Rice

Background for 1990 Farm Legislation

Nathan W. Childs
William Lin

Introduction

Three classes of rice are produced in the United States--short, medium, and long grain. There is relatively little substitution among classes for most users of rice. Hence, a supply-demand imbalance in the market for one class of rice can mask balance in the market for another. Moreover, the market situation within these classes can change quickly and dramatically over time. Planting of high-yielding, semidwarf, long-grain rice varieties became popular throughout the South in the mid-1980's, a development which is aggravating imbalances in the market for one rice type compared with another. However, farmers have begun to diversify their planting of rice varieties by including more disease-resistant ones such as Lemont to combat blast and other diseases in Arkansas or early-maturing varieties such as Gulfmont.

The Structure of the Rice Industry

Production Characteristics

Rice accounts for less than 2 percent of the field crops produced in the United States and about 3-4 percent of food and feed grain production. The bulk of the U.S. rice crop is produced in six States. Rice accounts for 8-11 percent of the value of field crop production in the four primary rice-producing Southern States--Arkansas, Louisiana, Mississippi, and Texas--and between 6-7 percent in California. The six rice-producing States supplied about 19 percent of the world's rice exports in 1985-88.

Structure of Rice Farms

The rice sector tends to be dominated by a relatively few large producers. According to the 1982 Census of Agriculture, 11,445 farms harvested just over 3.2 million acres of rice and all acreage was irrigated (table 1). The rice area of rice farms averaged 282 acres. But only 40 percent of the farms harvested 250 or more acres, and they produced three-quarters of the crop. Farms harvesting fewer than 100 acres of rice comprised more than a quarter of all rice farms, but contributed less than 5 percent of U.S. production.

Table 1--Number of rice farms by size and share of output, 1982

Acres of rice harvested	Number of farms	Percentage of farms	Percentage of output	Average yield per acre
	Number	- - - Percent	- - -	Pounds
1-99	3,142	27.5	4.7	4,536
100-249	3,880	33.9	18.7	4,549
250-499	2,775	24.2	28.7	4,664
500-999	1,244	10.9	26.2	4,862
1,000 or more	404	3.5	21.7	5,196
Total	11,445	100.0	100.0	4,793

Sources: (1) Special tabulation of the 1982 Census of Agriculture data. (2) U.S. Census Bureau, 1982 Census of Agriculture: United States Summary.

Table 2--Number of farms by State and share of output, 1982

State	Number of farms	Share of U.S. output	Average size	Average yield per acre
	Number	Percent	Acres	Pounds
Arkansas	5,436	36.7	232	4,503
Louisiana	2,508	15.2	228	4,100
Mississippi	714	6.5	337	4,206
Missouri	303	1.9	217	4,571
Texas	1,157	15.9	450	4,740
South	10,118	76.2	263	4,438
California	1,322	23.7	429	6,470
Total 1/	11,445	100.0	282	4,710

1/ Includes some farms in minor rice-producing States: Florida, Oklahoma, South Carolina, and Tennessee.

Sources: (1) Special tabulation of the 1982 Census of Agriculture data. (2) U.S. Census Bureau, 1982 Census of Agriculture: United States Summary.

Arkansas has the greatest number of rice farms, but Texas and California have the largest farms (table 2). The five Southern States produced over 76 percent of the U.S. crop in 1982 and over 80 percent in 1988.

The average yield in 1982 was 4,710 pounds of rice per acre. Larger farms in California and Texas reported the highest yields while Louisiana and Mississippi reported 20-25 percent lower yields. Yields on farms of more than 1,000 acres averaged 400 pounds an acre higher than that for all farms.

Profile of Rice Operators

Rice producers tend to be younger than producers of wheat, corn, cotton, or soybeans. About 45 percent of rice farm operators were under the age of 45, compared with only a third for operators of other crop enterprises (table 3). But there are also proportionately fewer full-owners of rice farms than other farms. Less than one-fourth of rice farm operators are full-owners, and roughly half are part-owners. The difference in tenure between producers of rice and other crops may largely be explained by the high cost of entry into rice farming.

Rice is very capital-intensive, as demonstrated by the value of land and buildings, machinery, and equipment. In 1982, the value of land and buildings for all farms averaged $350,000, according to the Census of Agriculture. But for rice, this figure was about $1.4 million per farm. Cotton had the next highest value at $1 million. The Census reported that for all farms, average machinery and equipment value was about $41,900. But, the value of rice farm machinery was four times higher at $163,800. Cotton ranked second again, but the value was only $109,600. These data suggest that entry costs are higher for rice producers than for other crop producers. It also helps explain why there are fewer full owner-operated rice farms than other crop enterprises.

Table 3--Enterprise and operator characteristics of selected grains, 1982

Characteristic	Rice	Wheat	Feed grain	Cotton	Soybeans	All farms
			Percent			
Tenure:						
Full-owner	23	35	42	27	36	59
Part-owner	50	50	43	50	46	29
Tenant	27	15	15	23	18	12
Age:						
Less than 35	21	18	19	19	20	16
35-44	24	18	19	18	20	20
45-54	24	22	23	23	22	23
55-64	22	25	25	25	25	24
65 or older	9	17	14	15	13	17
			1,000 dollars			
Per-farm value of land and buildings	1,396.2	580.8	464.8	1,001.0	335.7	345.9
Per-farm value of machinery and equipment	163.8	78.1	65.2	109.6	46.0	41.9

Sources: (1) Special tabulation of the 1982 Census of Agriculture data. (2) U.S. Census Bureau, 1982 Census of Agriculture: United States Summary.

Full-owners harvested almost 15 percent of the 1982 rice crop. Part-owners harvested 59 percent, while tenants harvested the remaining 27 percent. Part-owners, on average, farm more acres than tenants or full-owners. Output per farm was also greater for part-owners than for tenants or full-owners.

Rice Classes

In the United States, rice is referred to by length of grain: long, medium, or short. Other terms commonly used, especially in the world rice trade, are indica, glutinous, japonica, and aromatic. Indica rice is long grain, while glutinous and japonica refer to the shorter grains. Aromatic rice varieties comprise a negligible, specialty portion of world rice production. Large-scale production of aromatic varieties is generally confined to the few countries with a specific preference for them. The United States produces mostly indica, or long-grain rice. The bulk of the world rice trade is indica rice.

