Chapter

3

Rice Cultivars and Seed Production

Charles E. Wilson, Jr., Karen Moldenhauer, Rick Cartwright, and Jarrod Hardke

Public rice cultivars developed by land-grant institutions such as the University of Arkansas are currently planted on most U.S. rice acreage. This is, in part, due to the relatively small U.S. rice acreage. In contrast, private companies provide the majority of cultivars (varieties) for row crop commodities such as corn, soybeans and wheat. Recent technological advances in production of transgenic crop cultivars, hybrid rice development and specialty markets have stimulated private industry interest in rice breeding and cultivar development (Figure 3-1). Privately-owned cultivars represented approximately 71 percent of the Arkansas rice acreage in 2012, of which 50 percent were hybrids and 61 percent were Clearfield cultivars. Land-grant universities are cooperating with private industry to develop improved cultivars that will assist rice farmers in controlling pests and will add other valuable traits to rice that will help producers and consumers alike. University rice breeding programs remain committed to producing conventional public rice cultivars.

Since 1936, 41 varieties have been developed and released in Arkansas. Between 1936 and 1982, the rice breeding program in Arkansas was carried out by United States Department of Agriculture scientists working at the Rice Research and Extension Center near Stuttgart. The rice check-off program began providing partial financial support for the University of Arkansas rice breeding and development program in 1980, and a rice breeder was hired the same year. Since 1982, 25 varieties have been developed and released by the University of Arkansas rice breeding program. From 1984 to 2009, University of Arkansas-developed varieties were grown on 42 to 86 percent of

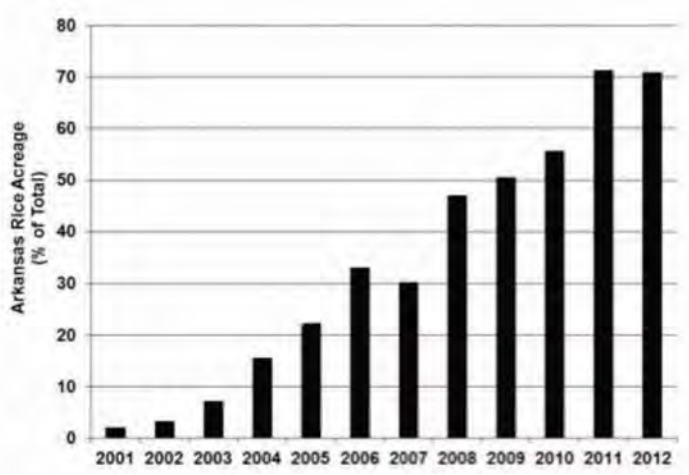

Figure 3-1. Adoption of cultivars marketed by private companies since 2001.

Table 3-1. Description of four seed rice certification classes.

Seed Class	Tag Color	Description
Breeder	White	Breeder seed is not available to the public and is reserved for licensed plant breeders for the production of foundation, registered or certified seed.
Foundation	White	Progeny of breeder seed. Is also reserved for licensed plant breeders. Must be produced under the direct supervision of licensed plant breeder to maintain genetic purity/identity of the variety.
Registered	Purple	Progeny of foundation seed.
Certified	Blue	Progeny of either registered or foundation seed.

the Arkansas rice acreage, depending on the year. Since 2009 the privately owned cultivars have increased dramatically.

Rice Seed Production

Certified rice seed can be divided into four distinct categories (Table 3-1). When a new cultivar is released, the cultivar and its complete description are registered with the National Committee on Registration of Crop Varieties. Foundation seed must be maintained according to these registered standards. The general field inspection and cleaned seed standards for rice seed certification by class are provided in Tables 3-2 and 3-3.

Table 3-2. Arkansas State Plant Board field inspection standards for seed rice certification†.

	Seed Class		
Factor	Foundation	Registered	Certified
Other cultivars	None	1 / 5 sq rods	1 sq rod
Noxious weeds	None	None	None
Red rice	None	None	1 plant/acre

†Standards as of 2006. Standards taken from the certified seed directory.

Table 3-3. Arkansas State Plant Board cleaned seed inspection standards for seed rice certification†.

	Seed Class		
Factor	Foundation	Registered	Certified
Pure seed (minimum)	98.0%	98.0%	98.0%
Other varieties‡	None	None	2 / lb
GMO varieties††	<0.01%	<0.01%	<0.01%
Other crop seed (maximum)	None	None	2 / lb
All noxious weeds	None	None	None‡‡
Total weed seed (maximum)	0.03%	0.03%	0.08%
Inert (maximum)	2.0%	2.0%	2.0%
Germination (minimum)	80.0%	80.0%	80.0%
Moisture (maximum)	14.0%	14.0%	14.0%

† Standards as of 1999. Standards taken from the certified seed directory.
‡ Other varieties shall not include variations which are characteristics of the varieties.
†† Includes genetically modified varieties, such as Liberty Link rice. Based on regulations passed December 28, 2006.
‡‡ Four pounds of cleaned rice seed is hulled from each lot to determine the noxious weed content, including red rice.

