate-grained rice compared to moist, clingy, sticky rice are found in the United States and the rest of the world. The two most important quality indicators for these characteristics are the percent amylose which is a predictor of stickiness and alkali spreading value which used to classify rice by gelatinization temperature. These chemical characteristics tend to be distinctly different by rice type in the United States. Specifically, the long grain types tend to have higher amylose, lower alkali spreading values resulting in dryer, fluffier, and less sticky rice, while the medium and short grain varieties have been selected for lower amylose and higher alkali spreading values resulting in moister, stickier rice.

Quality Characteristics of Concern to Specific Users.

Numerous other quality characteristics are important to only one or more end-users. Hull colour for instance is important for parboiled rice, since a darker golden hull colour will stain the endosperm a darker colour during the parboiling process. Since markets generally prefer a lighter stain, a lighter hull colour, therefore, is desired for rice that is to be parboiled. Bran colour has a similar staining effect on parboiled rice. However, bran colour is also an important quality characteristic for regular milled rice since removal of darker brans generally require higher milling pressure resulting typically in lower milling yields (higher breakage). Translucence is an important quality characteristic for all types of rice except glutinous varieties which are opaque. This type of rice has extremely low amylose and very high amylopectin resulting in a highly gelatinous product used commonly in dessert rice in the United States

Test weight is an important predictor of total milled rice yield and is a useful quality characteristic for determining weight and volume relationships in drying and storage of rough rice. The U.S. standard is 45 pounds per bushel however the average for long grain is 42-45 pounds while the medium and short grains range from 44 to 48 pounds per bushel (Webb, 1985).

Selective cooking and processing qualities are important to a few industries. The use of rice as a adjunct in beer production is enhanced by lower lipids which means that the rice must be well-milled, since most of the rice oils are in the bran layer. A high lipid or oil content in the rice adjunct can give beer an off-flavor, reduce fermentation efficiency and reduce foam formation and retention of the finished product (Yoshizawa and Kishi). Particle size of the broken rice is typically set at a permissible range by the brewery. Finally rice with a higher gel temperature and viscosity (typical in long grain varieties) reduces brewing efficiency. On the other hand these long-grain characteristics including a higher amylose percent are desired for grains used in canned rice, pre-cooked and parboiled rice.

A relatively new quality characteristic demanded in U.S. rice consumption is the aromatic type rice. Traditional and well-established Asian varieties such as basmati (Pakistan and India) and jasmine (Thailand) are popular aromatic varieties in world markets. Several aromatic varieties have been available in the United States for several years and the growth in the demand for this type of rice has been relatively rapid.

6.Quality Control in the Market Channel.

First Handler--voluntary, private.

Quality control in rice is initiated at the point at which the producer selects the variety for planting. Cultural practices including insect and weed control as essential in preventing harvested contamination with pecky rice, red rice and numerous other quality degrading factors. At harvest, producers can influence the quality of their harvest with regard to factors such as moisture content of the grain, rewetting field-dried rice, cylinder speed of the combine and the amount of foreign matter transferred into the grain bin. Harvest moisture in the grain has a non-linear relationship with milling yields with lower yields resulting from grain harvested at moisture levels above or below a range of 16 to 21 percent, although this varies by variety. Harvest at too high a moisture level, in addition to numerous other factors, is known to result in chalky rice (Webb, 1985). Harvest when grain is field dried below 16 percent moisture results in higher potential for stress cracking, mechanical injury and rewetting. In general, the slower the cylinder speed of the combine the higher the milling yield. This is even more important for grain harvested at lower moisture levels (Dilday).

On-farm drying and storage and commercial private storage not attached to a mill is relatively important in Mississippi, Louisiana, Texas and parts of Arkansas. The primary concern is drying the grain to a standard moisture level of 13 percent. While many factors during the drying and storage stage contribute to quality changes, most important is the rate at which the rice is dried. Drying too fast at too high a temperature will generally lead to a lower milling yield due to stress cracking (Kunze and Calderwood). Storage conditions including cleanliness, insect control, and adequate aeration are important quality control activities at this stage in the market channel.

Interfirm Transfers.

