SOME EFFECTS OF RICE QUALITY ON ROUGH RICE PRICES

B. Wade Brorsen, Warren R. Grant, and M. Edward Rister

Abstract

Quality discounts and premiums for rough rice in Texas rice bid/acceptance markets are analyzed. The most important quality factors determining the value of rough rice are head yield and peck. A one percentage point reduction in peck damage raises the price received per hundredweight of rough rice by $.13 to $.68 across markets and years. Since peck damage can be reduced by controlling the rice stinkbug, evaluation of alternative methods for better control of this pest in Texas rice fields is needed.

Key words: rice prices, quality factors, hedonic pricing, peck, stinkbugs, red rice, weed seeds.

The quality attributes of a rice marketing lot affect its value. Many quality attributes are related to management practices (e.g., insect damage, weed seeds, red rice, etc.). Producers need to know the value of these quality attributes when making economic management decisions and in deciding whether to accept an offered price. Researchers could also benefit from this information by knowing where to concentrate research efforts.

United States rough rice is marketed through contracts with mills, bid/acceptance markets, negotiated sales, and cooperative mills on a pooled basis. Cooperative mills handle over half of U.S. rice production (Mullins et al.). Bid/acceptance markets are the second most important marketing channel in Louisiana and Texas, accounting for one-third of the rough rice marketed annually (Mullins et al.).

In this paper, quality discounts or premiums for rough rice are determined for bid/acceptance markets on the western side of the Texas Rice Belt (i.e., west of Houston). Previous research has indicated significant price discounts in Texas being associated with various rice pests, including stinkbugs, weeds, and red rice (Brorsen et al.). Fryar et al. identified similar discounts in Arkansas. Brorsen et al. examined one year of data from one bid/acceptance market using highest bid prices. They, by using highest bid prices rather than final settlement prices, examined the effects of quality factors on demand. This paper looks at a different issue. By using final settlement prices, the reduced form effects of quality factors on equilibrium prices are examined. The work by Brorsen et al. is interesting in that it was one of the first looks at the effects of quality factors on demand. It did not provide, however, the information that rice producers need to know for production decisions; that is, the effect of quality factors on the final settlement price.

A considerable amount of the rice initially offered in bid/acceptance markets is sold through private negotiation after the highest bid has been rejected. As a result, substantially different sales prices and associated quality premium/discount differentials are often realized relative to those inferred by the highest bid price data. It is expected when using final settlement prices over highest bid prices that the estimated premiums/discounts will be larger/smaller, respectively. Further research in this area which addresses these shortcomings is needed, since the importance of stinkbug damage shown in the past research suggests changes are needed in both production practices and research (Garrett; Knowlton). In this paper, more markets and more crop years are examined than in past

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research, and only transaction prices are considered. Those in the rice industry should, thus, be able to place more confidence in these results. Analysis of covariance is applied to completed sales data, thereby allowing for testing of differences in discounts and/or premiums across markets and years.

HEDONIC PRICING MODEL

Hedonic pricing models are used to determine the effects of rice quality factors on rough rice prices. An hedonic price function is a regression of the observed price of a commodity against its quality attributes. The underlying assumption is that goods are valued for their utility-bearing characteristics and prices of goods vary with the specific amounts of each characteristic the goods contain (Lucas). The observed product prices are, thus, a composite of the value of the product's characteristics.

Hedonic price functions are regressions of the form (Lucas):

$$(1)\ P_i = P(V_{i1}, \ldots, V_{ij}; u_i),$$

where P_i is the observed price of commodity i, V_{ij} measures the amount of some "intrinsic quality" j per unit of commodity i, and u_i is a disturbance term.

Estimated hedonic price functions identify neither demand nor supply functions (Rosen). They, instead, show the reduced form effects of quality attributes on prices. Both observed and implicit prices of attributes may be affected by aggregate demand/supply conditions. The implied value of a quality attribute may not be the same across marketing years and may also vary with the specific market (location) being analyzed.

The data used in this study are pooled time-series/cross-sectional. The hedonic estimation technique must, therefore, be adjusted for differences in market forces over time. Ethridge and Davis and Martinez et al. accounted for temporal price changes by including a combination of linear and quadratic time trends and dummy variables for month or year in the model. Deaton and Muellbauer suggested using an index variable and proposed the following semi-logarithmic model:

$$(2)\ \ln(P_{it}) = \ln(I_t) + f(V_{i1}, \ldots, V_{ij}; u_i),$$

where I_t is the price of a reference commodity that measures the general price level. Since no weekly farm price is available for rice in the study area, the Texas weekly long grain mill price is used in this analysis as the index variable (USDA, *Rice Market News*).