Land where seed rice is grown must not have been planted to a different rice cultivar or uncertified seed of the same cultivar for two previous years. The State Plant Board (#1 Natural Resources Drive, Little Rock, Ark. 72205) is the agency responsible for regulating the seed industry in Arkansas. The State Plant Board sets and enforces seed certification standards and maintains a seed testing laboratory. Descriptions of each cultivar for which certified rice seed is produced in Arkansas are available. Additional information concerning certified seed production standards/regulations and laboratory services can be obtained from the Arkansas State Plant Board in Little Rock, Ark. (501-225-1598). Use of certified seed rice is highly recommended to ensure high quality seed and to aid growers in controlling the spread of noxious weeds.

The certification classes described pertain to "pure-line" varieties. Hybrid rice is developed quite differently. The seed for hybrid rice are the first generation of seed produced after a cross (F1 population). The seed produced from the cross has extremely high vigor, resulting in high yield potential. However, if the second generation of seed is planted, the plants segregate and a wide variety of plant types will result and only a small percentage of those plants will resemble the F1.

Management Key

Plant certified seed to reduce the spread of noxious weeds such as red rice, hemp sesbania, and northern jointvetch. Also, a guaranteed emergence percentage increases the chances of good stand establishment.

Because of the nature of hybrid seed, seed must be obtained by repeating the cross each year. Seed should not be saved from hybrid seed fields. Even in fields where rice follows hybrid rice, volunteer rice from the previous crop will often have a wide range of variability that results from segregation in the F2 generation. Although the production of hybrid seed does not follow the same pattern as conventional varieties (i.e., breeder, foundation, registered, etc.), the seed must conform to standards for germination, noxious weeds, red rice, etc. Hybrid rice must also state the percentage of the seed that is true hybrid (i.e. > 70%), which also reflects the maximum amount of the seed that "self-pollinated." This self-pollinated seed should resemble the female parent. Since only female rows are

typically harvested, these self-pollinated plants will resemble the female parent.

Genetically Modified Rice

Genetically modified rice is rice that has been "engineered" to exhibit a specific trait, such as herbicide resistance, added nutrients, disease resistance or insect resistance, by inserting a gene from another organism that will cause the plant to express that trait. This is the same process that was used to produce glyphosate resistance in soybeans, corn, cotton and other crops. Other transgenic traits include Bt corn and cotton, and numerous other traits in other crops.

While most of the row crops currently produced in Arkansas are genetically modified, rice and wheat are not, due to significant market resistance. These products have been approved by the USFDA and pose no health risks from the consumption of these products. However, consumer resistance in rice and wheat has stifled the adoption of this technology, and to this date no GMO rice is commercially grown in Arkansas.

Clearfield rice represents a successful technological development without utilizing genetic engineering to accomplish herbicide resistance. Clearfield rice does not have genes inserted from other organisms and subsequently is not genetically modified. Clearfield technology has been a successful advancement for rice farmers across the Mid-South and has had rapid adoption by producers.

Rice Cultivar Performance and Agronomic Characteristics

Many agronomic factors must be considered when choosing rice cultivars for production (Table 3-4). The general strengths and weaknesses of available cultivars are summarized in Table 3-5. Environmental factors affect grain and milling yield each year. Because the environment is different each year, several years of testing and observation are needed to make valid comparisons among cultivars. Therefore, data from the 2010-2012 Arkansas Rice Performance Trials have been summarized to better evaluate cultivar performance.

Several recently released cultivars have data for only one or two years. For more up-to-date information on cultivar performance and characteristics on different soil textures, consult the most recent edition of the Cooperative Extension Service's publication *Arkansas Rice Performance Trials*, available at your local county Extension office or it may be downloaded at http://www.arkansasvarietytesting.com.

Management Key

Select cultivars for specific fields and the conditions and history associated with that field.

Cultivar yield performance data in Table 3-4 should be used with disease ratings included in Chapter 11, Management of Rice Diseases, and nitrogen recommendations in Chapter 9, Soil Fertility, to assist in making cultivar selection. A general description of the major varieties and hybrids is provided in Table 3-5. A brief description of special-purpose varieties is presented in Table 3-6. Cultivars differ in grain and milling yield potential, maturity, straw strength, disease resistance and cooking and processing characteristics. Therefore, consider all of the following factors when selecting a cultivar.

