Marketing Research Report No. 330

Costs of Operating Southern Rice Mills

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PREFACE

The study described in this report is part of a broad research program designed to increase efficiency in the marketing of farm products and to reduce the price spread between the producer and consumer. The report contains an analysis of an important element of the price spread for rice, and it also provides a guide to the individual rice miller to evaluate his operating efficiency and his own competitive position within the industry.

This study was made possible through the cooperation of many rice millers who freely devoted their time to provide the necessary information. Valuable assistance was given by several rice millers who helped in the preparation of the questionnaire through which the basic data for this study were obtained.

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SUMMARY

Average annual costs per unit (100 pounds of rough rice milled) for processing and selling rice varied widely in the mills included in this study because of the variety of services offered by the mills, the differences in volume handled, and the differences in operating and marketing practices.

The 33 plants for which data were available milled about 70 percent of the entire annual rice crop in the South--25.9 million bags of rough rice. The average plant milled 760,000 hundredweight of rough rice. Thirty-one percent of the total was dried by the mills and 18 percent of all rice milled was packaged and sold in consumer-size containers. A substantial proportion of rice was stored in outside storage. Of the nearly 18 million hundredweight of all milled rice sold, 88 percent was sold through brokers.

About 54 percent of rice receipts and 81 percent of shipments for all 33 mills in the study were carried by railroads. The balance was shipped mainly by truck. Only small quantities were shipped directly by water. The large mills tended to rely more heavily on rail transportation than the small ones did.

Twenty-three of the 33 mills provided useful information on processing costs. Excluding transportation charges and the cost of rough rice, the average total unit cost amounted to 98 cents per 100 pounds of rough rice. This included costs for all types of services. The cost ranged from 63 cents to $1.48. Salaries, wages, and commissions averaged 37 percent of the total cost, with production labor accounting for over half of this amount. Packaging materials represented 21 percent of the total while administrative and selling expenses, excluding salaries, amounted to about 17 percent. Utilities, supplies, repairs and maintenance, depreciation, taxes, insurance, and storage made up the balance of the total cost.

Three-fourths of all differences in total unit costs among these 23 mills were the result of the volume of rice milled and the percentage of rice packaged in consumer-size containers. The extent to which the mills used their milling capacity and the scale of drying operations did not greatly affect the annual processing costs.

Total costs for mills which did not package the rice averaged 73 cents per hundredweight of rough rice milled. Mills in this category numbered 14. The costs ranged from 63 cents to 94 cents per hundredweight, depending largely on the scale of milling operation. On the average, wages and salaries to production workers in these mills represented about 25 percent of the total cost, and other salaries and commissions about 20 percent. The cost of bags was about 18 percent, while selling and administrative expenses excluding salaries and commissions represented about 16 percent of the total cost. Utilities, maintenance, taxes, insurance, and depreciation made up the balance.

The average cost of packaging 100 pounds of milled rice in consumer-size containers was $1.47. This figure was based on data from 8 plants which

reported costs for packaging separately. The cost of packaging included labor, utilities, repairs, maintenance, depreciation, and the cost of the packaging materials. The packaging materials alone represented 68 percent of the total cost of packaging. The total unit cost of packaging, including administrative and selling expenses but excluding the cost of rough rice and the cost of milling, varied widely depending on the percentage of milled rice packaged and the brand and quality of rice sold. A range from $2.00 to about $6.00 per 100 pounds packaged was estimated.

Administrative and selling expenses per unit of rice milled tended to be considerably higher in mills which packaged the rice in consumer-size packages.

Labor productivity varied considerably, both from month to month and from mill to mill, in part because of the difference in the use of plant capacity. After calculating the monthly output per man-hour at the peak level of performance the lowest output per hour was about 6 bags and the highest was twenty-four 100-pound bags of rough rice.

COSTS OF OPERATING SOUTHERN RICE MILLS

By Nicholas M. Thuroczy and Woodrow A. Schlegel, agricultural economists, Market Organization and Costs Branch, Agricultural Marketing Service

INTRODUCTION

Rice mills in the South provide a variety of services. Some mills dry all or part of the rice they mill during the season while others dry none at all. Some mills sell a large proportion of their rice in consumer packages, while other mills sell their rice in bulk or in 100-pound bags. Again, some mills handle only long grain or medium grain rice, while others handle both. The hourly milling capacity of the largest mill is several times the capacity of the smallest, and the annual volume handled by the largest mill exceeds the volume of the smallest plant by many times. With such a difference among rice mills, a survey of the plants is likely to reveal a wide variation in costs.

But the relative costs of processing and selling do not always depend on the size of the mill or the services offered. Rather, such costs may be the result of efficiency of operation. 1/

Frequently inefficiencies in operations may be attributed to the lack of complete knowledge on costs of processing. Plant managers often are not aware of the costs of other plants operating under similar conditions. Further, the costs associated with changes in scale of a given service operation are not always known.

OBJECTIVES AND PROCEDURE

The major objective of this study is to develop information on relative efficiency of operations in different size rice mills as an approach to increasing marketing efficiency. The study is based on a sample of 33 mills in the South. 2/

Among the secondary objectives are the following: (1) To determine the major cost items in processing and marketing rice during the rice milling

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1/ Efficiency in this study is defined in terms of operating cost per unit (100 pounds of rice milled). The plant operating at the lowest cost per unit, in providing a specific service, is the most efficient among plants having the same characteristics and operating under the same conditions.

2/ The number of mills used in each segment of the cost analysis varies depending on the nature of the data obtained from mills.

season of 1956-57, (2) to determine the factors related to variations in costs or major cost groups among different mills, and (3) to determine the relationship which prevailed between costs and individual factors responsible for variations in costs among different mills.

This report has been divided into two major parts. The first part is a review of the marketing practices and services rendered by all 33 mills in the sample. The second part discusses costs for various types of operating combinations.

First, the costs of processing and marketing rice are discussed in broad terms. All mills providing cost data, regardless of the type of services they performed or the form in which they marketed their rice, are analyzed by plant size and by major cost groups to determine some of the major factors which are responsible for the differences in costs.

Second, recognizing the difficulty of comparing cost data of different mills having different attributes and performing different services, relationships have been established which show changes in cost as a result of changes in each factor responsible for variations in costs among mills. These factors are the major services rendered by these mills and include drying, milling and packaging operations. Drying and packaging are not performed by all mills. They are usually considered as sideline operations to rice milling. Parboiling of rice is an additional service which is limited to only a very few mills.

Milling outturns per hour and per month for production labor are also analyzed for a selected number of rice mills. The emphasis is placed on milling capacity utilized and its influence on labor output per hour.

In the appendix both the sampling and the analytical procedures are discussed.

MARKETING PRACTICES AND SERVICES RENDERED

The mills in this study represented about half of all commercial rice mills in the South. Their combined annual volume of milling, however, accounted for nearly 70 percent of all rice milled in the South during the 1956-57 milling season or over 50 percent of all rice milled in the United States. 3/

Because of the relatively high percentage of the total volume of rice milled by these 33 plants in the South the averages in all size categories

3/ In 1956 there were 78 rice mills in the South, of which about 15 were operating part time or not at all. The combined volume of milling of these 15 mills did not exceed 2 percent of the annual milling in the entire South. These 15 mills consequently were excluded from the universe to be sampled. There were 9 rice mills operating during the 1956-57 season in California. These mills usually account for about one-fourth of all rice milled in the United States. Data on California mills have not been included in this study.

should be representative of the characteristics of the Southern rice milling industry.

All statistics in the tables on various practices are averages weighted by the annual volume of rice milled by the respective mills.

Buying

Of the 25 million hundredweight of rough rice milled by the sample of 33 mills, about 41 percent of all rice came directly from rice growers, 19 percent was obtained through competitive bidding for commercial rice and 40 percent represented rice contracted on Commodity Credit Corporation (CCC) account (table 1). 4/ On the average, large mills obtained a larger proportion of their rice on CCC account than small mills. The proportion of rice obtained directly from farmers tended to decrease as the volume of mill operations increased.

Table 1.--Source of mills' purchases of rough rice, by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Mills	Source			
		Rice growers	Dryers and warehouses	CCC	Total
	Number	Percent	Percent	Percent	Percent
Less than 300,000 cwt.	5	71.3	0	28.7	100
300,000 - 599,999 cwt.	9	37.7	12.3	50.0	100
600,000 - 1,000,000 cwt.	11	29.2	35.5	35.3	100
Over 1,000,000 cwt.	8	1/38.2	11.1	50.7	100
Total or average	33	40.8	19.1	40.1	100

1/ Excludes cooperative plants.

A somewhat different picture is obtained if rice milled on CCC account is excluded from all receipts. Of all the commercial rice milled, 63 percent was obtained directly from the farmers while only 37 percent was obtained through competitive bidding on the open market (table 2). About 22 percent of all the commercial rice was contracted in advance with the growers. These contracts are usually made some time before the harvest, assuring the farmer of at least the support price. Rice growers perhaps look favorably on such arrangements since they not only assure a market for their rice, but they tend to avoid also the sometimes burdensome procedures associated with storing and with CCC loan operations.

4/ In this report commercial rice denotes all rice which was not obtained through the Commodity Credit Corporation.

Table 2.--Source of mills' purchases of rough rice (except CCC rice), by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Mills	Source			
		Rice growers		Dryers and warehouses	Total
		Advance contract	After harvest		
	Number	Percent	Percent	Percent	Percent
Less than 300,000 cwt...	5	0	100.0	0	100
300,000 - 599,999 cwt...	9	54.9	34.1	11.0	100
600,000 - 1,000,000 cwt.	11	16.9	38.4	44.7	100
Over 1,000,000 cwt.....	8	18.6	33.7	47.7	100
Total or average...	33	22.1	40.5	37.4	100

On the average 54 percent of rice was received by rail while 46 percent was received by truck (table 3). In the small mills only 12 percent of rice was received by rail, but a gradual increase in rail transportation took place as the scale of operation increased. Truck transportation shows a reverse pattern. Larger mills are better equipped to use rail transportation, which often becomes economical only when a large volume is handled. 5/

By far the greatest proportion of rice was obtained in bulk either in trucks or rail cars. Only about 4 percent of rough rice was received in bags.

Table 3.--Form and means of transportation of all rough rice receipts, by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Mills	Form			Transportation to mill		
		Bulk	Bagged	Total	Rail	Truck	Total
	No.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Less than 300,000 cwt...	5	98.3	1.7	100	12.2	87.8	100
300,000 - 599,999 cwt...	9	93.0	7.0	100	40.9	59.1	100
600,000 - 1,000,000 cwt.	11	96.3	3.7	100	44.5	55.5	100
Over 1,000,000 cwt.....	8	97.4	2.6	100	67.6	32.4	100
Total or average...	33	96.4	3.6	100	54.2	45.8	100

5/ Industry sources indicate, however, that truck transportation has been increasing because frequently it is not only cheaper but it is also more flexible.

Drying

At the time of harvest, rice is green and cannot be milled. Before the milling process takes place the rice kernels must be dried. Rice may be dried on the farm, by commercial dryers, or by the mills.

The 33 mills dried about 30 percent, or about 8 million hundredweight of the total of 25.9 million hundredweight they processed. Some 10.4 million hundredweight, or 40 percent, represented rice obtained and milled for the Commodity Credit Corporation. Such rice is usually obtained through competitive bidding f.o.b. commercial dryers or from warehouses in dried form. The remaining commercial rice may have been dried on the farm or in commercial dryers.

Rice drying is most common with large mills (table 4). Presumably larger mills are more readily equipped to dry their own rice either in dryers which are part of the plant or in dryers which they control.

Table 4.--Proportion of rice dried at mills, by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Mills	Rice dried at mills	
		All rice including CCC	Non-CCC rice only
	Number	Percent	Percent
Less than 300,000 cwt...	5	18.3	25.6
300,000 - 599,999 cwt...	9	29.2	51.8
600,000 - 1,000,000 cwt.	11	26.8	41.3
Over 1,000,000 cwt.....	8	34.5	57.8
Total or average ..	33	30.6	49.8

Milling

The miller ordinarily buys, processes, and sells his own product. Milling for other mills or custom milling is seldom done.

There are no published data on the milling capacity and volume of rice handled for all mills in the South. The sample of 33 mills, however, may give some indication of the relative size of mills and volume handled by different groups. The average mill in the sample milled 760,000 hundredweight of rough rice with an average milling capacity of 241 hundredweight per hour (table 5). As expected a relationship was found between hourly milling capacity and annual volume of rice milled. However, while the average capacity of the largest mills is only five times the average capacity of mills in the smallest category, the average volume milled in the largest mills is more than eight

Table 5.--Capacity of rice mills, proportion of capacity utilized and length of operation, by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Mills	Annual average volume	Reported hourly milling capacity	Annual milling capacity utilized		Length of operation		
				Based on highest monthly milling 1/	Based on reported hourly capacity 2/	Peak season: Hours per day	Peak season: Weeks	Months
	No.	1,000 cwt.	Cwt.	Pct.	Pct.	No.	No.	No.
Less than 300,000 cwt..	5	176	69	51.8	30.5	21.5	12.2	10.4
300,000 - 599,999 cwt..	9	403	183	48.9	28.0	22.6	11.5	10.1
600,000 - 1,000,000 cwt.	11	790	301	49.5	32.7	21.7	12.5	10.5
Over 1,000,000 cwt.....	8	1,406	322	63.4	54.7	24.0	18.2	12.0
Total or average..	33	760	241	53.1	36.4	22.5	13.6	10.7

1/ Assuming that annual capacity is 12 times the largest quantity actually produced by the mills in any 1 month.