In addition, the different types of rice are considered imperfect substitutes, except by users who purchase rice for further processing. Five of the six rice-producing States--Arkansas, Mississippi, Louisiana, Texas, and Missouri--are in the South and they produce most of the long-grain rice. The sixth State, California, produces the bulk of the U.S. medium- and short-grain rice. Yields vary by type of rice produced, with short grain achieving the highest yields per acre, followed by medium and long grain.

For final use, long-grain rice is generally unsubstitutable for medium or short grain, especially among consumers in Japan and South Korea. Most U.S. consumers also prefer long-grain rice for direct consumption. Long-grain rice commands the premium price in the rice market and is the dominant type found in retail outlets. The shorter grains are lower priced and are predominantly used in processed foods and beer where processors are more price-sensitive.

Hence, supply-demand imbalances for the rice market as a whole are not necessarily good indicators of the market situation for any single class of rice. In the mid-1980's, medium-grain supplies were excessive in relation to demand because of the loss of the South Korean market, while long-grain supplies were in approximate balance. However, in 1986/87 and 1987/88, supplies of both long and medium grains were in line with demand, although medium grain's stock-to-use ratio still exceeded long grain's. However, the U.S. rice program does not distinguish between the various types of rice other than specifying short/medium and long grain loan rates. The loan rate was set at $6.75 per hundredweight (cwt) for 1988/89 long grain on rough basis while the rate for medium and short grain was set at $6.19. However, the acreage reduction and target price provisions of the program are uniformly applied to all rice classes and much of the information available for supply, demand, and price movements focuses on the all-rice market.

Trends in Production

Until the mid-1970's, increases in yield per acre were primarily responsible for most of the steady increase in rice production since the mid-1950's. At the turn of the century, average rice yields per acre were 1,144 pounds. By the 1950's, yields had increased to 2,800 pounds per acre and, in the next decade, yields increased to more than 4,000 pounds (tables 4 and 5). In the mid-1970's, historical acreage restrictions were suspended and harvested acreage rose,

Table 4--U.S. and State average rice yields per harvested acre, selected years

Crop year	United States	Arkansas	Louisiana	Mississippi	Texas	California
			Pounds			
1950	2,371	2,250	1,950	2,700	2,400	3,475
1955	3,061	3,125	2,800	2,850	3,050	3,450
1960	3,423	3,525	2,850	2,950	3,075	4,775
1965	4,255	4,300	3,550	3,700	4,600	4,900
1970	4,617	4,900	3,900	4,400	4,450	5,700
1971	4,558	4,770	3,810	3,900	4,560	5,750
1980	4,413	4,111	3,550	3,840	4,230	6,440
1985	5,414	5,200	4,370	5,350	5,490	7,300
1988 1/	5,511	5,350	4,500	5,300	6,000	7,000

1/ Estimate.
Source: U.S. Dept. Agr., National Agricultural Statistics Service.

Table 5--Average U.S. yields by length of grain, 1975-88

Crop year	Long	Medium	Short	All rice
		Pounds per harvested acre		
1975	4,375	4,590	5,687	4,558
1976	4,576	4,634	5,681	4,663
1977	4,240	4,415	5,746	4,412
1978	4,405	4,464	5,221	4,484
1979	4,159	5,397	6,019	4,599
1980	4,002	5,122	5,702	4,413
1981	4,449	5,347	6,770	4,819
1982	4,293	5,402	6,499	4,710
1983	4,169	5,402	6,932	4,598
1984	4,584	5,845	7,259	4,954
1985	5,168	6,050	7,650	5,414
1986	5,358	6,474	7,757	5,651
1987	5,241	6,339	7,212	5,555
1988	5,338	6,005	7,157	5,511

Source: U.S. Dept. Agr., National Agricultural Statistics Service.

Table 6--Rice acres harvested, yield, and production, selected years

Crop year	Area harvested	Yield per harvested acre	Production
	1,000 acres	Cwt 1/	Million cwt
1970	1,815	46.2	83.8
1975	2,818	45.6	128.4
1980	3,312	44.1	146.2
1985	2,492	54.1	134.9
1986	2,360	56.5	133.4
1987	2,330	55.6	129.6
1988	2,900	55.1	159.5

1/ Cwt = 100 pounds.
Source: U.S. Dept. Agr., National Agricultural Statistics Service.

increasing by 1.5 million acres from 1970 to 1980 (table 6). Record acreage and yields were both reported in 1981, with harvested acres totaling 3.8 million and yields averaging 4,819 pounds per acre. The 1981 yield record was broken again in 1984 and again in 1986 when yields reached 5,651 pounds per acre due in large part to widespread adoption of new semi-dwarf varieties.

U.S. rice yields are not as subject to many of the weather-related swings that affect other U.S. crops because the entire crop is irrigated and fertilized. Hence, rice yields have both higher and more stable yields than many other crops. Yields per acre during 1980-88 averaged 5,069 pounds, with annual variations of about 4 percent (200 pounds) per acre. Government acreage reduction programs during recent years have restricted the acres devoted to rice, but soil and climate data make it clear that U.S. rice acreage could expand well beyond the levels needed to meet domestic and export demand at current yield levels.

Rice culture requires level land suitable for irrigation and poor internal drainage to hold irrigation water. Studies have estimated that there are up to 10 million acres of land suitable for rice, and that a total of 5 million (of which 2.9 million acres were planted in 1988) of these could easily produce rice given current constraints on water supplies and crop rotation. Each rice farm has a USDA-certified rice acreage base, calculated from the farm's historical rice plantings record. This "program" acreage serves as the basis for USDA support payments and acreage control programs. The rice acreage base on record for 1988 totaled 4.2 million acres, 1.8 million less than the 5-million-acre short-term potential and roughly half the 10-million-acre longer term potential.

Acreage Response

The relationship between rice prices and production is important in estimating the effect of policies on supply and demand equilibrium. Rice acreage changes when expected net returns from producing rice change relative to returns from other crops. Changes in acreage also affect yields because, as prices change, less productive land is brought into rice production or withdrawn from it and

adjustments are made in input use. Using 1982 data, Grant, Beach, and Lin (1984) estimated that each 100,000-acre increase or decrease in rice acreage results in an opposite change in rice yields by 30-40 pounds per acre. Yields in Arkansas and Texas were estimated to be more responsive to acreage changes than the other rice-producing States which were found to be almost nonresponsive.