- Field history of disease and cultivar ratings: blast, sheath blight, smuts, stem rot.
- Field history of weed species and herbicide program.
- Soil texture and seedling vigor.
- Seeding method.
- Susceptibility to lodging.
- Maturity group and seeding dates.
- Grain and milling yield performance.
- Irrigation capacity.
- Geographic location.

Additional factors that must be considered before final selection are:

- Market demand for different grain types or cultivars.
- Availability of good quality, red rice-free seed.
- Planting dates and estimated harvest schedules.

Table 3-4. Results of the Arkansas Rice Performance Trials averaged across the three-year period of 2010-2012.

Maturity Group and Cultivar	Grain Length†	Straw Strength‡	50% Heading††	Plant Height	Test Weight	Milled Kernel Weight‡‡	Chalky Kernels‡‡	Milling Yield				Grain Yield by Year			
								2010	2011	2012	Mean	2010	2011	2012	Mean
		rating	days	inches	lb/bu	mg	%	% Head Rice - % Total Rice				Bushels / Acre			
Very Early Season															
CL111	L	3.7	82	41	42.4	21.14	0.843	58-65	57-72	62-71	59-69	163	158	179	**167**
CL151	L	4.0	83	40	41.9	19.71	1.187	54-64	60-66	63-71	59-67	178	142	204	**175**
CL261	M	3.0	82	40	42.3	20.01	1.126	55-66	56-68	59-69	57-68	164	163	180	**169**
Rex	L	1.3	84	42	42.6	21.80	0.968	55-64	63-71	63-69	60-68	164	175	196	**178**
RiceTec CL XL729	L	4.0	83	45	42.4	20.54	2.195	54-64	65-71	59-70	60-69	211	180	203	**198**
RiceTec CL XL745	L	4.7	79	45	42.0	21.27	1.132	55-66	63-72	57-72	58-70	203	184	205	**198**
RiceTec XL723	L	3.3	82	46	42.6	21.27	3.019	54-66	53-67	61-71	56-68	224	191	222	**212**
AREXP1	L	4.0	82	44	42.7	21.97	0.913	55-65	63-72	61-72	60-70	187	190	210	**196**
Bengal	M	3.0	85	38	41.1	22.58	0.781	51-66	61-73	61-70	58-70	171	153	216	**180**
Cheniere	L	1.7	86	38	42.5	18.60	0.907	51-65	66-71	65-73	61-69	158	177	192	**176**
CL142AR	L	3.7	85	45	42.8	22.01	1.103	54-66	67-73	63-71	57-70	165	174	193	**178**
CL181AR	L	1.0	86	36	42.8	19.99	0.750	54-65	65-71	61-70	60-69	145	181	195	**174**
Francis	L	2.7	85	42	42.6	19.08	1.025	55-65	68-72	63-72	62-70	179	195	213	**196**
JazzMan	L	2.3	86	41	42.0	21.02	0.373	54-64	68-72	60-70	61-69	148	170	153	**157**
Jupiter	M	2.0	85	37	42.5	20.23	1.062	59-66	68-72	61-68	63-69	156	196	204	**185**
Wells	L	2.0	86	43	42.7	21.68	0.801	54-66	61-72	54-71	56-70	163	182	205	**183**
RoyJ	L	1.0	90	43	41.9	20.61	0.733	54-64	64-71	64-72	61-69	176	196	234	**202**
Taggart	L	1.3	88	46	42.3	23.10	0.733	53-67	59-67	56-71	56-68	175	215	199	**196**
Templeton	L	2.3	88	44	42.3	18.87	0.526	51-64	64-72	61-71	59-69	161	166	186	**171**
Mean		**2.7**	**85**	**42**	**42.3**	**20.81**	**1.062**	**54-65**	**63-71**	**60-71**	**59-69**	**173**	**175**	**199**	**184**

† Grain Length: L=long grain; M=medium grain.

‡ Relative straw strength based on field tests using the scale: 0=very strong straw, 5=very weak straw; based on percent lodging.

†† Number of days from emergence until 50% of the panicles are visibly emerging from the boot.

‡‡ Data from 2010 and 2011 only.

Table 3-5. Brief description of conventional, Clearfield and hybrid rice cultivars.