DATA AND EMPIRICAL MODEL

Sales records, grade sheets, and confirmed prices were obtained from three bid/acceptance rice markets in Texas for the 1981/82 marketing year, and five such markets for the 1982/83 and 1983/84 marketing years. These records account for 24, 26, and 27 percent, respectively, of Texas production during the years surveyed. The markets are on the western side of the Texas Rice Belt, located at Alvin, Danbury, Bay City, El Campo, and Ganado (Figure 1).

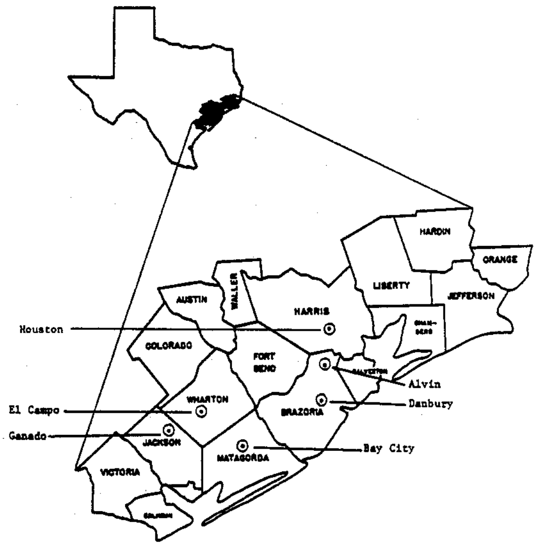

Figure 1. Location of the Bid/Acceptance Markets within the Texas Rice Production Area.

Most researchers have used a semi-logarithmic or linear relationship between prices and characteristics (Griliches; Ladd and Martin; Brorsen et al.; Wilson). In this study, a linear specification is used, and the mill price is included as a regressor.[1] The quality factors, thus, can be interpreted as discounts or

[1]The results in this study are similar regardless of whether a linear or semi-logarithmic specification is used. With a linear model, discounts are assumed to be constant values; while with a semi-logarithmic model, discounts are percentages of price. The linear model was selected following Brorsen et al. because discounts for rice were believed to be constant within a year. The functional form of the model for each market and year was tested using the Box-Cox transformation (Spitzer). Results indicate a linear model was appropriate in all cases.

premiums from the base price. The question still remains as to how data should be analyzed under a bid/acceptance system as exists in rough rice markets. Martinez et al. discarded the observations where the bid was not accepted (i.e., they assumed such observations were not reflective of an effective market). Brorsen et al. argued the bid price represented demand, since the bid price represents the highest price any participating bidder is willing to pay for a given lot of rice on a given day within the constraints of the bid/acceptance market. But this approach includes some bids which are not serious bids (Garrett). In this analysis, the final settlement price for each lot of rice is used as the dependent variable. The discounts associated with quality are expected to vary from year to year depending on aggregate supply and demand.

The data consist of a cross section of observations for a given sale. Data for each sale are pooled across crop years, resulting in one estimated hedonic price function for each crop year. Hypotheses that the intercept and slope coefficients are the same across markets were tested using analysis of covariance (Freund and Littell).[2] The resulting model is:

$$(3)\ P_{imtk} = a_{lk} + \sum_{n=2}^{N_k} a_{nk} D_n + b_{mk} P_{tk}^{mill} + \sum_{j=1}^{J} c_{jmk} V_{jimtk} + u_{imtk},$$

with $i = 1, \ldots, I_{mtk}$; $m = 1, \ldots, N_k$; $t = 1, \ldots, 52$; and $k = 1, 2$, and 3; where P_{imtk} is the settlement price for lot number i in market m during week t of year k; D_n is a dummy variable for market; P_{tk}^{mill} is the milled rice price in week t of year k; V is quality factor j for lot number i in market m during week t of year k; u_{imtk} is the error term; a_{mk}, b_{mk}, c_{jmk} are parameters to be estimated; I_{mtk} is the number of lots sold in market m during week t of year k; and N_k is the number of markets for which data are analyzed for year k. Three markets are included for 1981/82 ($N_1 = 3$), and five markets are included for 1982/83 and 1983/84 ($N_2 = 5$ and $N_3 = 5$). The model provides a framework for testing whether the slopes of the quality variables and the intercept term are the same across markets. This can be more easily accomplished with covariance analysis than with linear regression.