Statistical analysis by Grant, Beach, and Lin based on 1950-82 data also indicates that a change in the price of rice of $1.00 per cwt (14 percent of the 1987 price) adjusted for any offsetting change in cost of production will cause farmers to change harvested area in the same direction by about 44,000 acres (1.8 percent of the 1987 area). Empirical examples of this relationship can be seen in 1976, 1979-81, and 1986. During 1975, farm prices fell 27 percent. Farmers, expecting low returns to persist into 1976, reduced harvested area in that year by 12 percent. When rice prices rose 56 percent between 1978 and 1980, rice acreage rose 32 percent during 1979-81. Rice acreage declined 16 percent between 1984 and 1986 when prices dropped 54 percent. The 1983 payment-in-kind program coupled with a large mandatory acreage reduction program, made this relationship much less reliable between 1982 and 1984.

Sustained high or low prices over several years would likely result in even larger acreage shifts than short-term price changes. Farmers might be able to adjust resources that could not be changed in a single season, perhaps by preparing land for irrigation or acquiring equipment (irrigation, combines, and rice dryers) or finding alternative uses for idled land and machinery. Support prices and acreage reduction programs also make producers less responsive to price changes and nonresponsive to Government program changes.

The size of the acreage shift in response to a price change depends on profit opportunities with other crops. Table 7 indicates that rice farmers planted about 37 percent of their total harvested cropland to rice. In 1982, the principal alternative crops in the Delta region were wheat, soybeans, and cotton. Texas alternatives were feed grains and soybeans. However, wheat-soybean double-cropping was common in the South and competed for rice acreage. In California, a number of alternatives were similarly important: hay, sugar beets, vegetables, wheat, and feed grains. All of these alternative crops in California were irrigated. However, only a fifth of the soybean area was irrigated in Arkansas and less than a tenth was irrigated in the other Southern States. Rice has generally been competitive enough to hold on to its acreage base.

When cash receipts minus cash expenses are compared among crops, the relative economic advantage of producing rice is evident. Table 8 shows cash receipts (including marketing loan gain) less expenses have been higher for rice than other major field crops in all years since 1982. The data in table 8 reflect U.S. averages of yields, expenses, and receipts. Hence, regional returns may vary.

The lack of perfect substitutability among crops and rice's high entry costs likely cause rice acreage response to price increases to be less than for other major field crops and southern rice acreage to be less responsive than California acreage. And, once land is prepared for rice (leveled, levees constructed), sustained low prices may be required to shrink U.S. rice production capacity. Although farm prices for rice declined sharply after the 1980/81 marketing year and remained below that level since, capacity has not dropped and production has been maintained through yield increases.

Table 7--Crop acreage on farms harvesting rice, 1982

State	Rice	Wheat	Feed grains	Soybeans	Cotton crops 1/	Total five	Total harvested cropland
				1,000 harvested acres			
Arkansas	1,907	1,350	227	3,869	250	7,603	6,607
California	888	179	133	---	114	1,314	1,626
Louisiana	912	102	47	1,184	77	2,322	2,256
Mississippi	354	220	6	863	175	1,618	1,475
Texas	821	14	201	306	1	1,343	1,338
Total	4,882	1,865	614	6,222	617	14,200	13,302

--- = Not applicable.
1/ Exceeds harvested cropland for some States because of double-cropping.
Sources: (1) Special tabulation of the 1982 Census of Agriculture data. (2) U.S. Census Bureau, 1982 Census of Agriculture: United States Summary.

Table 8--U.S. average returns above cash expenses per planted acre, selected crops, 1982-87 1/

Crop 2/	1982	1983 3/	1984	1985	1986	1987
			Dollars per planted acre			
Rice	95	331	185	302	266	359
Wheat	36	64	39	51	54	64
Corn	98	146	61	82	73	108
Sorghum	49	68	41	59	55	85
Soybeans	71	98	44	71	65	108
Cotton	98	225	69	115	113	179

1/ Returns are cash receipts and Government payments less cash expenses. See table 16 for income and expense components for rice.
2/ Figures are for U.S. averages of receipts, expenses, and returns for crops.
3/ Value of payment-in-kind payments included.
Source: U.S. Dept. Agr., Agricultural Stabilization and Conservation Service, and Costs of Production for Major Crops, 1975-87, U.S. Dept. Agr., Economic Research Service, May 1989.

Rice plantings, in the absence of acreage control programs, would likely approach the U.S. rice acreage base and possibly increase to the 5-million-acre short-term potential because the target price--the price the Government uses to determine the direct payment per cwt made to farmers and thus what the farmer could expect to

receive on all planted area--is set high enough even after recent reductions to more than cover full production costs. The Food Security Act of 1985 mandated small decreases in the target price beginning in 1987/88.

Production Classes

In 1987, 69 percent of the total U.S. rice crop was long grain, 29 percent was medium, and 2 percent was short. The short-grain crop has declined considerably in importance since 1950 due to the loss of the Japanese market when it made up 20 percent of the total rice crop. Medium grain's share has wavered over the past 30 years, settling at around 25 percent of the total crop. Long-grain rice has increased from less than half of the total crop in 1950 to over 70 percent. The shifts in production by type partly reflect domestic demand, but more importantly reflect the growing importance of U.S. rice in world trade where long grain is the most demanded rice.

About 73 percent of total U.S. rice supplies were long grain in 1988/89 (table 9). Estimated use by type indicates that use of long grain was about one-and-a-half times that of medium and short grain. The tight supply situation for medium and short grain restricted exports of these types in 1988/89. Use by type of rice in the 1980's points to two very different market situations. Long-grain carryover stocks as a percentage of total use have been much lower than those for medium/short grain.

Medium-grain stocks were equal to 97 percent of total use in 1982, while long grain's stocks-to-use ratio was only 30 percent. A sharp decline in foreign demand from South Korea for U.S. medium-grain rice accounted for much of the medium grain inventory buildup in 1982. Although the payment-in-kind program reduced inventories of both grain types in 1983/84, by 1985/86 medium grain's stocks-to-use ratio equaled 77 percent while long grain's was 54 percent. After 1985/86, stocks-to-use ratios for both grain types declined to more historical levels. By the close of 1987/88, stocks of both types of rice were in short supply and stocks-to-use ratios are estimated at below 20 percent for long and medium grain for 1988/89.