Variety/Hybrid	Year Released and State	Highlights
Arize QM1003	2009 – Bayer Cropscience	A mid-season, long-grain hybrid with good grain and milling yield.
Banks	2004 – Arkansas	A short-season, long-grain LaGrue-type rice with blast resistance.
Bengal	1992 – Louisiana	A short-season, semi-dwarf, medium-grain with good yield potential and milling quality. It has a preferred large grain size.
Bowman	2008 – Mississippi	A short-season, long-grain rice with good grain and milling yield and high amylose content.
Caffey	2011 – Louisiana	A semi-dwarf, short-season, medium-grain rice variety with excellent yield potential and milling quality. Caffey is characterized by a very bold uniform milled grain. It is moderately susceptible to sheath blight, blast and sheath blight.
Catahoula	2008 – Louisiana	A short-season, semi-dwarf long-grain with good grain and milling yield and resistance to rice blast.
Cheniere	2003 – Louisiana	A short-season, semi-dwarf long-grain with good yield potential, less oil in bran than Cocodrie, and improved straighthead tolerance.
CL111	2009 – BASF, Horizon Ag	A very short-season, semi-dwarf long-grain similar to Trenasse with high tolerance to Newpath herbicide. It is very susceptible to sheath blight and susceptible to blast and straighthead.
CL131	2004 – BASF, Horizon Ag	A very short-season, semi-dwarf long-grain similar to Cocodrie with high tolerance to Newpath herbicide. It is very susceptible to sheath blight, moderately susceptible to blast and very susceptible to straighthead.
CL142 AR	2009 – BASF, Horizon Ag	A short-season long-grain Clearfield variety similar to Wells with excellent yield potential and good milling potential. It is susceptible to blast and moderately susceptible to sheath blight and straighthead.
CL151	2008 – BASF, Horizon Ag	A short-season, semi-dwarf long-grain Clearfield rice similar to Cypress with high tolerance to Newpath herbicide. It is very susceptible to sheath blight, susceptible to blast and susceptible to straighthead.
CL152	2011 – BASF, Horizon Ag	A short-season, semi-dwarf long-grain Clearfield rice similar to CL151 with high tolerance to Newpath herbicide. It has excellent yield potential and milling quality. CL152 is susceptible to sheath blight and moderately susceptible to both blast and straighthead.
CL161	2002 – BASF, Horizon Ag	A short-season, semi-dwarf long-grain Clearfield rice similar to Cypress with high tolerance to Newpath herbicide. It is very susceptible to sheath blight, moderately susceptible to blast and susceptible to straighthead.
CL162 (MS)	2011 – BASF, Horizon Ag	A short-season long-grain Clearfield rice variety with commercially acceptable tolerance to Newpath and Beyond herbicides. It is a high-yielding variety with very good milling quality and excellent straw strength. CL162 is susceptible to blast, sheath blight and straighthead.
CL171 AR	2005 – BASF, Horizon Ag	A short-season, semi-dwarf long-grain Clearfield rice similar to Wells with high tolerance to Newpath herbicide. It is moderately susceptible to sheath blight, susceptible to blast and moderately susceptible to straighthead.
CL181 AR	2009 – BASF, Horizon Ag	A short-season, semi-dwarf long-grain Clearfield rice with good yield potential and milling yield potential. It is very susceptible to sheath blight and susceptible to blast.
CL261	2009 – BASF, Horizon Ag	A short-season, semi dwarf medium-grain Clearfield rice with good yield potential and milling quality. It is moderately susceptible to sheath blight and blast and susceptible to straighthead and bacterial panicle blight.
CL XL729	2006 – Rice Tec, Inc.	A short-season long-grain hybrid with excellent yield potential, good milling yield potential, and good disease resistance.
CL XL730	2005 – Rice Tec, Inc.	A short-season long-grain hybrid with excellent yield potential, good milling yield potential, and good disease resistance.

(Continued on page 26)

Table 3-5. Brief description of conventional, Clearfield and hybrid rice cultivars. (cont.)