2/ Assuming that annual capacity is the quantity that would be produced if the mills operated at the reported hourly capacity for 365 24-hour days.

times the average volume handled by the smallest mills. Utilization of annual milling capacities was determined on the basis of (1) the reported hourly milling capacity, and (2) the actual monthly peak performance. Regardless of how plant capacity was defined the largest mills utilized their plants more fully than smaller mills (table 5). Not only is the average working day usually longer in the larger mills, but also their peak season tends to be longer. In addition, smaller mills frequently close down for several months, while larger mills operate all year round, closing only occasionally for repairs. Some of the differences in operating practices, among other things, may have been associated with the availability of Government rice for milling during the 1956-57 milling season.

Packaging

Scale of packaging operations could be estimated in two ways: The actual amount of rice packed in consumer packages, and the amount of rice sold in that form. The amount sold was used for the estimate because such information was more complete. Though the amount of rice packed in consumer packages during any given year may not necessarily be the same as the amount shipped in this form, the two quantities usually correspond fairly closely.

Packaging in consumer-size containers of 5 pounds or less is an additional service performed by some rice mills. While rice sold in 100-pound bags may carry brand names, rice sold in smaller packages almost always carries the name or brand of the rice mill, or the name or brand of the distributor. The latter group usually receive the rice from the mill either directly or through a broker in bulk or in 100-pound bags or already prepared in packages under the distributor's name. While the volume of packaged rice coming to the market from these distributors is still small in relation to all packaged rice sold, it has been increasing according to industry sources.

Seventy-eight percent of the rice handled by the mills was packed in 100-pound bags or bulk, 18 percent was packed in consumer-size containers of 5 pounds or less, and most of the rest was packed in 10-, 25-, and 50-pound bags (table 6).

Packaging operations are most common in large mills, and the proportion of rice packed increases gradually as the scale of rice milling operations is increased. The smallest mills on the average packed only about 3 percent of their rice in consumer packages while the largest mills packed 24 percent.

A different picture is obtained when the rice milled for the Commodity Credit Corporation is excluded from the total. Practically all CCC rice is shipped in 100-pound bags or in bulk. As shown in table 7, 65 percent of the commercial rice shipments were in 100-pound bags or in bulk, 28 percent in packages of 5 pounds or less, and the rest mainly in 10-, 25-, and 50-pound bags. As before, the proportion of rice packed in consumer packages became larger as the size of the mills increased. The largest mills packed an average of 37 percent of their commercial rice in 5-pound or smaller containers, while the smallest mills packed only 4 percent of their commercial milled rice in these containers.

Table 6.--Proportion of all rice packed in containers at mills, by size of mills and size of containers, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Mills	Size of containers			
		5 pounds or less	6 to 99 pounds	100 pounds or over	Total
	Number	Percent	Percent	Percent	Percent
Less than 300,000 cwt..	5	3.1	19.1	77.8	100
300,000 - 599,999 cwt..	9	9.3	1.1	89.6	100
600,000 - 1,000,000 cwt.	11	15.5	1.6	82.9	100
Over 1,000,000 cwt.....	8	24.1	4.3	71.6	100
Total or average..	33	18.4	3.5	78.1	100

Table 7.--Proportion of rice (except CCC rice) packed in containers at mills, by size of mills and size of containers, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Mills	Size of containers			
		5 pounds or less	6 to 99 pounds	100 pounds or over	Total
	Number	Percent	Percent	Percent	Percent
Less than 300,000 cwt..	5	3.9	27.0	69.1	100
300,000 - 599,999 cwt..	9	13.7	2.1	84.2	100
600,000 - 1,000,000 cwt.	11	22.2	2.7	75.1	100
Over 1,000,000 cwt.....	8	37.4	10.8	51.8	100
Total or average..	33	27.7	7.6	64.7	100

Selling

In selling rice, mills have traditionally depended heavily on brokers. This is shown in table 8, where the four main categories of merchandising media are listed. Brokers handled 88 percent of all commercial rice sales. This percentage rose to 95 and 97 percent for the smallest mills. In general, even large organizations which have their own sales staffs use brokers. Brokers often handle rice sales for more than one mill. Direct sales to wholesalers, jobbers, and exporters are of relatively minor importance.

Mills in the survey shipped approximately 81 percent of their rice by rail or by combination of rail and sea train and the balance by truck, although a very small proportion of rice was shipped by water (table 9). These shipments exclude overseas exports. As with receipts, rail shipments become gradually larger as the scale of milling operation increases. According to industry sources, truck shipments of milled rice are gradually increasing.

Table 8.--Proportion of mills' rice (excluding CCC rice) sold through different media, by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Mills	Merchandising media				
		Broker	Wholesaler	Exporter	Other	Total
	Number	Percent	Percent	Percent	Percent	Percent
Less than 300,000 cwt.	5	94.7	5.3	0	0	100
300,000 - 599,999 cwt.	9	97.4	0	2.3	0.3	100
600,000 - 1,000,000 cwt.	11	87.4	3.4	4.6	4.6	100
Over 1,000,000 cwt.	8	86.1	5.7	4.8	3.4	100
Total or average	33	87.6	4.4	4.5	3.5	100

Table 9.--Percentage of milled rice shipped to market by rail and truck, by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Mills	Transportation		
		Rail	Truck	Total
	Number	Percent	Percent	Percent
Less than 300,000 cwt.	5	51.5	48.5	100
300,000 - 599,999 cwt.	9	90.0	10.0	100
600,000 - 1,000,000 cwt.	11	80.1	19.9	100
Over 1,000,000 cwt.	8	80.2	19.8	100
Total or average	33	80.8	19.2	100

COSTS OF OPERATING RICE MILLS

Cost accounting data were provided by 23 mills of various sizes, with various annual volumes of milling. About half of these plants also operated either packaging or drying plants, or both, in different proportions of their annual millings. Thus an analysis of the cost records of these mills will reflect the effect of a combination of different services.

The total annual volume of rough rice milled by these plants represented about 46 percent of all rice milled in the South, or about 17 million hundredweight. Of this amount a total of 14 percent of rice was dried and 9 percent was packed and sold in consumer-size containers of 5 pounds or less. Also, while no quantitative estimates are available, a portion of the rice was stored in outside storage.

Definition of Costs

All average costs are expressed per 100 pounds of rough rice milled, except that costs of packaging operations are expressed per 100 pounds of milled rice.

The cost study in various phases had to be conducted in terms of rough rice since the main information on volume handled was available in this form. Information on actual milling outturn was not available. Cost figures in this report can be converted to milled rice equivalent by dividing the unit costs based on rough rice by an average percentage of total yield, say .69.

Annual cost accounting data have been secured and used throughout this study. All cost items summarized in this report relate to the fiscal year of 1956-57. The beginning of the fiscal year for most mills was July 1 or August 1. For practically all mills the time period during which the annual volume of rough rice milled was reported coincided with the accounting period.

Total costs include all expenses which rice mills accrued during the period studied, but exclude the cost of rough rice and freight charges to and from the mill.

Storage expenses both for rough and milled rice were included in total cost whenever such information was available. Some mills considered outside storage for rough rice as part of the standard milling operation and therefore reported these expenses as operating costs. Other mills considered outside storage as part of the cost of rough rice and did not report such expenses as operating costs. To the extent that some mills did not report these expenses, actual storage charges and consequently total costs per unit may be somewhat underestimated in the following cost analyses.

Because of the lack of a uniform accounting system among the mills, the following procedure was used in order to bring about a closer cost comparison among these mills. All individual costs accrued at various stages of operation for each mill were placed in a single cost category, regardless of the type of service performed. For example, labor costs reported separately for drying, milling, or packaging operations were combined under a single heading: Wages and salaries to production workers. This procedure was necessary because several mills performing more than one operation could not report costs separately.

Average Cost

Every item of cost presented in this section is an average of costs for all mills or a group of mills falling into different size categories. 6/ Two

6/ For a group of plants, a single average cost per unit, whether it is a total or an individual cost item, frequently may be meaningless since the process of averaging eliminates many factors which have marked influence on

kinds of averages are used. The first is the average cost weighted by the annual volume of rice milled by each mill. The second is a simple average giving equal weights to the costs of each mill.

Total Cost and Relative Importance of Individual Items

A summary of the average unit cost of processing and marketing 100 pounds of milled rice in the South during the 1956-57 milling season is presented in table 10. Eight broad items of costs are shown in order of their importance. Salaries and wages paid to production workers include all compensation for labor engaged in drying, milling, and packaging where applicable, and fringe benefits where such information was available. The definition of production labor is similar to the definition used by the U. S. Bureau of the Census. All other salaries and commissions represent the sum of all others, such as compensation to executive, clerical, and sales personnel. All packaging material includes the cost of bags and twine and other types of smaller containers where applicable. Buying, selling, general, and administrative expenses are a residual cost group obtained after deducting from total cost all other items listed in table 10. Depreciation includes the annual cost of the physical plant for the mill, warehouse or dryer if attached to the mill and if operated in conjunction with milling, and the annual cost of the packaging plant. Plant operating expenses include utilities, repairs, maintenance, fumigation, and all types of supplies except bags and packaging materials. Outside storage is the payment for storing rice at storage facilities not owned or operated by the mill. Taxes and insurance include expenses for milling, drying and packaging.

The average total cost per unit for processing and distributing 100 pounds of rough rice amounted to 98 cents during the 1956-57 milling season. Salaries and wages to production workers and all other salaries and commissions were by far the largest individual items.

All salaries and wages including wages to production workers amounted to 37 cents or over one-third of the total cost. Salaries and wages to production workers tended to be somewhat higher than salaries and commissions paid to all other employees. Bags and packaging materials of all types represented 20 cents or about 21 percent of the total. Buying, selling, administrative, and general expenses, excluding salaries, amounted to 16 cents or about 17 percent. Depreciation was the next item in importance and accounted for a little over 8 cents or about 9 percent of the total. Plant operating expenses, like utilities, repair, maintenance, fumigation, and all types of supplies, represented nearly 8 cents or 8 percent. Outside storage for rough and clean rice and all

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costs. This is particularly true when the plants are not performing the same type of services and are not of the same size.

Table 10.--Average cost to mills for processing and distributing 100 pounds of rough rice, South, 1956-57 milling season 1/

Cost item	Average cost per hundredweight			Coefficient of variation	Percent of total cost
	Weighted average 2/	Simple average	Range of costs found in 68 percent of the mills		
	Cents	Cents	Cents	Percent	Percent
Salaries and wages to production workers	20.0	22.2	15.8- 24.2	21.0	20.2
All other salaries and commissions	17.1	18.5	11.9- 22.3	30.4	17.2
All packaging material and bags	20.2	18.8	12.3- 28.1	39.1	20.6
Buying, selling, general and administrative expenses, excluding salaries and commission	16.4	14.2	8.1- 24.7	50.6	16.6
Depreciation	8.4	7.5	3.7- 13.1	56.0	8.6
Plant operating expenses, utilities, repairs, maintenance	7.7	8.5	6.0- 9.4	22.1	8.1
Outside storage of rough and milled rice	4.4	2.4	0.0- 8.8	100.0	4.5
Taxes and all insurance	4.1	4.4	2.0- 6.2	51.2	4.2
Total	98.3	96.5	74.8-121.8	23.9	100.0

1/ The 23 mills in this group on the average milled 744,000 hundredweight of rough rice; 17.9 percent of the rice was dried and 5.8 percent of milled rice was packed in consumer-size packages.

2/ Weighted by volume of rough rice milled by each mill.

taxes and insurance were the smallest items, and each accounted for about 4 cents per 100 pounds of rough rice.

Range and Variability

The range for each cost group indicates how costs of the 23 mills deviated from the average of all mills in the sample (table 10). The 68 percent range for each cost group means that the costs of about 68 percent, or 16 mills in the sample, will be found within this range. The range, as will be noted, varied considerably within different cost groups.