From equation (3), the rough rice price function estimated for each market in each year is:

$$(4)\ P_{imtk} = a_{mk} + b_{mk} P_{tk}^{mill} + c_{1mk} HEAD_i + c_{2mk} BROKENS_i + c_{3mk} SEED_i + c_{4mk} RED_i + c_{5mk} PECK_i + c_{6mk} SMUT_i + c_{7mk} CHALK_i + c_{8mk} HEAT_i + c_{9mk} TEST_i + U_{mk},$$

where P_{imtk} is the observed final settlement rough rice price for rice lot i in the mth bid/acceptance market during week t of year k, a_{mk} is the intercept term, P_{tk}^{mill} is the milled rice price in Houston during the week the rough rice was sold, (USDA, *Rice Market News*), b_{mk} is the coefficient for milled rice price, and $c_{1mk}, \ldots, c_{9mk}$ are the premiums/discounts associated with each quality factor. If the c_{jmk} is positive, the quality factor receives a premium; if it is negative, the quality factor receives a discount. The respective quality factors (V_{jimtk} of equation 3) for each rice lot i are:

$HEAD_i$	=	percent by weight of three-fourths or greater whole kernels in the sample;
$BROKENS_i$	=	percent by weight of kernels less than three-fourths of whole kernels (milling yield minus head yield);
$SEED_i$	=	number of whole or broken seeds of any plant other than rice;
RED_i	=	percent by weight of whole or broken kernels of rice on which there is an appreciable amount of red bran;
$PECK_i$	=	percent by weight of kernels damaged by stinkbugs;

[2]Hypotheses that the intercept and slope coefficients were the same across years were also tested but rejected.

$SMUT_i$	=	percent by weight of kernels infested by smut;
$CHALK_i$	=	percent by weight of whole kernels one-half or more chalky;
$HEAT_i$	=	percent by weight of whole kernels discolored and damaged as a result of heating; and
$TEST_i$	=	estimated weight (pounds) per bushel.

These variables are used to measure the level of the respective quality factors analyzed for each individual lot sold. Higher values of HEAD, BROKENS, and TEST are desirable, so their coefficients are expected to be positive. The other characteristics are undesirable so their coefficients are expected to be negative. The a and c_1 through c_9 values are the same across markets within a year unless the market location made a difference. Discounts or premiums per unit of the quality variables (c_1, . . . c_9) can be different across markets within a given year due to different factors (i.e., rice buyers discount differently by market, rice graders grade differently across markets, demand for rice shifts, and mills' processing procedures vary).

The more important quality factors, such as whole kernel yield, brokens, peck, weed seed, heat damage, and test weight, were collected in each bid/acceptance market during the study period. If no settlement price data were available for a given lot of rice, the observation was deleted. Data were weighted by the quantity (i.e., pounds of rough rice) in each lot.

The quality factors which may be controlled with production practices are peck, red rice (rice with a red colored pericarp), weed seeds, smut (a disease occurring as black spores on the endosperm of rough rice), and green or immature rice kernels. Each of these quality factors detracts from the appearance of rice on the grocery shelf. Rice millers, thus, try to remove them in the milling process. This

TABLE 1. ESTIMATED COEFFICIENTS FOR THE HEDONIC PRICE EQUATIONS FOR ROUGH RICE, TEXAS, 1981/82[a,b]

Quality variable	Market		
	Alvin	Ganado	Bay City
		Dollars/cwt.	
Intercept	−9.4588 (4.56)* [c]	−9.4588 (4.56)*	−9.4588 (4.56)*
Mill price	0.4478 (29.57)*	0.4478 (29.57)*	0.4478 (29.57)*
Head yield	0.1381 (4.07)*	0.0723 (2.01)*	0.1102 (2.82)*
Brokens	0.0359 (0.95)	0.0359 (0.95)	0.0359 (0.95)
Seed	−0.0071 (3.04)*	−0.0197 (3.64)*	−0.0197 (4.46)*
Red rice	−0.1716 (6.35)*	−0.1716 (6.35)*	−0.1716 (6.35)*
Peck	−0.2897 (7.86)*	−0.2897 (7.86)*	−0.2897 (7.86)*
Smut	0.0099 (0.24)	0.0099 (0.24)	0.0099 (0.24)
Chalk	−0.1448 (0.82)	−0.1448 (0.82)	−0.1448 (0.82)
Heat damage	−0.0037 (−2.82)*	0.0200 (1.84)	−0.1692 (1.02)
Test weight	0.0534 (1.19)	0.1255 (2.73)*	0.0943 (1.96)*

[a]Absolute t-ratios are shown in parentheses.

