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AN ECONOMIC ANALYSIS OF EFFECTS OF SELECTED QUALITY AND NON-QUALITY FACTORS ON PRICES OF MEDIUM AND LONG GRAIN ROUGH RICE IN LOUISIANA

A Dissertation

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ABSTRACT

This study was undertaken to determine and measure the effect of quality and non-quality factors on prices of medium and long grain rice in Louisiana.

Data for the period 1968-69 to 1973-74 were obtained from records of all transactions at the Louisiana Grain Exchange at Jennings, Louisiana. These data contained information on 5,706 lots of medium and long grain rice.

Several statistical procedures were used to attain the objectives of this study. Tabular analysis was used to study the distribution of the rough rice pricing and grading in Louisiana. The maximum R-squared improvement variable selection technique and the least squares means statistical procedures were used to determine and measure the factors significantly affecting price and grade of rough rice in Louisiana during the period studied. All analyses were conducted separately for medium and long grain rice.

The tabular analysis showed the relationship among price, quality and non-quality variables. These relationships were computed for medium and long grain rice separately and they were found to be similar. They were analyzed separately because they were not of the same magnitude.

Statistical models to determine and measure factors significantly affecting price and grade of medium and long grain varieties were developed. All grade factors were found to affect significantly the grade

level of long grain rice. The grade factor "others" failed to affect significantly the price of medium grain varieties.

Variables accounting for the effect of head rice yield and trend in prices were present in all models developed. Variables representing the Louisiana Grain Exchange and government grades did not significantly affect the price of medium grain rice. The situation was different for long grain varieties. The quadratic form of the Louisiana Grain Exchange grade exerted a significant effect on price, and the linear effect of the variable government grade significantly affected the price for the model for the last four seasons.

Of all grade factors considered in the model building process the only factor affecting significantly the price of medium and long grain rice was red rice. The grade factor "others" was present in the model for medium grain rice only.

The variable "variety" was highly significant in all models for medium and long grain rice.

The variable representing lot size in barrels was not present in any model. This variable had been proven to exert a significant effect on price of rough rice in previous studies. In fact, when only the first two seasons were considered this variable significantly affected the price of rough rice as expected; however, it was not significant for the last four seasons or for all six seasons considered together.

The last part of analysis comprised the testing of variables accounting for differences in price due to location, mills and month of the year. This was done by adding these variables to the statistical models developed in earlier parts of the study.

When these three variables were added to the statistical models developed earlier, the signs of the regression coefficients and the significance level of the variables in the model did not change. The added variables were significant at the required levels. The hypotheses stating that the mean prices per barrel of rough rice were equal among mills, locations and months were rejected. The seasonal patterns computed using the different models were similar within and among medium and long grain rice.

It was concluded that the present rice classification system needs to be redesigned with a reduction in the number of grade levels. It was recommended that a complete classification of rice be reorganized in relation to millers preferences.

CHAPTER I

INTRODUCTION

Rice is the basic daily diet for more than one-half of the world population and furnishes the basis for economic livelihood for millions of farmers and other persons engaged in rice marketing, distribution and related business.

The production of rice in the United States has increased in the last 15 years from 42,935,000 cwt. in 1958-59 to 92,823,000 cwt. in 1973-74.[1] Although most rice in the United States is exported, domestic distribution and per capita consumption have increased from 5.4 pounds in 1958 to 7.3 pounds in 1973.[2] The major increase in consumption has resulted from the introduction of new rice products and the increased usage of pre-cooked rice.

The rice-producing states of the U. S. are Arkansas, California, Louisiana, Texas, Mississippi and Missouri. The 1973 cash receipts as well as acres harvested, production and percentage of the total U. S. production for rough rice for the abovementioned states are shown in Table 1.

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[1] Food Consumption Prices Expenditures, Supplement for 1972 for Ag. Economics Report No. 138, USDA, ERS. Rice Situation, ERS, USDA, RS-24, October 1974, p. 14.

[2] National Food Situation, ERS, USDA, February 1974. Rice Situation, ERS, USDA, RS-25, April 1975, p. 11.

Table 1. Acres Harvested, Production, Cash Receipts and Percentage of the Total Rice Production for Rough Rice at Selected States, 1973-74 Season

State	Acres Harvested	Production	Cash Receipts	Percentage of Total U. S. Production
	1,000 Acres	1,000 Cwt.	1,000 Dollars	
Arkansas	533	25,424	398.072	27.4
California	401	22,579	259,659	24.3
Louisiana	620	21,394	288,819	23.1
Texas	549	20,530	287,420	22.1
Mississippi	62	2,670	42,203	2.9
Missouri	5.2	226	3,489	.2
Total	2,170.2	92,823	1,278,863	100.0

SOURCE: Rice Situation, Economic Research Service, USDA, March 1974. Field Crops, Production Farm Use Sales Value, 1972-73, Statistical Reporting Service, USDA, Washington, D. C., May 10, 1974.

Louisiana produced about one-fourth of the total U. S. production. Yield per acre for rice in Louisiana has increased substantially in the last 15 years (from 26.50 cwt. in 1958-59 to 34.51 cwt. in 1973-74).[3] Improved varieties and better cultural practices largely accounted for the increases. Total production of rough rice has increased in Louisiana in recent years due to technological improvements.

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[3]Lonnie L. Fielder, Jr. and others, Agricultural Statistics for Louisiana 1909-1968 and 1964-1968. Rice Situation, ERS, USDA, RS-24, October 1974, p. 14.

Rice production in Louisiana is centralized in the southwest region of the state. The rice production area includes nine parishes which produce nearly 92 percent of the total state production.[4] An additional 7 percent is produced in the northeast Louisiana Delta and 1 percent in scattered locations, mostly along the Mississippi and Red River areas in southern and central Louisiana. The sale of rough rice in Louisiana amounted to nearly 289 million dollars in 1973, or 32 percent of all field crop marketing and 21.4 percent of all farm marketing.[5]

Background

The price farmers receive for their rice is affected by several quality and non-quality factors. Quality as defined by Doll, Rhodes and West "is the sum of attributes of a product which influence its acceptability to many buyers, and, hence the price they are willing to pay for it."[6] According to the U.S.D.A. inspection handbook for rice, the quality of rice is determined by the following factors:

1. Grade level: the grade factors used to determine the grade level are weed seeds, damage, red rice, chalkiness, general appearance and "others." Table 2 shows the maximum limits for each of the grade factors for each grade level. This table can be interpreted as a "worst factor rule" table; that is, if a sample of rice has a classification of 1 in all grade factors but one, the final grade level for that sample will be the grade of the worst grade factor level.

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[4]Parishes of Allen, Acadia, Beauregard, Calcasieu, Cameron, Evangeline, Jefferson Davis, St. Landry and Vermillion.

[5]Louisiana Farm Income, Louisiana Crop and Livestock Service, USDA, Statistical Reporting Service, Alexandria, Louisiana, 1974.

[6]John P. Doll, V. James Rhodes and Jerry G. West, Economics of Agricultural Production, Markets and Policy, Ed. Richard D. Irwin, First Edition, 1968, p. 397.

Table 2. Grade and Grade Requirements for the Classes of Rough Rice

Grade	Maximum limits of: Seeds and heat-damaged kernels: Total (singly or combined)	Maximum limits of: Seeds and heat-damaged kernels: Heat-damaged kernels and objectionable seeds (singly or combined)	Maximum limits of: Red Rice and damaged kernels (singly or combined)	Maximum limits of: Chalky kernels: In long grain rice	Maximum limits of: Chalky kernels: In medium or short grain rice	Other types	Color requirements
	Number in 500 grams		Percent				
1	2	1	0.5	1.0	2.0	1.0	Shall be white or creamy.
2	4	2	1.5	2.0	4.0	2.0	May be slightly gray.
3	7	5	2.5	4.0	6.0	3.0	May be light gray.
4	20	15	4.0	6.0	8.0	5.0	May be gray or slightly rosy.
5	30	25	6.0	10.0	10.0	10.0	May be dark gray or rosy.
6	75	75	15.0*	15.0	15.0	10.0	May be dark gray or rosy.
7	Grade 7 shall be rough rice which: (a) does not meet the requirements for any of the grades from 1 to 6 inclusive, (b) contains more than 14.0 percent of moisture, (c) is musty, or sour, or heating, (d) has any commercially objectionable foreign odor, (e) is otherwise of distinctly low quality.						

*Rice in grade U.S. No. 6 shall contain not more than 6.0 percent of damaged kernels.

SOURCE: Inspection Handbook for the Sampling, Inspection, Grading and Certification of Rice, U.S.D.A., Agricultural Marketing Division, Hyattsville, Maryland, June 1, 1974. HB918-11, pp. 3.35.

2. Milling yield, which is "an estimate of the quantity of whole kernels and total milled rice (whole and broken kernels combined) that are produced in the milling of rough rice to a well milled degree."[7]

3. Class of rice which is determined by the length, width and thickness of the kernels of rice.[8]

At the Louisiana Grain Exchange the same three factors listed above determine quality of rough rice, and the technical procedures used in their measurement are similar. Even though the factors considered and the procedures used to determine quality of rough rice are similar, the same sample may be graded differently by the Louisiana Grain Exchange inspectors and by the government inspectors. The difference is due to the fact that U. S. grades are based primarily on specified grade factors levels, while the grade that millers use is based apparently on a different set of weights for the grade factors. Millers use the grade provided by the Louisiana Grain Exchange, arguing that federal grades do not relate properly rough rice grades and actual milling outturn.

In contrast with the quality factors, which refer to a well recognized group of physical characteristics, the non-quality factors are not related to these characteristics; they are external factors which do not affect the nature of the product. The non-quality factors which may affect prices and, therefore, will be analyzed in this study are:

1. Lot size.

2. Buyer of rough rice which can be either a commercial mill or a seed company.

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[7]U. S. D. A., op. cit., p. 3.06.

[8]For a more detailed explanation, see U.S.D.A. Inspection Handbook, p. 3.03.

3. Production area.

4. Date of sale.

Rice producers and processors need to be aware of the effect of these factors on price in order to maximize their profits. They need to know not only the price differentials due to variations in quality, but also the differences in prices received due to non-quality factors. An analysis and measure of factors affecting the price of rice can be used to indicate the most profitable type of rice to be produced, as well as the time and place elements which would maximize farmers' returns.

The Problem

Rice producers in Louisiana have been facing an uncertain market situation for rough rice because (1) there is no single standard of quality accepted and used by all buyers and sellers in the market and (2) lack of knowledge of non-quality factors affecting significantly the price farmers receive for their rice.

This lack of uniformity in standard of quality and lack of knowledge of non-quality factors affecting significantly the price of rice have been responsible for imperfections in the market in Louisiana because: (1) producers are reluctant to pool their rice on a quality basis before sale, preferring to maintain owner identity of lots offered for sale, even though it has been shown that they could market their rice more efficiently if they pooled small individual producer lots on an equal quality basis;[9] (2) individual lots are inspected by each prospective purchaser which is time consuming, inefficient and costly; and (3) producers do not have full confidence in the ability of the system of quality determination and description to relate quality to price with a degree of accuracy acceptable to them.[10]

The commingling of rough rice of the same variety, milling yield and quality has been widely accepted in California and Arkansas, two of the main rice producing states in the nation. In these two states mill operators contend that they can accurately estimate grade and milling yield from green samples, and growers readily accept such determinations.[11]

It has been shown that pooling offers savings to producers and operators, as well as to drier and storage units. These savings are obtained from a substantial reduction in procurement costs. If buyers for the mills could buy large commingled lots to fill their orders instead of traveling around purchasing many small lots, the procurement costs would be greatly reduced and some of these savings might be passed on to producers in the form of higher prices for their product.

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[9]Dewell R. Gandy and Harlon D. Traylor, An Economic Analysis of Commingling as a Method for Improving Rough Rice Marketing in Louisiana. D.A.E. Research Report No. 433, Department of Agricultural Economics and Agribusiness, Louisiana State University, Baton Rouge, La., April 1972.

[10]Francis X. O'Carroll and Harlon D. Traylor, An Economic Analysis of Quality Factors Affecting the Price of Medium Grain Rough Rice in Louisiana, D.A.E. Research Report No. 451, Department of Agricultural Economics and Agribusiness, Louisiana State University, Baton Rouge, La., May 1973.

[11]Marshall R. Godwin and Lonnie L. Jones (Eds.), The Southern Rice Industry, College Station, Texas, Texas A & M University Press, 1969.

Description and Source of Data

This study is concerned with the portion of the Louisiana rough rice production sold to millers as rough rice through the Louisiana Grain Exchange at Jennings, Louisiana.[12]

Data for the six seasons, 1968-69 through 1973-74, were obtained from records of all transactions at the Louisiana Grain Exchange. During these six seasons 5,706 lots were sold; of these lots, 2,081 were long grain varieties and 3,624 were medium grain varieties. Data were recorded for nine long grain varieties and six medium grain varieties; four out of the 15 varieties did not have enough observations (less than 30 observations over a 6-year period) and were deleted from the analysis. Seven long grain and four medium grain varieties were included in this study.[13] However, not all varieties were present in each one of the six seasons under consideration.

A number of quality and non-quality factors and price were recorded for each lot. The recording of quality factors such as grade factor levels, grade level, milling yield and total head rice, as determined by the Louisiana Grain Exchange and by the federal government will permit a series of relevant evaluations. For example, it will make possible (1) an examination of the manner in which individual grade factor levels, milling yield and total head rice influenced grade levels and (2) the

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[12]Rough rice as defined by the Rice Inspection Handbook published by the U.S.D.A. Consumer and Marketing Service, 1974, "is rice which consists of 50 percent or more of paddy kernels of rice (oryza sativa)."

[13]The long grain varieties were: Belle Patna, Blue Belle, Blue Bonnet, Star Bonnet, Toro, Labelle and Dawn. The medium grain varieties were: Saturn, Nato, Gulfrose, and Vista.

determination of the effect of the different grade levels and grade factors on price.

The data also provide information regarding the non-quality factors lot size, date of sale, delivery and payment, market location and production area. In most cases, the dates of sale, delivery and payment were not the same, the date of sale was the only date used in the entire study because the price rice producers receive is determined on the date of sale. The above provides information helpful in evaluations such as the best lot size and date of the year to perform business in order to maximize profits, as well as an analysis of price differentials among and within market locations and production areas. With respect to lot size, it is assumed that prices and milling yields obtained in larger lots simulate what could be expected from pooling small lots.

Purpose and Objectives of the Study

The major purpose of this study was to select and measure the effect of quality and non-quality factors on prices received by producers of medium and long grain rough rice sold through the Louisiana Grain Exchange. It was felt that if rice producers have sufficient knowledge of these factors, and thus the value of their rice, a number of current imperfections in the market could be eliminated. Producers could adjust their production practices in a way such as to produce the types of rice which would maximize their profits. The specific objectives of this study were:

1. To select quality and non-quality factors which have affected the price received by producers for medium and long grain rough rice in Louisiana.

2. To measure the influence and determine the statistical significance of factors affecting grade and price received by growers of rough rice, and to analyze whether or not influences were the same for medium and long grain varieties of rice during the period under study.

3. To determine price variations as related to market location and production area.

4. To analyze the seasonal variations of prices for different classes of rough rice, and to compute seasonal indexes for the period under consideration.

This study was designed so that its results may be used to upgrade the current rice grading system in accordance with present market practices. It was felt that a grading system based on actual practices would provide a more equitable and efficient market.

Previous Studies

Several studies concerning the price of rice as related to quality and non-quality factors, have been conducted during past years by the Department of Agricultural Economics and Agribusiness at Louisiana State University and other research institutions.

In 1957, Mullins in Arkansas found that marketing rice through cooperatives will benefit individual growers in two ways: (1) greater opportunities to contact customers with rice of each grain type at any given time. He said that these two advantages apply to individual growers who participate in cooperative marketing programs.[14]

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[14]Troy Mullins, Economic Considerations in the Production of Short, Medium and Long Grain Rice in Northeastern Arkansas, Agricultural Experiment Station, College of Agriculture and Home Economics, Special Report No. 3, October 1957.

Johnson and Goodwin, in 1958, conducted a study investigating pooling lots of feeder calves to obtain better prices.[15] In this study the advantages of group selling of cattle were determined. They were: (1) it reduces handling and selling time; (2) it reduces the number of pens needed for animals; and (3) it is more attractive to larger buyers. They also found a very close relationship between the average size of consignment and the average size of sales lot at the sale. The average price received for calves sold as a group was higher than for calves of the same grade sold as singles; also, the average price increased as the size of the lot increased. This study closely parallels in one aspect the rice pricing research with which this study was concerned.

In 1967, Traylor and others conducted a study analyzing costs of drying and storing rough rice.[16] The quality of rice dried and stored in various types of facilities was compared. Little difference in average value was found between rice dried in multipass and rice dried in stationary units. Such differences disappeared after the rice had been stored. An explanation for this disappearance of differences after storage is given by Faulkner and Wratten who found that milling yields increase when rice is stored for more than 3 weeks.[17]

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[15]Jack D. Johnson and Jimmy D. Goodwin, An Analysis of Special Calf Sales at Northern Louisiana Markets, 1958, D.A.E. Circular No. 267, Department of Agricultural Economics and Agribusiness, Louisiana State University, Agricultural Experiment Station, June 1960.

[16]Harlon D. Traylor and others, Cost of Drying and Storing Rough Rice in Louisiana and Texas, Marketing Research Report No. 799, U.S.D.A., Washington, D.C.: July 1967.

[17]Macon D. Faulkner and Finis T. Wratten, Abstracts on Drying and Storage, Summary of Rice Drying Research in Louisiana, Proceedings, Tenth Rice Technical Working Group, U.S.D.A., ARS 72-39, October 1965.