The same absolute range, however, for different cost items having various average magnitudes will have a different meaning. The absolute range is not always a good measure of variability. In order to present a more meaningful picture of the variability of the individual cost items among the 23 mills, a relative measure of variation for each cost group is also shown. This tells in percentage terms how much, on the average, the costs of individual mills deviate from the average of all mills. 7/

Wages and salaries for production workers and plant operating expenses showed the smallest variations--21 and 22 percent, respectively, from the average. The small variability of these cost items is mainly due to the characteristics of rice milling. The bulk of the two items are associated mainly with milling operations, which are performed by all mills. On the other hand, not all mills have the same selling and administrative organization since the form in which rice is sold (packaged goods vs. 100-pound bags) varies from mill to mill. This probably accounts for greater variability in selling and administrative expenses.

Although labor and direct operating costs show the smallest variability, there are appreciable differences in these cost items among different mills.

Weighted vs. Simple Average

Because of the differences between weighted and simple average costs (table 10) these averages should be explained. As noted earlier, the first cost item is an average cost of milling weighted by volume by each mill in the sample. This kind of average emphasizes the costs accrued by larger mills. The simple average does not take into account volume or the size of the mill, and therefore gives equal weight to the large and small mills.

For some cost items the weighted average tends to be higher and for others lower than the simple average. Since the weighted average emphasizes the costs of larger mills, the relationship between the two indicates that one of the

7/ In the succeeding cost analyses the average costs are shown, whenever possible, in the same manner as in table 10, including the 68 percent range and relative variability.

primary factors influencing different cost items must be the scale of milling operation. 8/

That the scale of milling operation has a different effect upon different cost groups also suggests that there must be additional factors associated with variations in costs among different mills.

Factors Influencing Costs

Differences in unit costs among mills offering different services and operating at different volumes might be attributed to a wide variety of forces. They may be classified into two somewhat interrelated categories. The first category includes factors directly associated with differences in processing services, such as the volume of milling, drying, and packaging, including the utilization of plant capacity for these services. The second category includes factors which are not directly associated with these services but which fall under marketing and operating practices discussed earlier in this report. Also this category includes differences in processing technology, location, wage rates, and other items. Forces falling into the second category and their effect on costs are not emphasized in this report.

The two main services other than milling which are provided by many mills are drying and packaging. 9/ Since milling operations are performed by all mills, differences in costs must be found largely in differences in the degree to which these two services are provided in addition to the scale of milling operations.

The average costs associated with mills in three different size categories are shown in table 11. Cost items are simple averages, so that in each volume group the effect of scale of milling operations is partially removed. These costs are again broad averages and include expenses for a wide variety of services.

Table 11 lists eight cost items, which will be grouped into three distinct categories. The first group includes those items which are usually called fixed costs, since the total tends to be fixed in any season and independent of the volume of operation. Taxes, insurance, and depreciation fall into this category. This cost group will be called "fixed costs."

The second group includes those costs which are usually identified with direct plant operation. Salaries and wages to production workers and plant operating expenses such as utilities, repairs, maintenance, fumigation, and various plant supplies fall into this category. This cost group will be called "direct operating costs."

8/ Variations in costs among mills is obviously influenced by the scale of rice milling operations because these average costs are expressed per unit of rice milled.

9/ Parboiling operations, provided by a few mills are not discussed in this report.

Table 11.--Average cost of processing and marketing 100 pounds of rough rice, by size of mills, South, 1956-57 milling season

Cost item	Size of mills (1,000 hundredweight of rough rice milled per year)					
	Less than 400 1/		400-800 2/		Over 800 3/	
	Simple average	Range of costs found in 68 percent of the mills	Simple average	Range of costs found in 68 percent of the mills	Simple average	Range of costs found in 68 percent of the mills
	Cents	Cents	Cents	Cents	Cents	Cents
Taxes and insurance	4.5	2.5- 6.5	5.8	3.6- 8.0	3.8	2.1- 5.5
Depreciation	8.5	.6- 16.4	5.6	1.9- 9.3	7.9	3.9- 11.9
Salaries and wages to production workers	25.5	21.4- 29.6	21.2	18.4- 24.0	19.0	13.9- 24.1
All other salaries and commissions.	20.6	13.8- 27.4	19.1	11.1- 27.1	15.2	10.8- 19.6
Plant operating expenses	9.4	7.2- 11.6	8.5	6.4- 10.6	7.3	6.1- 8.5
Selling, general and administrative	12.0	5.8- 18.2	14.5	4.5- 24.5	16.9	9.2- 24.6
Outside storage	0.2	0.0- 0.4	2.3	0.0- 4.6	5.0	0.7- 9.3
All packaging material	18.8	11.6- 26.0	17.3	8.2- 26.4	20.4	12.3- 28.5
Total	99.5	74.4-124.6	94.3	71.0-117.6	95.5	70.4-120.6

1/ The 9 plants in this group on the average milled 243,000 cwt. of rough rice. 18.6 percent of rice was dried and 3.3 percent of milled rice was packed in consumer-size packages.

2/ The 7 plants in this group on the average milled 641,000 cwt. of rough rice. 18.3 percent of rice was dried, and 5.8 percent of milled rice was packed in consumer-size packages.

3/ The 7 plants in this category on the average milled 1,492,000 cwt. of rough rice. 16.6 percent of rice was dried, and 9.7 percent of milled rice was packed in consumer-size packages.

The third group of costs includes all other items not classified under the first two groups. This category includes administrative and selling expenses, salaries and commissions to executive, clerical, and sales personnel, the cost of bags and packaging material, and outside storage. This cost group will be called "all other costs."

Table 11 indicates that some unit cost items do not show distinct trends, others tend to decrease, and still others tend to increase as the scale of milling operation increases. Most of the individual cost items in each category tend to show an identical pattern of behavior. Thus the category of fixed costs, although it would be expected to decline, shows items without any distinct trend; that of direct operating expenses shows items which tend to decline and the category of all other costs shows items which, with the exception of all salaries and commissions, tend to increase with increase in the scale of milling operation. Thus, if the averages for individual cost items in each category show fairly similar behavior, the average for the whole category is also expected to behave approximately the same way.

Fixed Costs

Fixed costs on the average varied little among different size-groups of mills, ranging from 11 to 13 cents per 100 pounds of rough rice. The coefficients of variation, however, indicate that there has been a considerable variation in each volume group (table 12).

Table 12.--Average fixed costs per 100 pounds of rough rice milled: Depreciation, taxes, and insurance, by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Average fixed cost	Range of costs found in 68 percent of the mills	Coefficient of variation	Percent of total cost
	Cents	Cents	Percent	Percent
Less than 400,000 cwt....	13.0	3.9-22.1	70.0	13.1
400,000 to 800,000 cwt...	11.4	7.4-15.4	35.1	12.3
Over 800,000 cwt.....	11.7	8.2-15.2	29.9	12.2

In comparing the averages in each size category, the unit costs indicate a fairly stable pattern. 10/ Yet it must be recognized that the stability is largely due to the process of averaging which combined the different influences of several factors on costs. Table 11 reveals that packaging operations tend to increase with large-scale milling operations. The defined fixed costs per unit associated with milling operations alone would very likely decline with

10/ The higher unit cost in the smallest category is attributed to a single plant which showed unusually high depreciation.

increasing scale of milling, so that larger mills would have a smaller unit cost than smaller mills. However, as the scale of milling operations is increasing, there is also a tendency to provide for more packaging services (table 11). The additional fixed charges accrued by the large mills for packaging in turn may raise their unit costs, expressed on the basis of milling, to a level comparable to those in smaller mills.

Depreciation appears to be the largest item in the fixed cost group. There are various methods by which the annual cost of the plant can be written off. Further, this cost item will also depend on the age of the plant. Thus fixed costs per unit may also be influenced by these factors.

Because of lack of data on these aspects, no attempt was made to investigate all the factors which might be responsible for variations in this cost group.

Direct Operating Costs

Direct operating costs (labor, utilities, repairs, and so on) were 35 cents per 100 pounds for small mills, 30 cents for medium-size mills, and 26 cents for large mills (table 13). The relative variability of costs in each volume group seems to be considerably narrower than the variability in fixed costs.

Table 13.--Average direct operating costs per 100 pounds of rough rice milled: Salaries and wages to production workers, utilities, supplies, maintenance, repairs and fumigation, by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Average operating cost	Range of costs found in 68 percent of the mills	Coefficient of variation	Percent of total cost
	Cents	Cents	Percent	Percent
Less than 400,000 cwt....	34.9	29.6-40.2	15.5	34.8
400,000 to 800,000 cwt...	29.7	26.2-33.2	12.2	31.5
Over 800,000 cwt.....	26.3	20.9-31.7	21.7	27.5

Analysis of the services rendered and their effect on direct operating costs reveals that by far the most important factors in explaining variations in cost among mills are the scale of milling, and packaging operations. 11/ On the average, volume of milling operation alone explained about 49 percent of variations in this cost category among the 23 mills. The proportion of rice packed in consumer-size containers explained an additional 23 percent in

11/ The results of the statistical regression analyses are shown in table 23.

the variations in direct operating costs. 12/ Thus, the combined effect of the scale of milling and packaging operations explained about 72 percent of the variations in direct operating costs. Drying operations or the annual capacity utilized apparently has little or no influence on direct operating costs. 13/

That the scale of milling operations is one of the main determinants of costs in this category is to be expected. A large mill can utilize its productive resources more economically. That packaging operations showed such a strong influence on variation in operating costs is also understandable. Operating a packaging plant in addition to the milling plant will increase costs for utilities, repairs, maintenance, and labor. However, workers in packaging plants often perform part of the function of mill workers. In a plant with milling operations only, mill workers also pack rice in bags and prepare it for shipment. Workers employed in a separate packaging department often prepare packaged rice for shipments, thereby carrying out part of the function the mill workers performed in the simple milling operation.

Two main factors suggest why the effect of drying operations on costs was of little importance. First, the unit costs described in this report were expressed on the basis of the annual volume of all rice milled for each mill. With only a small proportion of rice dried in most mills (table 10), drying costs, if distributed over the entire volume of rice milled, will be largely covered up by the much larger volume of rice milled. Second, frequently drying costs are somewhat underestimated if this service is performed in conjunction with milling operations. This is due to a partial substitution of drying for storage operations, at least in cost accounting. If a milling plant also operates a dryer, the drying plant with its storage facilities will be used by the mill for storage. If storage is part of the miller's standard operation, depreciation of the storage plant, for example, might be charged to milling rather than to drying.

It is difficult to explain why the annual milling capacity utilized by the plants appears to have no appreciable influence on variations in direct operating costs. One possible explanation is that an overall and uniform definition of milling capacity for all mills may not be valid. Mills whose cost records are reported here are not uniform in their operations. The direct operating expenses, as defined in this section, are the combined results of either milling or milling and packaging operations. Expressing capacity on the basis of milling alone will not show much effect on costs of those mills

12/ The proportion of rice packed in consumer-size containers was the quantitative measure for the scale of packaging operations rather than the absolute volume packed. The latter did not show any appreciable relationships to variation in costs.

13/ Using the largest quantity of rice milled in any one month as a measure of monthly capacity and multiplying this amount by the number of months worked during the season, the milling capacity utilized as an additional variable reduced the explainable proportion of variations in direct operating costs from 72 to 70 percent. Using the percentage of rice dried as an additional variable reduced the explainable proportion from 72 to 67 percent.

which perform packaging operations also. Capacities for packaging plants are not available. 14/

All Other Costs

All other costs represents the residual left after deducting fixed and direct operating expenses from the total. As noted earlier, the largest items in this group are administrative and selling expenses and the cost of packaging material. The group represents the largest proportion of total cost per unit. Larger mills tend to have a higher unit cost in this category than smaller mills (table 14). The coefficient of variation indicates that this cost group is highly variable within each volume group.

Table 14.--All other costs per 100 pounds of rough rice milled: Administrative, selling (including salaries and commissions), outside storage and packaging material, by size of mills, South, 1956-57 milling season

Size of mills (rough rice milled per year)	Average operating cost	Range of costs found in 68 percent of the mills	Coefficient of variation	Percent of total cost
	Cents	Cents	Percent	Percent
Less than 400,000 cwt...	51.6	37.4-65.8	27.2	52.2
400,000 - 800,000 cwt...	53.2	35.7-70.7	33.0	56.5
Over 800,000 cwt.....	57.5	37.3-77.7	33.9	60.2

Analysis of the services rendered and their effect on all other costs reveals that by far the most important factor is packaging, followed by the volume of milling. The proportion of rice dried and percentage of annual milling capacity utilized appeared to have no effect on the cost. That there may be other factors which influence such costs is very likely. These would fall mainly into the marketing practice category.

On the average, the percentage of rice packed in consumer-size containers explained 71 percent of variation in this cost group. Volume of milling alone explained only about 30 percent. However, the combined effect of rice packaging and volume of milling explained only about 49 percent of the variations, indicating that the effect of milling on this cost group was not important. 15/

14/ Even if capacity for packaging plants were available, it would be difficult to combine them with milling capacity. This problem of definition of a uniform capacity for all mills is further aggravated by the fact that different mills not only operate their plants different lengths of time during a given season, but they also differ in the length of peak season, in days per week, and even in hours worked during the day.