With the dominant movement from the farm to the producer cooperative with well-integrated dryer and mill operations, quality control at the first handler stage in U.S. rice tends to be comprehensive. The delivery is typically sampled for moisture and grouped by grade and variety to be cleaned, dried and stored. A dried sample will be sent to the quality control lab of the mill where milling grade is evaluated. As the commingled sample moves to the mill, the lot shipment is re-sampled to group for milling. Transfers from private elevators or rice auctions to the private mills is done similarly with dried samples available for inspection to rough rice buyers.

Exports.

Export shipments are graded by FGIS or by agreement with the importer by independent grading firms. Industry sources have indicated that approximately 50 percent is graded by FGIS. Official grades are used essentially as minimum standards in the U.S. rice trade. Because of the many different uses and requirements by rice processors, rice mills will typically have more specific quality requirements not reflected fully in the grade classification. An example of this is the generally more rigid criteria on peck and heat-damaged kernels for parboiled rice with greater allowance on chalk and head yield.

7.Grades and Standards

Inspection and Grades.

Long, medium and short grain rice types are graded as U.S. No. 1 through U.S. No. 6, or as U.S. Sample grade that does not meet the standards for the other six grades. The FGIS will inspect submitted samples that are sent to one of their offices. The grade placed on the submitted sample is for the rice contained in that sample only. An official lot inspection certificate can be obtained if an employee or inspector of the FGIS takes the sample from a lot of rice and inspects and grades that sample. Federal inspection is a service that is offered, but it is not mandatory. However, an inspection certificate that has been issued after a federal lot inspection is a safeguard for both buyers and sellers. Federal inspection is used primarily for rice that is being exported, but that service is used to an extent in all transactions from the farm to the final distributor.

General Description.

Grades and grade requirements for classes of rough rice, brown rice and milled rice are published in the ***United States Standards for Rice*** (U.S. Department of Agriculture, 1983) and ***Rice Inspection Handbook*** (U.S. Department of Agriculture, 1982)

Sources of authority--legislative, state and federal.

The statutory authority for rice standards is found in the Agricultural Marketing Act, part 68. California and Missouri currently inspect rice with state inspectors under federal authority. Inspection in all other states including Arkansas, Louisiana, Mississippi and Texas is conducted by federal inspectors. Since federal inspection is mandatory only for government-assisted exports, the use of federal inspection has increasingly become limited to this movement. Increases in user fees in addition to the vertical integration common throughout the industry has led to primary reliance upon internal quality control or independent grading firms. While FGIS is responsible for setting grades, a committee of the Rice Millers' Association, meets regularly to evaluate and propose changes in grade standards.

History of Grades and Changes.

While the grade standards have not changed significantly since their introduction, the focus of adjustment has been primarily in regard to procedures of inspection. Some standards have been changed, for example, seed limits in brown rice were tightened in response to industry needs. More recently with the growing importance

of specialty rice, new standards have been introduced. Waxy (glutinous) rice which has an opaque white appearance would make only sample grade under the milled rice standard. This is because its appearance is not easily distinguishable from chalky kernels. In response, a new grade standard has been introduced for waxy rice. Another recent issue has focused on how to grade aromatic rice. In appearance it grades similarly to most long grain varieties currently grown in the United States. However, mills do not want to get aromatic varieties mixed into their milling lots since the aroma can contaminate the equipment as well as the non-aromatic rice. The current procedure to grade aromatic is to require a special designation, "aromatic", along with the regular milled rice grade requirements. If the rice is inspected without a declaration of "aromatic", and a natural aroma is detected, then it is graded as sample grade.

8.Rice Quality Measurement Technology

Measurement technology for various quality factors in rice has not changed substantially over recent years. Comprehensive reviews of measurement technology and methods are found in Kunze and Wratten, Webb (1985), Juliano (1985), and USDA (1982, 1983). Due to the importance of appearance, many factors tend to have a high degree of subjectiveness. Rice inspectors, both federal and independent, attempt to control for this by submitting for review graded samples to another inspection office. Various attempts at more objective procedures to grading are being attempted. Japanese manufacturers are attempting to introduce equipment with the capability of measuring, simultaneously, a wide set of quality factors. Other research in the United States is attempting to develop measures of grain fissuring before the grain is dried. This would enhance the ability to sort and store rough rice by potential milling yield earlier in the market channel.