Ending stocks in California have risen in proportion to total U.S. carryover during most of the 1980's. At the end of the 1979/80 crop year, California carryover was about 22 percent of the total U.S. carryover. This share rose to 34 percent by 1980/81 to 39 percent in 1981/82, and to 43 percent in 1982/83. The share peaked at almost 50 percent at the close of the 1983/84 crop year. The imbalance is further heightened in view of California's share of U.S. production. Since 1982, California has produced a little over one-fifth of the U.S. crop, yet it currently holds about a third of the total stocks and held over 40 percent at the beginning of the 1987/88 season. In the 1983/84 crop year, when production was reduced by heavy participation in the acreage reduction program, California's beginning stocks were actually 40 percent greater than its production.

California began to shift some acreage planted from medium- to long-grain rice in the early 1980's. Prior to that time, climate and other growing conditions limited California's success in adopting southern long-grain rice varieties. But recent successes with new, higher yielding, early-maturing varieties (for example, the L-202 variety) have enabled California to expand production of this type of rice. Long-grain planted acreage in California grew from 14,000 acres in 1982/83

Table 9--Estimated supply and disappearance, by type of rice, 1987/88 and 1988/89

Item	1987/88 Total	1987/88 Long	1987/88 Medium/ short	1988/89 1/ Total	1988/89 1/ Long	1988/89 1/ Medium/ short
			Million cwt			
Supply:						
Carry-in	51.4	27.4	21.1	31.4	19.1	10.8
Production	127.7	88.9	38.8	159.5	118.7	40.9
Supply 2/	182.1	119.3	59.9	194.6	141.4	51.7
Use:						
Food	55.3	39.5	15.8	56.0	39.1	16.4
Seed	3.0	1.9	1.1	3.2	2.4	.8
Brewers	15.4	4.0	11.4	16.0	4.0	12.0
Domestic use	73.9	44.2	28.3	75.2	46.0	29.2
Exports	72.2	50.5	21.7	74.0	60.0	14.0
Total use 3/	152.6	100.3	50.9	156.2	112.0	44.2
Carryover	31.4	19.1	10.8	38.4	29.4	7.5
			Percent			
Stocks-to-use ratio	20.9	19.1	22.0	20.2	19.0	17.9

1/ Preliminary.
2/ Includes imports.
3/ Includes residual.
Source: U.S. Dept. Agr., National Agricultural Statistics Service.

to 57,000 in 1984/85, but declined to 20,000 acres in 1986 and then leveled off at 50,000 acres in 1988, 12 percent of all U.S. long-grain rice acres.

Rice Breeding and Emerging Technology

Productivity gains in rice have been realized through a combination of improvements in fertilizer, water management, and varieties. Increased water availability improves rice response to nitrogen fertilizer. All rice grown in the United States is irrigated and almost all planted area is fertilized. No other U.S. crop is entirely irrigated. Although fertilizer and irrigation were two important contributing factors to the yield increases achieved in the 1960's, varietal improvement became the dominant factor in the 1980's.

Not until after World War II was plant height given much consideration by plant researchers. Farmers continued to increase the application of high analysis fertilizer to increase yields, but this also increased the likelihood of plant lodging. Lodging is the tendency for plants to fall over or bend. This impedes efficient harvesting, thus reducing yield potential and lowering quality.

Although the Japanese had successfully bred shorter, stiffer rice varieties, U.S. researchers and farmers paid little attention until the early 1950's. When they did pay attention, few varieties were found to be satisfactory. Shorter rice varieties finally found their way into production with the release of Bluebelle in 1965 and Starbonnet in 1967. Shorter height and reduced lodging were also obtained by changing fertilizer applications in the 1960's. With a split fertilizer application, relatively high yields could be obtained with little lodging from plants of moderate height.

Since the late 1970's, the push for short-stemmed varieties has accelerated. These varieties are referred to as semidwarfs and their resistance to lodging as well as their increased yields--up to 25 percent higher than traditional varieties--could dramatically alter U.S. rice production. The use of semi dwarfs has raised production costs per acre, but unit costs of production have declined. The increased per-acre costs reflect additional fertilizer, pesticide, and irrigation costs that have been incurred. But these additional costs have been more than offset by yield increases.

Lemont, a new variety of long-grain rice selected for yield, was developed in Texas in the early 1980's. On test plots, Lemont produced yields 20-35 percent higher than conventional long-grain (such as Labelle) yields in Texas, bringing long-grain yields up to levels achieved by medium-grain rice at that time. U.S. rice yields showed little growth during the 1970's, with declines in long-grain offsetting gains in medium/short-grain yields. Some declines in long-grain yields had offset the medium/short-grain yield increases. With Lemont, national average rice yields began to increase and reached over 5,500 pounds per acre in 1986. Yields have stabilized at that level in more recent years.

Lemont was quickly adopted by Texas producers because of its higher profitability. Acreage planted in Lemont in Texas reached 72 percent of the total in 1987, a phenomenal rate of adoption. Lemont's share declined to 64 percent in 1988 as plantings of Gulfmont, an even newer variety, increased from 10 percent in 1987 to 26 percent in 1988. Lemont's popularity has spread to other Southern States. In 1988, the adoption rate reached 47 percent in Louisiana and 70 percent in Mississippi, up from 39 and 34 percent in 1987 (The Rice Journal, 1988).

Despite the popularity of Lemont in Texas, Louisiana, and Mississippi, it has not become as common in Arkansas for at least two reasons. First, while Lemont promised higher yields than conventional varieties such as Labelle in Texas, it did not increase yields over other varieties such as Newbonnet already in use in Arkansas. Second, cost of producing Lemont was considerably higher than the conventional varieties. As a result, Newbonnet remained the most popular variety, 55 percent of all rice acres, compared with 16 percent for Lemont in 1987. However, due to problems with blast for the 1986 and 1987 crops, producers reduced their planting in Newbonnet to a third of all rice acres in 1988 and increased the planting to Lemont to 28 percent because of Lemont's disease resistance.