15/ The results of the statistical regression analyses are shown in table 24.

That packaging operations would have such a strong influence on variations in this cost group is to be expected. Mills that sell rice in packaged form have higher administrative and selling expenses than mills handling only bagged rice. Because of the growing tendency for product differentiation through brand names in selling consumer-packaged goods, selling expenses have a marked and increasing effect on this cost group. The fact that selling and administrative expenses are larger in mills that sell packaged goods does not mean that returns are reduced. Retail price of some rice in packaged form per 100 pounds frequently is more than twice the price of rice in 100-pound bags.

The cost of packaging material is also higher with mills handling packaged goods. Small paper cartons, cellophane bags, and other types of containers are more expensive than jute or cotton bags for the same unit of rice.

Because larger mills tend to produce and sell a larger proportion of their rice in consumer packages, the administrative and selling costs per unit expressed on the basis of the annual volume milled will probably be influenced more by the scale of packaging operations than by the scale of milling operations.

Total Cost

The factors responsible for variations in different cost groups also will be expected to influence total costs. The degree, however, by which these forces determine total costs may be different from the degree by which they influenced individual cost items.

Analysis of the factors influencing total unit costs indicates that the two most important factors are again the proportion of riced packed in consumer-size containers and the volume of milling operations. The combined effect of these two factors explained 74 percent or nearly three-fourths of the variations in total unit costs among the 23 mills. 16/ As before, other factors, like drying operations and the annual capacity utilized, failed to explain additional variations.

Costs as Affected by Volume of Milling and Packaging

The previous cost analysis determined the main forces which were responsible for variations in unit costs among mills, but it did not establish relationships between costs and different levels of service operations. This section deals with the following two questions: (1) How are average unit costs affected by different levels of both milling and packaging operations; and (2) how are unit costs affected by different levels when milling and packaging operations are considered separately.

16/ The results of the statistical regression analyses are shown in table 25.

Combined Effect of Both Operations

Three cost categories were selected for this analysis: Total cost, which includes all expenses; cost for production labor in milling and packaging; and finally all salaries and wages, including the cost of production labor.

Total cost.--The effect of changes in the volume of milling at various levels of packaging operations is indicated in figure 1. The horizontal axis measures the annual volume of rice milled, while the vertical axis shows total unit cost with different scales of milling and packaging operations. Each curve represents a given level of packaging operation. Thus the bottom curve indicates the relationship between volume of milling and costs, when no packaging operation is performed. The next curve above indicates the relationship between volume of milling and cost, when 5 percent of the rice is packaged; and so on. 17/

A study of figure 1 reveals the advantages of large-scale milling and packaging operations up to a certain point, after which a further increase in operation is not likely to bring additional advantage. First, a given increase in milling at small volume will substantially reduce unit cost at all levels of packaging operations. As the volume of milling is increased, the reduction in cost becomes smaller at each successive increase in milling. At the volume of about 1.5 million hundredweight of rough rice milled, further increase in milling will have little effect on unit cost. Second, given the annual volume of rice milled, a given percentage increase in packaging will add considerably to total unit cost of milling, when packaging is only a small factor in mill operation. However, when a larger proportion of rice is packaged, successive increases in packaging will add smaller and smaller amounts to the total unit cost until these additions become relatively constant. This is shown by the reduction in the vertical distance between two successive curves as the proportion of rice packaged is increased, up to about 25 percent. Above this level each successive 5 percent increase in packaging tends to add about the same amount to the total unit cost.

Salaries and wages.--In recognition of the importance of the cost of labor and other salaries in the total cost, two tables were prepared showing the combined effect of both milling and packaging operations on these cost items (tables 15 and 16). The advantage of large-scale operation in both services is demonstrated again. The decline in average cost attributed to increase in milling operations is shown horizontally. At any given volume of milling operations a given increase in packaging will add smaller and smaller amounts to the total unit cost.

17/ Between 700,000 and 800,000 hundredweight of rough rice milled and at 5 percent of packaging operations, figure 1 indicates a total unit cost of about $1.00. This unit cost fairly closely approximates the average total unit cost of 98 cents per 100 pounds of rough rice milled shown in table 10. The average mill in table 10 operated at an annual volume of 744,000 hundredweight of rough rice and sold about 5.8 percent in consumer-size packages.

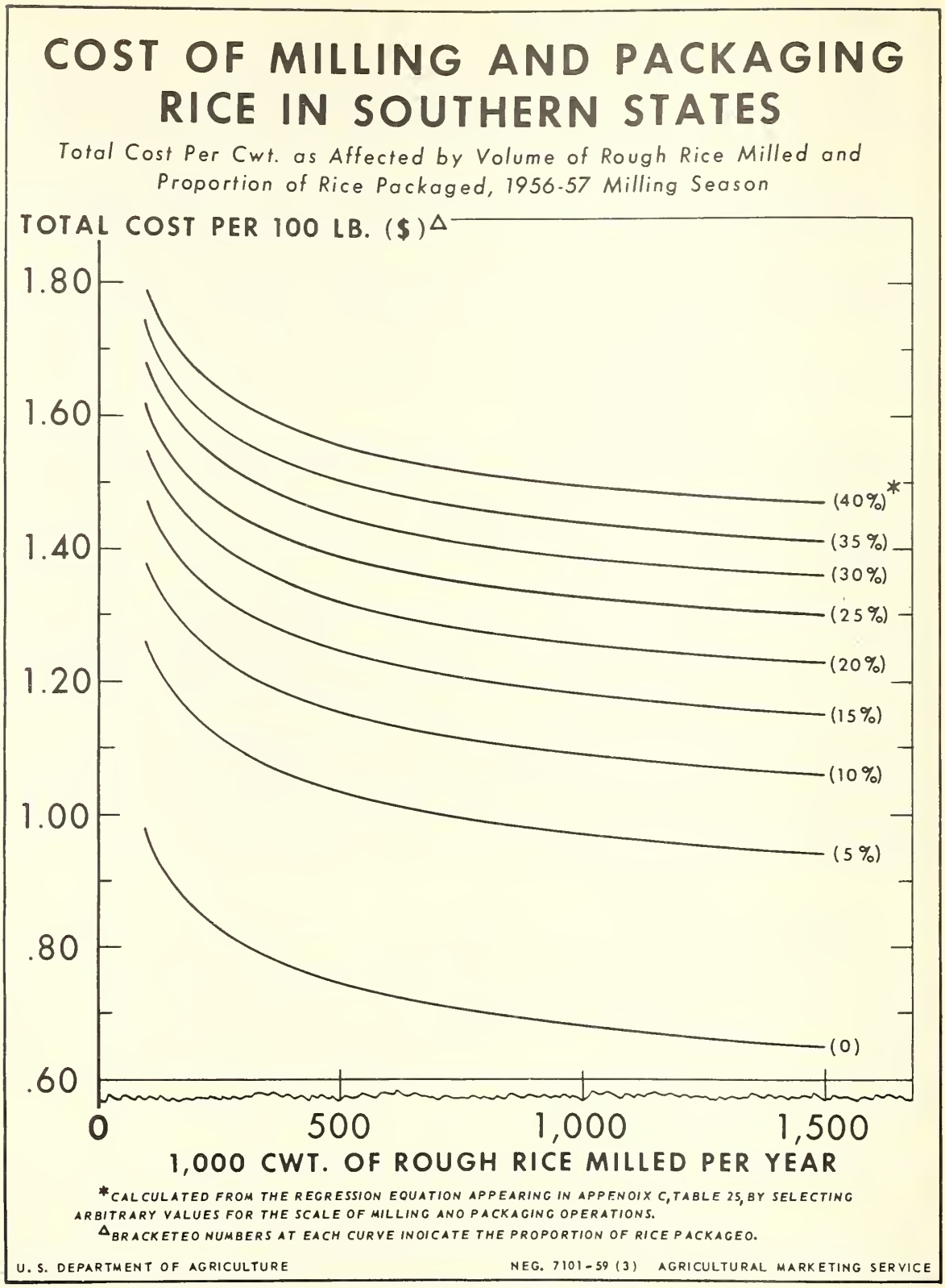
COST OF MILLING AND PACKAGING RICE IN SOUTHERN STATES
Total Cost Per Cwt. as Affected by Volume of Rough Rice Milled and Proportion of Rice Packaged, 1956-57 Milling Season
TOTAL COST PER 100 LB. ($)Δ
1.80
1.60
1.40
1.20
1.00
.80
.60
(40%)*
(35%)
(30%)
(25%)
(20%)
(15%)
(10%)
(5%)
(0)
0
500
1,000
1,500
1,000 CWT. OF ROUGH RICE MILLED PER YEAR
*CALCULATED FROM THE REGRESSION EQUATION APPEARING IN APPENDIX C, TABLE 25, BY SELECTING ARBITRARY VALUES FOR THE SCALE OF MILLING AND PACKAGING OPERATIONS.
ΔBRACKETED NUMBERS AT EACH CURVE INDICATE THE PROPORTION OF RICE PACKAGED.
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Figure 1

Table 15.--Production labor: Average cost per 100 pounds of rough rice milled, by size of mills and proportion of milled rice packed in consumer containers, South, 1956-57 milling season 1/

Percent of milled rice packed in consumer containers	Size of mills (1,000 cwt. of rough rice milled per year)														
	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400	1,500
	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
0	30	25	22	21	20	19	18	18	17	17	17	16	16	16	15
5	33	28	26	24	23	22	22	21	21	20	20	19	19	19	18
10	34	29	27	26	25	24	23	22	22	21	21	21	20	20	20
15	35	30	28	26	25	25	24	24	23	23	22	22	21	21	21
20	36	31	28	27	26	25	25	24	24	24	23	23	22	22	22
25	37	32	30	28	27	26	26	25	24	24	24	23	23	23	23
30	37	32	30	29	28	27	26	26	25	25	24	24	24	23	23
35	38	33	30	29	28	28	27	26	26	26	25	25	24	24	24
40	39	34	31	30	29	28	27	27	26	26	26	25	25	25	24

1/ Calculated from the regression equation in table 26 by selecting arbitrarily the values for the scale of milling and packaging operations.

Table 16.--All salaries, wages and commissions: Average cost per 100 pounds of rough rice milled, by size of mills and proportion of milled rice packed in consumer containers, South, 1956-57 milling season 1/

Percent of milled rice packed in consumer containers	Size of mills (1,000 cwt. of rough rice milled per year)														
	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400	1,500
	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
0	55	44	39	37	35	33	32	31	30	29	28	28	27	27	26
5	62	52	48	44	42	40	39	38	37	36	36	35	35	34	34
10	66	55	51	48	46	44	43	42	41	40	39	39	38	38	37
15	68	58	53	50	48	46	45	44	43	42	41	41	41	40	40
20	70	60	55	52	50	48	47	46	45	44	44	43	43	42	42
25	72	62	57	54	52	50	49	48	47	46	46	45	45	44	44
30	74	64	59	56	54	52	51	50	49	48	47	46	46	46	45
35	75	65	60	57	55	53	52	51	50	49	48	48	47	47	47
40	76	66	61	59	57	55	54	53	52	51	50	50	49	49	48

1/ Calculated from the regression equations in table 26, by selecting arbitrarily the values for the scale of milling and packaging operations.

The average additional cost for operating a packaging plant and selling packed rice is relatively small. The bulk of labor costs are still associated with milling operations and rice handling. However, there is an important difference between the two types of costs shown in the two tables. With a given increase in packaging operation at any given volume of milling, all salaries and commissions tend to increase much faster than the cost for production labor. For example, assume a volume of milling of 800,000 hundredweight of rough rice and packaging at a level of 20 percent (20 percent of 800,000 hundredweight milled equivalent). Production labor costs shown in table 15 are 18 cents for milling alone, and 24 cents for milling and packaging. When these figures are deducted from those given in table 16 for the same volume of milling and the same percentage of packaging, salaries and commissions alone are 13 cents for milling and 22 cents for milling and packaging. In the first case, the cost for production labor due to packaging operations increased 6 cents per 100 pounds of milled rice, or about 33 percent. Salaries and commissions on the other hand increased 9 cents, or about 70 percent. Thus with increased packaging operations the cost of administrative and sales personnel increases substantially faster than the cost for production labor.

Effect of Each Operation

The cost figures previously discussed were broad averages reflecting the combined effect of milling and packaging. These averages gave only little indication of how much of the changes in these costs were attributed to milling alone, and no indication of how much of the changes were attributed only to packaging. Markets for rice in 100-pound bags are quite different and considerably lower in price than markets for consumer-packaged goods, of the same quantity. Knowledge of the unit cost of a given amount of rice in 100-pound bags and that of the same amount in consumer packages at different levels of operation would be particularly useful in aiding managerial decisions. Such decisions may relate either to changes in volume of milling or changes in sales of packaged goods including the discontinuance of such sales and new entry into this market.