[b]The covariance analysis across markets has an R^2 of .8148 and an F-ratio of 109.53; the critical F value is 1.66 (5% level of significance). Ordinary least squares analysis for all markets combined has an R^2 of .8006 and an F-ratio of 183.09; the critical F value is 1.91 (5% level of significance). There are 467 observations in the data set.

[c]*Indicates rejection of the null hypothesis at the 5 percent level of significance. Rejection of the null hypothesis implies that the quality characteristic affected the rough rice settlement price by the estimated coefficient amount for each unit change in the quality characteristic.

removal increases the cost of processing and reduces finished product volume. Rough rice prices are discounted to cover these additional costs. Quality factors affected by post-harvest managment decisions (e.g., improper drying and heat damage) should also be of concern. A third category of quality factors, such as chalk (undeveloped or immature areas reflecting a "chalky" appearance) and other types of kernel damage, involves factors more affected by the environment than by management decisions.

In addition to the direct discount associated with the visible kernel damage caused by stinkbugs (i.e., peck), there is also an indirect discount due to lowering whole kernel yield and increasing brokens as well as a decline in test weight (Brorsen et al.; Fryar et al.). These effects are captured by modeling HEAD, BROKENS, and TEST as a function of PECK. The indirect effect for head yield then is the change in price due to a change in head yield times the change in head yield due to a change in PECK. The total effect is the sum of the direct and indirect effects.

RESULTS

Estimated hedonic functions for the three years of data are presented in Tables 1–3, and the indirect impacts of peck are reported in Table 4. Results describe the pricing structure for rough rice in bid/acceptance markets in Texas. These data can be used to derive estimates of the premium/discount (dollars/cwt. of rough rice) associated with a one unit change in a quality variable. Discounts (per 100 pounds and per acre) for peck, weed seed, red rice, chalk, heat damage, and smut are given in Table 5.[3]

Statistical test results indicate the intercept is different by market location in 1982/83 and 1983/84 and the parameters for head yield, weed seed, heat damage, and test weight varied across markets in 1981/82 (Table 1). Similarly, parameters for brokens, weed seed,

TABLE 2. ESTIMATED COEFFICIENTS FOR THE HEDONIC PRICE EQUATIONS FOR ROUGH RICE, TEXAS, 1982/83[a,b]

Quality variable	Market				
	Alvin	Danbury	El Campo	Ganado	Bay City
			Dollars/cwt.		
Intercept	10.1042 (1.79)	−2.9066 (0.48)	−8.5372 (3.59)*[c]	−3.1690 (1.28)	2.3944 (0.26)
Mill price	0.4173 (2.29)*	0.7104 (2.95)*	0.6560 (9.81)*	0.0419 (0.65)	0.3451 (6.84)*
Head yield	0.0920 (5.32)*	0.0920 (5.32)*	0.0920 (5.32)*	0.0920 (5.32)*	0.0920 (5.32)*
Brokens	0.1339 (2.91)*	0.0272 (0.91)	0.0394 (1.84)	0.0539 (2.64)*	0.0352 (1.61)
Seed	−0.0259 (1.42)	−0.0015 (0.26)	−0.0083 (6.07)*	d	−0.0120 (4.15)*
Red rice	−0.2267 (4.11)*	−0.2267 (4.11)*	−0.2267 (4.11)*	−0.2267 (4.11)*	−0.2267 (4.11)*
Peck	−0.3676 (2.14)*	−0.0895 (1.28)	−0.2179 (4.67)*	−0.0367 (1.12)	−0.1057 (4.67)*
Smut	−0.0002 (0.01)	−0.0002 (0.01)	−0.0002 (0.01)	−0.0002 (0.01)	−0.0002 (0.01)
Chalk	0.1627 (3.10)*	0.1627 (3.10)*	0.1627 (3.10)*	0.1627 (3.10)*	0.1627 (3.10)*
Heat damage	0.0052 (0.39)	−0.0357 (2.70)*	0.0068 (0.54)	0.0321 (0.42)	d
Test weight	−0.3299 (2.74)*	−0.1537 (1.76)	0.0064 (0.18)	0.1230 (3.14)*	−0.1113 (0.56)

[a]Absolute t-ratios are shown in parentheses.

[b]The covariance analysis across markets has an R^2 of .5102 and an F-ratio of 18.67; the critical F value is 1.50 (5% level of significance). Ordinary least squares analysis for all markets combined has an R^2 of .4002 and an F-ratio of 44.76; the critical F value is 1.91 (5% level of significance). There are 682 observations in the data set.