Higher yielding varieties could dramatically expand the productive capacity of the rice industry if sufficient demand exists to provide the appropriate price incentive for adoption. Field demonstrations show Lemont has a slight advantage in resisting plant disease over current popular varieties. Lemont also requires more fertilizer, herbicides, and fungicides, as well as more labor and management related to water control and chemical use. Nevertheless, Lemont remains popular because of its increased field yield and milling outturn. Estimated 1988 acreage

devoted to the new high-yielding rice varieties totaled over 1.1 million acres, or about 38 percent of the total acreage. Long-grain rice production reached 119 million cwt in 1988, accounting for over 74 percent of the U.S. rice crop.

Should the adoption rate of high-yielding varieties increase, the policy implications of new technology are enormous. At present demand levels, substantially less acreage will be needed to produce the rice required to meet domestic and export requirements. At current support levels, supplies would be excessive without regular large-scale acreage reduction programs.

From Farm to Consumer

Defining the Product

Nearly all rice is traded in some processed form, but Government programs treat only the farm product. Thus, it is important to distinguish between rough or paddy rice (the farm product) and milled rice (the traded commodity). Physical characteristics, demand, and prices vary considerably between the farm and consumer.

Rough, or paddy, rice contains the hull and bran. Depending on the extent of the milling process, four different products can be produced from rough rice. Rough rice may be parboiled, a process of soaking and pressure-cooking which causes the bran to blend with the inner kernel. From an economic position, millers can gain from purchasing lower quality rice at a price discount, parboiling the rice, and then selling at a higher price than for the regular milled product. In general, only long-grain rice is parboiled. This is because the shorter grains are too gummy for parboiling equipment.

Whether the rice is parboiled or not, the next stage of milling is removing the hull. This produces an intermediate product called brown rice. The final stage of milling removes the bran, leaving white milled rice.

Many of the kernels are broken when rice is milled. These pieces of rice are referred to as brokens and are classified and priced according to their length: second heads (the longest), screenings, and brewers (the shortest). Brokens are generally used in processed foods, primarily cereal, candy, and pet food, or in beer brewing where length of grain and appearance are less important.

Thus, there are four types of final rice products: parboiled, brown, milled, and broken rice. Rice is usually referred to using the length of grain and the milling process: long-grain parboiled, medium brown, or short milled, and so on. However, broken kernels lose their class identity and are often sold simply as brewers or screenings.

Long-grain rice usually receives a premium price relative to medium and short grain and whole kernels are always worth more than brokens. Parboiled rice ordinarily sells at a premium to white rice since it is usually processed for specific domestic and export markets. Discounts and premiums are also applied to reflect the presence or absence of certain quality characteristics (such as smut or peck) in the rough or milled rice.

Prices for milled rice (f.o.b. mills) are roughly two to three times the farm price. This margin partly reflects the actual costs incurred in milling rough rice. But it also reflects the cost of obtaining whole kernels. On average, the whole kernel yield from milling is about 58-63 percent (table 10). The rest will be hulls, bran, and broken pieces. On average, at least 145 pounds of rough rice must be processed to obtain about 100 pounds of milled, edible rice. If the milled rice is to be all whole kernels, then about 165 pounds of rough rice would be required. At an average farm price of $7.50 per cwt for long-grain rice, it would require approximately $13.00 worth of rough long-grain rice to produce the final milled product, excluding costs for drying, milling, bagging, transporting, and storing. These costs vary but generally add $4 to $5 per cwt to the price of milled rice. This adds up to milled prices at wholesale 2.3 to 3 times farm level prices after provisions are made to cover processing and marketing cost.

Trends in Domestic Use

Domestic use of rice is small compared with other grains. Very little rough and no milled rice is used as a livestock or poultry feed. Direct food, processed food, and beer comprise the domestic outlets for rice, which have more than tripled since 1950. Domestic use of rice (rough-equivalent basis) has increased from less than 18 million cwt in market year 1950 to over 55 million in market year 1987/88.

The average American in 1987 consumed 128 pounds of wheat flour, 45 pounds of fresh potatoes, 23 pounds of frozen potatoes, and only 13.4 pounds of rice for food use (table 11). However, this represents more than a doubling in per capita food use of rice since 1978. Including brewery use of rice in per capita calculations increases the total per capita consumption to over 17 pounds in

Table 10--Rough rice milled and milling yields, 1978-87

Crop year	Rough rice milled	Total milled produced	Whole kernels 1/	Whole kernel yield
	- - - - - - -	1,000 cwt - - - - - - -		Percent
1978	117,961	83,427	68,749	58.3
1979	124,340	89,820	78,943	63.5
1980	141,192	103,037	89,602	63.5
1981	131,922	95,074	82,011	62.2
1982	118,726	84,517	73,713	62.1
1983	111,151	79,012	68,237	61.4
1984	107,195	74,580	64,063	59.8
1985	115,542	81,808	69,347	60.0
1986	140,804	100,257	83,760	59.5
1987	130,818	91,481	76,863	58.8

1/ Includes brown rice.
Sources: Rice Miller's Association Monthly Statistical Statements and Rice Market News, U.S. Dept. Agr., Agricultural Marketing Service.

Table 11--Per capita consumption of selected foods, selected years

Year	Rice	Wheat flour	Fresh potatoes	Frozen potatoes	Pasta
			Pounds		
1929	5.8	177.0	159.0	N/A	N/A
1939	5.6	158.0	122.0	N/A	N/A
1949	5.0	136.0	110.0	0.1	N/A
1959	5.0	120.0	107.0	2.0	N/A
1969	8.3	112.5	61.3	9.8	N/A
1978	5.7	115.2	49.2	21.0	10.3
1979	9.4	117.2	47.6	20.7	10.2
1980	9.4	116.8	49.0	17.9	10.0
1981	11.0	115.8	43.8	19.1	10.0
1982	11.8	116.7	44.8	20.0	9.9
1983	9.7	117.4	47.9	19.1	10.5
1984	8.6	118.1	46.8	20.7	11.3
1985	9.1	123.3	44.7	22.0	12.9
1986	11.6	123.6	47.6	22.0	14.4
1987 1/	13.4	128.0	45.1	23.2	17.1

N/A = Not available.
1/ Preliminary.
Source: Food Consumption, Prices, and Expenditures, 1966-87, U.S. Dept. Agr., Economic Research Service, SB-773, 1989.