Gandy and Traylor, in 1969, studied effects of pooling as a prospective method for improving rough rice marketing in Louisiana.[18] They concluded that by pooling, average price per barrel of rice was likely to increase as lot size increased from smaller lots (below 1,000 barrels) to larger lots (over 1,000 barrels). Also, they showed that in each year during the period from 1960 to 1966, and for each medium grain variety, the continuous variables head rice yield, broken rice yield and grade had a statistically significant influence on rough rice price.

In the Philippines, in 1969, the Department of Agricultural Economics at the International Rice Research Institute studied the relationship between quality and price of rice.[19] Using regression analysis, it was found that percentage of broken rice and percentage of chalky grains were the two most important variables explaining price differences in wholesale milled rice of local varieties.

Godwin and others, in 1969, published a series of articles related to the southern rice industry.[20] They analyzed the rice industry in producing states. They stated that federal grades and standards are not used extensively by Texas and Louisiana mills in procurement operations. The reason given by millers was that discrepancies exist between rough rice grades and actual milling outturn and that this factor was dominant in determination of prices that millers will pay for the several varieties and types of rice. The quality attributes were of lesser importance, and U. S. standards are based on them.

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[18]Gandy and Traylor, op. cit.

[19]The International Rice Research Institute Annual Report, Los Banos, Laguna, Philippines, IRRI, 1969.

[20]Godwin and Jones, op. cit.

In 1971, O'Carroll and Traylor conducted an economic analysis of quality factors affecting the price of medium grain rough rice in Louisiana during the 1968 and 1969 seasons.[21] They divided this study into two parts, quality and price analysis. With respect to the quality analysis, they showed that seed, damage, chalk and red rice were the important grade factors. Their levels were weighted and this weighted value was added in grade level determination.

Regarding price analysis, they concluded that the grade factor damage did not have a significant effect on price in either season, and chalk did not have a significant effect on price in the 1969 season. They also found that by increasing lot size above the modal size, producers could increase revenue, but this did not apply for larger size of lots which could be offered for sale from a rice pool. The variables representing sellers and mills did not influence price during the 1969-70 season, but had a significant effect on price during the 1968-69 season.

Hudson and Williams, in 1975, studied the relationship of fiber test data and other factors to prices paid for Louisiana cotton.[22] In this study the extent to which cotton prices received by producers reflected variation in fiber quality was determined. Also, the effect of exogenous (non-quality) variables on price was measured and a comparison of the variations in price quality relationship from the merchant's side relative to the producer's side was made.

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[21]O'Carroll and Traylor, op. cit.

[22]J. F. Hudson and Douglas R. Williams, Relationship of Fiber Test Data and Other Factors to Prices Paid for Louisiana Cotton, D.A.E. Research Report No. 482, Department of Agricultural Economics and Agribusiness, Louisiana State University, Agricultural Experiment Station, April, 1975.

They found inefficiencies of the cotton classification system in relating quality and other factors to price received by farmers. A reorganization of the classification system of cotton was recommended; the new system should include additional quality characteristics which were directly related to the use value of cotton; this will enable producers to adjust their production and marketing practices to meet the needs of the textile industry. The analysis of quality and non-quality factors as related to market pricing of cotton is analogous with one of the objectives of this study.

Summarizing the above findings, it becomes apparent that improvements are needed in the grading system to obtain official quality designations that will be compatible with the way millers value rough rice when they buy. It appears that federal grades are not reflecting the value attributes of rice as seen by millers. Also, it is evident that farmers do not consider quality attributes in making their marketing decisions. This study was made to determine factors which have been affecting the pricing of rough rice in Louisiana during the past six years, and it will provide a basis for classification and pricing of rice according to its properties.

CHAPTER II

STATISTICAL PROCEDURE

A number of different methods of analysis were used to attain the objectives of this study. Even though the analysis was made separately for medium and long grain varieties, the procedure used in relation to each objective was the same in both cases. The procedures for each objective are described in the following paragraphs.

Objective 1

Selection of quality and non-quality factors which were likely to affect prices which producers received for rough rice was made on the basis of previous studies and by construction and analysis of tables of means and frequency distributions for the different variables.

The quality factors analyzed were:

1. Grade level as given by the Louisiana Grain Exchange and by the federal government and grade factors used to determine the grade level. These grade factors are: weed seeds, damage, red rice, chalkiness, general appearance and "others."
2. Milling yield, which is the estimate of the quantity of head rice and of total milled rice

that can be obtained from a unit of rough rice. In this study a unit of rough rice was a barrel or 162 pounds of rough rice.

3. Variety of rice. In this study, long and medium grain varieties were included but they were analyzed separately. There were seven long grain varieties and four medium grain varieties being analyzed. However, not all varieties were present in each of the six seasons under consideration.

The selected non-quality factors analyzed were:

1. Lot size in barrels. To analyze the effect of this variable on price, six lot size groups were created, each one having a range of 600 barrels, except the last one which included lot sizes of 3,000 barrels and more.
2. Sales associations or locations where farmers send their rice to be dried, stored and sampled. These associations send rice samples to the Louisiana Grain Exchange, and the bids from the different mills are based on it. These sales associations represent the production area, since farmers usually send their product to the closest processing facility.
3. Commercial mills and seed companies that bid through the Louisiana Grain Exchange to obtain rice from farmers. This variable was included because the commercial mill or seed company which makes

the highest bid gets the rice, and that is the price received by the farmer.

4. Date of sale. This variable was used to compute seasonal indexes which provide information regarding the periods of the year when price is likely to be the highest and lowest.

5. A trend variable was used to represent changes in the price of rough rice due to changes in the overall price level.

Objective 2

Multiple regression analysis and the least squares method of fitting constants were used to determine and measure the grade factors affecting the grade of rough rice as given by the Louisiana Grain Exchange and by the federal government, and to measure the influence and determine the quality and non-quality factors affecting significantly the price of rough rice. The statistical models were developed with the help of the maximum R-square variable selection technique as developed by Barr and Goodnight.[1] These procedures were used because the data contained continuous and discrete variables with unequal subclass frequencies, and there is not a single variable selection technique available to develop a model using these two types of variables at the same time. The procedure used in the model building process can be divided in three steps as follows:

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[1]Anthony J. Barr and James H. Goodnight, Statistical Analysis System, Raleigh: North Carolina State University, Department of Statistics, August 1972.

STEP 1. Regression Analysis. The Maximum R-squared Improvement.

The base of any statistical model is the general linear regression analysis, which estimates the dependence of some variable (the dependent variable Y) upon one or more variables (the independent variable X_j or the jth independent variables $X_1, X_2, \ldots, X_k$).[2]

The general model can be expressed as:

$$Y_i = \mu + \sum_{j=1}^{k} b_j X_{ij} + e_i$$

$$i = 1, 2, 3, \ldots,$$

where:

Y_i = dependent variable,

μ = value of Y when all $X_i 0$ or the intercept on the Y axis,

b_j = partial regression coefficients of the dependent variable (Y) on the independent continuous variables (X),

X_{ij} = the continuous independent variables for the corresponding Y_i observation. The X_{ij} are regarded as fixed and measured without error,

e_i = the random errors assumed to be independent and normally distributed.

After all parameters have been estimated the measure of the degree of relationship between the variables, the R-squared or coefficient of determination, is computed. This coefficient shows how well the model represents the data, or what percentage of the variation of the dependent variable is explained by the selected independent variables.

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[2]George W. Snedecor and William G. Cochran, Statistical Methods, The Iowa State University Press, 6th Edition, 1967.

To determine which variables should be included in regression models, several variable selection techniques have been developed. Of the several techniques developed the maximum R-square improvement was selected for this study. This technique is as good as calculating regressions on all possible subsets of the independent variables. It is based on the R-square value or coefficient of determination and can be summarized as follows:[3]

(a) Find the simple regression model with maximum R-square.

(b) To the model obtained in (a) add the variable providing the greatest increase in R-square.

(c) Compare each included variable with each un-included variable to see if an interchange will raise R-square. After all comparisons make the switch which maximizes R-square. Repeat the comparisons until no interchanges are made.

(d) To the model obtained above add the variable which produces the greatest increase in R-square.

(e) Repeat step (c). The comparing and switching process is repeated, the "best" three variable model is discovered, and so forth.

This statistical procedure was used as implemented in the "statistical analysis system" (SAS) computer program and it is based on the least squares minimization principle.

Even though this technique was very helpful during the model building process, it can be noted that it did not yield the desirable model at once. Instead, after inspection of the different regression models obtained using this technique some regression coefficients for

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[3] <u>Op</u>. <u>cit</u>., p. 128.

some variables had unexpected signs. On the other hand, some other variables had the expected sign but were of lower statistical significance and entered the model only after variables with unexpected signs were included. To obtain the desirable model, the variables with the unexpected signs were dropped from the analysis if they were not of crucial importance, then the variables with expected signs were added and all parameters were recomputed. The process was continued until all variables in the model had the expected signs and were statistically significant at a predetermined probability level. This technique was repeated until the model had the following properties:

(a) It explained at least 80 percent of the variation of the dependent variable.

(b) All estimated regression coefficients were statistically significant at least at the .05 level of probability.

(c) There were no discernible patterns in the residuals.

To obtain unbiased regression coefficients and perform valid significance tests, the following assumptions about how the observations used in the analysis had been generated were considered:[4]

(1) The first assumption states that $E(e_i) = 0$ for all i, where "e" refers to the error term, which means that the "e_i" are variables with zero expectation.

(2) The "e_i" have constant variance, property which is referred to as homoscedasticity. Also it states

[4]J. Johnston, <u>Econometric Methods</u>, 2nd Edition, McGraw-Hill, New York, 1972.

that the "e_i's" are pairwise uncorrelated.

(3) The sole source of variation in the dependent variable is variation in the error terms (e_i) and the properties of our estimators and tests are conditional upon the values of the independent variables.

(4) The final assumption is that the number of observations exceeds the numbers of parameters to be estimated and that no exact linear relations exist between any of the independent variables.

Hypotheses Tested and Statistics Used

The hypotheses tested state that the regression coefficients do not differ from zero, i.e., they do not have any significant effect upon the dependent variable in question. The general null hypothesis can be represented as follows:

$$Ho: \ \beta_i = 0$$
$$i = 1, 2, 3, \ldots k$$

The statistic used in testing each regression coefficient can be expressed as:

$$t = \frac{\beta_i - 0}{S_{bi}}$$

with (n-1) degrees of freedom;

where:

β_i = regression coefficient.

S_{b_i} = standard error of the regression coefficient.

Rejection of the null hypothesis means that the variable in question is exerting a significant effect on the dependent variable, price of rough rice per barrel, and therefore should be included in the statistical model.

STEP 2: Least Squares Method of Fitting Constants. One-way Classification.

The least squares method of fitting constants was used because the data contained discrete variables with unequal subclass frequencies; this type of variable can not be analyzed using the maximum R-square improvement method described earlier.

The general linear mathematical model for a one-way classification as used in this analysis can be represented as follows:[5]

$$Y_{ij} = \mu + a_i + e_{ij}$$

$$i = 1, 2, 3, \ldots p$$

$$j = 1, 2, 3, \ldots n_i$$

where:

Y_{ij} = jth observation in the ith A variety of rough rice,

μ = the overall population mean when equal frequencies exist among the classes of A,

a_i = the effect of the ith A variety of rough rice expressed as a deviation from the overall mean ,

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[5]Walter R. Harvey, Least Squares Analysis of Data with Unequal Sub-class Numbers, Washington, D. C.: U. S. Government Printing Office, 1960, Department of Agriculture, A.R.S. 20-8.

e_{ij} = random errors which are assumed to be independent and normally distributed.

The constant estimates are derived through the simultaneous solution of least squares normal equations as numerous as the constants to be fitted.

Restriction

A restriction is made that the sum of the constant estimates (effect of the ith class) within a given set sum is equal to zero.

Hypothesis Tested and Statistic Used:[6]

The hypothesis tested was that the mean price of all "p" varieties of rough rice within medium and long grain rough rice were equal; in other words, that the differences in mean prices were equal to zero. The general null hypothesis is expressed as follows for "p" varieties.

$$Ho: \bar{a}_1 = \bar{a}_2 = \bar{a}_3 \ldots \bar{a}_p$$

where:

$\bar{a}$ = varieties mean price

The statistic used in testing this hypothesis was as follows:

$$F = \frac{\text{Mean Square Due to Regression}}{\text{Residual Mean Squre}}$$

with (p-1) and $[n - (p + 1)]$ degrees of freedom;

where:

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[6] Jerome C. Li, Statistical Inference, (First Edition, Ann Arbor, Michigan: Statistics Inc., 1964), Vol. II, p. 270.

p = number of varieties

n = number of observations

Rejection of the hypothesis means that the variable being analyzed had a significant effect upon the dependent variable and, therefore, should be considered for further analysis in the model building process. Acceptance of the hypothesis means that the variable in question does not have a significant effect on the dependent variable and, therefore, can be dropped from the analysis.

STEP 3: One-way Classification with Multiple Regression.

In this step the statistical model obtained in Step 1 and the discrete variable found to exert a significant effect on the dependent variable in Step 2 were put together. The combination of the two models yields a one-way classification with multiple regression. The mathematical model can be represented as follows:

$$Y_{ijk} = \mu + a_i + \sum_{k=1}^{m} b_k X_{ijk} + e_{ijk}$$

$i = 1, 2, \ldots, p$

$j = 1, 2, \ldots, n_i$

$k = 1, 2, \ldots, m$

where;

Y_{ijk} = dependent variable, the jth observation for the mth variable in the ith A class,

μ = the overall mean for the Y_{ijk} when equal frequencies exist in each of the A classes,

a_i = the effect of the ith A class,

b_k = partial regression of the dependent variable (Y) on the independent continuous variables (X) holding the discrete variable (a_i) constant,

X_{ijk} = the continuous independent varieties for the corresponding Y_{ijk} observation. The X_{ijk} are regarded as fixed and measured without error,

e_{ijk} = the random errors assumed to be independent and normally distributed.

Here again, the constant estimates are derived through the simultaneous solution of least squares normal equations which are as numerous as the constant to be fitted.

Restriction

The restriction for this model is the same as that for the one-way classification which states that the sum of the constant estimates (effect of the ith class) within a given set sum is equal to zero.

Hypothesis Tested and Statistics Used

The statistical model containing one discrete variables (the rice variety effect) and continuous variables provides the following tests:

1. The mean prices for the different varieties were equal. The general null hypothesis is expressed as follows for "p" varieties:

$$Ho:\ \bar{a}_1 = \bar{a}_2 = \bar{a}_3 = \ldots \bar{a}_p$$

where:

$\bar{a}$ = varieties mean price

The statistic used in testing this hypothesis was as follows:[7]

$$F = \frac{\text{Mean Square for Varieties}}{\text{Residual Mean Square}}$$

with (p-1) and $[n - (p + 1)]$ degrees of freedom;

where:

p = number of varieties,

n = number of observations.

2. The hypothesis tested states that the regression coefficients do not differ from zero. The general null hypothesis can be represented as follows:

$$Ho: \beta_i = 0$$
$$i = 1, 2, 3, \ldots k$$

The statistic used in testing each regression coefficient can be expressed as:

$$t = \frac{\beta_i - 0}{S_{b_i}}$$

with (n-1) degrees of freedom;

where:

β_i = regression coefficient

S_{b_i} = the standard error of the regression coefficient.

If the null hypothesis for the discrete variable as well as for each of the regression coefficients were rejected, it was concluded that they had a significant effect on the dependent

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[7] Ibid.

variable and, therefore, should be part of the statistical model. If one or more of these variables were not significant, they were dropped from the analysis, and all parameters were recalculated. This process was repeated until no changes were needed and the model had the characteristics mentioned in Step 1.

Objectives 3 and 4

To determine price variations as related to market location, production area, and month of the year, the multiple-way least squares method of fitting constants with regression or covariance was used. The general linear mathematical model which includes market location, production area, months, varieties, and quality and non-quality variables can be represented as follows:

$$Y_{ijklmn} = \alpha + a_i + b_j + c_l + d_m + b_k X_{ijlm} + e_{ijklmn}$$

where:

Y_{ijklmn} = dependent variable; the nth observation of the ith A class and the jth B class and the lth C class and the mth D class of the kth variable of the data,

α = the overall population mean when equal frequencies exist in each subclass,

a_i = the effect of the ith variety,

b_j = the effect of the jth market location,

c_l = the effect of the lth production area,

d_m = the effect of the mth month of the year,

b_k = partial regression coefficient of the dependent variable (Y) on the independent continuous variables (X) holding the discrete variable constant.

e_{ijklmn} = the random errors. These are assumed to be independent, normally distributed, with mean 0, and finite variance.

The only difference between the model developed in this objective and that developed in the previous objective is the set of classification variables taken into consideration. That is, the variables accounting for possible differences due to market location, production area, and seasonal variations were added to the the statistical model obtained in Objective 2. All parameters were recomputed, and the significance of the variables already in the model in addition to the variables being added was checked.

Restriction

The restriction for this model states that the main effects variety, market location, production area, and month, sum to zero within a given set.

Hypotheses Tested and Statistics Used

The hypotheses tested using the statistical model developed in this objective can be expressed as follows:

1. The mean price for varieties, production areas, market location and months were the same. These hypotheses can be represented as follows:

(a) Ho: $\bar{a}_1 = \bar{a}_2 = \bar{a}_3 = \ldots \bar{a}_i$

(b) Ho: $\bar{b}_1 = \bar{b}_2 = \bar{b}_3 = \ldots \bar{b}_j$

(c) Ho: $\bar{c}_1 = \bar{c}_2 = \bar{c}_3 = \ldots \bar{c}_1$

(d) Ho: $\bar{d}_1 = \bar{d}_2 = \bar{d}_3 = \ldots \bar{d}_m$

where:

$\bar{a}$ = varieties mean prices,

$\bar{b}$ = market locations mean prices,

$\bar{c}$ = production areas mean prices,

$\bar{d}$ = months mean prices.