Variety/Hybrid	Year Released & State	Highlights
CL XL745	2007 – Rice Tec, Inc.	A short-season long-grain hybrid with excellent yield potential, good milling yield potential and good disease resistance.
CL XL746	2008 – Rice Tec, Inc.	A short-season long-grain hybrid with excellent yield potential, good milling yield potential and good disease resistance.
Cocodrie	1997 – Louisiana	A short-season, semi-dwarf long-grain with good yield potential and milling quality.
Cybonnet	2004 – Arkansas	A short-season, semi-dwarf long-grain with good yield potential and excellent milling quality similar to Cypress. It has blast resistance similar to Katy.
Cypress	1992 – Louisiana	A mid-season, semi-dwarf long-grain with good yield potential and excellent milling quality and excellent seedling vigor.
Drew	1996 – Arkansas	A mid-season long-grain with average yield potential and milling quality. It is blast resistant, straighthead tolerant, and has a larger kernel size than Kaybonnet.
Francis	2002 – Arkansas	A very short-season long-grain with excellent yield potential, susceptible to rice blast.
Jefferson	1999 – Texas	A very short-season, semi-dwarf long-grain variety with good yield potential. It is moderately susceptible to sheath blight and susceptible to blast.
Jupiter	2005 – Louisiana	A mid-season medium-grain with excellent yield potential, good milling quality, and resistance to bacterial panicle blight. It has a smaller seed size than Bengal.
Kaybonnet	1994 – Arkansas	A short-season long-grain with good yield potential and good milling quality. It is resistant to rice blast and has a small grain size.
LaGrue	1993 – Arkansas	A short-season long-grain with excellent yield potential and variable milling quality. It is susceptible to rice blast and kernel smut.
Lemont	1983 – Texas	A mid-season, semi-dwarf long-grain with good yield potential and milling quality. It has poor seedling vigor.
Neptune	2008 – Louisiana	A mid-season medium-grain with excellent yield potential, good milling quality, and partial resistance to bacterial panicle blight. It has a seed size that is similar to Bengal.
Newbonnet	1983 – Arkansas	A mid-season long-grain with good yield potential and good milling quality. It is susceptible to rice blast.
Presidio	2005 – Texas	A short-season, semi-dwarf long-grain with good yield potential and good milling quality.
Rex	2010 – Mississippi	A short-season, semi-dwarf long-grain with good yield potential, excellent straw strength and very good milling quality. Rex is susceptible to blast and sheath blight and moderately susceptible to straighthead.
Roy J	2010 – Arkansas	A mid-season, standard-statured long-grain with excellent yield potential, very strong straw strength, and good milling yield. Susceptible to blast and moderately susceptible to sheath blight.
Spring	2005 – Arkansas	A very short-season long-grain with good yield potential and rice blast resistance. It is one of the earliest maturing long-grain rice lines.
Saber	2001 – Texas	A mid-season, semi-dwarf long-grain with resistance to some rice blast races. It has yield and quality characteristics similar to Cypress.
Taggart	2009 – Arkansas	A mid-season, standard-statured long-grain with good yield potential and large kernel size.
Templeton	2009 – Arkansas	A mid-season, standard-statured long-grain with good yield potential and resistance to all of the know races of rice blast disease in Arkansas.
Trenasse	2005 – Louisiana	A very short-season long-grain with good yield potential. Very susceptible to sheath blight and straighthead; susceptible to blast.

(Continued on page 27)

Table 3-5. Brief description of conventional, Clearfield, and hybrid rice cultivars. (cont.)

Variety/Hybrid	Year Released & State	Highlights
Wells	1999 – Arkansas	A short-season long-grain with excellent yield potential, average milling quality, kernel size similar to Lemont and susceptible to rice blast.
XL723	2004 – RiceTec	A very short-season long-grain hybrid with good yield potential, average milling quality and resistance to blast and moderately resistant to sheath blight.
XL753	2011 – RiceTec	A short-season long-grain hybrid with excellent yield potential, good milling yield potential, and good disease resistance.

Table 3-6. Brief description of specialty cultivars.

Variety/Hybrid	Year Released ans State	Highlights
AB647	1996 – Anheuser Busch	Selection from Congui, a Chinese indica rice, that is a long-season medium-grain with high yield potential and atypical cooking qualities. Used for brewing.
Baldo	Italy	A very short-season, large-kerneled medium-grain used for risotto.
Bolivar	2001 – Texas	A very short-season long-grain with the same parboiling and canning properties as Dixiebelle.
Della	1971 – Louisiana	Aromatic, mid-season long-grain with low yield potential and average milling quality that is susceptible to lodging.
Dellmati	1999 – Louisiana	A semi-dwarf, aromatic long-grain which elongates when cooked.
Dellmont	1992 – Texas	Semi-dwarf, aromatic long-grain with good yield potential and milling quality.
Dellrose	1995 – Louisiana	A semi-dwarf, aromatic long-grain with high yield potential and good milling quality. It has grain size similar to Della.
Dixiebelle	1996 – Texas	Short-season long-grain with 'Newrex' quality; specialty rice used for canning and steam tables.
Hidalgo	2005 – Texas	A semi-dwarf long-grain with good yield potential and milling quality. Cooking type similar to Toro. It is susceptible to blast and moderately susceptible to sheath blight.
Jasmine-85	1990 – Texas	Aromatic long-grain with good yield potential and poor milling quality.
Jazzman	2008 – Louisiana	Aromatic long-grain with good yield potential and milling quality.
Jazzman-2	2010 – Louisiana	A semi-dwarf, fragrant long-grain with good yield potential, good milling quality and very strong aroma. Jazzman-2 is susceptible to rice sheath blight, bacterial panicle blight and straighthead but moderately resistant to blast.
JES	2009 – Arkansas/Florida	Aromatic long-grain with good yield potential and milling quality.
Koshihikari	Japan	A premium-quality short-grain with low yield potential and good milling quality. It is the standard for Japanese quality.
Neches	2005 – Texas	A long-grain waxy rice with good yield potential (similar to Lemont) used for flour and starch in processing industry. Moderately resistant to blast and very susceptible to sheath blight.
Pirogue	2002 – Louisiana	A short-season short-grain with good yield potential and good milling quality.
Sabine	2006 – Texas	Short-season long-grain with 'Dixiebelle' quality. Similar agronomic traits as Dixiebelle, with higher yield potential. Specialty rice used for canning and steam tables.
Sierra	2005 – Texas	An aromatic long-grain with the fragrance and cooking qualities of a basmati-style rice.
Toro 2	1984 – Louisiana	Special-purpose, low amylase and low gelatinization temperature, long-grain rice. Toro 2 cooks moist and sticky like a medium-grain rice.