1986/87 (Childs, 1989). The rice industry has much competition in the domestic food grain market, but its low market share indicates room for expansion.

Direct food use is the largest domestic outlet, averaging 60-64 percent of the total domestic disappearance of rice since the 1950's. Beer and processed foods account for the balance, with beer claiming 20-25 percent and processed foods the remainder. Processed foods include soups, cereals, pet foods, rice cakes, and baby foods. Most of the direct food use is long-grain rice. Processors and brewers usually purchase cheap medium grain, short grain, and brokens. However, all rice used in soups and about one-third of rice used in cereals is long-grain rice. Since the rice will be processed further and starch content is an important factor to many food processors, these groups tend to use the shorter, stickier grains. Processors are also more price-sensitive than direct food users because substitution among classes is feasible in some processed products such as candy and cereal, and the shorter grains tend to be cheaper than the long grains.

The predominate consumption of rice is still table use, often called direct food use. This category excludes all products for which rice is used as an ingredient in the manufacture of a new product. Direct food use of milled rice grew from 8 million cwt in 1955/56 to over 23 million in 1986/87, the last year of available distribution data (table 12). This represents almost a doubling of direct food use of rice since 1975/76.

Table 12--Distribution of milled rice to domestic outlets, selected years

Crop year	Unit	Direct food	Processed food	Beer	Total
1955/56	1,000 cwt	8,118	1,507	3,167	12,791
	Percent 1/	64	12	25	100
1966/67	1,000 cwt	11,087	2,961	3,148	17,196
	Percent 1/	65	17	18	100
1975/76	1,000 cwt	12,958	2,849	4,642	20,450
	Percent 1/	63	14	23	100
1980/81	1,000 cwt	18,790	4,491	7,667	30,948
	Percent 1/	61	15	25	100
1982/83	1,000 cwt	19,173	3,342	9,095	31,610
	Percent 1/	61	11	29	100
1984/85	1,000 cwt	21,664	4,971	7,038	33,673
	Percent 1/	64	15	21	100
1986/87	1,000 cwt	23,429	7,075	7,825	38,329
	Percent 1/	61	19	20	100

1/ May not add to 100 percent due to rounding.
Source: Childs (1989).

Processed food use accounted for 19 percent of total domestic demand for milled rice in 1986/87, up from 15 percent in 1984/85. Processed food use of rice has more than doubled since 1975/76, growing from 2.8 million cwt to 7.1 million cwt in 1986/87. Almost one-fourth of the growth in domestic rice consumption over the past decade has come from increased use by food processors. Between 1984/85 and 1986/87, processed food use accounted for 45 percent of the increase in domestic rice consumption. Cereals account for over half the processed food use of rice; this market grew from 2.1 million cwt in 1978/79 to 4.8 million in 1986/87. With numerous new products and effective marketing, use of rice in processed foods is the fastest growing segment of the domestic rice market (Childs, 1989).

Total domestic rice demand is very stable. Food demand changes very little in response to changes in farm and retail rice prices. Statistical analysis indicates that a 10-percent change in retail rice price is associated with a change of about 1.8 percent, in the opposite direction, in food use (Grant, Beach, Lin, 1984). The demand response to changes in farm prices is also very low. Changes in prices of potatoes, corn, and wheat products have been estimated to have almost no effect on domestic rice demand.

Population and income are more important than price in determining food demand for rice. A 5-percent increase in U.S. per capita income has been estimated to cause per capita food use to rise by about 3 percent (Grant, Beach, Lin, 1984). An increase in the Asian, and to a lesser extent Hispanic, population in the United

States has been a factor in the upward trend of rice consumption. Health benefits associated with increased consumption of rice and effective marketing have also been important factors increasing per capita consumption of rice in the United States.

There are several other reasons for this stable domestic rice market, including a simple marketing process and the lack of much exposure to volatile feed markets. Only rice millfeed--a mill byproduct consisting of bran and hulls--is fed to animals. Moreover, slowly changing tastes and preferences probably have more influence on the demand for rice than price or availability. Rice consumption is very much influenced by ethnic demographics. Per capita rice consumption is highest in the Pacific region (primarily California) and the Middle Atlantic region (primarily New York and New Jersey), both areas of high Hispanic and Asian concentrations.

The World Rice Market

Trends in Production and Consumption

The doubling of world rice production over the past 28 years is largely attributable to growth in yields. Research by the International Rice Research Institute (IRRI) in the Philippines on higher yielding rice varieties has significantly raised yields in major rice-producing countries. Since 1960, harvested area has increased just 21 percent, but yields have risen 75 percent. Global rough rice production in 1988/89 is estimated at a record 479 million metric tons, up 4 percent from 1987/88 (compiled from World Grain Situation and World Agricultural Production, U.S. Dept. Agr., Foreign Agricultural Service.)

Approximately 90 percent of the world's rice is produced in Asia. China alone harvests almost 40 percent of the global crop. But unlike the U.S. crop, only half of the Asian crop is irrigated. Thus, almost 45 percent of the world rice harvest depends on the critical timing of the Asian monsoon. Weather fluctuations in just one major rice consuming or exporting country can significantly shock world trade volume and patterns, and prices.

Rice accounts for about a fifth of the world's grain consumption. Although much of the Western and developed world relies on wheat as their principal food grain, rice remains a primary staple in Asian developing countries. Rice provides about 40 percent of the calories of the average Asian diet (Barker, Herot, Rose, 1985). China alone consumes nearly 40 percent of total world consumption. China, India, and Indonesia account for almost two-thirds of the world's rice consumption. Asia accounts for about 90 percent of world rice consumption.

Four types of rice are consumed in the world: glutinous, aromatic, japonica, and indica. Each is distinguished by the length of grain, starch content, and cooking qualities. As in the U.S. domestic market, countries generally have specific tastes and preferences for particular types of rice. Thus, there is typically not much substitution among the four types of rice.

Indica (long grain) rice is grown in warm or tropical regions, principally in China, South and Southeast Asia, Brazil, and the Southern United States. The bulk of world rice production and trade is in indica. Of the total rice traded in the world, only one-sixth is japonica (Bateman, 1988). This shorter grain, scented

rice is grown in cooler climates, primarily Japan, northern China, Taiwan, northern California, Italy, North and South Korea, and southern Brazil. Japonica rice accounts for 10-11 percent of total production. High-quality varieties of japonica rice are especially popular among consumers in Japan, South Korea, and Taiwan. Only limited substitution in production between grain types can occur without a significant loss in quality. Glutinous and aromatic rices account for 1-2 percent of production and less than 1 percent of trade, reflecting their more specialized nature.