The statistic used here was:

$$F_1 = \frac{\text{Mean Square for Varieties}}{\text{Residual Mean Square}}$$

with (i - 1) and /n - (i + 1)/ degrees of freedom;

$$F_2 = \frac{\text{Mean Square for Market Location}}{\text{Residual Mean Square}}$$

with (j - 1) and /n - (j + 1)/ degrees of freedom;

$$F_3 = \frac{\text{Mean Square for Production Areas}}{\text{Residual Mean Square}}$$

with (1 - 1) and /n - (1 + 1)/ degrees of freedom;

$$F_4 = \frac{\text{Mean Square for Months}}{\text{Residual Mean Square}}$$

with (m - 1) and /n - (m + 1)/ degrees of freedom.

where:

i = number of varieties

j = number of market locations

l = number of production areas

m = number of months

2. The regression coefficients for the different quality and non-quality variables included in the model were also tested. The null hypothesis can be represented as follows:

$$Ho: \quad \beta_i = 0$$
$$i = 1, 2, 3, \ldots k$$

The statistic used in testing each regression coefficient can be expressed as:

$$t = \frac{\beta_i - 0}{S_{b_i}}$$

with (n - 1) degrees of freedom;

where:

β_i = regression coefficient

S_{b_i} = standard error of the regression coefficient.

Upon completion of these tests, the variables significantly affecting the dependent variable were included in the model, and those with nonsignificant effects were dropped.

After all parameters were calculated, the mean prices for each month adjusted for each of the variables in the model were computed. These adjusted means are regarded as better estimates of any class effect than the unadjusted means because the sources of error are removed by the adjustments. The adjusted means were expressed as a percentage of the overall adjusted mean price and seasonal indexes for each month were computed.

Monthly seasonal price indexes are used to indicate the general pattern of price movements during the year; they provide a basis for answering questions such as the months of the year prices are likely to be the lowest and highest. Also, they show whether prices of a given commodity will increase or decrease from one month to the next.

An index of price variation is an average or typical index; it does not show perfectly what prices to expect at any particular time. It merely indicates the usual price change during the year based on a given number of years. Several factors influence commodity prices -- harvest dates and peak marketing, product supply and demand, storage holdings, demand for commodity by-products and many more. Seasonal price variation is only one of such factors. It is nearly impossible to accurately predict the behavior of all factors affecting prices and, therefore, prices in a given month seasonal price indexes show only what usually occurs within a year.

CHAPTER III

SELECTION OF QUALITY AND NON-QUALITY FACTORS AFFECTING GRADE AND PRICE OF ROUGH RICE

This chapter relates to the first objective of this study - the selection of quality and non-quality factors affecting grade and price of rough rice.

The selection of these factors was made on the basis of previous studies, knowledge of economic principles, and familiarity with the rough rice market. These factors were included in the data provided by the Louisiana Grain Exchange. In this chapter a tabular analysis is presented to obtain a better idea of the rough rice pricing and grading situation in Louisiana and to detect patterns and relationships among the different variables. This chapter provides the basis for explaining and understanding the statistical models to be developed in subsequent chapters.

The analysis presented in this chapter is divided into two parts. The first part contains the results for the medium grain varieties and the second part for the long grain varieties.

Medium Grain

The medium grain varieties represented in the sample were: Saturn, Nato, Gulfrose, and Vista. The relationship between price, quality and non-quality variables and the effect they have on the process of grade and price determination is explained in the following paragraphs.

Grade Level Frequency Within Seasons

Table 3 shows the percentage frequency distribution for the different grade levels as assigned by the Louisiana Grain Exchange during each season. This table shows that samples with grade 1 were not present during the first four seasons, and samples with grade level 2 were not present during the 1969-70 season.

Table 3. Percentage Frequency Distribution for the Different Grade Levels Within Seasons, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Louisiana Grain Exchange Grade	Marketing seasons					
	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
1	.00	.00	.00	.00	4.04	.13
2	3.48	.00	2.15	4.48	35.85	7.54
3	45.88	37.63	54.36	48.15	36.39	28.00
4	24.87	31.29	22.28	27.68	9.16	36.07
5	22.42	27.70	18.39	16.18	12.40	13.86
6	.39	2.32	1.34	.39	1.08	5.92
7	2.96	1.06	1.48	3.12	1.08	8.48

A closer examination of Table 3 reveals that grade levels 3, 4 and 5 accounted for most of the observations, grade 3 having the largest frequency during the first five seasons and grade 4 during the 1973-74 season. The remaining grade levels, 1, 2, 6 and 7 represented less than 8.5% of the observations within a given season, the only exception occurring during the 1972-73 season which had 35.85% of the observations at grade level 2.

Distribution Patterns of Grade Factors

Table 4 shows the frequency distribution of grade factor levels found during the period under study. It also shows the frequency

Table 4. Percentage Frequency Distribution for Grade Factor Levels, Louisiana Grain Exchange and Government Grade, Medium Grain Rice, Louisiana, 1968-69 to 1973-74*

Levels	Red Rice	Seeds	Chalk	Damage	Others	General Appearance	Louisiana Grain Exchange Grade	Government Grade
1	29.96	77.22	.74	57.61	89.12	.91	.44	11.26
2	32.06	3.34	15.99	10.22	2.24	6.99	7.04	37.45
3	20.33	9.55	62.94	12.78	4.14	42.14	42.23	21.64
4	8.56	5.25	18.45	10.74	3.34	26.07	26.26	16.66
5	4.83	2.35	1.63	4.86	.78	18.50	18.62	7.38
6	2.82	1.16	.22	1.41	.08	2.02	2.04	2.32
7	1.44	1.13	.03	2.38	.30	3.37	3.37	3.29

*The data for government grade are based on the last four seasons only, 1970-71 to 1973-74.

distribution for each grade level as given by the Louisiana Grain Exchange by the federal government. The distribution pattern and apparent relations among the variables included in the table can be summarized as follows:

Red Rice: The majority of samples were rated at levels 1 through 4. These 4 red rice levels comprised 90.91 percent of the observations.

Seeds: Level 1 of this grade factor accounted for 77.22 percent of the observations. The rest were evenly distributed among the remaining levels.

Chalk: Most observations were rated at level 3, with the remainder concentrated in levels 2 and 4. In fact, these three levels comprised 97.38 percent of the observations.

Damage: Level 1 accounted for 57.61 percent of the observations and levels 2, 3 and 4 comprised 33.74 percent, with levels 6 and 7 being of lesser importance.

Other: Level 1 of this factor had 89.12 percent of the observations, the remainder being evenly distributed among the other levels.

General Appearance: Over 85 percent of the observations were rated 3, 4 or 5, the remainder being evenly distributed at levels 2, 6 and 7; level 1 was assigned to only 0.91 percent of the observations.

Louisiana Grain Exchange Grade: Levels 3, 4 and 5 comprised 87.11 percent of the observations; levels 2, 6 and 7 had 7.04, 2.04 and 3.37 percent, respectively; level 1 comprised less than 0.5 percent of the observations. The close similarity in distribution for Louisiana Grain Exchange grade and general appearance was striking. It seemed that general appearance and grade were practically synonymous.

Government Grade: Levels 1, 2, 3 and 4 comprised 87.01 percent of the observations, the remainder being evenly distributed among the remaining levels. Comparing the distribution of government grade for the different levels with the Louisiana Grain Exchange grade distribution, the difference is evident. Apparently the federal government assigns better grades to the same sample of rice than those assigned by the Louisiana Grain Exchange.

Grade Factors Frequency Within Grade Levels

Table 5 shows the frequency distribution of the levels of grade factors as they occurred within the group of observations rated at different grade levels. Government grade was included in this table to analyze the origin of the differences of this grade with the grade given by the Louisiana Grain Exchange.

It can be seen that the frequency distribution of the grade factors red rice, seed, chalk, damage, "others" and general appearance, followed in a general way the same pattern as they exhibited when their frequencies were calculated on the basis of all grades together, as shown in Table 4. Also, it can be seen that most factor levels associated with a particular Louisiana Grain Exchange grade are equal to or better than grade level. However, in every grade level a small percentage of rice lots had a grade factor higher (inferior) than the grade level. This occurred in approximately 10 percent of the observations.

Table 5. Within Grade Level Percentage Frequency Distribution, for Grade Factor Levels, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

La. Grain Exchange Grade	Grade Factor	Grade Factor Levels 1	2	3	4	5	6	7
1	Red Rice	56.25	6.25	37.50				
	Seed	100.00						
	Chalk	87.50	6.25	6.25				
	Damage	93.75	6.25					
	Others	100.00						
	General Appearance	93.75	6.25					
	Government Grade*	93.75	6.25					
2	Red Rice	41.96	30.98	21.57	3.92	1.57		
	Seed	95.70	1.17	2.74	.39			
	Chalk	1.17	97.26	1.57				
	Damage	77.25	22.36	.39				
	Others	84.31	15.30	.39				
	General Appearance	.39	96.09	3.52				
	Government Grade*	35.53	63.59	.44				.44
3	Red Rice	35.51	37.28	20.01	5.62	1.45	.13	
	Seed	86.79	2.29	10.52	.20	.13		.07
	Chalk	.25	14.26	85.42	.07			
	Damage	77.44	7.91	14.65				
	Others	91.11	2.22	6.60	.07			
	General Appearance	.98	.32	98.63		.07		
	Government Grade*	16.68	64.22	19.10				
4	Red Rice	23.86	33.26	23.55	11.15	6.30	1.78	.10
	Seed	71.19	5.47	9.36	13.57	.10	.31	
	Chalk	.42	7.37	55.63	36.48		.10	
	Damage	45.43	13.14	10.51	30.92			
	Others	85.28	.74	4.42	9.56			
	General Appearance	.21	.10	.74	98.85	.10		
	Government Grade*	.66	16.23	41.31	41.80			

(Continued)

Table 5. (Continued)

La. Grain Exchange Grade	Grade Factor	Grade Factor Levels						
		1	2	3	4	5	6	7
5	Red Rice	21.37	21.51	17.51	13.95	12.17	10.09	3.40
	Seed	66.32	3.56	11.72	6.38	11.28	.74	
	Chalk	.30	4.60	52.07	36.20	6.68		.15
	Damage	31.31	9.50	19.73	13.95	25.51		
	Others	92.73	.15	.59	3.41	3.12		
	General Appearance			.30	.59	99.11		
	Government Grade*	.27	.81	18.70	37.13	43.09		
6	Red Rice	20.27	31.08	12.16	8.11	5.40	16.22	6.76
	Seed	37.84	2.70	2.70	8.11	6.76	41.89	
	Chalk	4.05	43.24	39.20	9.46	4.05		
	Damage	24.32		5.40		1.35	68.93	
	Others	85.14			4.05	8.11	2.70	
	General Appearance						98.65	1.35
	Government Grade*				1.67	16.67	81.66	
7	Red Rice	32.79	22.13	14.75	6.56	2.46	2.46	18.85
	Seed	46.72	4.09	6.56	6.56	.82	2.46	32.79
	Chalk		6.56	45.90	38.52	5.74	3.28	
	Damage	23.78	1.63	.82	.82	2.46		70.49
	Others	85.25		1.63	2.46	.82	.82	9.02
	General Appearance		.82					99.18
	Government Grade*		1.07	1.07	2.16	6.45	6.45	82.80

*The data for government grade are based on the last four seasons only, 1970-71 to 1973-74.

Further examination of Table 5 shows that in every case the limiting factor involved in these cases was red rice. This suggests that this factor is treated differently from the other factors in the process of grade determination.

Table 5 also contains the frequency distribution for government grade within the Louisiana Grain Exchange grade levels. A comparison of these two grade systems revealed that with a very few exceptions, government grade was better or equal to the Louisiana Grain Exchange grade; these exceptions occurred at grade levels 1 and 2. The largest discrepancy occurred at level 3 where 80.90 percent of the observations graded at that level by the Louisiana Grain Exchange were rated at levels 1 and 2 by the federal government. In fact, 64.22 percent were rated at level 2 and 16.68 percent at level 1.

<u>Relation Between Grade Levels, Price and Head Rice Yield</u>

Table 6 shows the mean prices and head rice yield for different grades for groups of lots within levels as rated by the Louisiana Grain Exchange and the government. It can be noted that as grade level

Table 6. Mean Price and Head Rice Yield per Barrel of Rough Rice for Observations Graded at Different Levels by the Louisiana Grain Exchange and by the Government, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Grade	Price per Barrel		Head Rice Yield per Bushel	
Level	La. Grain Exchange	Government*	La. Grain Exchange	Government*
1	10.72	12.26	104.81	97.48
2	10.84	12.19	100.71	95.51
3	10.68	11.96	95.09	90.99
4	10.59	12.28	91.36	89.46
5	10.42	12.01	88.45	85.77
6	10.09	11.79	88.31	88.40
7	10.30	11.37	81.29	80.96

* Means for government grade samples are based on the last four seasons only, 1970-71 to 1973-74, due to lack of data.

increases (goes from 1 to 7), price decreases. The mean price for the Louisiana Grain Exchange lots of rice rated at levels 2 and 7 and those rated by the government at levels 4 and 5 are exceptions to this pattern; the average prices for these grade levels were slightly higher than the mean prices for the subsequent grade levels. The mean prices for government grades were higher than the mean prices for Louisiana Grain Exchange grades due to the fact that government grade data was not available for the first two seasons under study, which exhibited the lowest prices.

With respect to average head rice yield it can be seen that it steadily decreases as grade level increases. This was noted for the observations graded at different levels by the Louisiana Grain Exchange and by the government. The only exception to this occurred for the observations graded at level 6 by the government, in which average head rice yield was higher than the average for the observations graded at level 5.

Relation Between Head Rice Yield and Price

Table 7 shows the average price for 21 selected head rice yield groups for each season under study. It can be seen that as head rice yield per barrel increases price also increases. This pattern was observed in each of the 6 seasons analyzed. Some exceptions to this relationship occurred, especially for the low head rice yield groups which also had a low number of observations.

Relation Between Price and Lot Size Group

Table 8 shows the average prices for 6 selected lot size groups in barrels for each season under study. An overall view of the table

Table 7. Mean Prices per Barrel of Rough Rice for Selected Head Rice Yield Groups for Each Season, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Head Rice Yield Group	Marketing Seasons 1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
10 - 19.99			5.35	4.08	9.37	11.16
20 - 24.99	5.00		4.96	4.50		
25 - 29.99		5.10	6.20			
30 - 34.99	6.13		5.39	5.68		
35 - 39.99			5.94		8.40	14.17
40 - 44.99	6.23	4.55	6.01	5.10		14.34
45 - 49.99	6.20		6.45	5.72		16.30
50 - 54.99	6.15		7.11	6.67	10.93	17.07
55 - 59.99	6.55		6.78	7.01		18.02
60 - 64.99	6.88		7.02	7.49	9.91	20.21
65 - 69.99	6.66	6.77	7.16	7.56	9.71	18.50
70 - 74.99	7.14	7.03	7.38	8.04	9.85	20.13
75 - 79.99	7.18	6.93	7.56	7.62	9.91	21.46
80 - 84.99	7.32	7.22	7.58	7.86	10.06	21.37
85 - 89.99	7.47	7.34	7.70	8.07	9.97	20.70
90 - 94.99	7.57	7.53	7.94	8.29	10.54	21.48
95 - 99.99	7.69	7.69	8.01	8.35	10.48	22.25
100 - 104.99	7.81	7.91	8.19	8.52	10.85	22.78
105 - 109.99	7.97	8.09	8.28	8.52	11.39	24.19
110 - 114.99	8.12	8.27	8.19	8.57	12.13	25.19
115 and over	8.02					

Table 8. Mean Prices per Barrel of Rough Rice for Selected Lot Size Groups for Each Season, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Lot Size (bbl.)	Marketing Season 1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
0 - 599.99	7.37	7.41	7.73	7.90	10.99	21.94
600 - 1199.99	7.56	7.67	7.85	8.23	10.47	21.88
1200 - 1799.99	7.65	7.74	7.91	8.13	10.56	22.02
1800 - 2399.99	7.73	7.85	7.98	8.21	10.58	22.03
2400 - 2999.99	7.75	7.73	7.97	8.17	10.93	23.04
3000 and over	7.72	7.70	8.02	8.43	11.38	22.94

reveals the positive relationship between price and lot size; that is, price increases as lot sizes increase. Exceptions occurred during each one of the 6 seasons, most of them being present for the larger lot size groups.

Relation Between Price and Rice Variety

Table 9 shows the mean price per barrel for each medium grain variety during each season of the period included in the study. It can be noted that in 4 of the 6 seasons the price of the variety Nato was the highest, and the variety Gulfrose had the highest mean price per barrel for the remaining 2 seasons. The Saturn variety exhibited the lowest price during each of the 6 seasons of the 1968-69 to 1973-74 period. The varieties Nato and Saturn were the only varieties for which transactions were recorded during each season of the period under consideration.