Seeding a large percentage of acreage in a single cultivar is not recommended. Planting several cultivars minimizes the risk of damage from adverse weather and disease epidemics and allows for a timely harvest which increases the chances of obtaining good quality seed with maximum milling yields. Since environmental conditions can greatly affect yield, it is also recommended to spread seeding dates so that cultivars do not reach critical growth stages at the same time. Consult the DD50 computer program to plan harvest schedules based on emergence dates of cultivars.

Management Key

Plant multiple cultivars across the farm acreage to reduce risk from diseases and adverse weather.

Other Cultivars

Cultivar characteristics and yield performance data presented in this section are for the rice cultivars grown on the majority of rice acreage in Arkansas. Information on other "specialty cultivars" or "older cultivars not commonly produced" may be available from the University of Arkansas Cooperative Extension Service and Agricultural Experiment Station upon request.

Kernel Classification and Cooking Qualities

Rice cultivars are classified as either long-, medium-, or short-grain by their rough, brown and milled kernel dimension ratios (Table 3-7). Since kernel type, dimension and cooking quality are of primary importance to millers and processors, these characteristics are considered in cultivar development.

The cooking qualities of rice depend on the chemical composition of the rice grain. The rice kernel is made of starch. Starch consists mainly of highly branched chains called amylopectin and some linear chains with fewer branches called amylose. The temperature at which the rice starch forms a gel when cooking is the gelatinization temperature. The amylose content and gelatinization temperature influence the cooking quality of the rice grain.

Table 3-7. Grain type classification based on kernel dimensions.

Grain Type	Grain Form	Kernel Length/Width Ratio
Long	Rough	≥ 3.4 to 1
Long	Brown	≥ 3.1 to 1
Long	Milled	≥ 3.0 to 1
Medium	Rough	≥ 2.3 to 1
Medium	Brown	≥ 2.1 to 1
Medium	Milled	≥ 2.0 to 1
Short	Rough	≥ 2.2 to 1
Short	Brown	≥ 2.0 to 1
Short	Milled	≥ 1.9 to 1

Most long-grain cultivars grown in the southern U.S. have cooking qualities described as typical. Cultivars with "typical southern U.S. cooking quality" produce rice that is dry and fluffy (nonsticky) when cooked. These cultivars are parboiled, quick-cooked or used in processed rice products. Aromatic long-grain cultivars, such as Della, Dellmont, and Jasmine 85, tend to have similar textures when cooked but also have a distinct taste and aroma when cooking. Cultivars such as Toro-2 are sticky rices due to low amylose contents and should not be commingled with other long-grain cultivars because of their nontypical physiochemical characteristics.

Medium-grain cultivars produced in the southern U.S. produce moist, sticky rice when cooked, in contrast to the dry, fluffy, long-grain types and are preferred for dry breakfast cereals, soups, baby foods and brewing purposes. Toro-2 is a low amylose long-grain variety that cooks sticky like medium-grain cultivars.

Traditional southern U.S. long-grain rices, such as Cypress, Drew, Wells and Roy J, have intermediate amylose contents of 20 to 24 percent and intermediate gelatinization temperatures of 70° to 75°C (158 to 167 °F). In comparison, extra high amylose rices, such as Rexmont and Dixiebelle, have an amylose content greater than 24 percent and intermediate gelatinization temperatures. The medium- and short-grain rices, such as Bengal, Nortai, Pirogue and Koshihikari, have low amylose content (10 to 20 percent) and gelatinization temperatures less than 70°C (158°F).