[c]*indicates rejection of the null hypothesis at the 5 percent level of significance. Rejection of the null hypothesis implies that the quality characteristic affected the rough rice settlement price by the estimated coefficient amount for each unit change in the quality factor.

[d]Data not reported.

peck, heat damage, and test weight varied across markets in 1982/83 (Table 2). For 1983/84, a difference in parameters was noted for head yield, peck, smut, and heat damage (Table 3).

The discounts for one percent peck damage (both direct and indirect) ranged from $.4125 to $.4486 per 100 pounds of rough rice or from $19.39 to $21.09 per acre in 1981/82 across markets.[4] This range across markets was slightly lower during 1982/83. Discounts for peck across markets during 1983/84 were larger and more variable than for the two previous years, ranging from $.1543 to $.6761 per 100 pounds or from $6.70 to $29.34 per acre. The discounts for peck indicate a one percentage point reduction in peck damage could have raised the price received per 100 pounds for rough rice by from $.1260 to $.6761 across all markets and years (i.e., from $5.91 to $29.34 per acre).

The discount for one weed seed per 500 gram sample across markets and years averaged from $.00 to $.0259 per 100 pounds (i.e., from $.00 to $1.19 per acre) (Table 5). Combining the discounts per unit of weed seeds with the average level of weed seeds reported by market and year shows discounts ranging from $.00 to $.13 per 100 pounds ($.00 to $6.11 per acre). The number of weed seed

TABLE 3. ESTIMATED COEFFICIENTS FOR THE HEDONIC PRICE EQUATIONS FOR ROUGH RICE, TEXAS, 1983/84[a,b]

Quality variable	Market				
	Alvin	Danbury	El Campo	Ganado	Bay City
			Dollars/cwt.		
Intercept	19.8324	5.1323	−2.0116	−4.0747	−4.1047
	(4.12)* [c]	(0.56)	(0.47)	(0.78)	(0.85)
Mill price	−1.0276	−0.6588	0.2611	−0.0736	−0.2839
	(5.75)*	(1.58)	(1.66)	(0.37)	(1.43)
Head yield	0.1393	0.2230	0.2203	0.1951	0.2624
	(3.80)*	(4.73)*	(5.82)*	(5.23)*	(6.72)*
Brokens	0.1795	0.1795	0.1795	0.1795	0.1795
	(4.40)*	(4.40)*	(4.40)*	(4.40)*	(4.40)*
Seed	−0.0077	−0.0077	−0.0077	−0.0077	−0.0077
	(4.81)*	(4.81)*	(4.81)*	(4.81)*	(4.81)*
Red rice	−0.1701	−0.1701	−0.1701	−0.1701	−0.1701
	(2.16)*	(2.16)*	(2.16)*	(2.16)*	(2.16)*
Peck	−0.6572	−0.0313	−0.2664	−0.3845	−0.1672
	(7.13)*	(0.28)	(3.11)*	(3.35)*	(2.44)*
Smut	−3.3430	−1.3706	−0.1352	0.1620	−0.2286
	(10.46)*	(3.10)*	(0.62)	(0.74)	(1.92)
Chalk	0.0641	0.0641	0.0641	0.0641	0.0641
	(0.60)	(0.60)	(0.60)	(0.60)	(0.60)
Heat damage	−0.0033	d	d	−0.0366	d
	(1.29)			(3.00)*	
Test weight	0.0773	0.0773	0.0773	0.0773	0.0773
	(1.51)	(1.51)	(1.51)	(1.51)	(1.51)

[a]Absolute t-ratios are shown in parentheses.

[b]The covariance analysis across markets has an R^2 of .4451 and an F-ratio of 21.81; the critical F value is 1.55 (5% level of significance). Ordinary least squares analysis for all markets combined has an R^2 of .2770 and an F-ratio of 33.11; the critical F value is 1.91 (5% level of significance). There are 875 observations in the data set.

[c]*indicates rejection of the null hypothesis at the 5 percent level of significance. Rejection of the null hypothesis implies that the quality characteristic affected the rough rice settlement price by the estimated coefficient amount for each unit change in the quality factor.

[d]Data not reported.

[3]The direct discount per unit for peck at the Alvin market at .2897 is taken directly from Table 1. All direct peck, weed seed, red rice, chalk, heat damage, and smut coefficients per cwt. in Table 5 are taken directly from Table 1. The indirect discount for peck (whole kernel, brokens, and test weight) is calculated as follows: for 1981/82, the effect of peck on head yield (1.1860) in Table 4 multiplied by the premium for each unit of head yield (.1381 for Alvin) in Table 1 produces the indirect discount in rough rice price (.1638) in Table 5. Other markets, years, and indirect effects are calculated similarly.