Unit cost behavior therefore will be analyzed as a result of the scale of a single service operation. There are two sources from which the net cost quantity relationships can be established separately for the two services. One source is the framework from which the relationships previously discussed were derived, while the second source is the cost data provided by those mills which restricted their operations to milling only or were providing separate cost data for packaging operations.

Milling.--Among the 23 mills reporting complete cost data only 14 restricted their operation to milling. In view of the finding that drying operations affected little or not at all the unit costs of different mills, the 14 mills were selected regardless of whether or not they dried a portion of their rice. Actually, only 6 of the 14 mills performed drying operations and only 1 mill dried as much as 40 percent of its annual milling. Among the rest none dried more than 25 percent of their rice.

A summary table (table 17) indicates the averages for each cost item for the 14 mills. On the average, the total unit cost of milling and marketing 100 pounds of rough rice was 73 cents. About 10 plants had a total cost ranging between 65 and 81 cents.

Table 17.--Milling and marketing: Average cost per 100 pounds of rough rice milled, in 14 mills with no packaging operations, South, 1956-57 milling season 1/

Cost item	Average cost per hundredweight: Weighted average 2/	Simple average	Range of costs found in 68 percent of the mills	Coefficient of variation	Percent of total cost
	Cents	Cents	Cents	Percent	Percent
Taxes and insurance	4.9	4.6	3.0- 6.8	38.7	6.7
Depreciation	4.7	4.7	2.9- 6.5	38.3	6.5
Wages and salaries to production workers	18.2	19.7	14.3-22.1	21.4	24.9
All other salaries	14.4	15.2	11.9-16.9	17.4	19.7
Utilities, repairs 3/	6.4	7.5	5.0- 7.8	21.9	8.8
Packaging material	12.8	13.5	9.7-15.9	24.2	17.5
Selling, general, and administrative	11.6	10.8	7.2-16.0	37.9	15.9
Total	73.0	75.0	65.1-80.9	10.8	100.0

1/ Based on cost records of 14 mills. The average volume of rough rice milled was 537,000 cwt.
2/ Weighted by volume of rough rice milled by each mill.
3/ Includes maintenance, supplies, and fumigation.

In the fixed-cost group relatively high variations, about 38 percent, were found for taxes and insurance and for depreciation. The two costs amounted to about 5 cents each per 100 pounds.

Among the operating expenses salaries and wages to production workers tended to be the most important single item of total cost, representing about one-fourth of all costs, or 18 cents per 100 pounds. Other salaries and commissions were the next most important item, amounting to about 14 cents per 100 pounds. All salaries and wages combined represented about 45 percent of all costs. Both these items showed considerably smaller variations than other cost items. Operating expenses, utilities, and repairs were about 6 cents per 100 pounds.

Among other costs, packing materials (jute, cotton bags, and twine) amounted to 13 cents. Selling, general, and administrative expenses, excluding salaries, were about 12 cents per 100 pounds of rough rice milled, representing

about 16 percent of the total costs. Presumably because of differences in management and sales organizations they showed a relatively high variability.

Because these selected mills render an identical service--that of rice milling--the volume of rice milled obviously must be the main determinant of most cost items.

The results of the statistical analysis of the volume of milling and its effect on specified cost groups are summarized in figure 2. This chart shows the effect of scale of milling on the major cost items included in the total unit cost of milling. Each line in this chart represents the cumulative additions of cost items shown between two lines and the average relationship between the accumulated costs and the annual volume of milling. 18/ Beginning at the bottom of figure 2, line X_2 indicates the average relationship between the cost of labor and the annual volume of milling. The next line above, X_3, indicates the relationship between all salaries and wages including commissions and the volume of milling operation. Line X_4 shows the relationship between the total of three cost items (all salaries and wages, and operating expenses) and the volume of milling. Thus each line in this chart represents the relationship between the accumulated costs at that level and the volume of milling operation. Line X_7 shows the relationship between total unit cost and the volume of milling.

For individual items cost behavior can also be approximated. The vertical distance between two lines at any level of operation indicates the average cost for that item. Table 18 summarizes this information in presenting the average changes in individual cost items as the scale of milling operations is changed.

The change in total cost associated with changes in the volume of milling is similar to that observed previously. No appreciable reduction in the unit cost will be expected when milling operations are increased beyond 1,500,000 hundredweight of rough rice.

Figure 2 also indicates the degree by which the selected cost groups are associated with the scale of milling operations. Only 58 percent of variations in production labor cost (X_2) could be explained by the annual volume of milling. However, when other salaries and commissions were added to wages paid to production workers (X_3), annual volume of milling explained 66 percent of all salaries and wages among the 14 mills. This increase in the degree of relationship suggests that in some cost records the distinction between these two cost items may not have been clear. 19/ The degree of relationship was still further

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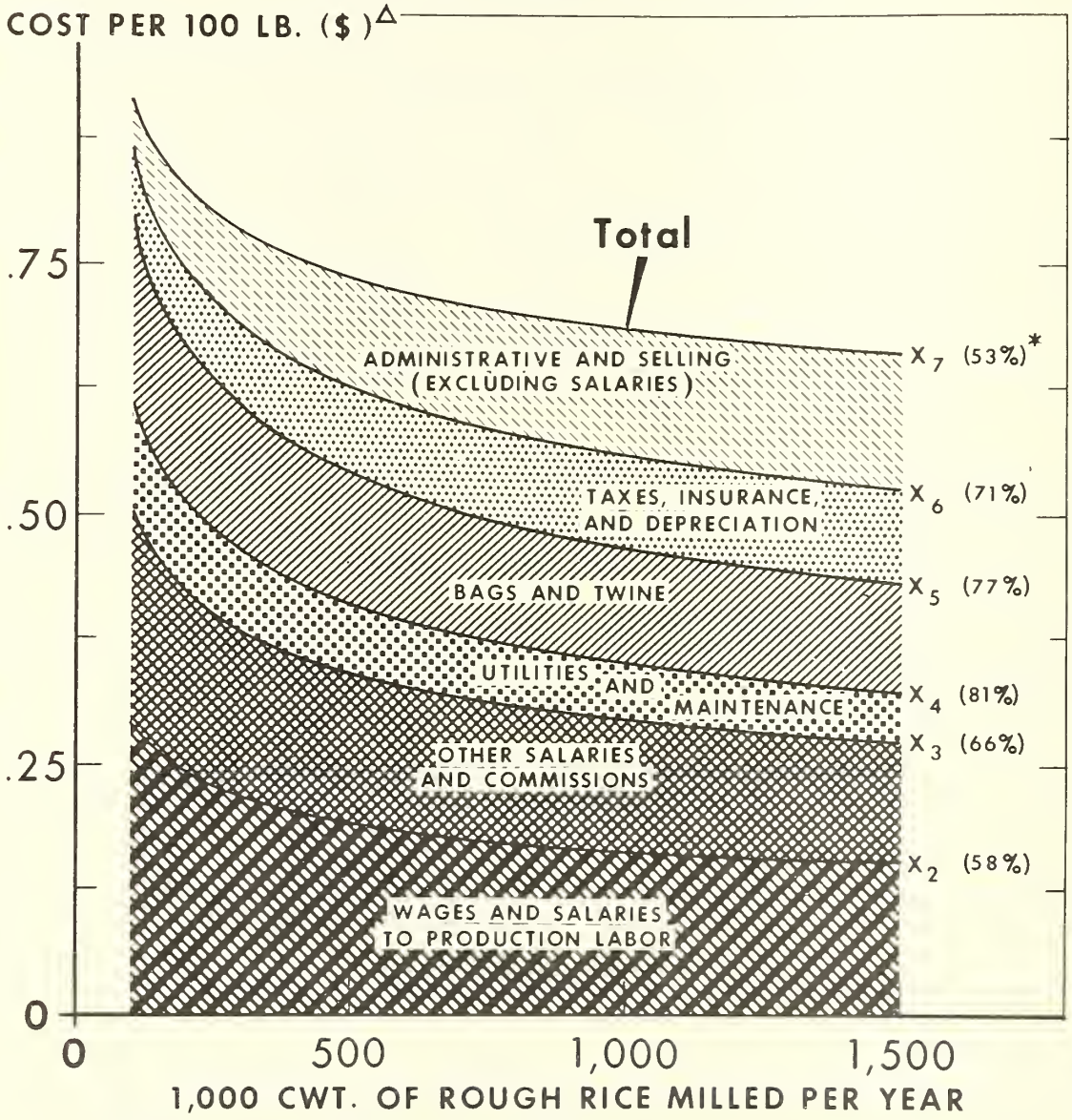
18/ The method of accumulated cost analysis was selected rather than analyzing individual cost items separately. In some cases it was difficult to identify certain cost elements. For example, the distinction between wages paid to production workers and all other salaries was not always clear. Combining these two cost items may have indicated a closer comparability of costs among the 14 mills than the individual items indicated.

19/ The low association between production labor cost and volume of milling might be also due to the omission of certain factors responsible for variations in this cost among mills. For example, local wage rates and strength of the union movement may all be important determinants of labor cost.

COST OF MILLING RICE IN SOUTHERN STATES

Specified Costs Per Cwt. as Influenced by Volume of Rough Rice Milled, 1956-57 Milling Season



ΔBASED ON TABLE 18. X_2 THROUGH X_7 DENOTE THE AVERAGE RELATIONSHIPS BETWEEN THE SCALE OF MILLING AND THE ACCUMULATED COSTS.

*NUMBERS IN BRACKETS INDICATE THE PERCENTAGE OF VARIATION IN SPECIFIED COSTS WHICH COULD BE EXPLAINED BY THE SCALE OF MILLING OPERATION.

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Figure 2

Table 18.--Average cost of milling and marketing rice per 100 pounds of rough rice milled in plants performing milling operations only, by size of mills, South, 1956-57 milling season 1/

Size of mills (rough rice milled per year)	Wages and salaries to production labor	All other salaries	Utilities, repairs, and maintenance	Bags	Taxes, insurance, and depreciation	Administrative and selling expenses	Total
	Cents	Cents	Cents	Cents	Cents	Cents	Cents
100,000 cwt.	28.8	21.3	10.8	18.6	6.5	5.2	91.2
200,000 cwt.	24.0	18.0	8.8	15.8	7.6	8.2	82.4
300,000 cwt.	21.7	16.5	7.9	14.5	8.1	9.5	78.2
400,000 cwt.	20.3	15.5	7.2	13.7	8.3	10.6	75.6
500,000 cwt.	19.2	14.9	6.8	13.1	8.6	11.0	73.6
600,000 cwt.	18.5	14.3	6.5	12.6	8.8	11.5	72.2
700,000 cwt.	17.8	13.9	6.2	12.3	8.9	12.0	71.1
800,000 cwt.	17.3	13.5	6.0	12.0	9.0	12.3	70.1
900,000 cwt.	16.9	13.2	5.8	11.8	9.2	12.4	69.3
1,000,000 cwt.	16.5	13.0	5.7	11.5	9.2	12.7	68.6
1,100,000 cwt.	16.2	12.7	5.5	11.4	9.2	13.0	68.0
1,200,000 cwt.	15.9	12.6	5.4	11.2	9.3	13.1	67.5
1,300,000 cwt.	15.6	12.4	5.2	11.0	9.4	13.3	66.9
1,400,000 cwt.	15.3	12.3	5.1	10.9	9.5	13.4	66.5
1,500,000 cwt.	15.1	12.1	5.1	10.8	9.5	13.5	66.1

1/ Average costs calculated from the regression equations in table 27, by selecting arbitrarily the scale for milling operations. Individual cost items here represent the difference between successively accumulated cost groups.

increased when operating costs, utilities, supplies, maintenance, and repairs were added to all salaries and wages (X_4). Volume of milling in this cost group explained 81 percent of all variations in costs among the 14 mills. As more and more cost items were added to this total (X_4) the volume of milling became less important as a cost determinant. At the cumulative cost level (X_5), with the inclusion of the cost of packaging material (bags and twine) the effect of volume on this cost group is still strong. However, the addition of fixed cost (line X_6) to X_5, and particularly the additional inclusion of administrative and selling expenses (X_7), reduced the degree of association to only 53 percent.

Table 18 demonstrates that the last two cost items tend to behave in an opposite manner than other cost items as the scale of milling operation increases. There is no clear indication why fixed costs, which include depreciation, taxes, and insurance, should increase with larger scale of milling operations. That the administrative costs will rise with increasing scale of operation is quite possible; a larger sales and administrative organization is needed for marketing larger volumes. In larger mills, however, the lower operating expenses due to large-scale operation more than compensate for the larger administrative and sales costs, as shown by the reduction in overall unit costs as the scale of milling operation is increased.

An attempt was made to determine additional factors which would have a bearing on the cost of milling and marketing rice. Neither utilized plant capacity nor drying operations showed appreciable effects on costs. On the assumption that selling costs are minimized in mills that process a substantial proportion of their rice for the Commodity Credit Corporation, a measure for this variable was also introduced in the equations. Total costs were not affected by the new variable.