Traditional southern U.S. long-, medium- and short-grain cultivars are translucent or clear in appearance. Waxy or glutinous rices have an amylose content of

only 1 to 2 percent, a low gelatinization temperature (< 70°C; <158°F) and an opaque appearance. They are often used in sweets, frozen products and as thickening agents. In general, if the amylose content is intermediate to high, the rice cooks drier and less sticky. Low amylose rice tends to cook stickier, and waxy rices are very sticky. The starch-iodine-blue test is used to estimate amylose content during early stages of cultivar development.

Rice kernel measurements for the long-, medium- and short-grain rice cultivars are illustrated in Table 3-8 and Table 3-9. Kernel measurements were taken from official cultivar descriptions. Actual kernel measurements for length, width, weight, etc., often vary when measured in different years due to differences in environmental conditions. This information should be used as a relative guide for comparison of kernel characteristics.

Table 3-8. Rough, brown and milled rice kernel dimensions and weights for selected long-grain rice cultivars.

	Kernel Weight			Kernel Length			Kernel Width			Kernel Thickness			Length Width Ratio		
	Rough	Brown	Milled	Rough	Brown	Milled	Rough	Brown	Milled	Rough	Brown	Milled	Rough	Brown	Milled
Cultivar	mg			mm			mm			mm					
Ahrent	22.3	18.5	17.5	8.86	7.04	6.67	2.65	2.29	2.36	1.84	1.67	1.64	3.34	3.08	2.82
Banks	22.9	18.4	17.9	9.10	6.88	6.47	2.44	2.15	2.07	1.91	1.90	1.63	3.72	3.20	3.13
Bowman	-	-	-	9.08	7.32	6.98	2.53	2.30	2.27	1.94	1.71	1.65	3.59	3.18	3.08
Catahoula	26.52	21.31	19.52	9.24	7.09	6.73	2.55	2.26	2.17	1.95	1.74	1.72	3.62	3.14	3.10
Cheniere	21.8	17.5	16.6	8.63	6.82	6.57	2.45	2.15	2.09	1.93	1.67	1.65	3.52	3.17	3.14
CL 111	-	-	-	9.34	7.31	6.45	2.61	2.27	2.15	-	-	-	3.58	3.22	3.00
CL142AR	25.9	23.3	20.4	9.08	7.28	6.80	2.64	2.38	2.24	2.01	1.76	1.70	3.44	3.06	3.04
CL151	-	-	-	8.74	6.68	6.36	2.61	2.22	2.14	-	-	-	3.35	3.01	2.97
CL152	-	-	-	8.61	6.77	6.50	2.30	2.07	1.96	-	-	-	3.73	3.27	3.32
CL 161	23.4	18.3	16.6	8.78	6.60	6.20	2.37	2.10	2.04	1.89	1.67	1.63	3.70	3.14	3.04
CL162	25.9	-	-	9.17	7.24	6.94	2.62	2.33	2.28	1.93	1.75	1.69	3.50	3.11	3.05
CL 171AR	22.1	19.0	17.9	8.77	6.92	6.53	2.53	2.18	2.11	1.94	1.70	1.63	3.47	3.17	3.09
CL181AR	24.2	19.6	17.9	8.96	7.08	6.68	2.47	2.29	2.14	1.97	1.73	1.67	3.63	3.09	3.12
Cocodrie	25.6	20.6	20.2	9.33	7.14	7.10	2.52	2.20	2.17	1.94	1.77	1.74	3.70	3.25	3.27
Cybonnet	24.3	20.5	19.1	9.47	7.59	7.03	2.71	2.36	2.31	1.84	1.74	1.59	3.49	3.21	3.04
Cypress	24.6	20.2	19.2	9.34	7.08	6.95	2.49	2.19	2.16	1.96	1.78	1.74	3.75	3.23	3.22
Drew	22.9	18.5	17.0	9.43	7.24	6.93	2.42	2.19	2.01	1.83	1.62	1.56	3.90	3.31	3.44
Francis	22.8	18.9	17.5	8.82	7.07	6.48	2.71	2.37	2.28	1.84	1.69	1.57	3.26	2.99	2.84
Jefferson	28.7	22.8	21.6	9.61	7.29	7.05	2.68	2.29	2.25	2.50	1.85	1.76	3.59	3.18	3.13
JES	26.5	-	-	9.76	-	-	2.64	-	-	2.07	-	-	3.70	-	-
Kaybonnet	20.8	17.4	15.7	9.23	7.07	6.63	2.36	2.04	1.95	1.89	1.66	1.62	3.91	3.47	3.40
LaGrue	25.1	21.0	19.0	9.36	7.43	7.07	2.58	2.21	2.13	1.96	1.77	1.70	3.63	3.36	3.32
Maybelle	23.9	20.6	18.2	9.21	7.01	6.84	2.55	2.12	2.07	1.95	1.74	1.72	3.61	3.31	3.30
Presidio	24.3	19.1	17.9	9.04	7.05	6.64	2.41	2.12	2.07	1.95	1.73	1.69	3.75	3.32	3.21
CL XP729	24.7	19.7	18.5	9.38	7.03	6.60	2.61	2.22	2.14	1.94	1.79	1.73	3.59	3.17	3.08
CL XL745	26.7	22.7	21.0	9.61	7.44	7.13	2.71	2.35	2.31	1.97	1.76	1.71	3.54	3.17	3.08
XL 723	22.4	19.3	17.8	9.14	6.51	6.14	2.58	2.21	2.16	1.93	1.73	1.64	3.54	2.95	2.84
XL753	24.8	20.0	18.1	9.24	7.15	6.84	2.48	2.14	2.09	1.93	1.73	1.67	3.73	3.34	3.27
Rex	26.0	-	-	9.56	7.35	7.13	2.71	2.32	2.31	1.95	1.72	1.67	3.52	3.20	3.12
Roy J	22.9	19.7	18.5	9.50	7.33	6.81	2.38	2.13	2.09	1.93	1.78	1.71	3.99	3.44	3.26
Spring	21.8	19.1	17.2	8.62	6.82	6.22	2.48	2.21	2.13	1.92	1.76	1.67	3.48	3.08	2.92
Taggart	26.9	21.2	19.7	9.62	7.59	7.22	2.58	2.29	2.28	2.05	1.79	1.74	3.73	3.31	3.17
Templeton	21.8	17.7	16.2	9.24	7.16	6.65	2.36	2.11	2.10	1.95	1.73	1.67	3.92	3.4	3.17
Trenasse	27.5	22.3	19.4	9.34	7.13	6.74	2.64	2.29	2.15	2.00	1.75	1.72	3.54	3.32	3.13
Wells	25.1	21.3	18.9	9.46	7.34	7.00	2.31	2.05	1.94	1.80	1.63	1.51	4.1	3.58	3.61