[4]State average yield for each year was multiplied by the quality discount per 100 pounds to derive discounts per acre. Texas rice yields average 4700 pounds, 4790 pounds, and 4340 pounds during 1981, 1982, and 1983, respectively (USDA, *Crop Production*].

across markets and years ranged from 1.9 to 12.8 per 500 gram sample, with most markets averaging below the seeds permitted for U.S. No. 2 rice (i.e., 7). Individual lots ranged, however, from 0 to 550 weed seed per 500 gram sample. The lots with high weed seed numbers brought sizeable discounts in the markets in addition to reductions in rough rice field yields (Smith).

The discount for red rice was relatively stable across bid/acceptance markets for all years, ranging from \$.1701 to \$.2267 per 100 pounds (\$7.38 to \$10.41 per acre) (Table 5). Applying the discount per unit of red rice to the

TABLE 4. IMPACT OF PECK ON SELECTED QUALITY VARIABLES AT SPECIFIED TEXAS RICE BID/ACCEPTANCE MARKETS DURING 1981/82, 1982/83, AND 1983/84 RICE MARKETING YEARS[a]

	Quality Variable					
	Head Yield		Brokens		Test Weight	
Market	Intercept	Peck	Intercept	Peck	Intercept	Peck
			1981/82[b]			
Alvin	60.4222 (83.39)* [c]	−1.1860 (5.41)*	10.6686 (17.20)*	0.6547 (3.49)*	45.7308 (239.83)*	−0.3482 (5.44)*
Ganado	56.3198 (131.28)*	−1.1860 (5.41)*	13.0379 (35.49)*	0.6547 (3.49)*	46.2103 (388.50)*	−0.5456 (6.84)*
Bay City	57.9692 (77.49)*	−1.1860 (5.41)*	11.9423 (18.64)*	0.6547 (3.49)*	45.8756 (177.66)*	−0.1653 (1.63)
			1982/83[d]			
Alvin	61.9614 (42.57)*	−1.3369 (1.78)	10.5203 (8.14)*	0.1469 (0.22)	45.3479 (133.87)*	−0.3227 (1.85)
Danbury	62.6049 (64.39)*	−1.8440 (4.03)*	9.1515 (10.60)*	0.7981 (1.96)	46.5073 (205.51)*	−0.2789 (2.62)*
El Campo	59.6911 (127.09)*	−1.8361 (6.37)*	10.0311 (24.04)*	1.3024 (5.09)*	46.1729 (422.38)*	−0.6142 (9.16)*
Ganado	57.0590 (174.23)*	−1.3330 (5.96)*	11.5255 (39.62)*	0.9289 (4.67)*	45.6822 (600.39)*	−0.1365 (2.62)*
Bay City	56.9703 (158.32)*	−0.7408 (4.87)*	12.2911 (38.45)*	0.2977 (2.20)*	45.4701 (542.91)*	0.0007 (0.02)
			1983/84[e]			
Alvin	59.7797 (78.21)*	−2.4335 (7.29)*	10.6821 (16.89)*	1.9212 (6.96)*	44.9782 (331.98)*	0.3214 (5.43)*
Danbury	60.7835 (92.78)*	−1.1594 (3.24)*	9.8308 (18.14)*	0.8857 (2.99)*	46.2986 (398.71)*	−0.3044 (4.80)*
El Campo	59.6286 (112.09)*	−0.6501 (1.92)	10.0537 (22.84)*	0.2100 (0.75)	46.3160 (491.16)*	−0.4922 (8.20)*
Ganado	57.5194 (93.90)*	−0.2122 (0.47)	11.6613 (23.01)*	−0.2565 (0.68)	46.3757 (448.15)*	−0.4979 (6.46)*
Bay City	57.8434 (97.71)*	−0.5653 (2.11)*	11.3608 (23.19)*	0.2342 (1.06)	45.4690 (433.31)*	0.0000 (0.00)

[a]Absolute t-ratios are indicated in parentheses.

[b]The covariance analysis across markets has an R^2 of .10 and an F-ratio of 16.44 for peck-head yield; an R^2 of .04 and F-ratio of 7.19 for peck-brokens; and an R^2 of .21 and an F-ratio of 24.76 for peck-test weight. Ordinary least squares analysis for all markets combined has an R^2 of .01 and an F-ratio of 6.61 for peck-head yield, an R^2 of .01 and an F-ratio of 2.39 for peck-brokens; and an R^2 of .17 and an F-ratio of 96.05 for peck-test weight. The critical F value is 3.92 (5% level of significance). There are 467 observations in the data set.