Table 9. Mean Prices per Barrel of Rough Rice for Each Variety Within Season, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

	Marketing Season					
Varieties	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
Saturn	7.58	7.60	7.84	8.15	10.67	21.61
Nato	7.68	7.99	7.98	8.29	10.83	23.56
Gulfrose	8.21			8.21	10.91	
Vista						21.98

Relation Between Price and Month of Year

Table 10 shows the mean price per barrel of rough rice for each month of the period being analyzed. It can be noted that the highest

Table 10. Mean Price per Barrel of Rough Rice for Each Month Within Seasons, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Month	Marketing Season					
	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
August	7.58	7.33	7.90	7.72	9.17	16.75
September	7.43	7.68	7.74	7.55	9.74	19.88
October	7.63	7.61	7.72	7.72	11.35	21.22
November	7.89	7.80	7.87	7.93	12.62	26.59
December	7.22	7.55	7.81	8.40	13.45	25.29
January	7.57	7.79	8.23	8.75	13.16	25.93
February	7.91	6.78	8.57	8.60	13.50	26.50

mean prices occurred during the last months of the season and the lowest prices occurred during the beginning of the season. The highest mean prices for the 1968-69, 1970-71, 1972-73, and 1973-74 seasons occurred during the month of February. The highest mean prices for the remaining two seasons, 1969-70 and 1971-72, occurred during the months of November and January, respectively.

Long Grain

The long grain varieties represented in the sample were: Belle Patna, Blue Belle, Blue Bonnet, Star Bonnet, Dawn, Toro and Labelle. The following paragraphs show the relationship between price, quality and non-quality variables and the role they play in the process of grade and price determination.

Grade Level Frequency Within Seasons

Table 11 shows the frequency distribution in percentages for the different grade levels as assigned by the Louisiana Grain Exchange during

Table 11. Percentage Frequency Distribution for the Different Grade Levels Within Season, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Louisiana Grain Exchange Grade	Marketing Season 1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
1	2.71	.00	2.15	.28	7.39	4.95
2	48.40	23.99	27.30	40.17	38.26	37.36
3	28.15	36.61	43.56	28.37	24.79	26.37
4	8.64	17.68	11.35	13.20	14.78	18.96
5	8.40	16.67	10.12	10.68	10.00	6.32
6	1.73	3.28	3.37	3.65	2.61	2.47
7	1.97	1.77	2.15	3.65	2.17	3.57

each season of the period under study. It reveals that levels 2, 3, 4, and 5, especially 2 and 3, comprised most of the observations within each season; in fact, grade level 2 had the largest frequency during the first and last three seasons. Each of the remaining grade levels, 1, 6, and 7, accounted for less than 9 per cent of the observations within each season. There were no observations graded at level 1 during the second season.

Distribution Pattern of Grade Factors

Table 12 shows the frequency distribution of grade factor levels as well as the frequency distribution for grade level as rated by the Louisiana Grain Exchange and the federal government. The distribution pattern of each grade factor and apparent relations among the variables included in the table can be summarized as follows:

Red Rice: Most observations were rated at levels 1, 2 and 3. These three levels comprised 80.88 percent of the observations. The remainder, 19.12 percent, was evenly distributed among the other levels.

Table 12. Percentage Frequency Distribution for Grade Factor Levels, Louisiana Grain Exchange and Government Grade, Long Grain Rice, Louisiana, 1968-69 to 1973-74*

Levels	Red Rice	Seeds	Chalk	Damage	Others	General Appearance	Louisiana Grain Exchange Grade	Government Grade
1	36.06	76.70	5.10	80.12	83.97	3.23	2.60	37.62
2	26.91	2.84	58.50	7.99	6.65	35.58	35.96	31.19
3	17.91	8.57	29.47	5.87	5.63	31.24	31.54	13.17
4	7.75	4.04	5.97	3.47	2.36	14.06	14.06	10.27
5	5.78	4.19	.91	1.35	.91	10.50	10.45	3.84
6	3.76	2.36	.05	.48	.24	2.84	2.84	2.11
7	1.83	1.30	.00	.72	.24	2.55	2.55	1.80

*The data for government grade are based on the last four seasons only, 1970-71 to 1973-74.

Seeds: Level 1 of this grade factor accounted for most of the observations, 76.70 percent of the observations being at this level.

Chalk: Levels 2 and 3 accounted for 58.50 percent and 29.47 percent of the observations, respectively. The remainder was concentrated at levels 1 and 4. There were no observations rated at level 7, and observations at levels 1 and 6 were of limited occurrence.

Damage: Level 1 was given to 80.12 percent of the observations. The remaining observations were concentrated at levels 2 through 5, with levels 6 and 7 being of limited occurrence.

Other: Level 1 of this grade factor comprised 83.97 percent of the observations. Levels 2, 3 and 4 comprised 6.65, 5.63 and 2.36 percent of the observations, respectively. Levels 6 and 7 together had a frequency of less than 0.5 percent.

General Appearance: Levels 2, 3 and 4 comprised 80.88 percent of the observations. Level 5 had a frequency of 10.50 percent, the remainder was evenly distributed among levels 1, 6 and 7.

Louisiana Grain Exchange Grade: Levels 2, 3 and 4 accounted for 80.56 percent of the observations. Level 5 comprised 10.45 percent of the observations, the remainder being evenly distributed among levels 1, 6 and 7. A comparison of the Louisiana Grain Exchange grade and general appearance frequency distributions show that they are practically the same. As in the case of medium grain, it seems as if general appearance and grade were equivalent.

Government Grade: Grade levels 1 through 4 accounted for 92.25 percent of the observations, with level 1 exhibiting the largest frequency, 37.62 percent. The remainder was distributed among levels 5, 6 and 7. Comparing the frequency distribution of government grade with the Louisiana Grain Exchange grade, it is clear that the federal government assigns better grades to the same lot of rice than those assigned by the Louisiana Grain Exchange.

Grade Factors Frequency Within Grade Levels

The frequency distribution of the levels of grade factors as they occurred within the groups of lots graded at the different levels by the Louisiana Grain Exchange is shown in Table 13. The factor general appearance is included in the table to show that it is practically synonymous with the grade level as given by the Louisiana Grain Exchange. Also, the table includes the frequency distribution of the government grades as they occurred within the groups of lots graded at different levels by the Louisiana Grain Exchange.

As shown in Table 13, the frequency distribution of the grade factors followed in a general way the same pattern that they had when their frequencies were calculated for each grade level as shown in Table 12. It also shows that most factor levels associated with a particular Louisiana Grain Exchange grade are equal to or less than grade level. However, at each grade level some observations showed levels for grade factors which were higher (inferior) to the grade level in question. This occurred in approximately 230 out of 2077 or 11 percent of the observations. Further analysis shows that at each grade level the

Table 13. Within Grade Level Percentage Frequency Distribution, for Grade Factor Levels, Long Grain Rice, Louisiana, 1968-69 to 1973-74

La. Grain Exchange Grade	Grade Factor	Grade Factor Levels						
		1	2	3	4	5	6	7
1	Red Rice	74.07	20.37	5.56				
	Seed	96.30		3.70				
	Chalk	96.30		3.70				
	Damage	100.00						
	Others	100.00						
	General Appearance	100.00						
	Government Grade*	100.00						
2	Red Rice	54.62	30.92	13.12	1.34			
	Seed	94.51	2.55	1.07	.80	.13	.94	
	Chalk	2.41	97.06	.40	.13			
	Damage	81.53	18.20	.27				
	Others	90.09	9.79	.13				
	General Appearance	1.48	97.33	.80		.13	.13	.13
	Government Grade*	67.10	32.68	.22				
3	Red Rice	32.52	32.52	26.26	7.18	1.52		
	Seed	75.56	3.36	19.24	.76	.46	.31	.31
	Chalk	3.05	41.68	54.96	.31			
	Damage	82.44	1.68	15.88				
	Others	85.04	5.50	9.46				
	General Appearance	.15	1.68	98.02	.15			
	Government Grade*	38.61	61.08	.31				
4	Red Rice	17.12	22.60	19.18	25.00	15.07	1.03	
	Seed	63.70	2.40	7.53	19.86	.68	4.45	1.38
	Chalk	3.77	35.96	40.07	20.20			
	Damage	70.20	3.43	2.74	23.63			
	Others	74.32	7.19	6.85	11.64			
	General Appearance				99.66	.34		
	Government Grade*	3.21	20.86	34.76	41.17			

(Continued)

Table 13. (Continued)

La. Grain Exchange Grade	Grade Factor	Grade Factor Levels						
		1	2	3	4	5	6	7
5	Red Rice	13.82	11.52	12.45	10.60	27.19	22.12	2.30
	Seed	47.93	3.69	7.83	5.07	33.64	1.84	
	Chalk	1.84	35.02	42.40	15.67	5.07		
	Damage	79.72	3.69	2.77	1.38	12.44		
	Others	73.27	3.69	12.90	5.07	5.07		
	General Appearance	.46		.46		99.08		
	Government Grade*	1.71	9.40	15.38	41.03	32.48		
6	Red Rice	6.78	5.08	13.56	11.86	10.17	40.68	11.87
	Seed	40.68	3.39	3.39	5.08	8.47	37.29	1.70
	Chalk		35.59	38.98	22.03	1.70	1.70	
	Damage	79.66		1.70			16.94	1.70
	Others	76.28		5.08	5.08	5.08	8.48	
	General Appearance						98.30	1.70
	Government Grade*		10.26	5.13	12.82	20.51	48.72	2.56
7	Red Rice	7.55	18.87	15.09	1.89	1.89	5.66	49.05
	Seed	49.05	1.89	1.89	1.89	5.66	1.89	37.73
	Chalk	1.89	24.53	32.08	28.30	13.20		
	Damage	67.92	1.89	1.89		1.89		26.41
	Others	73.59		5.66	1.89	9.43		9.43
	General Appearance		1.89			1.89		96.22
	Government Grade*	2.63	5.26	2.63	2.63	7.89	21.05	57.91

*The data for government grade are based on the last four seasons only, 1970-71 to 1973-74.

factor involved was red rice. Again, as in the case of medium grain, this suggests that this factor is treated differently from the other factors in the rice grading process.

Table 13 also contains the frequency distribution for government grade within Louisiana Grain Exchange grade levels. A comparison of these two grade systems revealed that, with a very few exceptions, government grade was equal or better than the grade level assigned by the Louisiana Grain Exchange to the sample lots of rice. Some exceptions occurred at levels 2 and 6. The largest discrepancy in grades assigned was for samples at level 3, where, of the total samples graded at that level by the Louisiana Grain Exchange, 99.69 percent of those observations were rated at levels 1 and 2 by the federal government; in fact, levels 1 and 2 had frequencies of 38.61 and 61.08 percent, respectively.

Relation Between Grade Levels, Price and Head Rice Yield

Table 14 shows the average price and head rice yield for different grades, for the groups of lots within levels as rated by the Louisiana Grain Exchange and by the government. It can be seen that as grade level increases price decreases. For lots graded at different levels, price decreased from $11.56 per barrel for lots graded at level 1 by the Louisiana Grain Exchange to $8.43 per barrel for lots graded at level 7. A similar relationship can be noted for the lots graded at different levels by the government, average price was equal to $12.78 per barrel at level 1 and decreased to $9.21 per barrel at level 7.

The average prices at the different grade levels were higher for the government due to the fact that the data for government grade during the first two seasons, which exhibited the lowest prices, were not available.

A similar relationship can be observed for average head rice yield. Head rice yield steadily decreases as grade level increases. It decreased from 91.94 pounds per barrel for level 1 to 65.79 pounds per

Table 14. Mean Price and Head Rice Yield for Observations Graded at Different Levels by the Louisiana Grain Exchange and by the Government,* Long Grain Rice, Louisiana, 1968-69 to 1973-74

Grade	Price per Barrel		Head Rice Yield per Barrel	
Level	La. Grain Exchange	Government	La. Grain Exchange	Government
1	11.56	12.78	91.94	88.78
2	11.20	12.70	87.79	87.65
3	10.97	12.41	85.08	84.53
4	10.93	12.23	82.55	80.21
5	10.37	11.59	78.59	79.43
6	9.34	10.66	75.27	74.07
7	8.43	9.21	65.79	66.00

*Means for government grade samples are based on the last four seasons only, 1970-71 to 1973-74, due to lack of data.

barrel for level 7 for lots graded by the Louisiana Grain Exchange, and for lots graded at different levels by the government it decreased from 88.78 pounds per barrel for level 1 to 66 pounds per barrel for level 7.

Relation Between Head Rice Yield and Price

Table 15 shows the average price for 19 selected head rice yield groups for each season under study. It can be noted that as head rice yield per barrel increases price also increases. This pattern was observed in each of the 6 seasons being analyzed. As in the case of medium grain, some exceptions to this pattern occurred, but they were of minor importance.

Relation Between Price and Lot Size Group

Table 16 shows the average price per barrel for 6 selected lot size groups for each of the seasons of the period under study. An overall view of the table shows the positive relationship between these two

Table 15. Mean Prices per Barrel of Rough Rice for Selected Head Rice Yield Groups for Each Season, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Head Rice Yield Group	Marketing Seasons 1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
15 - 19.99						6.25
20 - 24.99				3.75		
25 - 29.99				5.00		
30 - 34.99		2.04				7.57
35 - 39.99	5.85		5.15			
40 - 44.99		4.88		5.83	6.55	
45 - 49.99				6.80		
50 - 54.99	7.01	5.72	6.37	6.90	5.00	14.68
55 - 59.99	6.61	6.28	6.08	6.59	7.51	16.29
60 - 64.99	6.87	6.20	6.59	6.04	9.79	17.03
65 - 69.99	7.18	6.76	7.40	7.48	8.68	17.63
70 - 74.99	7.39	7.10	7.70	7.40	9.49	20.43
75 - 79.99	7.68	7.34	7.80	7.76	10.85	21.63
80 - 84.99	7.89	7.71	8.20	8.19	9.60	21.90
85 - 89.99	8.33	7.78	8.44	8.62	10.42	22.69
90 - 94.99	8.49	8.21	8.63	8.77	10.73	23.80
95 - 99.99	8.66	8.47	8.96	8.98	11.04	24.30
100 - 104.99	8.77	8.42	9.32	9.28	10.66	26.19
105 - 109.99	7.92		9.55		11.14	30.43

Table 16. Mean Prices for Selected Lot Size Groups for Each Season, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Lot Size (bbl.)	Marketing Seasons 1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
0.00 - 599.99	7.66	7.20	7.98	8.02	10.47	22.51
600.00 - 1199.99	8.05	7.68	8.33	8.53	9.91	23.32
1200.00 - 1799.99	8.11	7.86	8.46	8.78	10.55	21.73
1800.00 - 2399.99	8.23	8.15	8.49	8.67	10.39	22.90
2400.00 - 2999.99	8.34	7.70	8.67	8.70	9.39	23.31
3000.00 and over	8.38	7.76	8.32	8.86	10.83	24.39

variables; that is, price per barrel increases as lot size increases. This relationship can be clearly seen for the 1968-69 and 1970-71 seasons, when only one exception to this pattern was found. The mean price per barrel for the largest lot size group for the 1970-71 season was lower than that of the preceding group. The positive relationship between these two variables was not as definite for the remaining 4 seasons as it was for the 1969-70 and 1970-71 seasons.

Relation Between Price and Rice Variety

Table 17 shows the mean price for each long grain variety during each season under study. The Toro variety showed the highest prices during the 1970-71, 1971-72 and 1972-73 seasons, being equal to $9.24, $9.04 and $11.44 per barrel, respectively. The Blue Bonnet variety had

Table 17. Mean Prices for Each Variety Within Seasons, Long Grain Rice, Louisiana, 1968-69 to 1973-74

	Marketing Seasons					
Varieties	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
Belle Patna	8.05	7.65	8.12	8.45	9.70	21.15
Blue Belle	7.85	7.44	7.97	7.77		22.48
Blue Bonnet	8.65		8.95	8.49		28.47
Star Bonnet			8.49	8.56	10.75	24.04
Dawn	7.66		7.75	8.68		
Toro	8.49		9.24	9.04	11.44	25.02
Labelle						22.00

the highest prices during the 1968-69 and 1973-74 seasons, being equal to $8.65 and $28.47 per barrel, respectively. The Belle Patna variety had the highest price during the 1969-70 season and was equal to $7.65 per barrel. Dawn and Blue Belle varieties exhibited the lowest prices during the 1968-69, 1969-70, 1970-71 and 1971-72 seasons, while Belle Patna had the lowest prices during the last two seasons of the period being analyzed.

Relation Between Price and Month of the Year

Table 18 shows the mean price per barrel of rough rice for each month of the period being studied. It can be seen that highest prices

Table 18. Mean Price for Each Month Within Seasons, Long Grain Rice, Louisiana, 1968-69 to 1973-74

	Marketing Seasons					
Month	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
July	8.49	7.00	8.41	8.61	9.44	18.00
August	7.88	7.23	8.23	8.63	8.92	18.58
September	7.64	7.79	8.36	8.34	10.07	22.06
October	8.14	7.75	8.41	7.62	11.14	23.82
November	8.03	7.31	7.24	8.20	11.54	24.88
December	8.18	7.15	7.76	8.38	13.48	18.81
January	8.33	7.62	8.66	8.55	11.00	24.83
February	8.62	7.87	6.95	8.95	12.00	26.11

occurred during February in the 1968-69, 1969-70, 1971-72 and 1973-74 seasons. The highest mean price for the 1970-71 and 1972-73 seasons occurred during January and December, respectively. It was noted that the lowest prices for each season occurred during the early months of the season, the exception being the 1970-71 season, in which the lowest price occurred during February.

Table 18 also shows the upward trend in prices during recent years, the 1969-70 season exhibiting the lowest prices and the 1973-74 season the highest prices.

Synopsis

The following generalizations were made concerning medium and long grain varieties, based on the tabular analysis presented in this chapter.