9.Issues and problems related to quality.

Price-quality relationships.

A limited amount of research has investigated price and quality relationships in rice. Hedonic price models have been studied by Grant et al, Brorsen et al, Fryar et al, and Denison et al. The models regress rough rice price as a function of the mill price and a set of quality factors. The studies vary by method in regard to type of rough rice price used. Some used the bid price, reflecting demand for quality characteristics, while others studied the relationship to settlement price to examine the effect of quality on equilibrium supply and demand of quality factors. Quality factors typically included wer : head yield, broken, seed, peck, red rice, smut, chalk, green rice, heat damage (stack), test weight. Results of these studies indicate that the most important quality characteristic is the percent of head yield, reflected in price premiums. Important discount factors consistent with grade standards were seeds, peck, and red rice.

The study by Brorsen et al (1984) argued the rough rice grades inadequately represented the value of rough rice, based on a comparison of price models as a function of rough rice grade alone compared with models of specific quality factors and both grade and quality factors. Their results specifically show that in addition to the rough rice grade that head yield, mill yield and test weight variables independently helped explain rough price. Thus there is the possibility that a U.S. No. 1 rough rice lot could mill-out with high broken and result in a milled rice grade lower than U.S. No. 1. However, much of the skill and activity in a rice mill is oriented to make a low rough rice grade result in a higher milled rice, through cleaning, sorting, and mixing.

There has been little examination of the price and quantity relationship. Brorsen et al (1984) have reported that size of the lot shipment influenced acceptance price behavior by producers. Specifically the larger the lot size, the less likely a given bid price would be accepted. Producers with small lot sizes were more likely to accept a given bid price rather than hold out for a higher bid. Cooperatives have traditionally not discriminated in price based on size of delivery.

Optimum vs maximum quality.

Given that quality control is implemented throughout the market channel, beginning with the producer, the hedonic price models for rough and milled rice prices can provide a framework to identify the value of improving a given, measured quality factor. Such information in the hedonic price models however tends to show that the economic returns to quality control vary from year-to-year as a function of supply and demand forces (Brorsen et al, 1988). Optimum costs of controlling red rice, peck damage, breakage and other factors, while reported in these studies, is generally not well known from year-to-year and location-to-location. Red rice which has been one of the most persistent problems in U.S. rice production has been subject to industry-wide quality control campaigns.

Characteristics to be included.

Because most rice is consumed by humans as a whole grain, most economically important characteristics are included in the grade and quality information used for transacting rice. Changes in the comparatively undifferentiated U.S. rice market however are likely to challenge the grading and quality evaluation system as more diverse rice types imported from the rest of the world continue to be demanded by the U.S. consumer (Wailes and Livezey). Factors such aroma, colour, appearance, and cooking properties will influence future rice quality issues.

Quality and Market Competitiveness.

The U.S. rice industry has had the world-wide reputation for offering the highest quality rice. This has resulted from careful breeding programs, improved cultural practices, and modern and sophisticated rice drying and storage and milling sectors. Thus the United States has had a dominant market share in the high quality rice import markets such as Europe and the Middle East. Two factors related to quality have however led to a loss in U.S. market share. The first is that our export competitors, most specifically Thailand, have over the past twenty years made substantial improvements in the quality of its rice exports. Examination of the premium commanded by U.S. long grain No. 2, 4% broken relative to a "comparable" Thailand grade shows a marked reduction. Investment in better handling and milling facilities in Thailand has improved its export quality. The second factor that has contributed to a loss of U.S. market share has been that the high quality import market has grown relatively slowly compared to lower quality markets. This is due to both demographic and income relationships to consumption in the high and low quality markets. The low quality markets tend to be much more competitive from an export supply position, in large part because the market infrastructure and costs can be lower and also because of a large amount of government-to-government sales of low quality rice. In order for the United States to compete in the low quality market it has been necessary to rely on the assistance of government export programs. Thus the cost of a system necessary to deliver high quality rice has resulted to some degree in pricing the United States out of the low quality world markets.