[c]* indicates rejection of the null hypothesis at the 5 percent level of significance. Rejection of the null hypothesis implies that peck affected the quality characteristic by the amount of the estimated coefficient for each unit change in peck.

[d]The covariance analysis across markets has an R^2 of .26 and an F-ratio of 27.28 for peck-head yield; an R^2 of .13 and an F-ratio of 11.74 for peck-brokens; and an R^2 of .22 and an F-ratio of 21.89 for peck-test weight. Ordinary least squares analysis for all markets combined has an R^2 of .08 and an F-ratio of 57.98 for peck-head yield; an R^2 of .04 and an F-ratio of 29.45 for peck-brokens; and an R^2 of .03 and an F-ratio of 25.17 for peck-test weight. The critical F value is 3.92 (5% level of significance). There are 708 observations in the data set.

[e]The covariance analysis across markets has an R^2 of .18 and F-ratio of 21.67 for peck-head yield, an R^2 of .22 and an F-ratio of 26.96 for peck-brokens; and an R^2 of .44 and an F-ratio of 77.69 for peck-test weight. Ordinary least squares analysis for all markets combined has an R^2 of .09 and an F-ratio of 86.07 for peck-head yield; an R^2 of .07 and an F-ratio of 66.28 for peck-brokens; and an R^2 of .18 and an F-ratio of 198.37 for peck-test weight. The critical F value is 3.92 (5% level of significance). There are 889 observations in the data set.

average level of red rice in each market and year indicates discounts ranging from $.00 to $.17 per 100 pounds ($.00 to $7.97 per acre). The average samples for the bid/acceptance markets met the red rice quality requirements for U.S. No. 2 or better. Levels of red rice in some of the areas were so low that the data were not recorded. Analysis of data from American Rice, Incorporated (Knowlton) indicates more red rice is present in samples of red rice grown in the eastern portion of the Texas Rice Belt. The highest average levels of red rice were in the Alvin area, though these levels were lower than that permitted for U.S No. 2 rice (i.e., 1.5 percent). The presence of red rice in the sample also indicates lower yields (Diarra et al.)

Discounts for smut ranged from $.00 to $3.34 per hundredweight ($.00 to $145.09 per acre) (Table 5), but were significant only in the Alvin and Danbury markets during 1983/84. Hurricane Alicia lowered the quality of unharvested rice in 1983. Discounts per acre at the sample means were $12.15 in Danbury and $36.46 in Alvin. No quality problem with smut was detected in the other markets during the time period analyzed. Chalk and heat damage had little effect on rough rice prices.

The suggestion that final settlement prices produce larger premiums and smaller discounts than the highest bid prices used by Brorsen et al. was not tested statistically. In the one bid/acceptance market where direct comparisons can be made, however, the premium ($/%) for head rice is slightly larger ($.1102 versus $.1010) when estimated with settlement prices. The discounts ($/%) for red rice ($−.1716 versus $−.3470) and heat damage ($−.1692 versus $−.4860) were less with settlement prices, but the discounts for weed seed ($/seed) ($−.0197 versus $−.0136) and peck ($/%) ($−.2897 versus $−.2860) were greater. Thus, the impact of peck (i.e., the rice stinkbug) appears to be somewhat greater than earlier conjectured, due to the larger estimate for peck discount and the greater estimated value for head rice. Similarly, the presence of weed seed is estimated to be more costly, while red rice and heat damage are not as costly.

SUMMARY AND CONCLUSIONS

In this paper, results of analyses of 1981/82, 1982/83, and 1983/84 data from five rough rice bid/acceptance markets on the western side of

TABLE 5. DISCOUNTS (DOLLARS) PER ACRE FOR SELECTED QUALITY ATTRIBUTES AT SPECIFIED TEXAS RICE BID/ACCEPTANCE MARKETS DURING RICE MARKETING YEARS 1981/82, 1982/83, AND 1983/84