The operative grade levels of the market were levels 2, 3, 4, and 5. The remaining grades were either absent for 1 or more of the seasons or comprised less than 9 percent of the observations.

The frequency distribution of grade factors for medium and long grain rice was very similar. The only difference was with respect to the grade factor damage, which was at level 1 in 80.12 percent of the medium grain observations and was distributed among levels 1 through 4 for long grain.

Government grade seemed to assign better grades to some lots of rice than the Louisiana Grain Exchange. This was noted in the medium and long grain varieties.

For both medium and long grain observations most factor levels associated with a particular Louisiana Grain Exchange grade were equal to or less than grade level. Some exceptions occurred in both cases, usually the factor red rice.

General appearance was practically synonymous with Louisiana Grain Exchange grade.

For both medium and long grain varieties a positive relationship was noted between grade and price, grade and head rice, head rice and price, and lot size and price, even though this last relationship was not as definite as the others mentioned.

The seasonal movements and trend of prices were similar for both the medium and long grain rice varieties. It was noted that prices were relatively low at the beginning of the season or at harvest time, and relatively high at the end of the season. Also, there was an upward movement in price for both types of rice in recent years.

Tables showing the mean price per barrel at each location and for each mill within seasons for medium and long grain rice varieties are presented in Appendix Table 1.

Even though the same overall relationships between the different variables was found to exist for medium and long grain varieties, they were analyzed separately in this chapter as well as in the following chapters, because these relationships were not of the same magnitude. The following chapter provides a measure of the extent and significance of the variables which affect the grading and pricing of rough rice in Louisiana.

CHAPTER IV

WEIGHTING OF GRADE FACTORS IN GRADE DETERMINATION AND SIGNIFICANCE AND MEASURE OF FACTORS AFFECTING PRICE OF ROUGH RICE

This chapter deals with the main purpose of this study - the weighting of grade factors in grade level determination and the selection of quality and non-quality factors significantly affecting the price of rough rice in Louisiana. Two main sections comprise the chapter; the first is concerned with the weighting of grade factors in grade level determination and the second is concerned with price analysis. The analyses were performed separately for medium grain and long grain varieties.

Weighting of Grade Factors in Grade Determination

Multiple regression analysis and the maximum R-squared improvement variable selection technique (as explained in Chapter II) were used to determine the significance and measure the weight of grade factors in the assignment of grade levels to lots of medium and long grain rice varieties.

The independent variables considered in this analysis were the grade factors red rice, seeds, chalk, damage and "others." The grade factor general appearance was not included in this analysis because it was practically synonymous with Louisiana Grain Exchange grade and highly correlated with government grade, which in turn, were the dependent variables being studied. When this grade factor was included in the analysis it accounted for most of the grade level variations and the magnitude of its regression coefficient was very large in relation to those of the other grade factors.

The following paragraphs present the results obtained for medium and long grain rice for the two selected independent variables.

Medium Grain

The results for the medium grain varieties are presented in Table 19. The hypothesis that grade factor levels had a significant and additive effect on grade levels is justified by the results of the analysis. The grade factor "others" was not significant in either of the two grading methods and was dropped from the analysis. In all other cases the regression coefficients for the grade factors were significant at the .0001 probability level.

The R-squared values for the two models were significant at the .0001 level of probability and were equal to 68.54 percent for the model with the Louisiana Grain Exchange grade level as the dependent variable and equal to 77.83 percent for the model with government grade as the dependent variable. These R-squared values show the percentage of variation in grade explained by the grade factors included in the model.

The magnitude of the regression coefficients of the grade factors indicate their average weighting in grade determination. When the two models were compared, the weight attached to each grade factor appeared to be different. Chalk appeared to exert the greatest influence (.6848) for the Louisiana Grain Exchange grade, then in descending order were damage (.3475), seeds (.2636), and finally red rice (.1519). For

Table 19. Regression of Louisiana Grain Exchange Grade and Government Grade on Grade Factors, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Louisiana Grain Exchange			Government Grade*		
	Regression Coefficients	t-Values	Significance Level	Regression Coefficients	t-Values	Significance Level
Intercept	.1503			-.5623		
Red Rice	.1519	19.60	.0001	.2438	24.91	.0001
Chalk	.6848	42.91	.0001	.3966	18.97	.0001
Seeds	.2636	31.30	.0001	.1713	15.43	.0001
Damage	.3475	50.00	.0001	.5991	68.24	.0001
R Squared	68.54%			77.83%		

* The analysis for Government Grade was based on the last four seasons due to lack of data.

Table 20. Regression of Louisiana Grain Exchange Grade and Government Grade on Grade Factors, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Louisiana Grain Exchange			Government Grade*		
	Regression Coefficients	t-Values	Significance Level	Regression Coefficients	t-Values	Significance Level
Intercept	-.3843			-1.2769		
Red Rice	.3468	32.43	.0001	.4673	33.86	.0001
Chalk	.6644	30.00	.0001	.4723	15.57	.0001
Seeds	.3976	36.65	.0001	.2251	16.05	.0001
Damage	.0798	5.16	.0001	.4088	21.54	.0001
Others	.2348	12.47	.0001	.1376	5.53	.0001
R-Squared	73.09%			74.58%		

* The analysis for Government Grade was based on the last four seasons due to lack of data.

government grade the situation was different; damage appeared to exert the greatest influence (.5991), being followed by chalk (.3966), red rice (.2438), and finally seeds (.1713).

Long Grain

Table 20 shows the results of the grade determination analysis for long grain varieties. As in the case of medium grain varieties, grade as given by the Louisiana Grain Exchange and by the government was used as dependent variable and the grade factors, red rice, seeds, damage, chalk, and "others" as the set of independent variables.

This table shows that all regression coefficients for the two models were significant at the .0001 level of probability. The R-squared values were equal to 73.09 percent when Louisiana Grain Exchange was the dependent variable, and equal to 74.58 percent when government grade was the dependent variable. These coefficients show the percentage of grade variation explained by the grade factors in the model.

The regression coefficients for the different grade factors indicate their average weighting in grade level determination. A comparison of the regression coefficients from the two models showed that they were weighted differently by the Louisiana Grain Exchange and by the federal government. Chalk appeared to exert the greatest influence (.6644) for the Louisiana Grain Exchange grade determination, then in descending order were seeds (.3976), red rice (.3468), "others" (.2348) and damage (.0798). In the determination of government grade chalk also appeared to exert the greatest influence (.4723) being closely followed by red rice (.4673), damage (.4088), seeds (.2251), and finally "others" (.1376).

Synopsis

After studying Tables 19 and 20 it is clear that the Louisiana Grain Exchange and the federal government did not treat the levels of the various quality characteristics as true grade factors. The grade factors were weighted differently by the Louisiana Grain Exchange and by the federal government and these weights were not equal for all grade factors. Also, there was a difference in grading and weights of grade factors in the determination process of grade level for medium and long grain varieties. All grade factors appeared to be significant for the two long grain rice models, while for the medium grain rice, the grade factor "others" was not statistically significant in any of the two models.

Price Determination

To determine the significance and measure the effect of quality and non-quality factors on price, the statistical procedure outlined in Chapter II for Objective 2 was used.

The price of rough rice per barrel was used as the dependent variable. The independent variables considered can be classified as continuous and discrete variables. The continuous variables analyzed were head rice in pounds per barrel, lot size in barrels, grade level, the 5 grade factors used in grade level determination, and a trend variable; these variables were considered in their linear, quadratic and logarithmic form. The variable broken head rice was dropped from the analysis due to its high negative correlation with head rice; its inclusion would have caused confounding in the price analysis results. The estimate of the effect of head rice yield on price is interpreted as a measure of the effect on price per barrel of both the increment in head rice and its concomitant decrease in broken rice yield.

The only classification variable considered here was that accounting for differences in price due to the variety of rice. As before, 4 medium grain and 7 long grain varieties were studied.

Two statistical models based on different independent variables representing the time and form components of price were developed. These two models are referred to as Model A and Model B which can be represented as follows:

Model A: Price = f(grade, non-quality factors)

Model B: Price = f(grade factors, non-quality factors)

In order to analyze and compare the effect of Louisiana Grain Exchange grade and government grade on price, these two variables were included one at a time in model A. This distinction was made for the medium and long grain rice varieties.

The following paragraphs present the statistical models obtained at each stage as explained in Chapter II, for medium and long grain rice varieties. These steps can be summarized as follows:

Step 1: The maximum R-squared improvement variable selection technique was applied to the data. Models A and B were determined using the sets of independent variables mentioned above.

Step 2: The least squares means, one way classification analysis of variance statistical model was used to select classification variables affecting significantly the price of rough rice. The only variable considered in this step was that accounting for possible differences in price due to rice variety; therefore, models A and B do not apply for this step.

Step 3: In this step to models A and B as developed in step 1, the variable representing variations in price due to rice variety was added if it was significant at the desired level. The significance levels and the signs of the regression coefficients of the variables in the model were checked.

Medium Grain

Step I--Model A

Table 21 shows the analysis of variance, regression coefficients and statistics of fit obtained for model A at step I. Head rice yield and the variables accounting for the linear and quadratic trend effects were the only variables affecting significantly the price of rice; in fact, they were significant at the .0001 probability level.

It is important to note that this model considered a variable accounting for differences in price per barrel due to differences in grade level as given by the Louisiana Grain Exchange and by the federal government. Since this variable did not have the expected sign nor the desired significance level to remain in the model, it was dropped from the analysis. The expected positive relationship between price per barrel and grade level (the better the grade, the higher the price per barrel) is a common practice observed in the rice market and was shown to exist in the tabular analysis presented in Chapter III.

Table 21. Analysis of Variance, Regression Coefficients and Statistics of Fit for Model A, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients	t-Value	Significance Level
Regression	3	109606.92			
Intercept			8.4759		
Head Rice	1	1165.55	.0434	13.97	.0001
Trend	1	14044.28	-5.2944	48.49	.0001
Trend Sq.	1	32170.30	1.1165	73.39	.0001
Error	3618	21610.83			
Corrected Total	3621	131217.74			
R-Squared	83.53%				

The variable accounting for price differences due to lot size, which had been proved in previous studies to affect the price of rough rice per barrel significantly, did not exert a significant effect on price during the period under consideration and was not included in the statistical model.

The regression coefficient for the variable representing head rice yield, as shown in Table 21, was equal to .0434, which means that for each increase in one pound of head rice yield per barrel of rice, price per barrel increases $.0434 on the average or approximately 4 cents per barrel.

The regression coefficients for the linear and quadratic effects for the trend variable were equal to -5.2944 and 1.1165, respectively. This merely indicates the trend of rice prices over the period being analyzed. The trend of rice prices was downward through the middle of 1969-70 and was upward during the last four seasons.

It can be noted that the sign of the regression coefficients for the variables in the model were those expected and in accordance with the tabular analysis of Chapter III.

The coefficients of determination for this statistical model was equal to .8353 and significant at the .0001 level of probability. This means that 83.53 percent of the variation in prices was explained by head rice yield, trend, and trend squared as included in the model.

Step I--Model B

As previously explained, the difference between Model A and Model B is the set of independent variables. Here, instead of Louisiana Grain Exchange or federal government grade levels, the grade factors red rice, seeds, damage, chalk and "others" were considered as independent variables. The grade factor general appearance was left out of the analysis because of its high correlation with Louisiana Grain Exchange grade level and with government grade.

Table 22 presents the results for this analysis. It shows the analysis of variance, regression coefficients and statistics of fit for the developed model. The variables present in this model, those affecting significantly the price of rough rice, were: head rice yield in its linear and quadratic forms, the grade factors red rice and "others" and the trend variable in its linear and quadratic form. These variables had the expected signs and were significant at the .0001 probability level, the only exception being the quadratic effect for head rice yield, which was significant at the .0085 probability level.

The regression coefficients for the linear and quadratic effects for head rice yield were equal to .0849 and -.0003, respectively. This means that as the head rice yield per barrel increases 1 pound, price per barrel, on the average, increases .0849 due to the linear effect and decreases -.0003 due to the quadratic effect. The total effect was an increase in price per barrel at a diminishing rate as head rice per barrel increases.

With respect to the grade factors which were included in the set of independent variables being considered, only the factors red rice and "other" affected significantly the price of rice. Their regression coefficients were equal to -.2902 for red rice and -.7034 for "others." This means that an increase of 1 unit in level of red rice or "others" decreases price per barrel, on the average, by $.2902 and $.7034, respectively.

Table 22. Analysis of Variance, Regression Coefficients and Statistics of Fit for Model B, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients	t-value	Significance Level
Regression	6	110,914.13			
Intercept			8.6907		
Head rice	1	112.17	.0849	4.49	.0001
Head rice sq.	1	38.49	-.0003	2.63	.0085
Red rice	1	515.68	-.2902	9.64	.0001
Others	1	892.94	-.7034	12.69	.0001
Trend	1	13,102.65	-5.3930	48.61	.0001
Trend sq.	1	29,497.79	1.1537	72.93	.0001
Error	3,615	20,042.83			
Corrected total	3,621	130,956.96			
R-squared	84.70%				

The regression coefficients for the linear and quadratic forms of the trend variable were equal to -5.3930 and 1.1537, respectively. This shows the overall price movement throughout the period being studied. Prices decreased during the first and part of the second season, then steadily increased during the remaining four seasons.

The coefficient of determination for this statistical model was equal to .8470 and different than zero at the .0001 probability level. This coefficient of determination shows the percentage of the variation in prices accounted for by the independent variables included in the model.

Step II

Table 23 presents the analysis of variance and least squares means for each of the medium grain varieties. Here, only one model was determined due to the fact that there was only one classification variable to be tested in the model.

Table 23. Analysis of Variance and Least Squares Means, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients	t-value	Significance Level
Regression	3	27,616.82		322.20	.0001
Intercept			13.8201		
Saturn			-3.7492		
Nato			-1.2896		
Gulfrose			-3.1214		
Vista			8.2602		
Error	3,618	103,340.13			
Corrected total	3,621	130,956.95			

This table shows an estimate for the intercept which in this case is an estimate of the overall mean price, it would be the mean price if equal class frequencies existed but this is not the case. The different least squares means represent the deviation of each class of variety from the estimated term.

It can be seen that the variety "Vista" had the highest mean price which was equal to $22.0803 per barrel while the variety "Saturn" had the lowest price equal to $10.0709. These means are obtained by adding the constant term or intercept and the respective least squares mean.

The hypothesis tested with this model was that of equality of price means for all varieties. The F-value was equal to 322.20 and the hypothesis was rejected at the .0001 significance level. The strong rejection of this hypothesis led to the conclusion that variety was an important factor in the process of price determination and, therefore, should be included in the statistical model explaining price variations.

Step III - Model A

The final statistical model developed using the set of independent variables for Model A is presented in Table 24. This table shows the analysis of variance, regression coefficients, least squares means and statistics of fit for this model. As explained earlier, in this step the statistical models developed for Model A at Step I plus the model obtained at Step II were put together, and the signs of the regression coefficients and their significance levels were checked.

Table 24. Analysis of Variance, Regression Coefficients, Least Squares Means, and Statistics of Fit for Model A, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and Least Squares Means	t-values	Significance Level
Regression	6	110,180.58			
Intercept			7.8914		
Head rice	1	1,163.58	.0437	202.40	.0001
Trend	1	12,266.75	-5.0631	2,133.77	.0001
Trend sq.	1	27,388.12	1.0766	4,764.10	.0001
Varieties	3	808.15		6.84	.0001
Saturn			.2765		
Nato			.7092		
Gulfrose			-2.6403		
Vista			1.6546		
Error	3,615	20,776.37			
Corrected total	3,621	130,956.95			
R-squared	84.13%				

The variables that were found to exert a significant effect on price were: head rice yield, the linear and quadratic forms of the trend variable, and the variable accounting for differences in varieties of rice. In other words, variables found to be significant in the models developed at Step I and Step II, when combined kept their significance levels and signs as related to the effect on price.

The regression coefficient for the variable head rice was equal to .0437, this shows the increase in price per barrel as head rice yield increases by one pound per barrel.

The linear and quadratic effects of the trend value were equal to -5.0631 and 1.0766, respectively. As before, they show the general movement of the price level throughout the period under study. Prices decreased during the first and part of the second season, then, they steadily increased during the remaining four seasons.

This table also shows the least squares means for each medium grain variety. The variety "Vista" exhibited the highest mean price and the variety "Gulfrose" had the lowest mean price after the effects of head rice yield and the linear and quadratic trend effects had been removed.

The coefficient of determination for this model was equal to .8413 or 84.13 percent of the variation in prices was accounted for by the independent variables included in the model.

Step III - Model B

Table 25 shows the analysis of variance, regression coefficients, least squares means and statistics of fit for Model B. Here, and as with the previous model, the statistical model developed for Model B at Step I and the model obtained at Step II were combined.

Table 25. Analysis of Variance, Regression Coefficients, Least Squares Means and Statistics of Fit for Model B, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and Least Squares Means	t-values	Significance Level
Regression	9	111,796.88			
Intercept			8.5276		
Head rice	1	83.56	.0736	3.96	.0001
Head rice sq.	1	22.31	-.0002	2.05	.0404
Red rice	1	491.28	-.2842	9.62	.0001
Others	1	1,002.55	-.7473	13.75	.0001
Trend	1	11,745.52	-5.1900	47.05	.0001
Trend sq.	1	26,035.97	1.1193	70.05	.0001
Varieties	3	904.70		7.54	.0001
Saturn			.3564		
Nato			.8134		
Gulfrose			-2.8801		
Vista			1.7103		
Error	3,612	19,160.07			
Corrected total	3,621	130,956.95			
R-squared	85.37%				

The following variables were found to have a significant or highly significant effect on price of rough rice: head rice yield in its linear and quadratic form, the grade factors red rice and "others", the linear and quadratic terms of the trend variable, and the variable accounting for differences in prices of the different varieties.