Packaging.--About one-half of the plants in the sample of 33 mills sold a portion of their rice in consumer packages which ranged from 12 ounces to 5 pounds in different types of containers. Among the 16 mills rendering packaging services, only 8 were able to provide cost data on this operation. Other plants did not keep separate packaging cost records, and in most of these plants packaging operations were not an important segment of the entire mill operation.

All the reported costs referred to actual operating expenses and excluded the administrative and selling expenses due to sales in packaged form. The packaging plants upon which the average operating cost records for packaging were based packaged a total of 2 million hundredweight of milled rice in packages of 5 pounds or less. This represented about 70 percent of the packaged rice in the sample or well over one-half of all packaged rice sold in the United States. The average mill in this category handled an annual volume of 960,000 hundredweight of milled rice, of which nearly 30 percent was processed and sold in consumer packages.

On the average the total of the listed operating costs amounted to $1.47 per 100 pounds of milled rice packaged, with a considerable range of variation (table 19). The most important item in this total was the cost of packaging material, amounting to about 68 percent. Salaries and wages for labor engaged

in packaging operations represented 20 percent of all operating costs. The group of costs labeled "operating expenses" represented about 9 percent of the total. This is the residual left after deducting the cost of labor, depreciation, and packaging material from the total. It includes utilities, repairs, maintenance, fumigation, taxes, and insurance. Some mills reported these items as "other," and there was no way of breaking this cost group down into individual elements. Depreciation amounted to nearly 3 percent.

Table 19.--Packaging rice in consumer containers: Average cost per 100 pounds of milled rice packaged, 8 mills in the South, 1956-57 milling season 1/

Cost item	Average cost per hundredweight: Simple average	Weighted average 2/	Range of costs found in 68 percent of the mills	Coefficient of variation	Percent of total cost
	Cents	Cents	Cents	Percent	Percent
Wages and salaries to production workers	31.0	26.4	18.1- 34.7	31.4	19.8
Operating expenses 3/	14.6	12.4	10.5- 14.3	15.3	9.3
Depreciation	6.6	3.4	.3- 6.5	91.1	2.6
Packaging material	94.5	90.8	65.7-115.9	27.6	68.3
Total	146.7	133.0	99.5-166.5	25.2	100.0

1/ Nearly 30 percent of all rice milled by the 8 mills was placed in consumer containers ranging from 12 ounces to 5 pounds.
2/ Weighted by volume of rough rice milled at each mill.
3/ Utilities, repairs, maintenance, payroll taxes, and pest control.

An attempt was made to determine relationships between the volume of packaging and variations in individual groups of costs. As before, the degree of association between the cumulative cost groups and volume of operation was examined. 20/ However, the relationships were not significant. Only 30 percent of the variations in labor cost was explained by variations in volume of packaging. The addition of "operating expenses," defined previously, raised the degree of association only one more percentage point. The inclusion of depreciation in the previously accumulated total cost raised the relationship to 42 percent. However, the addition of the cost of packaging material to the previously accumulated total (total operating cost) reduced the association nearly to zero.

20/ The results of the statistical regression analyses are shown in table 28.

The mere fact, that variations in packaging costs could not be explained satisfactorily by variations in the scale of packaging operations alone, suggests the presence of other important cost determinants. Labor costs, for example, might vary from one locality to another. Labor costs and other operating expenses combined may be influenced by the type of packaging equipment used and by the capacity of the packaging plant utilized. Some plants may use more expensive packaging materials than other plants. Due to lack of information on these elements, no attempt was made to investigate statistically their effects on cost of packaging.

The cost of packaging discussed thus far represents only a segment of the total cost of packaging and selling rice in packaged form, because administrative and selling expenses associated with sales of packaged goods have not been considered. It would be an easy task to estimate these expenses, if they were identical for sales in both 100-pound bags and consumer packages. Records of the 23 mills reveal that these expenses, including salaries and commissions, on a unit basis, are higher in mills which sell some of their rice in consumer packages (tables 10 and 17).

In the previous cost analyses certain relationships were established from which operating and total unit costs for packaged rice could be estimated. On the basis of different proportions of milled rice packaged these estimates are shown in table 20. 21/

Several important observations result from an analysis of table 20. First, the cost estimates indicate a wide range of variations with different proportions of rice packaged. Second, the operating expenses shown in table 20, at the 30 percent packaging level, closely correspond to the average operating costs shown for the eight plants in table 19. Third, administrative and selling costs decline much faster than operating expenses with an increase in the scale of packaging.

Because of the great influence of the scale on packaging costs, it is necessary to determine these scales for current industry operations in order to appraise the actual cost conditions under which the industry packages rice and sells it in packaged form.

Approximately 80 percent of all packaged rice in 5-pound or smaller containers sold in the United States was covered by this survey. The remaining 20 percent was about equally divided between the remaining mills not covered in the survey and those distributors which package rice on their own account.

In this survey more than half of all packaged rice coming to the market in packages of 5 pounds or less originated in mills which sold over 55 percent

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21/ The preceding analysis has shown that it is the proportion rather than the absolute volume of rice packed which is the dominant factor influencing costs. Table 20 therefore should be applicable to almost all mills, operating at different annual volumes of milling. The estimates exclude profits.

Table 20.--Packaging and selling rice in consumer containers: Average cost per 100 pounds of rice packaged, by percentage of milled rice packaged, South, 1956-57 milling season 1/

Percent of rice packaged	Operating expenses 2/	All other (administrative and selling expenses) 3/	Total cost 4/
Percent	Dollars	Dollars	Dollars
5	2.17	6.23	8.40
10	1.81	4.09	5.90
15	1.65	3.15	4.80
20	1.56	2.64	4.20
25	1.49	2.27	3.76
30	1.45	1.95	3.40
35	1.41	1.76	3.17
40	1.38	1.57	2.95
45	1.36	1.42	2.78
50	1.34	1.30	2.64
55	1.32	1.20	2.52
60	1.30	1.11	2.41
65	1.29	1.03	2.32
70	1.28	.95	2.23
75	1.27	.89	2.16
80	1.26	.83	2.09
85	1.25	.78	2.03
90	1.24	.73	1.97
95	1.23	.68	1.91
100	1.22	.65	1.87

1/ Calculated from the appropriate net regression coefficients in appendix C, by assuming specific proportions of rice packaged. For packaging material 95 cents per 100 pounds packaged was assumed.

2/ Includes labor, utilities, repairs, maintenance, and the cost of packaging material.

3/ Includes depreciation, taxes, insurance, and outside storage.

4/ F.o.b. mill, excludes profit, the cost of milling, and the cost of rough rice.

of their rice in consumer packages. This group has an average total cost of $2.52 or less for 100 pounds of rice packaged (table 20). Most of the remaining packaged rice originated in mills which sold less than 40 percent of their rice in consumer packages, with a total unit cost in excess of $2.95. Relatively little rice came from mills which packaged less than 10 percent of their rice in consumer packages and practically no rice originated in mills which packaged more than 80 percent of their product. It would appear therefore that on the basis of proportion of rice packaged, the total unit cost of packaged rice (excluding the cost of milling and the original cost of rough rice)

might be anywhere from $2.00 to about $6.00 per 100 pounds. This range, representing the cost of all types of packaged rice, is so wide that an exact analysis of packaging cost is not possible. Further, a comparison of these cost estimates with the industry markup for an ordinary quality of packaged rice becomes even more difficult. 22/

The scale of packaging operations, however, is not the only factor influencing costs. Actually, the markup varies from mill to mill, depending on the particular brand and quality of rice in addition to the size and type of container in which the product is sold. This study did not consider these factors, and consequently the resulting cost estimates, are broad averages.

Even though the cost estimates in table 20 refer to all brands of rice and to all types of consumer packages, there is a tendency to operate at lower cost as the packaging operation becomes larger. This, however, does not mean that a mill operating at a smaller scale of packaging cannot find its packaging operation profitable.

First, for high-quality rice commanding a higher-than-average retail price, the miller can usually obtain a higher markup than for an ordinary brand. Second, a mill selling low-quality rice and operating its packaging department at small scale can frequently avoid high costs through an efficient packaging operation and sales organization. Third, millers may spread the higher costs associated with small-scale packaging operations equally over the entire volume of rice marketed, including that sold in 100-pound bags. In such cases sales of rice in consumer packages are subsidized through sales of 100-pound bags. Needless to say, while this may enable the miller to compete with large-scale packers the method of spreading costs equally over the entire sales will cut considerably into his profit margin, unless the packaging or milling operation is highly efficient. The packaging operation of each mill must be evaluated individually to determine its competitive position. This analysis of the industry can only point out the relation between proportion of rice packed and costs. It does not consider similar effects of product differentiation, better-than-average efficiency, or the spreading of costs.

CAPACITY UTILIZED AND ITS IMPACT ON LABOR PRODUCTIVITY

In earlier sections it was pointed out that the annual milling capacities utilized by different mills failed to show any appreciable effect on variations in costs among several mills. The failure to obtain meaningful relationships between costs (operating efficiency) and capacity utilized was mainly attributed to the difficulty of defining a uniform measure of capacity applicable to all

22/ In September 1958 the average markup for 100 pounds of a cheap quality of rice in 1-pound cellophane packages appeared to be about $2.30 above the mill price for rice in 100-pound burlap bags, with a range of about $2.10 to $2.50. The average markup for rice of this quality in all kinds of consumer packages, including the more expensive cartons and the cheaper 3- or 5-pound packages, may have ranged from about $1.90 to $2.90. Industry sources indicate that a markup perhaps twice as high can be obtained for a high-quality product.

mills, when they performed different services. In this section some of the difficulties associated with this definition will be removed.

Milling capacity utilized and its effect on operating efficiency will refer to a single mill in different time periods. This is in contrast to the earlier discussion where milling capacities referred to different mills in a single period. Because operations in a single mill are likely to remain uniform over a season whereas many variations exist between mills, a uniform measure of capacity can be more easily defined for a single plant. Thus the relationship obtained between milling capacities utilized and operating efficiencies for a single mill should be more pronounced than for several mills. For comparative purposes data for all seven mills, providing useful information for this phase of the study, were used to analyze these relationships.

Monthly hours worked in milling operations and monthly volumes of rice milled were available for these mills. Maximum milling capacity was defined as the peak performance in any given month, and the volume milled in other months was expressed as a percentage of this maximum. Thus a measure of milling capacity utilized in each month for each mill was established. Total monthly hours worked by production labor in milling operations were divided by the monthly volume of rice milled. This gave a measure of milling per man-hour in each month for each mill. The relationships between monthly milling capacity utilized and hourly millings are charted for the seven mills in figure 3.

Several important observations can be made by studying figure 3. First, the associations between monthly capacities utilized and output per hour are significant and fairly high for most mills. Second, as the percentage of milling capacity utilized is increased, output per hour increases also, but at a decreasing rate. This is to be expected since the size of a plant in any given season tends to be fixed. Third, there appear to be great differences in labor productivity among mills. The annual volume of rice milled (size of the plant) does not seem to explain these differences. Some factors which may explain these differences are:

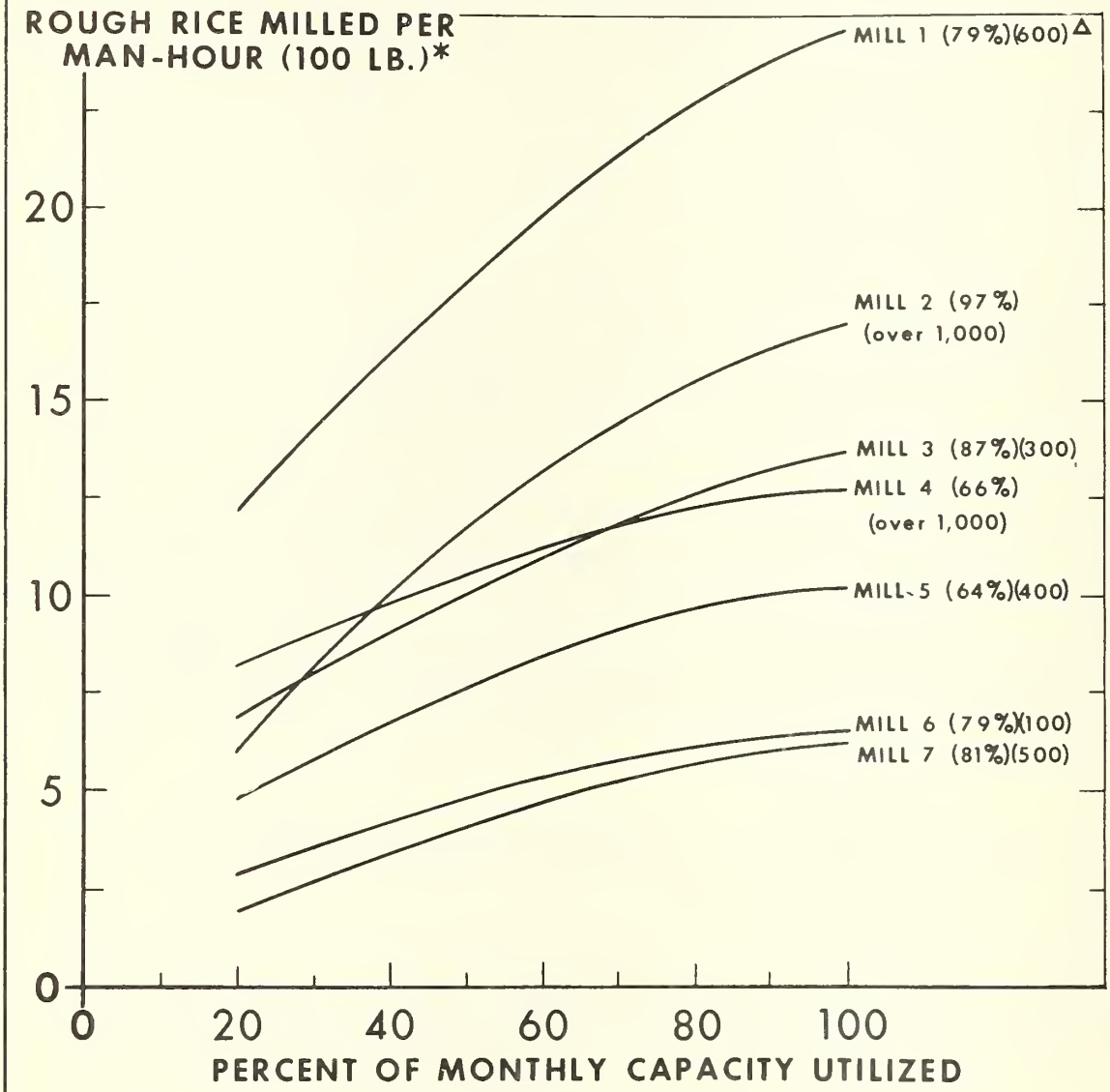
(1) Some mills may add to or reduce the labor force with changes in output, while other mills, due to location, relative strength of labor movement, or management policy, keep a stable labor force regardless of the amount of rice available for milling.

(2) The definitions of milling labor used by these mills may not be identical, despite the identical terminology. Some mills, especially the smaller ones, may require milling workers to perform other functions, not necessarily directly associated with milling operations. In the large mills, however, the worker in most cases has clearly defined tasks.

(3) Differences in labor productivity could also be attributed to differences in equipment used. Some of the newer mills have the latest and most modern labor-saving equipment while others do not.

RICE MILLED PER MAN-HOUR AND MILLING CAPACITY UTILIZED

Monthly Average Relationships in Selected Mills in Southern States, 1956-57 Milling Season



*OUTPUT PER MAN-HOUR FOR INDIVIDUAL MILLS IS CALCULATED FROM THE CORRESPONDING REGRESSION EQUATIONS APPEARING IN APPENDIX C, TABLE 29.

ΔTHE FIRST NUMBER IN BRACKETS IS THE PERCENTAGE OF VARIATIONS IN OUTPUT PER HOUR FOR EACH MILL WHICH COULD BE EXPLAINED BY THE PERCENTAGE OF MILLING CAPACITY UTILIZED. THE SECOND NUMBER IN BRACKETS IS THE ANNUAL VOLUME OF ROUGH RICE MILLED, IN 1,000 CWT. ROUNDED UP TO THE NEAREST 100.

U. S. DEPARTMENT OF AGRICULTURE NEG. 7103-59 (3) AGRICULTURAL MARKETING SERVICE

Figure 3

Reliability of Estimates

It is important in any statistical estimation to discuss the reliability of the results. The confidence one can place in these results depends on how good the estimates are.

In most cost estimates in this report the results of the analysis were presented in two forms. One indicated the broad averages which were derived from the cost data provided by the mills in the sample. These averages alone, of course, are seldom meaningful. However, when they are considered in terms of their variability or range more meaning can be attached to them. These measures have been indicated in most of the tables.

The second form of the cost analysis established relationships between total costs or selected groups of costs and factors which affected their variations among mills. Tables and charts presenting these relationships were calculated from the statistical framework establishing these relationships. How good these estimates are is suggested by the degree of association between the relevant variables. In most of the estimates a large proportion of variations in costs could be explained by factors associated with these variations, and the results indicate that the relationship as well as the variables were highly significant within the framework of statistical probability. These measures of significance are shown in the appendix in the tables summarizing the results of the regression analyses.

In a cost study of this type it is practically impossible to account for all the factors which would explain 100 percent of the variations in costs, and so a certain unexplained variation is expected to remain. In general the unexplained portion of the variations in costs might be attributed to two factors. One is the error inherent in any statistical analysis; the second is the possibility of omitting some of the important factors which in fact had an influence on variations in costs among mills.

With respect to the first, errors may occur when data are collected or when the statistical framework for the analysis is established. In errors due to omissions, some of the neglected variables are measurable while others cannot be measured or are not available. The type of equipment used in milling and packaging operations may cause considerable differences in costs among mills. The various operating and marketing practices which individual mills follow or the condition under which some mills must operate may all affect costs. 23/

23/ It is interesting to note how important certain omitted factors are. Among the 23 plants rendering all types of services, 4 were unionized. With the exclusion of these 4 plants from the statistical regression analysis of operating costs (labor and utilities, repairs, maintenance, etc.) nearly 78 percent of variations in this cost item could be explained by the scale of milling and packaging operations, as against only 72 percent when the cost data of these 4 plants were included.

The fact that about three-fourths of the variations in most cost items could be explained by the selected factors indicates that these are important determinants. Because of the relatively high degree of association between various cost groups and the factors which affected them, and because these factors appeared to be in most cases highly significant in terms of statistical probability, the average relationships established and the estimates derived from these relationships should be viewed with confidence.

APPENDIX B

Sampling Procedures

A directory of 88 mills, representing all known plants in the milling industry in the United States, was secured from Commodity Stabilization Service, U. S. Department of Agriculture.

Excluded from the list of 88 mills were 15 mills of less than 1,000 hundredweight per 24-hour daily milling capacity. Presampling interviews showed that reliable data on milling operations and marketing practices would be difficult to obtain from these small mills. Further, most of these mills did not operate their plant during the season for which data were obtained. These 15 mills, excluded from the list, represent about 20 percent of all mills in the United States, but their combined milling capacity represents only about 2 percent of the entire industry. The remaining 73 mills were stratified with respect to (1) geographical distribution (States) and (2) size according to their daily milling capacities (table 21).

Table 21.--Number of rice mills in the United States, by size of mills and by States, 1956 1/

Size of mills 2/	States				Total
	Arkansas	Louisiana	Texas	California	
	Number	Number	Number	Number	Number
Small	4	8	-	2	14
Medium	8	19	8	4	39
Large	3/3	8	6	3	20
Total	15	35	14	9	73

1/ 15 mills of less than 1,000 cwt. daily milling capacity were excluded.
2/ For sampling purposes, small mills were defined as those with 24-hour milling capacities in the range of 1,000-2,500 cwt.; medium-size mills, 2,600-6,900 cwt.; and large mills, 7,000 cwt. and over.
3/ Includes 1 mill in Tennessee.

For sampling purposes, the industry was divided into small, medium, and large plants, based on the frequency distribution of milling capacities of all the establishments in the defined population. The sample to be interviewed was arrived at by choosing at random 50 percent of the mills in each of the 12 geographic and volume segments. However, the sample included 4 plants whenever the segment was less than 8, or the entire segment if less than 4. The remaining plants in each volume category were used as alternatives. If an alternative of the same size was not available, a plant with the closest comparable capacity and geographical location was selected. This sampling

method covered about 75 percent of all rice milled during 1956-57 and about 72 percent of all the rice mills. Table 22 gives the breakdown on the interviews and response of the mills.

The few observations available on California rice mills indicated that the milling industry in California operated under somewhat different economic conditions than in the South. The small response by California mills did not warrant an interregional comparison of rice mill operations between the South and California. Data on California mills therefore were excluded from this study.

Table 22.--Rice mills desired for sample, visited, and cooperating by States, January and February 1958

State	Mills desired for sample	Mills visited	Mills cooperating
	Number	Number	Number
Arkansas	11	15	11
Louisiana	17	23	14
Texas	8	12	8
Total South	36	50	33
California	9	9	3
Total United States.	45	59	36

Statistics on Regression Analyses

The selection of factors affecting unit costs of different mills conformed with the traditional concept of theory on costs. Charts prepared on the basis of raw data indicated the usual curvilinear relationship: At small scale, with a given change in the scale of operation a sharp change in cost was observed, while at large scale, the change in cost for the same amount of change in scale appeared to be relatively small.

Curvilinear relationships may be measured through various methods. In this study the method of regression analysis was used. This method required the transformation of the original independent variables into a different form in order to indicate a linear regression on cost. The limitations of this approach are recognized. Not only is there a wide range of form for each independent variable, which would show a linear regression, but the relationships established on the basis of the transformed variables may not necessarily measure the true nature of this relationship. Despite the limitations of this approach the relationships established can be useful. The main objective of this study was to estimate costs at different scales of milling and packaging operations. If the derived relationships are used for this purpose only, the limitations of this approach are considerably reduced. 24/

In view of the relatively small number of rice mills, tables summarizing the original data are not shown in this report. However, a summary of the results of the regression analyses is presented in tables 23 to 29.

24/ Under certain circumstances the average unit cost at different volumes of operation could also be estimated from a simpler model by establishing relationships between total cost, volume, and other related variables, without modifying these variables. Unit cost then at each volume of operation could be obtained by dividing the estimated total cost by the corresponding volume of operation. This approach would have had more limitations than the approach adopted in this study. Not only was the relationship between total cost and volume found to be curvilinear (a linear relationship would have permitted the use of a simpler model), but the measure of statistical significance of the factors affecting unit costs would have been less meaningful. So long as any costs are variable there will always be some relationship between total cost and volume, even if the relationship between unit cost and volume is zero.

Table 23.--Coefficients for the statistical regression analysis of direct operating costs (X_1): Labor, utilities, repairs, maintenance, and supplies, 23 rice mills in the South, 1956-57 milling season 1/

Constant term	Independent variables and regression coefficients				Adjusted or simple correlation coefficients $\bar{R}$ or r
	$\frac{1}{\log X_4}$	$\sqrt{X_5}$	$\frac{1}{X_6}$	$\sqrt{X_7}$	
-1.7815	84.1846	--	--	--	0.6992
-13.3917	106.9963	1.8819	--	--	.8465
	(7.32)**	(4.43)**			
-13.4156	106.9567	1.8799	2.3006	--	.8376
		(4.00)**	(.11)		
-12.3309	104.9892	1.8043	--	-.0626	.8233
	(6.72)**	(3.96)**		(.26)	

1/ X_4 is the volume of milling in 1,000 cwt., X_5 is the proportion of rice packed in consumer-size containers, X_6 represents the percent of capacity utilized from the milling plant, while X_7 refers to the proportion of rice dried in the mill.

In this and in the following tables the number in brackets indicates t ratios calculated for the multiple regression equations only. In these equations, 2 asterisks indicate that the regression coefficient is significant at 1 percent level and 1 asterisk indicates that the regression coefficient is significant only at 5 percent level. No asterisk indicates that the regression coefficient is not significant at 5 percent level of probability.

Table 24.--Coefficients for the statistical regression analysis of general administrative and selling costs, including all salaries and commissions (X_2), 23 rice mills in the South, 1956-57 milling season 1/

Constant term	Independent variables and regression coefficients		Multiple adjusted or simple correlation coefficients $\bar{R}$ or r
	$\frac{1}{\log X_4}$	$\sqrt{X_5}$	
-14.7577	185.7835	--	0.5416
40.8968	--	8.4003	.8440
-81.5994	314.5733	11.4134	.6991
	(1.79)*	(7.09)**	

1/ X_4 is volume of milling in 1,000 cwt., and X_5 is the proportion of rice packed in consumer-size containers.

Table 25.--Coefficients for the statistical regression analysis of total costs (X_3), 23 rice mills in the South, 1956-57 milling season 1/

Constant term	Independent variables and regression coefficients		Multiple adjusted or simple correlation coefficients $\bar{R}$ or r
	$\frac{1}{\log X_4}$	$\sqrt{X_5}$	
85.7764	28.7424	--	0.0599
78.1914	--	11.1774	.8041
10.1756	174.5217	12.8833	.8608
	(3.16)**	(8.04)**	

1/ X_4 is the volume of milling in 1,000 cwt. and X_5 is the proportion of rice packed in consumer-size containers.