	Quality Attribute									
	Peck									
Market	Direct	Whole Kernel	Brokens	Test Weight	Total	Weed Seed	Red Rice	Chalk	Heat Damage	Smut
					1981/82[a]					
Alvin	−13.62*[b]	−7.70*	1.10	−0.87	−21.09	−0.33	−8.07*	−6.81	−0.17*	0.47
Ganado	−13.62*	−4.03*	1.10	−3.22*	−19.76	−0.93*	−8.07*	−6.81	0.94	0.47
Bay City	−13.62*	−6.14*	1.10	−0.73	−19.39	−0.93*	−8.07*	−6.81	−7.95	0.47
					1982/83[c]					
Alvin	−17.24*	−5.77	0.92	4.99	−17.09	−1.19	−10.41*	7.47*	2.24	−0.01
Danbury	−4.20	−7.95*	1.02	2.01	−9.12	−0.07	−10.41*	7.47*	−1.64*	−0.01
El Campo	−10.22*	−7.92*	2.41	−0.18	−15.55	−0.38*	−10.41*	7.47*	0.31	−0.01
Ganado	−1.72	−5.75*	2.35	−0.79*	−5.91	d	−10.41*	7.47*	1.47	−0.01
Bay City	−4.96*	−3.20*	0.49	−0.00	−7.67	−0.55*	−10.41*	7.47*	d	−0.01
					1983/84[d]					
Alvin	−28.52*	−14.71*	14.97*	−1.08	−29.34	−0.33*	−7.38*	2.78	−0.14	−145.09*
Danbury	−1.36	−11.22*	6.90*	−1.02	−6.70	−0.33*	−7.38*	2.78	d	−59.48*
El Campo	−11.56*	−6.21	1.64	−1.65	−17.78	−0.33	−7.38*	2.78	d	−5.87
Ganado	−16.69*	−1.80	−2.00	−1.67	−22.16	−0.33	−7.38*	2.78	−1.59*	7.03
Bay City	−7.26*	−6.44*	1.82	0.00	−11.88	−0.33*	−7.38*	2.78	d	−9.92

[a]Weighted by state yield in 1981 (47 cwt.) (USDA *Crop Production*).

[b]*indicates coefficients were significant at the 5 percent level.

[c]Weighted by state yield in 1982 (46.9 cwt.) (USDA *Crop Production*).

[d]Data did not include information for this quality attribute for the given market/year situation.

[e]Weighted by state yield in 1983 (43.4 cwt.) (USDA *Crop Production*).

the Texas Rice Belt are reported. The objective of the analyses was to determine the premium/discounts associated with various rough rice price quality factors.

Whole kernel yield, brokens, peck, red rice, weed seed, smut, chalk, heat damage, and test weight were analyzed to determine their impact on rough rice price ($/cwt.) As expected, the proportion of edible rice in the sample of rough rice was the most important factor. The premium per unit of whole kernel yield varied from $.0723 at Ganado during 1981/82 to $.2624 at Bay City during 1983/84. The premium per unit of brokens averaged $.1795 in each market during 1983/84. When evaluating new varieties, researchers should consider the milling yield and ability to resist cracking rather than just yields of rough rice. Total discounts per unit of peck varied from $.4125 to $.4486 during 1981/82. The range across markets was slightly lower during 1982/83. Peck discounts during 1983/84 were larger and more variable, however, than during the two previous years. Discounts in the rough rice markets coupled with stinkbug induced field losses point to sizeable losses in revenue where peck damage is a problem.

Discounts per unit of red rice ranged from $.1701 to $.2267. Red rice also indicates possible lowering of rice field yields due to competition from red rice. The occurrence of red rice was low, however, in the bid/acceptance markets.

The discount per each weed seed in a 500 gram sample varied from $.0071 to $.0197. The average number of weed seed per sample across markets and years ranged from 1.9 to 12.8 per 500 gram sample, with most of the markets averaging below the number of seeds permitted for U.S. No. 2 rice. Lots with high weed seed numbers brought sizeable discounts in the markets in addition to any reductions in rough rice field yields.

Discounts for smut were only significant in the Alvin and Danbury markets during 1983/84. Hurricane Alicia moved through these areas in August 1983. Discounts for chalk and heat damage had little effect on rough rice prices in the bid/acceptance markets studied.

Depending on costs associated with controlling the respective quality characteristics, rice producers may be experiencing significant economic losses as a result of price discounts associated with peck, red rice, weed seed, chalk, heat damage, and smut, among other quality attributes. Results of this and other studies can provide a basis for producers to evaluate rice production and marketing strategies.

Additional research is needed to 1) identify the aggregate impact of yield losses associated with several factors contributing to poor rough rice quality, and 2) identify the appropriate economic levels of control which affect the specific quality attributes of rough rice. This will require research by entomologists and economists on 1) efficient use of various stinkbug control tactics, and 2) impact of stinkbug level on both field yields, peck damage, and milling characteristics of the damaged rice. Similarly, cooperative efforts between agronomists and economists are in order with respect to red rice and other problems.

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