Other issues related to rice quality include whether the economic incentives adequately reflect the qualities demanded for end use. A major problem in rice is relating cooking properties to physical characteristics of uncooked rice. The use of only a few varieties with known cooking characteristics is a primary way by which the industry deals with this issue. The interrelationship of variety and quality is discussed by Webb (1985).

10.Information dissemination.

Price, quantity, and quality information.

Information on rice prices, quantity and quality are available for only a relatively small proportion of the quantity marketed. This is due to the dominance of the producer cooperatives where pricing and quality is an intra-firm activity. Rice auctions in Texas, Louisiana, and Arkansas provide information on bids and acceptance prices but these are not widely published. The ***Rice Market News*** (USDA) typically reports representative Louisiana rough rice sales reporting lot size, grade, variety, head and total milling yield and price. Milled rice price data is typically reported by grade and percent broken. The Rice Market News will typically report United States, Thailand, Argentina, Uruguay, Surinam, Guyana, Italy, Brazil and Australia offering prices.

Promotion and advertising--government.

The U.S. government provides for foreign market development through the Foreign Agriculture Service. Responsible for a wide array of U.S.- produced farm products, rice is promoted especially in traditional importing countries but also in countries with significant trade barriers. Due to the tendency for rice, as a staple crop in most Asian countries, to be politically sensitive, trade protection and substantial import restrictions are common.

Commodity group promotion.

The Rice Council for Market Development located in Houston, Texas has the primary responsibility of promotion and market development for domestic and export markets. Because there does not exist an international rice grading system, the Rice Council initiated a study to evaluate world rice varieties and types. Rice samples used in their studies are collected by USDA and Rice Council representatives throughout the world. These samples are graded by FGIS according to the U.S. Standards for Rice. The Rice Council has received TEA funds to promote U.S. rice in export markets and cooperates with the Foreign Agriculture Service, USDA in foreign market development.

11.Anticipated Industry Changes That Will Influence Quality.

Changes in utilization.

The growth in the domestic consumption of rice both direct and in processed foods has the potential to challenge the quality requirements for the industry in the future. Relatively new and growing uses include, rice flour where quality control of microbial activity is important. The growth in the demand for ready-to-eat and easy-to-cook rice may require new varieties for which the current standards are inadequate.

With the potential for trade liberalization in rice, the United States may have the opportunity to export rice to countries with very rigid quality requirements such as Japan and South Korea. Similarly, specialty rice imports into the United States have increased by 20-fold during the 1980s (Wailes and Livezey). The growth of market niches may give rise to domestically produced substitutes for these imports. As discussed already, aromatic varieties, as they become more popular, may need to have its own standards.

Changes in production.

Production changes regarding quality are most influenced by choice of variety, location and cultural requirements. The development and maintenance of a national germplasm collection at Arkansas and other state experiment stations can provide the basis to continue to improve the quality characteristics. The current geographic specialization of indica-type long and medium grain in the Southern states and japonica-types in California is unlikely to change rapidly, however as world and domestic markets shift to create opportunities for different rice types and varieties, adjustments in quality characteristics by location and varieties will challenge the breeders, producers and processors to adjust and develop qualities of rice that meet the end-use demand.

Marketing structure changes.

The market structure of rice in the United States experienced a rapid growth in the 1970s, followed by a contraction in the early 1980s, and then stable production in the late 1980s. As a result of the contraction, rice firms and cooperatives have been forced to compete more aggressively for the more limited production. The restructuring in the market has left firms and cooperatives that appear to be capable of providing a more diverse rice product, both for domestic markets in direct and processed uses but also for the volatile export markets. With larger and more vertically integrated firms, the tendency will be to internalize the pricing and

quality relationship, making such information more difficult to obtain. Thus the ability of the market channel to provide adequate signals back to the producers and breeders may be more difficult. Despite the sophistication in pricing and quality in the rice industry in general, most rice producers do not have good estimates of the optimum quality and associated production practices and costs that are needed to improve their net incomes.

Measurement of quality.

The continuation of research on measurement of quality and the economic value of quality characteristics is needed. The growth in the specialty rice markets will require new techniques and tests for texture, taste and flavor. New technology poses the opportunity for improved grading, earlier in the market channel so that pricing and technical aspects of processing can be more efficient.

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