Trends in World Rice Trade

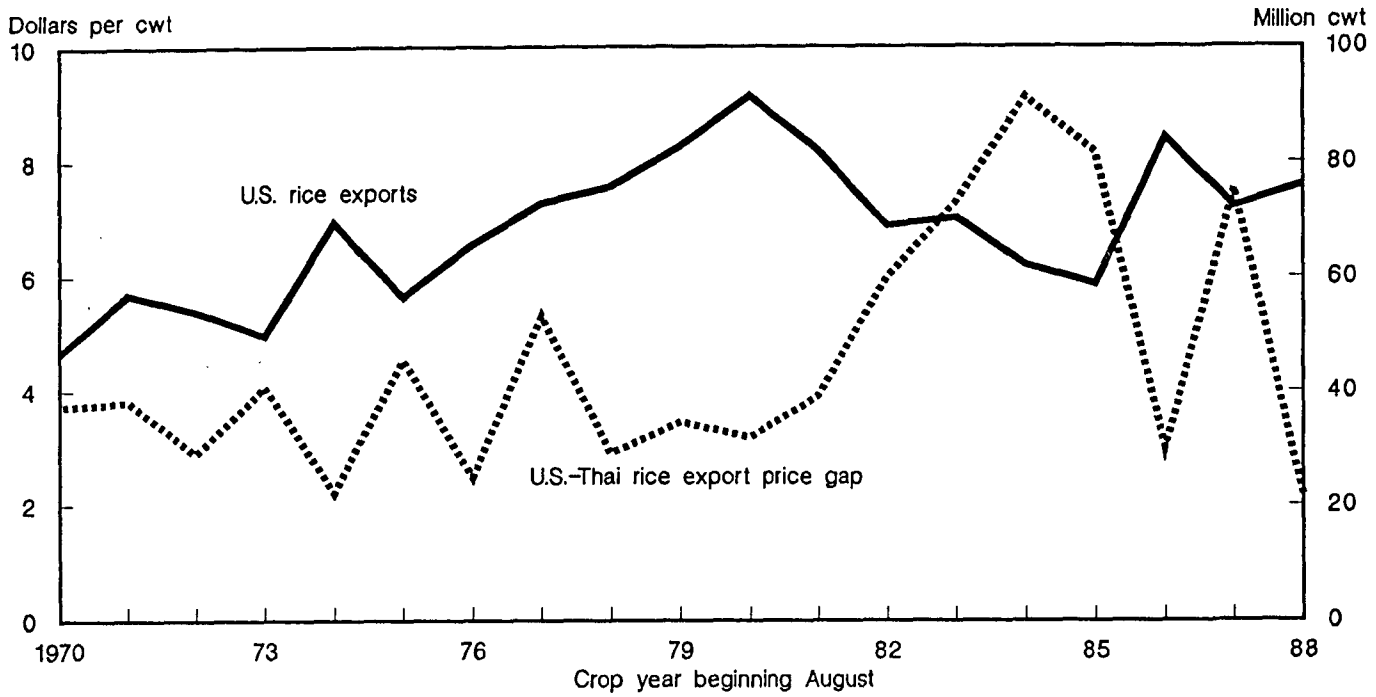
Despite the importance of rice as a food staple for a third of the world's population, the volume traded is small. Between 1983/84 and 1987/88, only about 12.4 million tons--or less than 4 percent of production--was traded. This compares with 18-19 percent for wheat. Hence, most rice is consumed in the country in which it is produced. Moreover, 70-75 percent of world exports are supplied by just five countries: Thailand, the United States, Burma, Pakistan, and China. The United States and Thailand normally account for over half of the rice exported.

Since 1981/82, Thailand has become the world's largest rice exporter, mainly because of uncompetitive U.S. rice prices and the Thais' elimination of export taxes in 1986. U.S. milled rice prices exceeded Thai prices for comparable rice by $3.19 per cwt in 1980/81, but by $9.10 in 1984/85. The marketing loan provision of the Food Security Act of 1985 was largely responsible for narrowing this differential to $3.01 in 1986/87, more in keeping with U.S. quality advantages (fig. 1). Thailand eliminated its export tax and special stockholding requirements for exporters in January 1986. This has allowed domestic rice prices in Thailand to rise, benefiting farmers, but allowing them to remain competitive in world markets.

The world rice market is both volatile and risky because of the weather uncertainty, the concentration of trade among a few key countries, and the relatively small volume of production entering world trade. These characteristics have led many governments to intervene in their domestic rice markets to ensure adequate food supplies at politically acceptable prices. These policies have distorted trade patterns and reduced traded volumes. Over the years, trade patterns have changed frequently and sometimes drastically, as growing conditions and government policies shifted a country from a net importing position to temporary self-sufficiency or, in the extreme, to a net exporter position.

Government involvement in the rice market is usually aimed at ensuring domestic stability. However, the policies enacted typically affect the world market also, as governments attempt to estimate the appropriate level of stocks to maintain, subsidize domestic production, provide some domestic food rations, restrict or ban imports, or subsidize exports. Hence, some countries' producers and consumers (for example, in Indonesia, Japan, and South Korea) are less responsive to changes in the world price. Finally, since many importing and exporting countries are developing nations, foreign exchange problems are more likely to beset them and cause them to substantially reduce imports or shift suppliers. Factors accounting for recent variations in the volume of world rice trade have included exchange rate fluctuations, declining oil revenues, high real interest rates, the prevalence of government-to-government trade, and export subsidies and discounting of announced prices.

Figure 1
U.S.-Thai rice export price gap and U.S. rice exports[1]



1/ U.S. exports are on a rough-equivalent basis.

Thus, the world rice market is inherently unstable with respect to price and sources of demand and supply. With a limited number of exporters, one unexpected or new buyer can have dramatic consequences on trade volume and prices. A sudden downturn in demand of a key importer, or an unexpected seller caught with a large surplus and inadequate storage, will cause equally sharp price swings. And, errors by governments in executing food policies, such as self-sufficiency at any cost, also contribute to price variability. Finally, no country plays the role of residual supplier for rice as the United States does for wheat and corn.