The regression coefficients for the linear and quadratic effects for head rice yield were equal to .0736 and -.0002, respectively. This means that as head rice yield per barrel increases, price per barrel increases, but at a diminishing rate.

The grade factors red rice and "other" were the only ones which affected significantly the price of rice. Their regression coefficients were equal to -.2842 and -.07473, respectively, which means that an increase of one unit in level of red rice or "others" causes a decrease in the price of rice per barrel of $.2842 and $.7473, respectively.

The linear and quadratic forms of the trend variable had regression coefficients equal to -5.1900 and 1.1193, respectively. These two coefficients show the overall price of rice movements throughout the period being studied. The trend of rice prices was downward through the middle of 1969-70 and was upward during the last four seasons, 1970-71 to 1973-74.

This table also shows the least squares means for each medium grain variety. The variety "Vista" had the highest mean price and the variety "Gulfrose" had the lowest one, after the effects of head rice yield, red rice, "others" and trend had been accounted for. Also, the mean prices for the medium grain varieties were different at the .0001 level of probability.

The coefficient of determination for this model was equal to .8537 which means that 85.37 percent of the variations in price was explained by the independent variables included in the model.

<u>Long Grain</u>

Step I - Model A

The analysis of variance, regression coefficients and statistics of fit obtained for Model A at Step I are presented in Table 26. The linear and quadratic forms of head rice yield, the quadratic form of the Louisiana Grain Exchange grade level and the linear and quadratic forms of trend were the variables having a significant effect on price.

Table 26. Analysis of Variance, Regression Coefficients and Statistics of Fit for Model A, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients	t-values	Significance Level
Regression	5	58,996.35			
Intercept			5.0401		
Head rice	1	94.01	.1525	3.89	.0001
Head rice sq.	1	28.33	-.0005	2.14	.0328
Grade sq.	1	29.69	-.0133	2.18	.0291
Trend	1	9,632.28	-6.0360	39.38	.0001
Trend sq.	1	19,688.82	1.2074	56.31	.0001
Error	2,072	12,860.79			
Corrected total	2,077	71,857.15			
R-squared	82.10%				

A variable allowing for variations in price due to changes in lot size was considered. This variable, contrary to the expected, did not affect the price of rough rice significantly and was dropped from the analysis.

In this model, and as stated previously, a variable representing the federal government grades was analyzed. This analysis was limited to the last four seasons due to lack of data. This variable affected significantly the price of rice during that period; the results of the analysis are presented in Appendix Table 5.

Table 26 shows that the regression coefficients for the linear and quadratic forms of the head rice yield variable were equal to .1525 and -.0005, which means that as head rice yield per barrel increases price also increases but at a diminishing rate.

The variable representing the quadratic form of the Louisiana Grain Exchange grade level had a regression coefficient equal to -.0133. The linear form of this variable was not significant at the required level, and was not included in the model. The sign of this regression coefficient was negative as expected. This means that as grade level increases or goes from better to worse, the price of rice per barrel decreases at an increasing rate.

The regression coefficients for the linear and quadratic effects for the trend variable were equal to -6.0360 and 1.2074, respectively. This indicates the general price of rice changes throughout the period under consideration. The trend of rice prices was downward through the middle of the 1969-70 season and was upward during the last four seasons, 1970-71 to 1973-74.

The signs of the regression coefficients for the variables in the model were those expected and in accordance with the tabular analysis of Chapter III.

The coefficient of determination for this model was equal to .8210 and was significant at the .0001 level of probability. It means that

82.10 percent of the variation on prices was accounted for by the variables in the model.

Step I - Model B

Table 27 shows the analysis of variance, regression coefficients and statistics of fit for Model B. Here instead of grade level, the grade factors red rice, seeds, damage, chalk and "others" were considered as independent variables. The grade factor general appearance was not included because of its high correlation with grade level.

Table 27. Analysis of Variance, Regression Coefficients and Statistics of Fit for Model B, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients	t-values	Significance Level
Regression	5	59,590.42			
Intercept			5.6428		
Head rice	1	107.10	.1619	4.25	.0001
Head rice sq.	1	46.06	-.0007	2.79	.0053
Red rice	1	623.67	-.3932	10.26	.0001
Trend	1	8,561.75	-5.7689	38.02	.0001
Trend sq.	1	18,361.32	1.1767	55.68	.0001
Error	2,072	12,266.73			
Corrected total	2,077	71,857.15			
R-squared	82.93%				

The variables found to exert a significant effect on price during the period under study were: the linear and quadratic forms of head rice, the grade factor red rice, and the linear and quadratic forms of the trend variable. These variables had the expected sign and were significant at the .0001 level of probability; the only exception to this was the regression coefficient for the quadratic form of the head rice yield variable which was significant at the .0053 level of probability.

The regression coefficients for the linear and quadratic effects for head rice yield were equal to .1619 and -.0007, respectively. This means that as the head rice yield per barrel increases one pound, price per barrel, on the average, increases by $.1619 due to the linear effect and decreases by $.0007 due to the quadratic effect, the total effect being an increase in price per barrel at a diminishing rate, as head rice yield increases.

With respect to the grade factors which were included in the set of independent variables to build the statistical model, only the grade factor red rice affected significantly the price of rice. Its regression coefficient was equal to -.3932, which means that an increase on one unit in level of red rice causes a decrease in the price of rice per barrel equivalent to approximately $.39.

The regression coefficients for the linear and quadratic forms of the trend variable were equal to -5.7689 and 1.1767, respectively. This gives an indication of the overall price of rice changes during the period being analyzed.

The coefficient of determination for this model was equal to .8293 and it was significant at the .0001 level of probability. This coefficient states that 82.93 percent of the variation in prices was accounted for by the variables included in the model.

Step II

Table 28 shows the analysis of variance and least squares means for each of the long grain varieties. This table also shows a value for the intercept, which in this case is an estimate of the overall mean price. It would be the mean price if equal frequencies exist, but this is not the case. The least squares means represent the deviation of the mean price of a given variety from that constant estimate.

Table 28. Analysis of Variance and Least Squares Means, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Least Squares Means	F-value	Significance Level
Regression	6	20,012.10		133.17	.0001
Intercept			11.9820		
Belle Patna			-2.2469		
Blue Belle			-3.9689		
Blue Bonnet			-1.4585		
Star Bonnet			.8328		
Dawn			-4.2860		
Toro			1.1125		
Labelle			10.0050		
Error	2,071	51,845.04			
Corrected total	2,077	71,857.14			

The variety "Labelle" had the highest price which was equal to $21.9870 per barrel, while the "Blue Belle" variety had the lowest price equal to $8.0141 per barrel. These means are obtained by adding the constant term or intercept and the respective least squares means.

The hypothesis tested with this model was that the mean prices for each variety were equal. When this test was performed an F-value of 133.17 was obtained and the hypothesis was rejected at the .0001 probability level.

From this test it was concluded that the specific variety of rice of a given sample was an important factor in the price determination process and, therefore, should be analyzed in connection with other variables affecting the price of rice.

Step III - Model A

Table 29 presents the statistical model developed using the set of independent variables for Model A. This table contains the analysis of variance, regression coefficients, least squares means and statistics of fit for the above mentioned model. As before, the statistical model developed for Model A in Step I and the model obtained in Step II were combined, and the sign of the regression coefficients and their significance levels were checked.

The variables that were included in the model were head rice yield and trend, each in its linear and quadratic form, the quadratic effect of the Louisiana Grain Exchange grade level variable and the variable accounting for differences in price due to the variety of rice.

The regression coefficients for the variables accounting for the linear and quadratic effect of the head rice yield were equal to .1695 and -.0007, respectively. This shows the variation in price as head rice yield per barrel changes by one pound.

The variable accounting for the quadratic form of the variable representing the Louisiana Grain Exchange grade level had a regression coefficient equal to -.0147, negative as expected, which means that as

Table 29. Analysis of Variance, Regression Coefficients, Least Squares Means and Statistics of Fit for Model A, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and Least Squares Means	t-values	Significance Level
Regression	11	59,222.91			
Intercept			4.7581		
Head rice	1	111.01	.1695	4.26	.0001
Head rice sq.	1	41.10	-.0007	2.59	.0096
Grade sq.	1	34.42	-.0147	2.37	.0178
Season	1	8,096.92	-6.0418	36.38	.0001
Season sq.	1	16,629.55	1.2028	52.13	.0001
Varieties	6	226.55		2.48	.0001
Belle Patna			-.3625		
Blue Belle			.2880		
Blue Bonnet			.3001		
Star Bonnet			-.0259		
Dawn			-.9284		
Toro			.1244		
Labelle			.6042		
Error	2,066	12,634.24			
Corrected total	2,077	71,857.15			
R-squared	82.42%				

grade level increases or goes from better to worse, the price of rice per barrel decreases. The linear form of this variable was not significant at the .01 level of probability, and was therefore, not included in the final model.

The regression coefficients for the linear and quadratic effects for the trend variable were equal to -6.0418 and 1.2028, respectively. This gives an indication of the price of rice changes throughout the period being studied. Rice prices decreased during the first and part of the second season, then they steadily increased during the remaining four seasons.

The signs of every regression coefficient in the model were as expected and in accordance with the tabular analysis presented in the previous chapter.

This model had a correlation coefficient of .8242 significant at the .0001 probability level. It means that 82.42 percent of the price variation was accounted for by the variables in the model.

The final model obatined from this set of variables using the federal government grade instead of the Louisiana Grain Exchange grade as the independent variable appears in Appendix Table 6.

Step III - Model B

Table 30 presents the analysis of variance, regression coefficients, least squares means and statistics of fit for Model B. Here, as in the previous models, the models developed for Model B at Step I and the model developed at Step II were combined. After the signs and significance levels of the regression coefficients in the model were checked, the following variables were found to be exerting a highly significant effect on price: head rice yield and the trend variable, each one in its linear and quadratic form, the grade factor red rice and the variable accounting for the differences in price due to variety of rice.

The regression coefficients for the linear and quadratic effects for head rice yield were equal to .1888 and -.0009, which means that as head rice yield per barrel increases, price per barrel also increases but at a diminishing rate.

The grade factor red rice was the only grade factor affecting significantly the price of long grain rice. Its regression coefficient

Table 30. Analysis of Variance, Regression Coefficients, Least Squares Means and Statistics of Fit for Model B, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and Least Squares Means	t-values	Significance Level
Regression	11	59,881.26			
Intercept			5.4429		
Head rice	1	138.72	.1888	4.89	.0001
Head rice sq.	1	75.64	-.0009	3.61	.0003
Red rice	1	692.77	-.4278	10.93	.0001
Season	1	7,465.62	-5.8407	35.88	.0001
Season sq.	1	15,809.24	1.1785	52.21	.0001
Varieties	6	290.84		2.89	.0001
Belle Patna			-.5099		
Blue Belle			.1396		
Blue Bonnet			.3971		
Star Bonnet			.1293		
Dawn			-1.0800		
Toro			.4535		
Labelle			.4704		
Error	2,066	11,975.89			
Corrected total	2,077	71,857.15			
R-squared	83.33%				

was equal to -.4278, which means that an increase of one unit in level of red rice is associated with a decrease in the price of rice per barrel of $.4278.

The linear and quadratic forms of the trend variable had regression coefficients equal to -5.8407 and 1.1785, respectively. These coefficients represent the overall price of rice changes during the period being analyzed. Rice prices decreased during the first and part of the second season, then, they steadily increased during the remaining four seasons.

Table 30 also shows the least squares means for each of the seven long grain varieties. The variety "Labelle" had the highest mean price and the variety "Dawn" had the lowest one after the effects of the other variables in the model had been removed. The mean prices for these long grain varieties were different at the .0001 level of probability.

The coefficient of determination for this model was equal to .8333 which means that 83.33 percent of the variation in prices was explained by the variables in the model.

Synopsis

Several similarities and/or differences can be noted for the above models within and among medium and long grain rice varieties.

The variables accounting for the linear and quadratic effect of head rice yield affected significantly the price of rice in all models but one. The exception was Model A for the long grain rice varieties where only the linear effect was significant at the desired level.

With respect to the Louisiana Grain Exchange grade and government grade variables, they did not significantly affect the price of medium grain varieties. However, the situation was different for the long grain varieties; the quadratic form of the Louisiana Grain Exchange grade exerted a significant effect on price during the period under study, and the linear effect of the government grade level variable significantly affected the price for the model applied to the last four seasons.

Of all grade factors considered in the model building process the only factor affecting significantly the price of medium and long grain rice was red rice. The grade factor "others" was present in the model for medium grain rice only.

The class variable "variety" was highly significant in all cases, for medium and long grain rice. The hypothesis that different price levels existed for the different varieties was well justified.

The linear and quadratic forms of the trend variable were present in each model with no exceptions.

The regression coefficients for these two variables indicated, in each individual model, the upward trend in prices during recent years. It also indicated that the 1969-1970 season had the lowest prices of the six-year period being analyzed.

From the above models, it can be noted that the variable representing the size of the lot was not included in any of the models. This variable had been proven to exert a significant effect on price per barrel of rough rice in previous studies. In fact, when only the first two seasons 1968-69 and 1969-70 were considered, this variable significantly affected the price of rough rice as expected; however, it was not significant for the last four seasons or for all six seasons considered together.

The coefficient of determination was always greater than .80; that is, each model explained more than 80 percent of the variation in prices of rough rice during the 1968-69 to 1973-74 period.

In Chapter II the desirable properties of the statistical models to be developed were listed. The first two properties; R-squared values of at least .80 and significance of the regression coefficients at the .05 level or better; are easy to verify from tables 22 and 23 for medium grain varieties and from tables 27 and 28 for long grain varieties.

With respect to the last property; the absence of discernible patterns in the residuals; its verification is more complex. Here, the values of the regression coefficients at the different stages of the model building process provide the basis for this test. Comparison of the values of the regression coefficients shows that they had similar values at the different steps, regardless of the variable or variables being added to the model. For example, the value of the regression coefficient for head rice yield was equal to .0434 and .0437 at Steps I and III, respectively for medium grain, a difference of only .0003 or $.0003 per barrel of rough rice. This fact was true for the other variables in the models and for the medium and long grain varieties.

CHAPTER V

EFFECT OF MILLS, PRODUCTION AREAS, AND DATE OF TRANSACTION ON PRICE OF ROUGH RICE

This chapter deals with the last two objectives of this study, which involve the determination of price differentials as related to mills, production area and time of the year when transactions are made. As in previous chapters, the analysis was conducted separately for medium and long grain varieties.

In this chapter the variables above were added to the statistical models built in chapter IV and the significance levels and signs of the continuous and discrete variables already in the model were checked. The number of observations for models developed here was somewhat lower than that of previous chapters. It was desired to have a minimum of 15 observations in each class during the 6 years period; classes with less than the minimum required number of observations were deleted from the analysis.

The variables accounting for price differences due to mill, production area and seasonal variations were added to the statistical models based on the following considerations:

Production Area

To represent production areas the local sales organizations which act as the link between the producer and the Louisiana Grain Exchange were selected. The sales organizations are identified with the local commercial dryer which the majority of its members patronize, and with the local production area possessing its own peculiar characteristics of soil, climate and level of production skills.

Since differences among sales organizations could cause a difference in prices received by rice farmers, this variable was included to determine if it had a significant effect on price. There were 9 sales associations handling medium grain rice and 10 sale associations handling long grain rice.

<u>Mill</u>

This variable was included to determine price differentials for mills buying rough rice and to determine if differences in prices paid by millers affected significantly the price of rough rice received by farmers in Louisiana.

There were 25 rice mills handling medium and long grain rice. Of these 25 mills only 14 had enough observations throughout the six years period to be analyzed. The data also contained information of transactions performed by seed companies. These companies buy most of their rice from Texas and Arkansas farmers which produce a better quality rice and, therefore, were deleted from the analysis.

<u>Seasonal Analysis</u>

A variable accounting for differences in prices due to seasonal movements was included in the model. This variable represents the price variations during the different months of the season. The data provided by the Louisiana Grain Exchange had transactions performed during the months of August to February for medium grain varieties and for the months of July to February for long grain varieties. Seasonal indexes were computed for both medium and long grain rice varieties and for each month of its season.

The following paragraphs contain the statistical models developed to explain price variations as related to mill, production area, and seasonal variations in addition to the variables found to affect significantly the price of rice in previous models. Models A and B as defined earlier and as developed in chapter IV were used for both medium and long grain rice varieties.

Medium Grain

Model A

Table 31 shows the analysis of variance, least squares means, regression coefficients and statistics of fit for medium grain rice, model A. It can be seen that the continuous variables head rice yield, trend and trend square plus the class variable variety, found to affect significantly the price of rough rice in a previous chapter were present, and significant at the .0001 level of probability. The class variables added to the statistical model in this chapter mill, location, and month were all significant at the .0001 level. This means that the hypotheses concerning equality of price per barrel of rough rice for the different varieties, locations, mills and months were rejected, after the variation in prices due to head rice, trend, trend square and variety had been removed.

The regression coefficients for the continuous variables head rice yield, trend and trend square were equal to .0476, -5.1090 and 1.0628 respectively, indicating the amount in dollars by which price per barrel of rough rice changes as these variables each increase by one unit.