Table 3-9. Rough, brown, and milled rice kernel dimensions and weights for selected medium-grain rice cultivars.

	Kernel Weight			Kernel Length			Kernel Width			Kernel Thickness			Length Width Ratio		
	Rough	Brown	Milled	Rough	Brown	Milled	Rough	Brown	Milled	Rough	Brown	Milled	Rough	Brown	Milled
Cultivar	mg			mm			mm			mm					
Bengal	27.4	23.7	21.8	8.27	6.45	6.04	3.15	2.79	2.64	2.14	2.04	1.92	2.63	2.31	2.29
Caffey	28.7	-	-	8.08	5.97	5.68	3.19	2.76	2.67	-	-	-	2.53	2.17	2.12
CL261	24.6	20.1	16.9	7.40	5.75	5.31	3.22	2.89	2.66	1.99	1.77	1.70	2.30	1.99	2.00
Earl	26.7	22.6	20.7	8.15	6.36	6.01	3.13	2.73	2.59	2.07	1.99	1.92	2.63	2.33	2.32
Jupiter	25.8	21.0	19.3	7.95	5.77	5.44	3.09	2.71	2.60	2.12	1.89	1.85	2.58	2.13	2.10
Mars	23.5	21.2	18.7	8.35	6.26	6.07	3.00	2.53	2.46	2.06	2.06	1.81	2.78	2.47	2.47
Medark	28.5	23.6	22.0	8.37	6.24	5.88	3.32	2.83	2.85	1.88	1.81	1.80	2.52	2.20	2.06
M-201	-	22.5	-	-	6.10	-	-	2.80	-	-	-	-	-	2.18	-
M-202	28.1	23.1	20.6	8.13	6.15	5.61	3.20	2.90	2.68	2.16	1.87	1.84	2.54	2.12	2.09
M-204	-	23.6	-	-	6.20	-	-	2.85	-	-	-	-	-	2.18	-
Neptune	27.4	22.4	20.9	8.08	6.02	5.65	3.11	2.72	2.64	2.13	1.94	1.87	2.60	2.21	2.14
Orion	23.4	20.0	18.9	8.06	6.13	5.72	3.24	2.81	2.65	2.04	1.76	1.72	2.49	2.18	2.16
Rico-1	27.2	21.4	19.9	7.81	6.01	5.66	3.13	2.84	2.66	2.21	1.94	1.81	2.50	2.12	2.13