There is no single world market price recognized by traders due to the lack of uniform grades and standards. The price of rice depends on specific quality characteristics of the rice. And, because consumer preferences can exert a powerful influence over demand, prices for different types or qualities move somewhat independently of each other based on the supply-demand factors for that market.

Trading of long-grain rough rice futures on the Chicago Board of Trade began in August 1986 with May (old crop) and September (new crop) contracts. The number of traded contracts remains quite small in comparison with total rice production. The lack of an effective, sizable, and liquid futures market for rice means most trade is conducted without hedging. So traders often incur large profits or losses, reflecting the substantial risk exposure. Traded volumes of each class and type of rice are insufficient to allow the futures market to effectively reduce producers' risks. However, an effective futures market for rice may eventually develop. Rice futures trading grew from 31,114 contracts (2,000 cwt per contract)

in 1987 to 47,627 contracts in 1988 and the acquisition of a July contract in April 1989 allowed trading to expand even more.

The Role of Government in World Rice Trade

Governments play a large and growing role in world rice trade. An exception is Thailand which eliminated its export tax in January 1986. In most lower income Asian developing countries, governments attempt to assure adequate supplies at low retail prices, especially in urban areas. But this type of price policy often conflicts with farm income and employment in countries where rice farmers represent a significant share of the population. These two objectives often imply tight reins on both domestic production and trade by the government. A government monopoly will typically purchase all the domestic rice that meets a given standard at a specified price often below the border price. The government will typically supplement this with imports to assure stable retail prices at or below a preset level. Many lower income Asian developing countries provide producers with subsidies for various inputs such as fertilizer, fuel, and credit to help compensate for farm prices below cost of production.

Higher income developing Asian countries, such as South Korea and Taiwan, and developed countries typically set producer prices above the world level and restrict or ban imports. Consumers bear most of the cost of these programs. Farm income, food security, and foreign exchange policy objectives tend to dominate in these countries. Consumers in South Korea, Taiwan, the European Community, and especially Japan pay prices substantially above world levels to support domestic production. This myriad of programs is reflected in the very limited role the private trade plays in the world rice market.

Of the 12 million tons of rice traded in 1983, government agencies imported over 60 percent, 7.2 million tons. Government agencies exported about 46 percent of all rice exported in 1983, about 5.6 million tons. Except for Thailand, which removed its export tax in January 1986, government involvement is also becoming more pervasive. The world's current leading exporter, Thailand, sells an average of 25 percent of its rice through a government agency, although the amount has been as high as 40 percent in some years, depending on domestic conditions. And even in countries where sales transactions are made through private parties (such as the United States, Italy, and Spain), government subsidies play a big role in export volumes.

Exports under government programs, primarily PL 480 and other aid programs, accounted for 32 percent of total U.S. exports in calendar year 1985, but only 12 percent in 1986. The marketing loan provision of the Food Security Act of 1985 made U.S. commercial exports more competitive, thus reducing use of PL 480. Although currently larger in absolute volume, PL 480 shipments now account for a much smaller share of U.S. rice exports than in the 1950's, 1960's, and early 1970's.

Government involvement varies widely in form but generally adds to international instability by treating the rice market as a residual source of supply, sharply varying the amount of rice imported from year to year. In addition, government purchasing agencies are often slow to anticipate needs and slow to act on them. Although government policies add to world rice market instability, the policies are more a reaction to instability and thinness caused by weather than the primary cause. The importance of the timing of the Asian monsoon to almost half the

world's rice producers is the primary cause of market instability. The thinness of traded volumes compared with other agricultural commodities is sometimes more a reaction to instability than a cause of instability.

Trends in Importing Countries

Developed countries account for a relatively small but stable portion of world imports, about 14 percent in 1980-88. This reflects rice's position as a relatively new or minor item in developed country diets, excluding Japan. Developments in Japan are important enough, however, that policy affects the operation of the world market.

Japan has long maintained a policy of high price supports for producers and has kept consumer prices high to minimize taxpayer costs. But Japan has also allowed the consumer price of rice to increase relative to wheat, encouraging a shift toward more westernized diets. Japanese consumers currently pay three to four times the world price for rice but roughly 100-150 percent of the world price for wheat. The Japan Food Agency uses its import monopoly to support the price of rice. Japanese consumers prefer a high-quality japonica rice currently produced only in a few areas outside Japan, primarily California, Italy, Taiwan, and Australia.

Japanese rice consumption peaked in 1971 at 12.5 million tons and has been falling since in response to more westernized diets. Japanese production increased through the late 1960's and peaked in 1968 at 13.1 million tons.

Production declined during most of the 1970's but stabilized thereafter at 9-11 million tons. By the late 1970's, production exceeded consumption by 1-2 million tons and carryover stocks grew. In response to the large ending stocks, the Japanese Government offered payments to producers to divert acreage to other grain crops, subsidized use of rice in livestock feed, and subsidized exports. These policies stimulated Japanese barley production, displaced imported U.S. corn and sorghum in the Japanese livestock feeding rations, and displaced U.S. rice exports in key Asian markets such as Korea and Indonesia.

Although a net importer of rice from 1960 to 1967, Japan became a net exporter between 1968 and 1982 as a result of its price support and surplus disposal policies. Although rice diversion schemes were able to reduce carryover stocks between 1979 and 1983, surpluses have been growing since 1984. Rice diversion schemes have had only limited and temporary success in Japan because of continued high net returns, no program provision preventing returning diverted acres to rice production, and rice farming's special "part-time" appeal to many operators. The Japanese government has recently indicated a willingness to reduce the price support-import price differential and increase imports but in combination with measures that will increase productivity.

Imports of rice by the centrally planned countries, particularly China, increased as a share of world imports from the early 1960's through the 1970's. The centrally planned countries' share of world imports peaked at over 20 percent in the late 1960's and 1970 because of large imports by North Vietnam and the Soviet Union. However, the centrally planned countries accounted for an average of only 11 percent in the 1980's. The Soviet Union substantially increased its purchases of rice in the late 1970's and early 1980's, exceeding 1.2 million tons in 1980. Much of the Soviet's purchases of rice are shipped to Vietnam. Both consumption