Table 31. Analysis of Variance, Least Squares Means, Regression Coefficients, and Statistics of Fit for Model A, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and Least Squares Means	F-Values	Significance Level
Regression	33	84270.45			
Intercept			8.6289		
Head Rice	1	837.79	.0476	213.70	.0001
Trend	1	7513.00	-5.1090	1836.57	.0001
Trend Square	1	16612.71	1.0628	4061.02	.0001
Variety	3	275.63		22.46	.0001
Saturn			.3924		
Nato			.4114		
Gulfrose			-2.0265		
Vista			1.2227		
Location	8	370.35		11.32	.0001
Crowley			-.1853		
Elton			-.7226		
Fenton			.3883		
Iowa			.0888		
Welsh			-.1236		
Basile			-.3082		
Kinder-Elton			-.0555		
Roanoke			-.2765		
Abbeville			1.1946		
Mill	13	485.53		9.13	.0001
Argca			.2266		
Blue Ribbon			.3459		
Broussard			.0907		
Ed Duhe			-.4547		
Dore			1.1915		
Eagle			-.1060		
Estherwood			.0572		
Farmers			.0516		
Kaplan			1.1565		
Mermentau			-.2978		
Mississippi			-.4856		
P & S			.2966		
Republic			-.1987		
Riviana			.4463		
Month	6	2468.34		100.57	.0001
August			-1.8651		
September			-1.2471		
October			-.6302		
November			.4406		
December			-.5231		
January			1.3359		
February			2.4894		
Error	2897	11850.97			
Corrected Total	2930	96121.42			
R-Squared	87.67%				

After the variation in prices was accounted for by the variables in the model, the variety Vista exhibited the highest least squares mean (1.2227) while the variety Gulfrose had the lowest least squares mean (-2.0265). The Elton location had the lowest least squares mean (-.7226) while the Abbeville location had the highest least squares mean (1.1946). The Dore rice mill had the highest least squares mean (1.1915) while the Kaplan rice mill had the lowest least squares mean (-1.1565).

The seasonal analysis showed that the month of February had the highest prices, on the average, while the month of August had the lowest ones. The seasonal indexes computed from this model are shown in table 33.

The coefficient of determination for this model, 8767, was significant at the .0001 level of probability; thus, 87.67 percent of the variation in prices of rough rice per barrel was accounted for by the continuous and discrete variable included in the model.

Model B

Table 32 contains the analysis of variance, least squares means, regression coefficients and statistics of fit for medium grain, model B. The variables that exerted a significant effect on price before the introduction of the variables accounting for differences in prices due to location, mill and month, kept their expected signs and significance levels as developed in Chapter IV. All variables, the linear and quadratic effect of the head rice yield and trend variable, plus the variables red rice and "others," were significant at the .0001 level of probability.

Table 32. Analysis of Variance, Least Squares Means, Regression Coefficients, and Statistics of Fit for Model B, Medium Grain Rice, Louisiana, 1968-69 to 1973-74.

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and least Squares Means	F-Values	Significance Level
Regression	36	84773.52			
Intercept			6.6312		
Head Rice	1	168.50	.1286	42.97	.0001
Head Rice Sq.	1	80.96	-.0005	20.65	.0001
Red Rice	1	295.62	-.2488	75.39	.0001
Others	1	148.37	-.3266	37.84	.0001
Trend	1	6954.94	-5.0927	1773.69	.0001
Trend Square	1	15252.01	1.0755	3889.65	.0001
Variety	3	291.69		24.80	.0001
Saturn			.3875		
Nato			.5209		
Gulfrose			-2.1279		
Vista			1.3095		
Location	8	344.82		10.99	.0001
Crowley			-.3225		
Elton			-.6860		
Fenton			.4206		
Iowa			.1017		
Welsh			-.0449		
Basile			-.1953		
Kinder-Elton			-.0377		
Roanoke			-.3724		
Abbeville			1.1365		
Mill	13	454.40		8.91	.0001
Argca			.3081		
Blue Ribbon			.4043		
Broussard			.0137		
Ed Duhe			-.4745		
Dore			1.0965		
Eagle			-.1646		
Estherwood			.1141		
Farmers			.0556		
Kaplan			-1.1055		
Mermentau			-.2385		
Mississippi			-.4391		
P & S			.2411		
Republic			-.1936		
Riviana			.3824		
Month	6	2106.70		89.54	.0001
August			-1.8238		
September			-1.1062		
October			-.5590		
November			.4060		
December			-.5019		
January			1.2403		
February			2.3446		
Error	2894	11347.90			
Corrected Total	2930	96121.42			
R-Squared	88.19%				

With respect to the discrete or classification variables variety, locations, mill and month, they are also significant at the .0001 level of probability. The variety Vista, the Abbeville location and the Dore mill exhibited the highest least squares means, which were equal to 1.3095, 1.1365 and 1.0965, respectively. On the other hand, the lowest least squares means corresponded to the variety Gulfrose, the Elton location, and the Kaplan rice mill, and were equal to -2.1279, -.6860 and -1.1055, respectively.

Here, and as with model A, the month of August had the lowest prices , on the average, and the month of February the highest. Seasonal indexes for each month were computed from these models. The seasonal indexes obtained from this model as well as those obtained from model A appear in table 33.

This model had a coefficient of determination equal to .8819, which was significant at the .0001 probability level. This value means that 88.19% of the variation in prices is explained by the variables included in the model.

Seasonal Analysis

Table 33 shows the seasonal indexes for the month of August through February, computed from the adjusted means obtained from models A and B. From this table, it can be noted that the seasonal indexes exhibited the same pattern regardless of the model used in their determination.

Table 33: Seasonal Indexes Obtained Using Models A and B, Medium Grain Rice, Louisiana, 1968-69 to 1973-74.

Month	Model A	Model B
August	83.34	83.61
September	88.88	90.06
October	94.38	94.98
November	103.93	103.65
December	95.34	95.49
January	111.91	111.15
February	122.18	121.08

The lowest seasonal index was found for the month of August; it was equal to 83.34 and 83.61 for models A and B, respectively. In contrast, the highest seasonal index was exhibited by the last month of the season which was February; these seasonal indexes were equal to 122.18 and 121.08 for the two models, respectively.

A closer examination of table 33 reveals that the seasonal indexes obtained from both models steadily increased from August to November, then declined in December, and finally increased again during January and February.

Long Grain

Model A

Table 34 contains the analysis of variance, least squares means, regression coefficients and statistics of fit for model A for long grain rice.

The continuous variables head rice yield in its linear and quadratic form, the Louisiana Grain Exchange grade in its quadratic form and the linear and quadratic effects of the trend variable were found to be

Table 34. Analysis of Variance, Least Squares Means, Regression Coefficients, and Statistics of Fit for Model A, Long Grain Rice, Louisiana, 1968-69 to 1973-74.

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and Least Squares Means	F-Values	Significance Level
Regression	49	43873.24			
Intercept	1		2.5253		
Head Rice	1	136.58	.2291	31.31	.0001
Head Rice Sq.	1	65.33	-.0010	14.98	.0001
Grade Sq.	1	116.43	-.0321	26.69	.0001
Trend	1	4821.06	-5.8295	1105.16	.0001
Trend Sq.	1	9823.76	1.1567	2251.96	.0001
Variety	6	157.98		6.04	.0001
Belle Patna			.1155		
Blue Belle			.4568		
Blue Bonnet			.3613		
Star Bonnet			-.1699		
Dawn			-.6521		
Toro			-1.0230		
Labelle			.9114		
Location	9	98.73		2.51	.0076
Crowley			-.1848		
Elton			-.2858		
Fenton			.0407		
Iowa			-.1688		
Welsh			.0068		
Basile			.0269		
Kinder-Elton			-.5796		
Mamou			.6736		
Roanoke			-.0734		
Abbeville			.5444		
Mill	13	379.48		6.69	.0001
Argca			-.0887		
Blue Ribbon			.3323		
Broussard			.1556		
Ed Duhe			.0687		
Dore			-.8793		
Eagle			1.2942		
Estherwood			-.2409		
Farmers			-.8577		
Kaplan			-.5326		
Mermentau			-.5890		
Mississippi			-.4578		
P & S			.9141		
Republic			.0707		
Riviana			.8104		
Month	7	1207.56		39.55	.0001
July			-1.6078		
August			-1.1747		
September			-.8821		
October			.3552		
November			.6589		
December			.1952		
January			1.4798		
February			.9755		
Error	1624	7084.39			
Corrected Total	1673	50957.63			
R-Squared	86.10				

significant at the .0001 level of probability. In other words, when the discrete variables location, mill and month were added to Model A, as developed in chapter IV, all variables in the model kept their expected signs and the minimum required significance levels.

The variety Labelle, the Mamou locations and the Eagle rice mill exhibited the highest least squares means, which were equal to .6916, .6618 and 1.3630, respectively; while the variety Toro, the Kinder-Elton location and the Dore rice mill had the lowest means, equal to -.7367, -.5261 and -.7389, respectively.

With respect to the least squares means for the different months of the year, it can be noted that July had the lowest while January had the highest. The seasonal indexes computed from this model are shown in table 36.

The coefficient of determination for this model was significant at the .0001 level of probability and was equal to .8610, indicating that 86.10 percent of the variation in prices of rough rice per barrel was accounted for by the continuous and discrete independent variables included in the model.

Model B

Table 35 presents the analysis of variance, least square means, regression coefficient and statistics of fit for model B, long grain.

The continuous variables head rice yield in its linear and quadratic form, the grade factor red rice, and the linear and quadratic effects of the trend variable were found to be significant at the .0001 level of probability. The classification variables accounting for differences in price due to different varieties and locations were significant at the

Table 35. Analysis of Variance, Least Squares Means, Regression Coefficients, and Statistics of Fit for Model B, Long Grain Rice, Louisiana, 1968-69 to 1973-74.

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and Least Squares Means	F-Values	Significance Level
Regression	40	44254.47			
Intercept			2.3020		
Head Rice	1	166.91	.2534	40.44	.0001
Head Rice Sq.	1	95.42	-.0012	23.12	.0001
Red Rice	1	497.66	-.4206	120.57	.0001
Trend	1	4341.03	-5.5845	1051.72	.0001
Trend Sq.	1	9206.09	1.1281	2230.39	.0001
Variety	6	121.73		4.92	.0002
Belle Patna			-.0253		
Blue Belle			.3802		
Blue Bonnet			.4650		
Star Bonnet			-.1120		
Dawn			-.6628		
Toro			-.7367		
Labelle			.6916		
Location	9	88.03		2.37	.0117
Crowley			-.1142		
Elton			-.3167		
Fenton			-.0607		
Iowa			-.2537		
Welsh			.0127		
Basile			.1046		
Kinder-Elton			-.5261		
Mamou			.6618		
Roanoke			-.0725		
Abbeville			.5648		
Mill	13	343.07		6.39	.0001
Argca			-.0406		
Blue Ribbon			.4119		
Broussard			.0412		
Ed Duhe			.0787		
Dore			-.7389		
Eagle			1.3630		
Eatherwood			-.2575		
Farmers			-.7836		
Kaplan			-.6152		
Mermentau			-.8841		
Mississippi			-.3259		
P & S			.9399		
Republic			.0400		
Riviana			.8511		
Month	7	1134.04		39.25	.0001
July			-1.7740		
August			-1.1129		
September			-.7299		
October			.4468		
November			.7040		
December			.1236		
January			1.3947		
February			.9450		
Error	1624	6703.17			
Corrected Total	1664	50957.63			
R-Squared	86.85%				

.0002 and .0017 levels of probability, respectively. The other two classification variables mill and month were statistically significant at the .0001 level. In other words, when the discrete variables location, mill and month were added to model B, as developed previously in chapter IV, all variables in the model kept their signs and significance levels and the added variables were also significant at the desired levels.

Here, and as in model A for long grain, the variety Labelle, the Mamou location and the Eagle rice mill exhibited the highest least squares means, which were equal to .6916, .6618 and 1.3630, respectively, while the variety Toro, the Kinder-Elton location and the Mermentau rice mill had the lowest ones, and were equal to -.7367, -.5261 and .8841, respectively.

With respect to the least squares means for the different months of the year, July had the lowest prices, while the month of January had the highest. The seasonal indexes computed from this model are presented in table 36.

The coefficient of determination for this model was significant at the .0001 level of probability and was equal to .8685. This means that 86.85 percent of the variation in prices of rough rice per barrel was accounted for by the continuous and discrete variables included in the model.

Seasonal Analysis

Table 36 contains the seasonal indexes for the months of July through February, computed from the adjusted means obtained with models A and B.

The lowest prices occurred during the month of July; the seasonal indexes for this month were equal to 84.86 and 83.30 for models A and B, respectively. On the other hand, the highest seasonal indexes occurred during the month of January and were equal to 113.94 and 113.13 for the two models, respectively.

Table 36: Seasonal Indexes Obtained Using Models A and B, Long Grain Rice, Louisiana, 1968-69 to 1973-74.

Month	Model A	Model B
July	84.86	83.30
August	88.94	89.53
September	91.69	93.13
October	103.35	104.21
November	106.21	106.63
December	101.84	101.19
January	113.94	113.13
February	109.19	108.89

Prices showed a steady increase from July to November, then they were somewhat lower during December, reached a highest during January and decreased a little during February. The highest prices were 13.94 and 13.13 index points above their average during the month of January, for indexes computed from models A and B, respectively.

Synopsis

In this section a summary of the above findings and a comparison of the results obtained from both models and for medium and long grain varieties is presented.

The statistical models developed in this chapter were based on the models developed in chapter IV. Variables accounting for differences in prices due to locations, mills and months of the season were added to those models. The variable location was represented by the rice growers associations at different sites as explained earlier; these associations are the link between the seller and buyer of rough rice through the Louisiana Grain Exchange. The variable mill represented the price differentials at different commercial rice mills. A total of 14 mills were considered in the analysis.

The variable accounting for seasonal variations was created by dividing the data according to date of transaction during each month of the season. Data were recorded from August to February for medium grain and from July to February for long grain varieties.

When these three variables were added to the models obtained in chapter IV, the signs of the regression coefficients and the significance levels of the variables in the model did not vary; also, the added variables were significant at the required levels. This means that the hypotheses stating that the mean prices per barrel of rough rice were equal among mills, locations and months were rejected.

The price differentials found with either of the models, A or B, within medium and long grain varieties were almost the same.

The seasonal pattern computed for medium and long grain varieties using models A and B was very similar. Prices were low at the beginning of the season and high at the end of it. An exception to this was, for medium and long grain varieties and for models A and B, the price index for the month of December which was somewhat lower than the indexes of the preceding month. The prices for the medium grain varieties were at their highest during the month of February, while the prices for the long grain varieties were at their highest during January.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

A market imperfection found in rough rice marketing in Louisiana is lack of a single standard of quality accepted and used by all buyers and sellers in the market. Rice producers are not aware of the significance and extent to which quality and non-quality factors affect the price of rough rice.

The lack of uniformity in standard of quality and lack of knowledge of the effect of non-quality factors on price has been responsible for imperfections in the market where: (1) producers, reluctant to pool their rice on a quality basis before sale, persist in maintaining owner identity of lots offered for sale, even though it has been shown that they could market their rice more efficiently if they pooled individual lots on an equal quality basis; (2) individual lots are inspected by each prospective purchaser - which is time consuming, inefficient and costly; and (3) producers do not have full confidence in the ability of the system of quality determination and description to relate quality to price with a degree of accuracy acceptable to them.

The main purpose of this study was to examine the relationships and measure the effect of quality and non-quality factors on prices of rough rice received by Louisiana producers, with the objective of identifying potential changes to improve the rice marketing system. The specific objectives of this study were:

1. To select quality and non-quality factors which have affected the price received by producers for medium and long grain rough rice in Louisiana.

2. To measure the influence and determine the statistical significance of factors affecting grade and price received by growers of rough rice, and to analyze whether or not influences were the same for medium and long grain varieties of rice during the period under study.

3. To determine price variations as related to market location and production area.

4. To analyze the seasonal variations of prices for different classes of rough rice, and to compute seasonal indexes for the period under consideration.

Quality of rice is determined by the following factors: (1) grade level determined by the grade factors weed seeds, damage, red rice, chalk, general appearance and "others," (2) milling yield, and (3) type of rice.

The Louisiana Grain Exchange at Jennings, Louisiana provided the data used in the analysis. This set of data contained prices per barrel of rough rice which were generated by competitive bidding between millers for each lot offered for sale. The data describing the quality of each sample were determined by the Louisiana Grain Exchange and represents its estimate which claims to see quality "through the eyes of a miller." It was expected that this quality measurement would have been equal to the average quality level that Louisiana millers would have assigned to a given sample. The data provided an estimate of the grade level that would have been assigned by the federal government for each sample lot. This information was available for the last four seasons of the period being studied.

The data also contained information about the following variables: rice variety, head rice yield, total rice yield, broken head rice, production area, mill buyer or rice, lot size and date of transactions. Data for six seasons, from 1968-69 to 1973-74, were obtained from records of all transactions at the Louisiana Grain Exchange. During these six seasons, 5,706 lots were sold. Of these lots, 2,081 corresponded to long grain varieties and 3,624 to medium grain varieties. These data were divided among seven long grain varieties and four medium grain varieties. The medium grain varieties were Saturn, Nato, Gulfrose and Vista. The long grain varieties were Belle Patna, Blue Belle, Blue Bonnet, Star Bonnet, Toro, Labelle and Dawn.

Several statistical procedures were used to attain the objectives of this study. Construction and analysis of tables showing means and percentage frequency distributions for the different quality and non-quality variables was used extensively to attain objective 1, which comprised the selection of quality and non-quality factors which likely affect grade and prices received by rough rice producers. Multiple regression analysis and the maximum R-squared improvement variable selection technique were used to determine the significance and measure the weight of grade factors in the assignment of grade levels to lots of medium and long grain rice varieties. The independent variables were the grade factors red rice, seeds, chalk, damage and "others." The grade factor general appearance was dropped from the analysis due to its high correlation with the dependent variables Louisiana Grain Exchange grade and government grade.