Table 26.--Coefficients for the statistical regression analyses of production labor costs (X_8) and all salaries, wages and commissions (X_9), 26 rice mills in the South, 1956-57 milling season 1/

Dependent variables	Constant term	Independent variables and regression coefficients		Multiple adjusted correlation coefficients $\bar{R}$
		$\frac{1}{\log X_4}$	$\sqrt{X_5}$	
X_8	-8.6045	76.0677 (4.93)	1.4425 (3.21)**	0.7279
X_9	-22.5833	153.9692 (5.15)**	3.5013 (4.03)**	.7607

1/ X_4 is the volume of milling in 1,000 cwt., and X_5 is the proportion of rice packed in consumer-size containers.

Table 27.--Coefficients for the statistical regression analysis of specified costs (X_2.....X_7) for 14 rice mills performing milling operations only, South, 1956-57 milling season 1/

Dependent variables	Constant term	Independent variable and regression coefficients $\frac{1}{\log X_1}$	Simple correlation coefficients r
X_2	-8.1836	74.0254	0.7596
X_3	-11.7297	123.6202	.7831
X_4	-16.6420	155.2230	.8657
X_5	-18.9118	196.7774	.8440
X_6	- 4.4252	180.8958	.8130
X_7	23.3736	135.7135	.6997

1/ X_1 is the volume of rough rice milled in 1,000 cwt.
X_2 is cost for production labor.
$X_3 = X_2$ + other salaries and commissions.
$X_4 = X_3$ + operating expenses, utilities, supplies, and maintenance.
$X_5 = X_4$ + bags and twine.
$X_6 = X_5$ + depreciation, taxes, and insurance.
$X_7 = X_6$ + administrative, general, and selling expense, excluding salaries and commissions.

Table 28.--Coefficients for the statistical regression analyses of specified packaging costs (X_2.....X_5), 8 rice mills in the South, 1956-57 milling season 1/

Dependent variables	Constant term	Independent variable and regression coefficients $\frac{1}{\log X_1}$	Simple correlation coefficients r
X_2.....	13.0125	36.8408	0.5479
X_3.....	23.3133	42.9862	.5579
X_4.....	12.2505	78.3417	.6489
X_5.....	139.3920	12.2870	.0478

1/ X_1 is the volume of rice packed in consumer-size containers.
X_2 is cost for production labor
X_3 = X_2 + operating expenses, utilities, repairs, maintenance, and fumigation, and payroll taxes
X_4 = X_3 + depreciation
X_5 = X_4 + all types of packaging material

Table 29.--Coefficients for the statistical regression analysis of monthly output per man-hour, 7 rice mills in the South, 1956-57 milling season 1/

Mill number	Dependent variable	Constant term	Independent variable and regression coefficients $\sqrt{X_8}$	Simple correlation coefficient r
1.....	X_1	2.2832	2.2395	0.8887
2.....	X_2	-1.8235	1.9244	.9869
3.....	X_3	4.4275	.8594	.8108
4.....	X_4	1.1461	1.2769	.9321
5.....	X_5	.4168	1.0111	.8025
6.....	X_6	-1.4471	.8008	.9205
7.....	X_7	.0981	.6748	.8891

1/ X_1 through X_7 represent monthly milling of rough rice per man-hour (cwt.) for the seven mills. X_8 represents the corresponding monthly milling capacities utilized for each mill, setting in each case the highest monthly volume milled equal to 100 percent.

APPENDIX D

Some Theoretical Aspects of Net Cost Estimates

Assume that in the United States rice milling industry the individual plants provide only two services, but at different scale: Milling and packaging. All mills perform milling operations, but not all perform packaging. For mills rendering packaging services the volume may range from zero to any amount of the rice milled. Assume further that aside from the scale of milling and packaging operations all mills in the industry operate under the same conditions, such as plant capacity utilized, technology, and the competitive factor and product market. At the end of the production period rice will be sold in bulk or in 100-pound bags by mills not performing packaging operations, while mills rendering packaging services will sell rice in consumer packages as well as in bulk or in 100-pound bags. 24/

Total costs for the individual mills may arise from milling operations only or from a combination of milling and packaging. Differences in the total cost among mills will be due to differences in scale of providing these two services.

With a large number of mills providing information on aggregate cost, volume of milling, and volume of packaging, the relationship between the aggregate cost of individual mills and various services rendered can be shown in figure 4. The horizontal axis represents the scale of milling operations while the vertical axis indicates the scale of packaging expressed as a percentage of all milled rice handled.

If all mills, with identical aggregate costs, are placed in a single total category, a series of schedules will be obtained, each showing different combinations of milling and packaging at the same aggregate cost. $TC_1 \ldots TC_n$ are cost isoquants, each indicating the line of equal costs. Thus for example the isoquant TC_3 indicates that total cost, including processing and selling expenses, will be identical for mills operating at the following alternative scales: (a) 1.2 million hundredweight of rough rice milled but no packaging operations, (b) 800,000 hundredweight of rough rice milled and about 5 percent of the rice packaged and (c) 600,000 hundredweight of rough rice milled and about 10 percent packaged. There will be of course an infinite number of these cost isoquants.

Because the vertical axis is expressed in a different unit (percent) than the horizontal axis (volume), the shapes of the isoquants are likely to be different at different levels of operations. The isoquants will become parallel to the vertical axis as the scale of packaging increases. However, the

24/ In reality these assumptions are seldom met completely. However, on the basis of the available information on the rice milling industry of the South, these assumptions do not appear to be too restrictive.

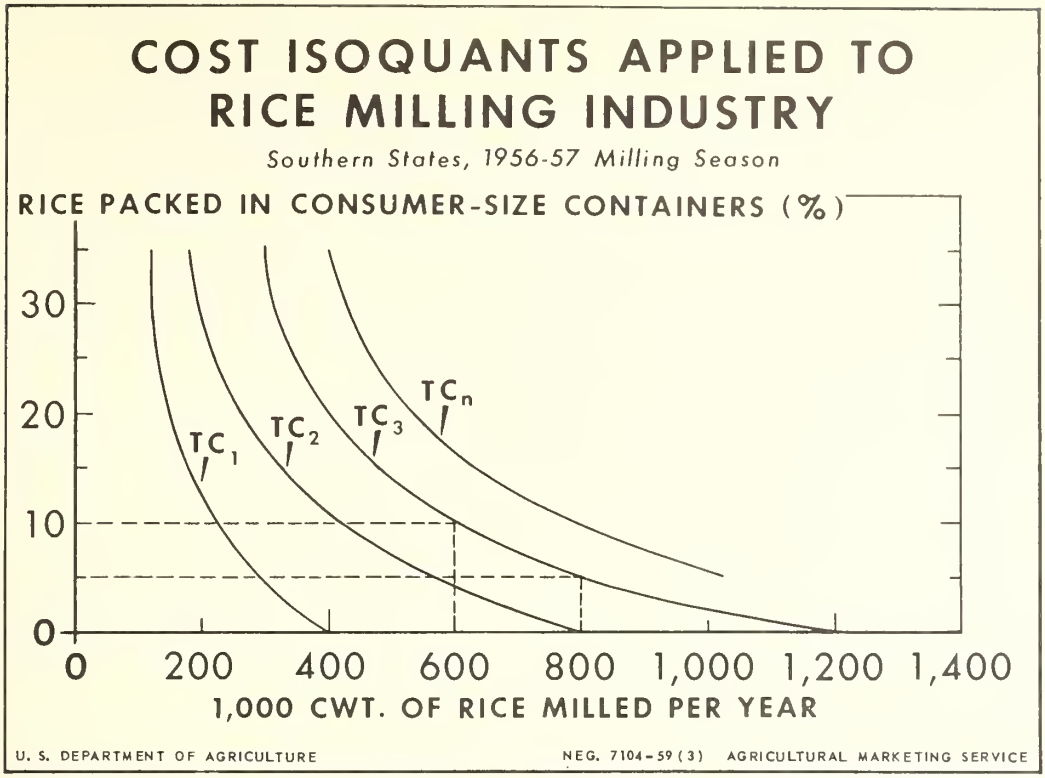


Figure 4

isoquants will gradually approach the horizontal axis and will end at a point on the axis, because all mills perform milling operations and no packaging services could be rendered in these mills without milling operations. Thus at the level of zero milling there will be no expenses due to packaging operations. However, at the level of zero packaging, milling operations can be performed at various scales. 25/ Indirectly figure 4 suggests that there are 4 types of aggregate costs present in various forms in this model:

1. At the level of zero packaging, changes in aggregate costs at various levels of milling operations are indicated by the tangents of the isoquant curves with the horizontal axis. These costs are net costs associated with milling services only.

2. At a given level of packaging operation, changes in aggregate costs are indicated by the higher and higher isoquants as the scale of milling

25/ With certain modifications the model outlined above may have some relation to the theoretical concept of joint costs and revenues. Such a modified model could indicate the theoretical optimum combination of output or sales at each level of total cost. Further discussion of this subject falls outside the scope of the present study. For a more detailed discussion of joint costs and revenues the reader is referred to Sun Carlson, A Study on the Pure Theory of Production, New York, 1956.

operation increases. These costs show the combined effect of milling and packaging operations.

3. At a given level of milling, changes in aggregate costs associated with various levels of packaging operations are indicated in the vertical direction. These costs again show the combined effect of both service operations.

4. Net aggregate costs of packaging at different scales are indicated in the vertical direction when the aggregate costs associated with milling operations alone are deducted from the aggregate costs associated with both service operations at different level of packaging.

Ordinarily, quantification of the isoquants in figure 4 would be necessary to provide a framework to estimate the net relationship between costs and individual service operations.

For empirical measurements, however, it would be difficult to use this model directly. Not only would it be difficult to express mathematically the various forms of isoquants just discussed, but the little information available on costs would not be sufficient to warrant mathematical derivation of these isoquants.

From the limited data available from the survey, an indirect approach was adopted to calculate aggregate costs at different scales of milling and packaging. As indicated before, the simple three-variable regression equation for the analysis of total unit cost was taken of the type

$$X_1 = b_o + b_1 \frac{1}{\log X_2} + b_2 \sqrt{X_3}$$

where X_1 referred to the total cost per unit of rough rice milled, including processing and selling expenses, X_2 was the annual volume of rough rice milled, and X_3 was the proportion of milled rice packed in consumer containers. From this relationship a table was prepared, showing the calculated average cost per unit milled at different assumed levels of both service operations. The obtained average costs then were multiplied by the assumed annual volume of rough rice milled in order to obtain aggregate cost, at each level of milling and packaging operations. These aggregate costs are shown in table 30 which roughly approximates in quantified form the model discussed in figure 4. On the basis of equal aggregate costs a few isocost curves are also drawn.

Referring to table 30 the net cost-quantity schedule per unit for milling operation alone can be obtained for different scales at zero packaging (where the isoquants become tangent to the horizontal axis) by dividing the aggregate costs by the respective volume of rough rice milled. Other unit cost schedules at different levels of milling and packaging can be calculated in the same manner.

Table 30.--Aggregate cost of milling and packaging, by quantity of rough rice milled per year and proportion packaged in consumer containers, South, 1956-57 milling season 1/

Aggregate cost, 1,000 dollars

Percent packaged in consumer containers	(200)		(400)		(600)	(800)	(1,000)								
40	179	335	486	635	780	932	1,072	1,214	1,360	1,497	1,639	1,772	1,920	2,058	2,205
35	174	324	472	615	756	894	1,034	1,176	1,317	1,449	1,586	1,714	1,848	1,990	2,111
30	168	315	453	604	724	865	995	1,126	1,261	1,387	1,518	1,648	1,785	1,903	2,039
25	162	299	435	569	693	824	952	1,082	1,205	1,332	1,450	1,573	1,704	1,816	1,946
20	165	288	414	541	659	787	903	1,027	1,143	1,263	1,374	1,490	1,615	1,719	1,842
15	147	272	393	508	624	737	845	960	1,068	1,180	1,290	1,408	1,507	1,623	1,728
10	138	254	362	472	580	683	782	889	1,022	1,090	1,192	1,300	1,390	1,488	1,594
5	126	230	327	425	521	613	700	789	882	973	1,055	1,151	1,238	1,314	1,408
0	98	172	242	309	376	439	502	558	621	683	736	803	861	927	973
	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400	1,500

Rough rice milled per year, 1,000 cwt.

1/ Average costs calculated from the regression equations in table 25 and converted to aggregate cost at specified levels of milling and packaging. The lines drawn in this table approximate the position of cost isoquants, the lines of equal cost at alternative levels of services rendered, for 200, 400, 600, 800, 1,000 thousand dollars of aggregate costs, denoted by numbers in parentheses.

The net total cost of packaging at each level is obtained by deducting from the aggregate cost at each level of packaging, the aggregate costs associated with milling operations alone (at the level of zero packaging). The resulting net aggregate cost for packaging then is divided by the actual volume of rice packaged and sold. In order to obtain the actual volume of rice packed in consumer packages, a single level of milling is selected and is converted to milled rice equivalent on the basis of an assumed total yield of 69 percent. When the milled rice equivalent of the annual rough rice milled is obtained, the percentage figure indicated on the vertical scale is used to obtain the actual volume of rice packaged at various scales.

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