The determination and measure of quality and non-quality factors significantly affecting the price of rough rice was attained using multiple regression analysis, one-way classification analysis of variance and the maximum R-squared improvement statistical procedures. Two statistical models based on different independent variables representing the time and form components of price were developed. These two models are referred to as models A and B and are represented as follows:

Model A: Price = f(grade, non-quality factors)

Model B: Price = f(grade factors, non-quality factors)

To analyze and compare the effect of Louisiana Grain Exchange grade and government grade on price, these variables were included one at a time in model A. This distinction was made for medium and long grain rice varieties. The model building process was divided into three steps, as follows:

Step 1: The maximum R-squared improvement variable selection technique was applied to the data. Models A and B were determined using the sets of independent variables mentioned above.

Step 2: The least squares means, one-way classification analysis of variance statistical model was used to select classification variables affecting significantly the price of rough rice. The only variable considered in this step was that accounting for possible differences in price due to rice variety; therefore, models A and B do not apply for this step.

Step 3: In this step to models A and B as developed in step 1, variable representing variations in price due to rice variety was added if it was significant at the desired level. The significance levels and the signs of the regression coefficients of the variables in the model were checked.

To attain the last two objectives of this study the variables accounting for variations in prices due to mills, production area and time of the year when transactions were made, were added to the statistical models previously developed, if they were significant at the required probability levels.

After all parameters were calculated for a particular model, the mean prices adjusted for each of the independent variables in the model were computed for each month. These adjusted means were expressed as a percentage of the overall adjusted mean price, and seasonal indexes for each month were computed.

The tabular analysis presented in Chapter III showed the relationships between the variables included in this study. The analysis was done separately for medium and long grain varieties, and the results were similar in various respects.

Most of the observations for medium and long grain were rated by the Louisiana Grain Exchange at levels 2 through 5, the remaining grade levels being absent or occurring in less than 8 percent of the lots at each other level. This distribution was very similar for each of the six seasons being analyzed.

The distribution patterns of grade factors were very similar for the medium and long grain varieties, the only difference occurring for the grade factor damage, which for medium grain was at level 1 in 80.12 percent of the observations and for long grain the observations were distributed among levels 1 through 4.

The variable representing government was also analyzed and compared to the Louisiana Grain Exchange grade, though data for government grade was not available for the first two seasons of the period under study. The results of this comparison showed that the federal government tends to assign better grades to the same lot of rice than the grade assigned at the Louisiana Grain Exchange for the medium as well as the long grain varieties. This explains why farmers use only federal grades to obtain loans under the government price support program.

Most factor levels associated with a given Louisiana Grain Exchange grade level were equal to or less than the grade levels for medium and long grain rice varieties. Exceptions to this rule occurred (several grade factors being involved), but in all cases the grade factor red rice was the limiting one showing the highest percentage of discrepancy. This suggests that the grade factor red rice is treated differently in the process of grade determination. It seems as if red rice is an important factor in the grade determination process. Of all the grade factors used in grade determination high levels of red rice are the least desirable of all due to its costly removal and problems it might cause during the milling process.

It was shown that the grade factors level used by the Louisiana Grain Exchange in the process of grade determination were not used as true grade specifications or grade tolerances. This is confirmed by the fact that the variable general appearance was practically synonymous with the Louisiana Grain Exchange grade and highly correlated government grade, which shows the nature of the broad approach used in grading rough rice. The inspectors, in assigning a level of general appearance to a particular lot, seemed to have been influenced by the levels they had assigned to other grade factors.

For both types of rice, medium and long grain, a positive relationship was found to exist between grade and price; in other words, higher prices were paid for higher quality rice. Similar relationships were found between head rice yield and price, head rice yield and either Louisiana Grain Exchange grade or federal government grade.

With respect to the relationship between lot size and price, it was noted that higher lot size carried a higher price per barrel during the first two seasons of the period being considered for medium grain rice, and during the first and third seasons for the long grain rice varieties. However, this pattern was not well defined for the remaining of the period for any class of rice.

The same relationship was observed to be present for both medium and long grain rice varieties, as far as seasonal variation and overall price movements are concerned. It was noted that prices were lower at the beginning of the season than at the end. Prices increased over time during any given season. This increase was expected to be large enough to cover the costs of holding rice in storage during the period from harvest to date of sale.

Chapter IV presented the results of the weight of grade determination and the significance and measure of factors affecting price of rough rice.

Statistical models were developed for medium and long grain rice varieties, using different sets of independent variables. The first part of this analysis used the Louisiana Grain Exchange grade level and the government grade as dependent variable, and the grade factors seeds, chalk, damage, "others" and red rice as independent variables.

Results of this analysis indicated that the Louisiana Grain Exchange and the federal government did not treat the levels of the various quality characteristics as true grade factors. The grade factors were weighted differently at both institutions and these weights differed for medium and long grain varieties. In the model with the Louisiana Grain Exchange grade as dependent variable, for the medium grain varieties, the grade factor chalk had the highest regression coefficient (.6840), while red rice had the lowest (.1519). For the model with government grade as dependent variable, the grade factor damage had the highest regression coefficient value (.5991), while seeds had the lowest (.1713). It is noted that in these two models, the grade factor "others" was not significant at the desired level of probability, and therefore was not included. All other grade factors, red rice, chalk, seeds and damage, were significant at the .0001 level of probability and had the expected signs.

The statistical models obtained for the long grain varieties, using the Louisiana Grade Exchange and government grade as dependent variables, showed all five grade factors used in grade determination exerting a highly significant effect on price. In both models the grade factor chalk had the highest regression coefficient value, equal to .6644 and

.4723, respectively. The R-squared values for these models were significant at the .0001 level of probability, and in all cases greater than .68; that is, they explained at least 68 percent of the variation in grade level.

Several statistical models were developed to determine the significance and measure the quality and non-quality factors affecting price of rough rice. These models showed that the variables accounting for variation in prices due to head rice yield and price trend were present in every one of the models, had the expected signs, and were significant at the required levels of probability.

The variables representing the Louisiana Grain Exchange grade and the government grade did not affect significantly the price of medium grain varieties. Model A, as defined earlier for the long grain varieties, was the only model which had the Louisiana Grain Exchange grade variable, in its quadratic form, affecting significantly the price of rough rice. The linear effect of the government grade level variable significantly affected price in the model applied to the last four seasons.

Of all grade factors considered in the model building process the only factor affecting significantly the price of medium and long grain rice was red rice. Its regression coefficient values were equal to -.2842 and -.4278, respectively, indicating a decrease in price of rough rice per barrel as level of red rice increased. The grade factor "others" was present in the model for medium grain rice only. The regression coefficient for this factor was equal to -.7473, showing that an increase in "others" level causes price to decrease by $.7473 per barrel, keeping all other factors constant.

The class variable variety was highly significant in all models for medium and long grain rice. The hypothesis that different price levels existed for the different varieties was well justified.

The linear and quadratic forms of the trend variable were present in all models. The regression coefficients for these two variables indicated, in each model, the upward trend in prices during recent years. It also indicated that the 1969-70 season had the lowest prices of the six year period being analyzed.

The variable representing lot size was not present in any of the models. This variable had been proven to exert a significant effect on price of rough rice per barrel in previous studies. In fact, when only the first two seasons, for medium and long grain, were considered, this variable significantly affected the price of rough rice; however, it was not significant for the last four seasons or for all six seasons considered together.

The coefficient of determination was, in all cases, greater than .80; that is, each model explained more than 80 percent of the variation in prices of rough rice during the 1968-69 to 1973-74 period.

In Chapter V, variables accounting for differences in price due to locations, mills and month of the year were added to the models developed in Chapter IV. The variable location was represented by the rice growers associations at different sites. These associations are the link between seller and buyer of rough rice through the Louisiana Grain Exchange. The variable mill represented the price differentials at the several rice mills included in this study.

The variable accounting for seasonal variations was created by dividing the data according to date of transaction during each month of the season.

When these variables were added to the models obtained in Chapter IV, the signs of the regression coefficients and the significance levels of the variables in the model did not change; also, the added variables were significant at the required levels. This means that the hypotheses stating that the mean prices per barrel of rough rice were equal among location, mills and months of the season were rejected.

The price differentials found with both of the models, A and B, within medium and long grain varieties were almost the same. The seasonal patterns computed for medium and long grain rice using these models were similar. Prices were low at the beginning of the season and high at the end of it.

Conclusions

The statistical analysis made in this study showed that pricing and grading of rough rice by the Louisiana Grain Exchange during the 1968-69 to 1973-74 seasons, for medium and long grain varieties, was consistent and systematic. The expected relations between some of the variables considered were found to exist.

In the process of grade determination, the grade level assigned by the Louisiana Grain Exchange followed the table of maximum grade factor levels as given by the U. S. D. A. more closely than the grade levels assigned to a particular lot by the government. Here, grading rice according to levels of grade factors, is where improvement is needed. Most grade factors associated with a particular Louisiana Grain Exchange grade were equal to or less than the grade level. Exceptions occurred for several grade factors, but in all cases the limiting grade factor was red rice. It was concluded that the grade factor red rice was treated differently in the process of grade determination. High levels of red rice are less desirable than high levels of other grade factors, due to its costly removal and problems that it causes during the milling process.

The factor general appearance was the same as the grade given by the Louisiana Grain Exchange and similar to government grade; it was not truly a grade factor or used effectively in grade level determination. Inspectors, in assigning level of general appearance to a particular lot seemed to have been influenced by the levels that they had assigned to other grade factors.

The statistical models developed in this study suggest that the grade factors are not equally weighted in the process of grade determination, and these weights are different for medium and long grain rice varieties.

The failure of most grade factors to affect significantly price of rough rice indicates that the basic grade factor level specifications may need to be designed with, perhaps, a reduction in the number of levels.

Head rice yield, the annual trend and rice variety were the most important factors in the price determination process, grade and grade factors being of lesser importance. This shows that the present rice classification system does not adequately reflect the price of rice.

The variable accounting for differences in price due to differences in lot size did not significantly affect the price of medium or long grain rough rice, even though previous studies had shown that rice producers could obtain better prices by pooling lots of rice of the same quality characteristics.

In general, it can be concluded that available quality considerations are reflected in the pricing system. The lack of marketing efficiency that arises here is the fact that those quality characteristics which are of paramount importance in the determination of quality at the mill, which inspect quality "through the eyes of the miller," are not reflected in the classification system. This leaves the producer in a position of producing rice on the basis of quality evaluations which are not in accordance with that of the mills.

Several marketing implications have been noted throughout this study with respect to factors which are influential in the establishment of prices. Many marketing bottlenecks which presently exist can be resolved by basing the classification of rice on quality and non-quality factors as desired by buyers.

The variables accounting for differences in price due to mill, location and month of the season all affected significantly the price of rice. Even though transportation costs were not included in this study, these price differentials can be effectively used by rice producers to maximize profits. Using the price differentials for the different class variables, producers can determine what kind of rice to produce, and where and when to sell it so that profits are maximized. They can use seasonal indexes in their planning process to determine the best time of the year to sell rice and to make plans as far as storage is concerned.

In general, it is not advocated that the present rice classification system be abandoned. It is recommended that the complete classification of rice be reorganized in relation to millers preferences. It is recommended that, as technology advancements occur and are adopted by rice millers, the economic importance of each grade factor be re-examined with the purpose of making appropriate changes in grade specifications so that grades can continue to identify differences in quality and differences in market value.

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APPENDIX

Appendix Table 1. Mean Price per Barrel for Each Rice Production Area Within Seasons, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Location	Marketing Seasons					
	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
Crowley	7.71	7.56	7.76	8.23	9.71	21.00
Elton	7.67		7.87	8.13	11.44	19.67
Fenton	7.68	7.59	7.89	8.21	9.52	22.64
Iowa	7.58	7.64	7.69	7.90	11.38	23.11
Welsh	7.84	7.75	7.99	8.20	10.84	21.59
Basile	7.60	7.60	8.03	8.57	10.58	21.12
Kinder & Elton	7.51	7.46	7.79	7.96	9.36	21.65
Roanoke	7.30		7.84	7.72	9.56	20.00
Vermillion	7.39	7.78	7.75	7.91	11.62	24.86
Miscellaneous	7.49		8.21	8.54	11.14	23.69

Appendix Table 2. Mean Price per Barrel for Each Mill Within Seasons, Medium Grain Rice, Louisiana, 1968-69 to 1973-74

Mill	Marketing Seasons					
	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
Argca	7.68	7.80	8.04	7.79	11.42	22.12
Blue Ribbon	7.70	7.89	7.76	8.30		20.64
Broussard	7.90		8.49	8.55	12.56	24.14
Ed Duhe	7.60	7.68	7.80	8.25	10.66	20.03
Dore	7.91		7.93	8.89	12.37	28.68
Eagle	7.87		8.17	8.21	9.02	20.46
Estherwood	7.69	7.63	7.98	8.26	9.79	20.48
Farmers	7.48	7.50	7.76	8.14	10.32	21.87
Kaplan	7.00		7.28	7.67	10.33	20.57
Mermentau	7.68		8.00	8.54	10.47	
Mississippi	7.44	7.48	7.84	8.02	9.83	20.42
P & S			8.13	8.48		21.11
Republic	7.63	7.72	7.90	8.11		
Riviana	7.83			8.08	11.14	22.57

Appendix Table 3. Mean Price per Barrel for Each Rice Production Area Within Seasons, Long Grain Rice, Louisiana, 1968-69 to 1973-74

	Marketing Seasons					
Area	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
Crowley	7.94	7.95	7.99	8.64	10.15	22.81
Elton	8.35	7.91	8.80	8.32	12.30	26.62
Fenton	8.11	7.51	8.20	8.62	9.51	21.92
Iowa	8.06	7.55	8.23	7.93	9.71	23.25
Welsh	8.28	7.76	8.24	8.56	9.66	21.83
Basile	8.02	7.61	8.40	8.75	11.23	23.87
Kinder & Elton	7.91	7.45	8.45	8.37	10.19	22.35
Mamou	7.38	7.32	8.02	8.08		21.17
Roanoke	7.83	7.63	8.22	8.62	10.26	20.81
Vermillion	7.81	7.47	8.45	7.92	10.87	25.89
Miscellaneous	7.85		8.43	8.61	10.38	23.87

Appendix Table 4. Mean Price per Barrel for Each Mill Within Seasons, Long Grain Rice, Louisiana, 1968-69 to 1973-74

	Marketing Seasons					
Mill	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
Argca	8.23	7.61	8.39	8.42	9.47	21.84
Blue Ribbon		7.43	7.71			20.10
Broussard	8.04	7.55	8.56	8.48	11.23	23.91
Ed Duhe	8.12	7.95	8.37	8.55	10.81	23.45
Dore	8.66	8.35	8.62	8.93	11.98	21.96
Eagle			9.33	9.17	11.09	26.27
Estherwood	8.22	7.76	8.29	8.77	10.16	21.57
Farmers	7.48	6.70	7.53	7.22	10.19	17.87
Kaplan	7.43	6.40	6.92	8.40	7.55	
Liberty			8.75		9.86	20.12
Mermentau	8.17	7.32	8.28	8.36	9.18	17.63
Mississippi	7.63	7.40	7.80	8.06	10.15	21.53
P & S	7.15	7.30	8.03	7.41	10.89	23.04
Republic	8.18	7.31	7.86	7.77		
Riviana	8.17	7.85	8.50	8.62	11.06	24.47

Appendix Table 5. Analysis of Variance, Regression Coefficients and Statistics of Fit for Model A with Government Grade as Independent Variable, Long Grain Rice, Louisiana, 1968-69 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and Least Squares Means	t-Values	Significance Level
Regression	4	51230.34			
Intercept			40.5389		
Head Rice	1	1064.19	.0981	27.59	.0001
Gov. Grade	1	23.67	-.1135	13.25	.0484
Trend	1	7451.23	-22.2618	1.98	.0001
Trend Sq.	1	11143.31	2.9814	47.87	.0001
Error	1271				
Corrected Total	1275				
R-Squared	86.93%				

Appendix Table 6. Analysis of Variance, Regression Coefficients, Least Squares Means and Statistics of Fit for Model A with Government Grade as Independent Variable, Long Grain Rice, Louisiana, 1970-71 to 1973-74

Source	Degrees of Freedom	Sum of Squares	Regression Coefficients and Least Squares Means	t-Values	Significance Level
Regression	10	51584.87			
Intercept			42.5260		
Head Rice	1	703.88	.0868	11.01	.0001
Gov. Grade	1	66.98	-.1989	3.39	.0007
Trend	1	7223.39	-22.7637	35.25	.0001
Trend Sq.	1	10658.23	3.0518	42.83	.0001
Varieties	6	354.23		3.18	.0001
Belle Patna			-.6352		
Blue Belle			.1742		
Blue Bonnet			1.2726		
Star Bonnet			.3169		
Dawn			-.1504		
Toro			-.0841		
Labelle			.8940		
Error	1265	7351.52			
Corrected Total	1275	58936.08			
R-Squared	87.53%				

VITA

Adolfo Martinez was born in Cali, Colombia, on July 30, 1948. He attended grade school in Cali, Colombia and graduated from Lacordaire High School in 1965.

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EXAMINATION AND THESIS REPORT

Candidate: Adolfo Martinez

Major Field: Agricultural Economics

Title of Thesis: An Economic Analysis of Effects of Selected Quality and Non-quality Factors on Prices of Medium and Long Grain Rough Rice in Louisiana.

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:

November 6, 1975